ABSTRACTS

Plenary Speech 1 (Room H)

January 25 (Tuesday), 17:00-17:50

Chair: Fumitoshi Matsuno (Kyoto University, Japan)

Biomorphic Robot Controls: Event Driven Model Free Deep SNNs for Complex Visuomotor Tasks

Rüdiger Dillmann

KIT/FZI Karlsruhe, Germany

The long term goal of this research within the framework of the European Human Brain Project (HBP) is to understand, to model and to translate biomorphic neural principles towards biocybernetic robot control systems. In comparison to conventional computing the brain is superior in terms of energy efficiency, robustness and adaptivity. Thus, we investigate into modeling biologic processes enabling the brain to perform sensomotoric computation and finally to implement it in silicon in form of biomorphic hardware. Todays neuromorphic hardware consists of spiking neural networks (SNNs) which can perform fast and efficient computations with continuous input - output streams based on synaptic plasticity. We focus on brain like senso-motor control tasks and ground them with the help of real robots. Spiking neural networks have the potential on replicating real neurons representing parts of their biological characteristics. SNNs are capable to perform synaptic spike-based communication with local brain functionalities supporting learning with the help of neural plasticity mechanisms. We assume, that the brain is forming sensor-motor primitives within building blocks composed for object detection, localization, event prediction, and finally the generation and execution of motion and interaction. The combination of neural motion primitives represent complex muscle motor synergies with the potential to learn complex large scale motions. Our SNN control architecture is capable to perform tasks like object recognition, object tracking, target reaching and grasping as well as collision- and obstacle avoidance. Closing the visuomotor loop by mapping the learned visual representation to motor commands show that SNNs learn without any planning algorithms nor inverse kinematics. SNNs are event driven and model free. We introduce deep continuous local learning mechanisms achieving state of the art robot accuracy on event stream benchmarks. Biologically plausible reward-learning rules based on synaptic sampling show that SNNs are capable of learning policies and various movement characteristics.

Links between reward-modulated synaptic plasticity and online reinforcement learning show proposing results. The hyper-parameters of this neuromodulation and their impact on performance are to be discussed with the help of some closed-loop sensorimotor experiments. The potential of deep reinforcement learning for target reaching affects object interaction, manipulation and grasping tasks and allows its realtime execution within dynamic situations. An event-driven binocular DVS system is used in stereo mode driven by micro saccades. The spiking feedback information from the DVS and from proprioception is mapped towards motion generating SNNs applying reward coupling and prediction error minimization techniques.

Future work towards the effective use of neuromorphic vision with emphasis to eye movement, micro saccades, visual affordance learning and high performance event prediction will be discussed. In addition it can be shown, that the brain-inspired computational paradigm can be extended towards SNN based navigation and mapping (BSLAM) forming episodic spatial neural memories with multi-scale learning capabilities. A software framework for developing and programming the related SNN-clusters and some complex biomorphic robot platforms are outlined.

Biography:

Rüdiger Dillmann received his PhD from University of Karlsruhe in 1980. Since 1987 he has been Professor of the Department of Computer Science and Director of the Humanoids and Intelligence Systems Lab. at KIT. 2002 he became director of the innovation lab. IDS (interactive diagnosis systems) at the Research Center for Information Science (FZI), Karlsruhe. 2009 he founded the Institute of Anthropomatics and Robotics at the Karlsruhe Institute of Technology. His research interest is in the areas of human-robot interaction, neurorobotics with special emphasis on intelligent, autonomous and interactive robot behaviour generated with the help of machine learning methods and programming by demonstration (PbD). Other research interests include machine vision for mobile systems, man-machine cooperation, computer supported intervention in surgery and related simulation techniques. He is author/co-author of more than 1000 scientific publications, conference papers, several books and book contributions. He was Coordinator of the German Collaborative Research Center "Humanoid Robots" and several large scale European IPs. He is Editor in Chief of the book series COSMOS, Springer. Since 2018 he is Professor emeritus. He is now research director at FZI and is consulting start up companies and SMEs of his former PhD students.

He is IEEE- and IROS Fellow.

Plenary Speech 2 (Room H)

January 26 (Wednesday), 11:00-11:50

Chair: Hee-Hyol Lee (Waseda University, Japan)

Balancing Control in Systems

Seul Jung

Intelligent Systems and Emotional Engineering (ISEE) Laboratory
Department of Mechatronics Engineering
Chungnam National University
Daejeon, Korea

Maintaining balance in the nature is the most factor for human beings to keep our lives in peace and happiness. If the balance in nature breaks, human beings will be in danger and disaster. A human body itself is a balanced system. Likewise, balancing the system plays an important role in every dynamical machine and system. The balancing systems can be categorized into two parts: passive and active. The passive balance can be achieved from mechanical design such as center of gravity-based design and parallelogram. The active balance can be challengingly achieved by using various control algorithms. Each system requires an appropriate control algorithm to satisfy the balance from unstable condition. Therefore, the selection of appropriate balancing control algorithm is quite important in the system, which leads to the development of balancing control algorithms. In this talk, research from the inspiration of the balancing mechanism and control is introduced and shared. The balancing control of various systems is introduced in association with the appropriate control algorithms used in artificial intelligence, control and robotics areas.

Biography:

Dr. Seul Jung was born in Incheon, Korea. He received the B.S. degree in Electrical & Computer Engineering from Wayne State University, MI, USA and the M.S & Ph.D. degrees from University of California, Davis, USA, both in Electrical & Computer Engineering.

Dr. Jung has joined the Department of Mechatronics Engineering at the Chungnam National University, Daejeon, Korea from 1997. While at Chungnam National University, he has engaged in research and teaching in the areas of intelligent systems, digital control, and signal processing. He has focused his efforts in robotics and intelligent control systems. He developed a graduate program in intelligent control and established an Intelligent Systems and Emotional Engineering (I.S.E.E) Laboratory for both theoretical and experimental studies. The Lab focuses on validation of theories by experimental studies of Mechatronics systems. He has published over 350 papers on these subjects. He is an author of 15 technical books about robotics, intelligent control, signal processing, and control system in Korean. His robotics research includes robot manipulator control, mobile robots, intelligent Mechatronics systems, and robot education. More recently, he has been engaged in developing control moment gyroscopes (CMGs) for Mechatronics systems. From 2002, he has organized the Creative and Intelligent Robot Contest (CIRO) for college student robotic competition and it continues until now.

Dr. Jung has been an active member in several IEEE Societies. He has served as a program committee member for many conferences. He also has been an executive office member in the Institute of Control, Robotics, and Systems (ICROS) in Korea. His important services include the organizing committee members and Program Chairs of many conferences. Now he serves as a general co-chair of ICCAS 2021.

Plenary Speech 3 (Room H)

January 26 (Wednesday), 15:00-15:50

Chair: Takaya Arita (Nagoya University, Japan)

Exploring online social ecosystems through bio-inspired perspectives

Mizuki Oka

University of Tsukuba, Japan

Understanding how organisms reproduce and adapt to their environment and evolve is a significant issue in natural ecosystems. Similarly, online social systems such as social media are new ecosystems with complex functions. Recently, there has been a lot of attention on how much we can explain the ecosystem of social systems by using analogies of biological ecosystems because of the expectation that natural ecosystems provide a comprehensive theory for understanding social systems. In line with this research approach, I will discuss how the phenomena occurring in the online social ecosystem relate to living organisms' characteristics in this talk. By doing so, we hope to develop a strategy to transform online social systems into a constructive and democratic forum for making suggestions, debating, and communicating new ideas.

Biography:

Mizuki Oka is an Associate Professor at the University of Tsukuba. She is also a head of the Artificial Life Research Group of the Japanese Society for Artificial Intelligence, an associate editor of Artificial Life Journal, a project manager of the IPA Exploratory IT Talent Search and Development Project, and a technical advisor to Blank Space Inc.

She conducts research on data analysis and utilization using machine learning, deep learning, and artificial life technologies. Based on her research at university, she focuses on the social implementation of new technologies and the provision of innovative value by bringing in unprecedented perspectives.

Invited Talk 1 (Room A)

January 25 (Tuesday), 9:00-9:30

OS13 AROB: Control System Security and Encrypted Control

Chair: Kenji Sawada (The University of Electro-Communications, Japan)

Encrypted Control: Secure Implementation of Digital Controllers

Kiminao Kogiso

Associate Professor,
The University of Electro-Communications, Japan

The cybersecurity of networked control systems is a matter of critical importance. Many cyberattacks targeting control systems have been reported, such as the controller parameter falsification attack by the “Stuxnet” computer worm and the false data injection attack suffered by the Ukraine power grid. These incidents have motivated research into the prevention and detection of cyberattacks against networked control systems. In this talk, we present a new concept of encrypted control to enhance the cybersecurity of networked control systems and introduce how to encrypt a linear controller using our modified homomorphic encryption schemes based on public-key encryption systems. A remarkable advantage of the controller encryption is to conceal information processed inside the controller device, such as controller parameters, references (recipes), measurements, control commands, and parameters of plant models in the internal model principle, maintaining an original function of the controller. Even if malicious users hacked the controller device by unauthorized access, it would take much time and cost to decipher and steal the control system’s information. Furthermore, by introducing our recent achievement of a dynamic-key encryption scheme, we discuss the possibility of creating a new academic field to develop control-oriented dynamic-key homomorphic cryptosystems, which it enables to push into practical use.

Biography:

Dr. Kogiso is an Associate Professor in Department of Mechanical Engineering and Intelligent Systems, The University of Electro-Communications, Tokyo, Japan. He received the B.S., M.S., and Ph.D. degrees in Mechanical Engineering from Osaka University, Japan, in 1999, 2001, and 2004, respectively. He was a postdoctoral researcher of the 21st Century COE Program and became an Assistant Professor in Department of Information Systems, Nara Institute of Science and Technology, Nara, Japan, in 2004 and 2005, respectively. In March 2014, he joined the Department of Mechanical Engineering and Intelligent Systems, The University of Electro-Communications. From November 2010 to December 2011, he was a visiting scholar at the Georgia Institute of Technology, GA, USA.

Dr. Kogiso currently serves as an Associate Editor for SICE Journal of Control, Measurement, and System Integration.

Invited Talk 2 (Room A)

January 25 (Tuesday), 9:30-10:00

OS13 AROB: Control System Security and Encrypted Control

Chair: Kenji Sawada (The University of Electro-Communications, Japan)

Safe, Secure, and Stable Motion Control of Telemanipulators

Jun Ueda

Professor, Mechanical Engineering,
Georgia Institute of Technology, USA

Industry 4.0 will transform the conventional automation systems to efficient cyber-physical systems by taking advantage of today's information technology. Rapidly transforming automation system architecture introduces cybersecurity risks that did not exist in the past. While protection of cyber-physical systems at the communication level has been extensively studied, there is a void in the study of protection at the motion control level. Allowing malicious system identification and data breach attacks to a motion controller would result in a) leaking of controller architecture, gains, and models, b) interception of motor commands and monitoring signals, and c) system disruption due to falsification of controller gains. Research is needed to establish control theoretic methods to enhance cyber security for networked motion control systems that are tightly coupled with other control requirements such as stability and safety. This talk with provide an overview of the speaker's recent research activities on safe, secure and stable motion control of networked robotic manipulators. One of the projects encrypts control algorithms, sensor signals, model parameters, and feedback gains, and perform necessary computation of motion commands to servo systems in the ciphertext space without a security hole. Encrypted motion control may be applicable to systems including unilateral remote assembly systems and bilateral teleoperation systems. Another project studies spectral performance measures for a manipulandum-type telemanipulator that physically interacts with a human operator.

Biography:

Dr. Jun Ueda is a Professor in the G.W.W. School of Mechanical Engineering at Georgia Institute of Technology. Dr. Ueda received the B.S., M.S., and Ph.D. degrees from Kyoto University, Kyoto, Japan, in 1994, 1996, and 2002 all in Mechanical Engineering. From 1996 to 2000, he was a Research Engineer at the Advanced Technology Research and Development Center, Mitsubishi Electric Corporation, Japan. He was an Assistant Professor of Nara Institute of Science and Technology, Japan, from 2002 to 2008. During 2005-2008, he was a visiting scholar and lecturer in the Department of Mechanical Engineering, Massachusetts Institute of Technology. He joined the G. W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology as an Assistant Professor in 2008. He served as the Director for the Robotics PhD Program at Georgia Tech for 2015-2017.

Dr. Ueda currently serves as an Associate Editor for the IEEE Transactions on Robotics and the Chair of the Conference Editorial Board for the IEEE International Conference on Advanced Intelligent Mechatronics (AIM). He is the author of Cellular Actuators: Modularity and Variability in Muscle-Inspired Actuation, Butterworth-Heinemann, 2017, and Human Modeling for Bio-Inspired Robotics, Academic Press, 2017. He received the Fanuc FA Robot Foundation Best Paper Award in 2005, IEEE Robotics and Automation Society Early Academic Career Award in 2009, Advanced Robotics Best Paper Award in 2015, and Nagamori Award in 2021.

Invited Talk 3 (Room A)

January 25 (Tuesday), 18:55-19:25

OS35 SWARM: e-ASIA Joint Research Project 2: Informational system for management of flood and landslide disaster areas using a distributed heterogeneous robotic team

Chair: Fumitoshi Matsuno (Kyoto University, Japan)
Co-Chair: Jackrit Suthakorn (Mahidol University, Thailand)

e-ASIA Joint Research Program: Recent progress in development of an international collaborative informational system for emergency situations management of flood and land slide disaster areas

Evgeni Magid

Kazan Federal University, Russia

East Asia is a region that is vulnerable to natural disasters, including floods, land slides and earthquakes. Every year such disasters take human lives and bring significant economic losses. Therefore, it is important to develop technological solutions, which could employ robots and informational systems in order to help predicting natural disasters and negotiating with their consequences.

The project "Informational system for management of flood and land slide disaster areas using a distributed heterogeneous robotic team" is supported by e-ASIA Joint Research Program. Our joint project includes research teams from Russia, Thailand, and Japan, each contributing unique experience and expertise toward achieving common research goals. Based on our experiences of different disasters response, we develop a joint international operation framework for a disaster site management with distributed heterogeneous UAV/UGV/UUV/USV robotic teams. The robot-based information system considers interaction protocols, thematic mapping approaches and map fusion processes. Each team uses different robots to maximize available sensors usage and create a separate thematic map, following joint framework rules. We target to construct and test an informational system that creates a large joint thematic multi-layer map for management of a disaster site.

Japanese team designs control strategies for heterogeneous UAVs/UGVs, graphical user interfaces and Geological Information System that can handle collected data flexibly. Russia team develops a robot simulator in Gazebo and simultaneous localization and mapping technologies. Thailand team develops a new terrestrial mobile robot with rough terrain mobility and manipulation capability and its teleoperation system.

The project provides a new working framework and control strategies for heterogeneous robotic teams' cooperative behavior in sensing, monitoring and mapping of flood and landslide disaster areas. The new control strategies, interfaces, and communications protocols will be extensively tested in simulations and verified in field experiments. The project improves the understanding of mechanisms involved in technologically supported decision-making for the efficient management of emergency situations. The project affects industrial and technological advancements through the development of autonomous robots and their components, and contributes to society needs through creating a new generation of technological tools for international and national emergency centers.

This talk will summarize the goals, the framework, a recent progress and achievements of the project.

Biography:

Professor Evgeni Magid is currently an acting Head of Intelligent Robotics Department, a Professor, a founder, and a Head of Laboratory of Intelligent Robotic Systems (LIRS) at Kazan Federal University, which is one of the top 10 Russian universities and the third oldest university in Russia. Professor, founder and a Head of Intelligent Robotic Systems Laboratory at Innopolis University, Russia. He worked at University of Bristol and Bristol Robotics Laboratory, UK; Robotics Institute at Carnegie Mellon University, USA; University of Tsukuba, Japan and National Institute of Advanced Industrial Science and Technology (AIST), Japan. He earned his Ph.D. degree (2011) from University of Tsukuba, Japan, and Master (2006) and Bachelor (2002) degrees from Technion – Israel Institute of Technology, Israel. Senior member of IEEE, member of ACM and INSTICC. His research interests include urban search and rescue robotics, mobile robotics, path planning, robotic teams, and human-robot interaction. He authors over 200 publications in English, Russian and Japanese languages and 5 patents. As a PI, he conducted over 20 research projects with governmental and industrial external funding, including 3 international projects that engaged foreign research partner teams from top universities of India, Israel, Japan and Thailand.

Invited Talk 4 (Room A)

January 26 (Wednesday), 13:15-13:45

OS14 AROB: Human-Centered Robotics-I

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)

Haptic Information Systems in XR Horizons

Ali Israr

Research Scientist, Facebook Inc., USA

Haptic feedback is a powerful medium for information communication, yet current XR technologies underutilize the capacity and capabilities of the haptic system in everyday applications. In today's consumer industry, simple vibrotactile actuators are commonly incorporated in handheld devices, controllers and wristbands to provide feedback for low information throughput of tactile contacts, impacts, icons, button clicks, and surface texture. Complex and dynamic haptic events, such as object stiffness, shape, and weight during real and virtual object manipulations; spatiotemporal tactile guidance for instructions and user navigation; rich tactile messages for language and interpersonal communication; and haptic feedback for user wellness and well-being, are limited to academic investigations and institutional research. Lack of haptic proliferation in XR landscape is mainly due to the challenges in the size, weight, power, conformability, safety and form factor of the haptic delivery system, while maintaining robust and repeatable performance in the broad dynamic range of haptic perception for high information transfer rates. In this presentation, I will dissect these challenges and review recent developments in actuation technologies and haptic perception studies to realize potential haptic solutions for XR applications.

Biography:

Ali Israr is an engineer and researcher, leading haptics research and development in Facebook Inc., USA. Ali's interests are in the field of haptics and physical sensory feedback, and explores the use of "touch feedback" technologies in entertainment, assistive, educational, social, therapeutic, virtual and everyday settings. Ali has engineered tools and technologies for interactive sensory experiences, developed solutions for seamless flow of sensory information between a user and their devices, and authored technical publications in numerous conferences and journals. Before joining Facebook, Ali led haptic research as in Imagineer in Disney Research, Pittsburgh, USA. Ali received his B.Sc degree from UET, Lahore, Pakistan and MS and PhD degrees in Mechanical Engineering from Purdue University, USA.

Invited Talk 5 (Room A)

January 26 (Wednesday), 16:20-16:50

OS11 AROB: Brain Theory from ALIFE

Chair: Hiroyuki Iizuka (Hokkaido University, Japan)
Co-Chair: Takashi Ikegami (The University of Tokyo, Japan)
Keisuke Suzuki (Hokkaido University, Japan)

Bayesian agents in a physical world

Nathaniel Virgo

Earth-Life Science Institute (ELSI),
Tokyo Institute of Technology, Japan

Agents, whether living organisms or artificially constructed robots, have a dual nature. On the one hand they are physical systems; we believe that their behaviour can, in principle, be explained entirely in terms of physical laws. On the other hand, calling something an agent implies that it has some goal that it is trying to fulfil, or that it has some beliefs about the world that it might update in light of new information. These two views seem to live in different mathematical worlds: the physical world is one of coupled dynamical systems, while the intentional world is one of goals, beliefs and actions.

These two views must presumably be compatible, since a human-built robot is a physical system and can also be interpreted as an agent that achieves some degree of success at a given task. However, in order to produce a theory of the brain and other living systems it will be crucial to develop a mathematical understanding of how these two distinct but mutually compatible worlds relate to one another. I will present some progress toward a detailed mathematical understanding of their relationship.

In particular, we explore what it means for a physical system to be interpreted as reasoning in a Bayesian way, using a prior to represent its uncertainty and updating it to a posterior using Bayes' theorem. We propose a mathematical definition of such an interpretation. One interesting consequence is that while such interpretations often exist they are essentially never unique, suggesting that the relationship between the physical world and the cognitive world might be much more subtle than a simple one-to-one mapping. I will also touch on the meaning of goal-directedness and the possible implications of the work for machine learning and robotics.

Biography:

Nathaniel Virgo is an Associate Professor at the Earth Life Science Institute (ELSI) in Tokyo. He has had a long term interest in understanding the living world through mathematics and computer simulation, including research on ecology, cognitive science, nonequilibrium thermodynamics and the origin of life, as well as contributions to the field of Artificial Life more broadly. As part of this long-term research theme, his current interests are in using the tools of information theory, category theory and artificial life to understand the nature of agency. He holds a doctorate in Informatics from the University of Sussex in the UK, as well as a masters in mathematical ecology. He is a also a fellow of the European Centre for Living Technology (ECLT) in Venice.

Invited Talk 6 (Room B)

January 26 (Wednesday), 18:00-18:30

OS15 AROB: Human-Centered Robotics-II

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Yasar Ayaz (National University of Sciences and Technology (NUST), Pakistan)

Novel devices for microsurgery and challenging medical operations

Leonardo De Mattos

Italian Institute of Technology, Italy

Robotics has large potential to enhance the overall capacity and efficiency of healthcare systems. Robots can help surgeons perform better quality operations, leading to reductions in the hospitalization time of patients and in the impact of surgery on their post-operative quality of life. In particular, robotics can have a significant impact on precision medical treatments, such as microsurgeries. These operations present stringent requirements for super-human precision and control of the surgical tools, which makes them prime application areas for robotics. However, the gap between ultra-performing new technologies and their real use in clinical practice is often very difficult to be overcome. The reasons are varied – from regulatory to economical – but they all contribute to a challenging and very long time-to-market. On the other hand, relatively simple technologies can have a much faster way into the market and yet largely improve clinical performance. In this talk, I will present translational research being conduct at IIT to address major issues in precision medical treatments using robotics technologies. This includes innovations in mechatronics, perception and surgeon-robot interfaces aimed at introducing novel computer and robot-assisted technologies into demanding surgical specialties such as laryngology and pediatrics. Specifically, two main applications will be discussed: Transoral laser microsurgery and peripheral intravenous catheterizations.

Biography:

Leonardo De Mattos is a Permanent Researcher and Head of the Biomedical Robotics Laboratory at the Italian Institute of Technology (IIT, Genoa). His research background ranges from robotic microsurgery and assistive human-machine interfaces to computer vision and micro-biomanipulation. Leonardo received the B.Sc. degree from the University of São Paulo (USP, São Carlos, Brazil) in 1998, the M.Sc. degree in 2003, and the Ph.D. degree in 2007, both in Electrical Engineering from the North Carolina State University (NCSU, Raleigh, USA). Leonardo worked as research assistant at the Center for Robotics and Intelligent Machines (CRIM, NCSU) from 2002 until 2007. Since then he has been a researcher at IIT's Department of Advanced Robotics. Dr. De Mattos collaborates closely with other institutions, including hospitals and industry. Leonardo was the PI and coordinator of the European project μRALP – Micro-Technologies and Systems for Robot-Assisted Laser Phonomicrosurgery, and of the TEEP-SLA project (dedicated to the creation of new communication interfaces and assistive systems for ALS patients). He is currently the PI and coordinator of the translational project Robotic Microsurgery and of two other industrial projects in the areas of robotic surgery and smart medical devices. Leonardo has graduated 16 PhD students and is currently supervising 5 PhD candidates. He is the author or co-author of more than 170 peer-reviewed publications, and has been the chair and main organizer of several international scientific events, including the 4th and the 9th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery (CRAS 2014 and CRAS 2019), the IEEE BioRob 2014 Workshop on Robotic Microsurgery and Image-Guided Surgical Interventions, and the IEEE BioRob 2012 Workshop on Robot-Assisted Laryngeal Microsurgery. He is current serving as Editor for Applied Sciences, Associate Editor for IEEE Robotics and Automation Letters, IEEE ICAR 2021, and IEEE IROS 2021, and Guest Editor for Frontiers in Robotics and AI.

Invited Talk 7 (Room C)

January 26 (Wednesday), 19:15-19:45

OS38 SWARM: Snake Robots

Chair: Tetsushi Kamegawa (Okayama University, Japan)
Co-Chair: Motoyasu Tanaka (The University of Electro-Communications, Japan)

Robust undulatory swimming generation in lampreys, eels and Robots.

Kamilo Melo

KM-RoBoTa Sarl, Renens, Switzerland
and EPFL, Biorobotics Laboratory, Lausanne, Switzerland

Undulatory swimming is a prevalent locomotor mode for a variety of animals that live in aquatic environments. Both vertebrate as well as invertebrate species rely on this particular motion pattern and control their muscles through an interplay between central and peripheral mechanisms. Corresponding studies have helped to unravel distinct building blocks of this neural control system that includes distributed central pattern generators and mechanisms for intersegmental coordination. However, given that undulatory animals perceive their hydrodynamic environment by means of specific sense organs that provide information about fluid flow and pressure, it remains unclear how these exteroceptive sensor modalities influence or possibly even help to generate undulatory swimming. In this talk, I will show with the use of a robot and additional simulated fluid-body interactions that simple local synchronization of body actuation with hydrodynamic forces can lead to robust self-organized undulatory swimming. In this work, we demonstrate that these conceptual synchronization mechanisms have both the ability to provide motion coordination between body segments in the absence of internal neural coupling, and to spontaneously generate oscillations in the absence of explicit central pattern generators. In particular, experiments with the robot and in simulation, show that undulatory swimming can in principle be generated by either purely central or purely peripheral mechanisms, and that the combination of both is remarkably more robust against lesions in control circuits than any of these mechanisms alone. Our findings foster new hypotheses on how animals potentially use local feedback to master swimming, clarify the benefits of combining central and peripheral control mechanisms, and provide new perspectives for the design and control of swimming robots based on self-organizing principles.

Biography:

Kamilo Melo designs, builds and maintains advanced bio-robotic systems for scientific research and industry. In parallel to his work as director of KM-RoBoTa, he currently is scientific advisor of the Biorobotics Laboratory of EPFL in Lausanne, Switzerland. The focus of his work is the creation of animal-like robots and automated machines informed by real animals and other biological organisms, to be used in different fields. These include academic research, industrial inspection and intervention, disaster response, art and entertainment. He has carried out important research in bio-robotics that has been featured in the cover of prestigious scientific journals including: Science Robotics (08.2021), Nature (01.2019), and the JRSInterface (07.2016). Among his robots (https://km-robota.com) there is a crocodile robot broadcasted in the BBC's documentary "Spy in the Wild" in 2017, and several art pieces commissioned by artists like Pamela Rosenkranz (2019) and Nina Canell (2021). Kamilo has a Bachelor in Electrical Engineering, a Masters in Mechanical Engineering, a PhD in Robotics, and several years of postdoctoral training with Profs. Raja Chatila (Paris Sorbonne, France), Antonio Bicchi (University of Pisa, Italy) and Auke Ijspeert (EPFL, Switzerland). With KM-RoBoTa, he currently leads research in the USA, Singapore and Colombia, and performs tech-transfer from research to products and services in robotics across Europe, Asia and Latin America markets.

Invited Talk 8 (Room B)

January 27 (Thursday), 9:15-9:45

OS32 SWARM: Collective Intelligence in Living/Non-Living agents

Chair: Takashi Ikegami (The University of Tokyo, Japan)

Variation among ant colonies in collective behavior

Deborah M. Gordon

Stanford University, USA

Collective behavior operates without central control, using local interactions among participants to allow groups to respond to changing conditions. Ant colonies function collectively, and the enormous diversity of more than 14,000 species of ants, in different habitats, provides opportunities to look for general ecological patterns. For example, harvester ants (Pogonomyrmex barbatus) live in the desert, where water is limited but conditions are stable. Foraging activity is regulated to manage the tradeoff between water loss when foraging and obtaining food, using brief olfactory encounters between returning and outgoing foragers. Colonies differ in how they regulate foraging in dry conditions. These differences among colonies are important for colony reproductive success, in offspring colonies. Thus natural selection can act on interactions to shape collective behavior.

Biography:

Deborah M Gordon received her PhD from Duke University, then did postdoctoral research in the Harvard Society of Fellows, at Oxford University, and the Centre for Population Biology at the University of London, and joined the faculty at Stanford in 1991. She is the author of two books, Ants at Work (Norton 2000) and Ant Encounters: Interaction Networks and Colony Behavior (Primers in Complex Systems, Princeton University Press, 2010), and awards include a Guggenheim Fellowship, fellowships at the Center for Advanced Study in Behavioral Sciences, and the Quest award of the Animal Behavior Society.
http://www.stanford.edu/~dmgordon/.

Invited Talk 9 (Room C)

January 27 (Thursday), 10:00-10:30

OS3 AROB: AI in Life Sciences 1

Organizer: Kazushi Ikeda and Junichiro Yoshimoto
(Nara Institute of Science and Technology, Japan)
Chair: Toshitaka Yamakawa (Kumamoto University, Japan)

Learning from Intelligence of Insects ~ Odor Source Orientation Robot Based on Insect Sensory and Neural System ~

Ryohei KANZAKI

Director and Professor
Research Center for Advanced Science and Technology,
The University of Tokyo, Japan

To elucidate the dynamic information processing in a sensor and a brain underlying adaptive behavior obtained through evolution (i.e., biological intelligence), it is necessary to understand the behavior and corresponding neural activities. This requires animals which have clear relationships between behavior and corresponding neural activities. Insects are precisely such animals and one of the cadaptive behaviors of insects is high-accuracy odor source orientation, which is not yet available in conventional approaches. Insects are valuable model systems in neuroscience due to the balance between the moderate complexity of their nervous systems and a rich behavioral repertoire. Insect brains contain on the order of 105 to 106 neurons. The concept of individually identifiable neurons and small networks composing functional units have been vital for understanding insect brains. Insects are also uniquely suited for multidisciplinary studies in brain research involving a combined approach at various levels, from molecules over single neurons to neural networks, behavior, modeling, and robotics.

To examine the neural basis of the odor-source orientation behavior, we have employed a strategy that tackles the question at multiple levels, from genes, single cells of the neural system to the actual behavior. We implemented a model of the neural circuit reconstructed from single neurons, and integrated it with a mobile robot and a drone. We have developed an insect-robot hybrid system, which moves depending on the behavioral or the neural output of a brain, as a novel experimental system. The robot is controlled by the behavior of an insect tethered on the robot or by the neural activity of the insect brain. This system has contributed to better understanding of the behavioral and neural basis of adaptive behavior. We also have developed highly sensitive olfactory sensors based on olfactory receptor proteins of insects using a genetic engineering.

At first in this lecture, strategy of odor navigation of a male silkmoth and its neural basis revealed by using multidisciplinary approaches will be shown. Second, the extent of adaptation in the behavioral strategy, as governed by the neural system and investigated via a robotic implementation, will be introduced.

Our multidisciplinary research will enable us to use the full potential of the features of insect sensors and brains as model systems for understanding the dynamical sensory and neural substrates of adaptive behaviors (i.e., biological intelligence). As well as being of biological interest, this topic is also of interest for engineering including robotics and AI, because they also need to execute tasks in changing environmental conditions. The bottom up and top down interdisciplinary studies are key and fundamental approaches to understand the biological intelligence acquired through evolution.

Biography:

Ryohei Kanzaki is currently a director and professor of Research Center for Advanced Science and Technology (RCAST), The University of Tokyo. He is interested in biological intelligence (BA) developed through evolution and in reconstructing BA using multidisciplinary approaches. He is a Program Officer of JST PRESTO "Bio-Multisensory Systems" from April 2021.

Ryohei Kanzaki received his B.S., M.S. and D.Sc. degree in Neurobiology from University of Tsukuba in 1980, 1983 and 1986, respectively. From 1987 to 1990 he was a postdoctoral research fellow at the Arizona Research Laboratories, Division of Neurobiology, University of Arizona. From 1991 to 2003 he was successively an assistant professor, associate professor, and full professor at the Institute of Biological Sciences, University of Tsukuba. From 2004 to 2006 he was a professor at Graduate School of Information Science and Technology, the University of Tokyo. Since 2006 he is a professor at RCAST. Since 2016 he has been a director of RCAST. He was a president of the Japanese Society for Comparative Physiology and Biochemistry (JSCPB) from 2012 to 2015. He received an honorary degree from the University of Milano-Bicocca in computer sciences in 2019 and was awarded the Wakayama Prefecture Cultural Prize in 2020. He is also contributing to art and science education project of children by JST project as a chair.

Invited Talk 10 (Room B)

January 27 (Thursday), 13:00-13:30

OS40 SWARM: Swarm and Bio-inspired Systems 2

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Hokkaido University, Japan)
Chair: Yasumasa Tamura (Hokkaido University, Japan)

DNA nanotechnology for soft micromachines and molecular robots

Masahiro Takinoue

Department of Computer Science,
Tokyo Institute of Technology, Japan

A living cell is a soft microrobots constructed with biological information molecules. Inspired by the living cells, the bottom-up construction of cell-like molecular robots and artificial cells has been actively challenged. Our group has been studying nano to micrometer sized molecular robots based on DNA nanotechnology and micro electro mechanical systems (MEMS) technology. In this presentation, we would report two topics:
(i) DNA-based molecular robots: Recently, the development of DNA-based molecular machines and robots has attracted much attention due to their promising applications in medical, agricultural, and environmental technologies. DNA nanodevices and nanomachines have been constructed based on DNA sequence design, which enables us to program functions and to control the devices and machines according to the program. Here, we will report a DNA droplet produced through liquid-liquid phase separation of a DNA nanostructure (named DNA Y-motif) solution [1,2]. In this study, we found that the fusion of the liquid-like DNA droplets could be controlled based on the sticky-end sequence and that the autonomous fission of DNA droplet could be achieved with enzymatic reaction. These results show that the condensed soft matter phase of DNA nanostructure can be used as a molecular robot body that has the integration ability of functional molecules such as proteins.
(ii) autonomous collective motion of microparticles: In nature, collective behaviors of living systems are often observed such as ant colony, flocks of birds and fish, self-organization of cellular slime molds, and group locomotion of human beings. The collective behavior is an emergent phenomenon produced from many elements with only a few simple functions. Since it is generally difficult to implement very complex function into nano to micrometer-sized robots, the concept of collective behaviors is important for the construction of molecular robots. Here, we will report an autonomous collective motion of microparticles. The microparticles were placed under a stationary asymmetric sawtooth-like electric field in an oil phase with a surfactant. Even though the electric field was not changed, the microparticles exhibited autonomous unidirectional collective motion through particle-particle interaction when the microparticles were crowded condition. This phenomenon is considered to be caused by a novel principle, which we named an auto-flashing ratchet model, and to be achieved due to a nonequilibrium electron transfer through the surfactant micelles. This principle will be applied to transport various microparticles and micromachines in the future.

1. Sato, Y., et al., Science Advances, Vol. 6, no. 23, eaba3471 (2020).
2. Kurokawa, C., et al., Proc. Natl. Acad. Sci. USA, 114(28), 7228 (2017).
3. Hayakawa, M., et al., Advanced Intelligent Systems, 2, 2000031 (2020) (cover picture).

Biography:

Masahiro Takinoue is a biophysicist studying artificial cell engineering and DNA molecular robotics. He received a B.Sc. in Physics in 2002, M.Sc. in Physics in 2004, and Ph.D. in Physics in 2007 from The University of Tokyo, Japan. After serving as a postdoctoral fellow of Research Fellowship for Young Scientists of Japan Society for the Promotion of Science (JSPS) at the University of Tokyo (2007-2008), a postdoctoral fellow at Department of Physics and Astronomy, Kyoto University, Japan (2008-2009), an assistant professor at Institute of Industrial Science, The University of Tokyo, Japan (2009-2011), he has been an associate professor at Tokyo Institute of Technology, Japan (2011-). He joined École Normale Supérieure, Paris, France as an invited Professor (2018). He won several awards such as Outstanding Researcher Award on Chemistry and Micro-Nano Systems from the Society for Chemistry and Micro-Nano System, Japan (2021) and The Young Scientists' Prize from MEXT, Japan (2017).

Invited Talk 11 (Room B)

January 27 (Thursday), 15:00-15:30

OS41 SWARM: Swarm and Bio-inspired Systems 3

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Hokkaido University, Japan)
Chair: Toshiyuki Yasuda (University of Toyama, Japan)

Penguin-mimetic robotic wing mechanism

Hiroto Tanaka

Tokyo Institute of Technology, Japan

Penguins are wing-propelled diving birds who are capable of high-speed foraging, agile maneuver, and deep diving by the flapping wings. Considering their compact size as well as the swimming ability, penguins are promising models for mobile biomimetic underwater robots. The biomechanics and hydrodynamics studies of penguin swimming, however, are sparse to date, remaining the details of the propulsion mechanism unclear. Here, our research group conducted the first 3-D motion analysis of flapping-wing swimming of penguins at an aquarium. Based on the results, an electric 3-DoF penguin-mimetic wing mechanism was designed and created. ‘Flapping’ produces hydrodynamic force, while ‘feathering’ adjusts angle of attack and force magnitude. ‘Pitching’ of the flapping axis largely changes the direction of the force. The performance of the wing mechanism was evaluated by a water tunnel experiments. The above biomimetic robot can contribute to both robotics and biological studies in swimming penguins.

Biography:

Hiroto Tanaka received the BSc degree in mechanical engineering at The University of Tokyo, Tokyo, Japan, in 2003, MSc degree in information science and technology at The University of Tokyo, Tokyo, Japan in 2005, and the PhD degree in information science and technology at The University of Tokyo, Tokyo, Japan in 2008. He was a JSPS research fellow in Isao Shimoyama lab at The University of Tokyo from 2006, to 2009, a postdoctoral fellow in Robert Wood lab at Harvard University from 2009 to 2011, and an Assistant Professor in Hao Liu lab at Chiba University from 2011 to 2015. Currently, he is an Associate Professor of Department of Mechanical Engineering at Tokyo Institute of Technology, Tokyo, Japan. His current research interests include biomechanics, biomimeitcs, and soft robotics of flying and swimming animals. He is leading one of the teams of JSPS (Japan Society for the Promotion of Science) KAKEHI Grant-in-Aid for Scientific Research on Innovative Areas “Science of Soft Robots” since 2018.

January 25 (Tuesday), 09:00-11:25

Room A

OS13 AROB: Control System Security and Encrypted Control

Chair: Kenji Sawada (The University of Electro-Communications, Japan)

Invited Talk 1 Encrypted Control: Secure Implementation of Digital Controllers

Kiminao Kogiso (The University of Electro-Communications, Japan)

See page 15

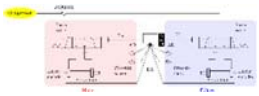
Invited Talk 2 Safe, Secure, and Stable Motion Control of Telemanipulators

Jun Ueda (Mechanical Engineering, Georgia Institute of Technology, USA)

See page 16

OS13-1 Implementation of Encrypted Control of Pneumatic Bilateral Control System Using Wave Variables

Naoto Shono[1], Tetsuro Miyazaki[1], Kaoru Teranishi[2,3], Takahiro Kanno[4], Toshihiro Kawase[5,6], Kiminao Kogiso[2], and Kenji Kawashima[1]
([1]Department of Information Physics and Computing, The University of Tokyo, Japan)
([2]Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications, Japan)
([3]Research Fellow of Japan Society for the Promotion of Science, Japan)
([4]RIVERFIELD Inc., Japan)
([5]Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental University, Japan)
([6]Institute of Innovative Research, Tokyo Institute of Technology, Japan)



This study implemented an encrypted controller to an experimental system for force feedback type bilateral control system and confirmed that the control performance was almost the same as the normal control system. The experimental system consists of a master device and a follower robot driven by pneumatic cylinders. The calculation of the control voltage of the servo valve and the calculation of the wave variables were divided into matrix and vector products, and we applied an encrypted controller to each. As the experimental result, we confirmed that the controller gains and signals of the control system were secret. We also confirmed that the position synchronization performance and reaction force feedback performance of the master and follower cylinders are almost the same as those of the normal control system, indicating that the encrypted control can be applied to the pneumatic driving system's force feedback type bilateral control.

OS13-2 Effects Analysis and Detection of False Data Injection Attacks in ADMM-Based Distributed State Estimation of Power Networks

Sho Obata, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

In power networks, it is important to detect a cyber attack. In this paper, we propose a detection method of false data injection (FDI) attacks in the distributed state estimation. An FDI attack is well known as one of the cyber attacks in power networks. As a detection method of FDI attacks, we consider calculating the residual (i.e., the difference between the observed value and the estimated value). In the proposed detection method, the tentative residual (estimated error) in ADMM (Alternating Direction Method of Multipliers), which is one of the powerful methods in disributed optimization, is used. The detection parameter is introduced based on the residual. The proposed method is demonstrated by a numerical example on the IEEE 14-bus system.

January 25 (Tuesday), 09:00-11:25

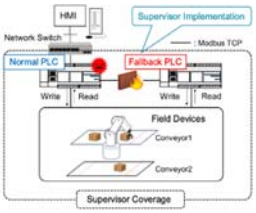
OS13-3 Examination of Allowlist Using Markov Decision Process for Industrial Control Systems

Shintaro Fujita and Kenji Sawada
(The University of Electro-Communications, Japan)

System modeling is important for detecting abnormalities in the control system. Both controller and plant models are required for modeling. The controller model can be obtained from the program, but it is difficult to obtain the plant model. In this paper, we created a stochastic model of the plant by the Markov decision process and examined the method of anomaly detection. We implemented the proposed method using a plant simulator and conducted an anomaly detection experiment of simulated cyber-attacks.

OS13-4 Synthesis and Implementation of Resilient Fallback Control Logic Under Cyberattacks

Kousei Sakata, Shintaro Fujita, Kenji Sawada
(The university of Electro-Communications, Japan)



To allow safe operation of an industrial control system under cyberattacks, we have developed a resilient fallback control system that focuses on the attack resistance of the continuous operation of field devices. This system is composed of programmable logic controllers (PLCs) for normal control and for fallback control. The normal PLC controls the field devices, and the fallback PLC takes over control after the control PLC is attacked. This paper aims to model the system in terms of discrete event systems (DESs) and supervisory control theorem. We realize the systematical fallback control design and implement the supervisor in the fallback PLC. This makes it possible to quickly switch the operating state of the control system under cyberattacks.

OS13-5 Poisoning Attack for Virtual Internal Model Tuning

Taichi Ikezaki and Osamu Kaneko
(The University of Electro-Communications, Japan)

Cyber attacks against control systems have been increasing. In recent years, Data-driven control is known as a low-cost method of tuning control systems. Because this method enables us to tune the control system so as to realize the desired characteristics by directly using the data of the control target. If the data is attacked, the performance of the control system using the controller obtained by the data-driven method is not prefer. In worst case, control system is to be unstable. Thus, it is important to study the effect of cyber-attacks to data used in the data-driven method. As one of the directions of this research, this paper consider a poisoning attack to the data used in the data-driven control method. Particularly, we focus on VIMT as one of the data-driven control methods.

January 25 (Tuesday), 09:00-10:15

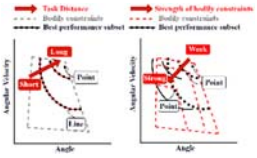
Room B

GS9 Cognitive science

Chair: Keisuke Suzuki (Hokkaido University, Japan)

GS9-1 Characterizing throwing tasks using a simple pendulum

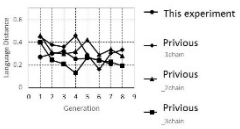
Ryunosuke Tazawa, Takuma Torii, and Shohei Hidaka
(Japan Advanced Institute of Science and Technology, Japan)



The human body is a physical system with high degrees of freedom (DoF), in which each body part interacts with the other in a complex manner. Controlling such a high DoF system faces to a ill-posed problem, in which there are more than one possible trajectory of body parts to meet a given goal. Despite this theoretical difficulty, in practice humans can smoothly control their body to achieve a given goal. Two distinct streams of research have accounted for how such identification of a trajectory. Dynamic systems approach considers it as emergence or synergy out of embodied interactions, while optimal control approach considers it as optimization with a constraint. In this study, we propose a new idea integrating these seemingly distinct approaches: A unique trajectory is identified by interaction between task structure and physical body constraint. We demonstrated this idea by a simulation study on a throwing-a-ball-to-target task using a single pendulum as an arm. By analysis the task error landscape with a physical constraint, it suggests that gives a ill-posed trajectory identification problem for relatively easy throw task, but a uniquely identifiable trajectory emerges for a more difficult task.

GS9-2 Verification of the Emergence of a Hierarchical Structure of Language through Cultural Inheritance with Consideration of the Mother Tongue

Ryuichi Matoba[1], Taichi Masui[1], and T. D. Cooper[2]
([1]National Institute of Technology, Toyama College, Japan)
([2]University of Toyama, Japan)



In recent years, the increase in the number of non-regular workers is one of the social problems in Japan. Since non-regular employment is a form of employment that can be dismissed at any time, the increase in non-regular employment leads to instability in the employment structure of Japanese. Since non-regular employment is a form of employment that can be dismissed at any time, the increase in non-regular employment leads to instability in the employment structure of Japanese society. For this problem, we implement a computer simulation using a multi-agent model to verify the effect of the revised law with Deep Q-Network. As a result, we were able to construct a model that is close to the employment status in the real world, and the simulation confirmed that the revised law is The simulation confirmed that the revised law is effective.

January 25 (Tuesday), 09:00-10:15

GS9-3 The Cultural Evolution of Memes Based on Communicative Interactions in Language among Chatting Agents Using a Generative Model

Soichiro Hirata[1], Reiji Suzuki[2], and Takaya Arita[2]
([1]School of Informatics, Nagoya University, Japan)
([2]Graduate School of Informatics, Nagoya University, Japan)

Meme is the information unit of cultural transmissions. Constructive approaches have played a significant role in the development of our understanding of cultural evolution and meme transmission. However, it is still unclear how novel memes emerge from complex communications in human language in the real world. We propose a conceptual framework of the cultural evolution of memes based on communicative interactions among chatting agents using a generative model. Agents uttering sentences generated from their genes and memes in a two-dimensional social space get together or away from each other according to the similarity of their sentences, and they receive words as memes from their neighbors. The preliminary experiments showed that active interactions among agents based on the creation of novel utterances and memes can affect the dynamics of social relationships. We also found that an influencer agent can facilitate the creation of interacting clusters by getting other agents together if the influencer has a longer reach of her utterances and memes and these are easily accepted by others. This indicates that the proposed framework enables us to discuss the cultural evolution of novel memes and word use in communicating agents in language.

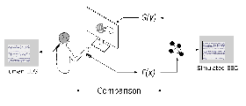
GS9-4 Increasing complexity of symbol sequences in adversarial imitation learning experiment

Kazufumi Nomura[1], Wataru Noguchi[2], Hiroyuki Iizuka[2,3], Masahito Yamamoto[2,3]
([1]Graduate School of Information Science and Technology, Hokkaido University, Japan)
([2]Faculty of Information Science and Technology, Hokkaido University, Japan)
([3]Center for Human Nature, Artificial Intelligence, and Neuroscience, Hokkaido University, Japan)

In the evolution of human communication, it has been hypothesized the basis of structural features of the communication signals are created by cultural transmission, and this hypothesis has been verified using iterated learning and other methods. The results show that the structural features are created by the trade-off between competing pressures. However, in the previous studies using iterated learning, the random sequences are given at the beginning and they are compressed by being simplified by memory. When simple sequences are given at the beginning, competing pressures are not generated and structural features are not created. In our study, we made an experiment on human communication using sequences by the learning process we call“adversarial imitation learning” and shared embodiment. Our results showed that communication using adversarial imitation and shared embodiment leads to the complication of color sequences, which have a long repetitive structure using embodiment when adversarial imitation was successful.

GS9-5 Prospects of Inter-brain Synchronization with a Virtual Agent: Preliminary Considerations

Chen Lam Loh and Tom Froese
(Embodied Cognitive Science Unit, Okinawa Institute of Science and Technology Graduate University, Japan)



The recent discovery of the occurrence of inter-brain synchronization during social interaction tasks has led to interests to investigate its benefits and mechanisms. This conceptual paper proposes a paradigm to study inter-brain synchronization in a way that offers more control over hyperscanning methods. Specifically, this paradigm involves a human interacting with a virtual agent (VA) endowed with a connectome-based model. Accordingly, the virtual agent (VA) tracks the human movement and generates its next execution based on pre-simulated data. Furthermore, the VA has a connectome model which simulates neurophysiological data that synchronizes with the human subject’s recorded neurophysiological data in real-time. Following the proposal, we show our first step in an attempt to implement the paradigm without the neurophysiological component and report example results of the implementation using a fingerpointing task. Then, we further discuss our views on the paradigm and the next steps for realization.

January 25 (Tuesday), 09:00-10:30

Room C

OS29 ISBC: Mathematics and physics of biological and abiological systems

Chair: Ken Naitoh (Waseda University, Japan)
Co-Chair: Toru Ohira (Nagoya University, Japan)

OS29-1 Generalized Multiplicative Stochastic Processes Arising from One-Dimensional Maps with Noise

Taichi Haruna[1] and Kohei Nakajima[2]
([1]Tokyo Woman's Christian University, Japan)
([2]The University of Tokyo, Japan)

We propose a class of generalized multiplicative stochastic processes obtained by introducing an endo-perspective into one-dimensional maps with additive noise. We define an internal state for the noisy dynamics of a given one-dimensional map and study its statistical behavior. We found an intermittency characterized by two power-laws in the dynamics of internal state for the logistic map and the BZ map with noise which exhibit different noise-induced phenomena, namely, noise-induce chaos and nose-induced order, respectively. We show that the power-laws can be explained in a unified way from the theory of generalized multiplicative stochastic processes.

OS29-2 Prognostic medicine: its detailed validation on population effect and energy loss

Daichi Igarashi and Ken Naitoh
(Waseda University, Japan)

A macroscopic kinetic theory for predicting catastrophic phenomena in biochemical reactions, i.e., the time-dependent pattern of sickness of human beings, has been shown with a nonlinear ordinary differential equation, describing logically temporal features of six macroscopic molecular groups chemically interacting in living beings. Here, we show that influence of increment size of parameters on prediction results, i.e., whether or not this equation can evaluate the population size on the number of patient record patterns, is discussed. Finally, we discuss whether or not the ratio of energy loss and limit of energy input, i.e, the surface-volume ratio of human body, influence on the predictions of patient record patterns.

OS29-3 Super-prognostic medicine: for finding early premonition of heavy sickness

Daichi Igarashi and Ken Naitoh
(Waseda University, Japan)

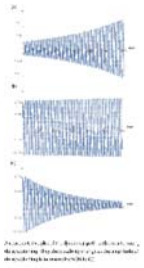
Prognostic medicine proposed by the authors, i.e., macroscopic kinetic theory for predicting catastrophic phenomena in biochemical reactions, like the time-dependent pattern of sickness of human beings, has been shown with a nonlinear ordinary differential equation, describing logically temporal features of six macroscopic molecular groups chemically interacting in living beings (Naitoh, 2011, Naitoh and Inoue: 2013). The previous theory of us (prognostic medicine) makes it possible to predict the catastrophes only just before their occurrences, i.e., a few months before heavy sickness. (Konagaya< Naitoh et al. 2017, 2020) In the present report, an advanced theoretical critical mathematical condition is proposed for finding earlier premonition of heavy sickness. The theoretical condition shows possibility for predicting biological catastrophes at a few years before their occurrences (super-prognostic medicine).

January 25 (Tuesday), 09:00-10:30

OS29-4 Enhancement of Stability with Delay Switching

Toru Ohira
(Graduate School of Mathematics, Nagoya University, Japan)

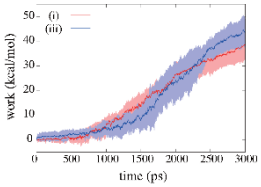
We propose a simple delay differential equation with a delay switching. In this model, the delay is a variable taking two values across the stability boundary. With this switching of the delay, there are cases that the region of stability is enhanced. We also show that this is in contrast to the analogous case of switching of coefficient parameters in the equation. We also considered the case of stochastic switchings where the delay is a stochastic process. Similar phenomena of stability enhancement are observed. We can view this stochastic delay switching model with these associated behaviors as yet another example showing the intricate interplay between delay and stochasticity.



OS29-5 The role of DNA sequence in the stability of double-stranded structure

Tomoko Mizuguchi, Takashi Aoki, Susumu Fujiwara
(Kyoto Institute of Technology, Japan)

The separation process of double-stranded DNA was examined for three different base sequences using molecular dynamics simulations. We applied an external force to an atom on the DNA backbone and calculated the work required to pull the double strands away. A DNA fragment consisting of guanine-cytosine pairs shows a sharper change in work than DNA fragments consisting of adenine-thymine pairs. This fact is attributed to the difference in the number of hydrogen bonds between base pairs. Meanwhile, even between the same base pairs, the ease of breaking hydrogen bonds differs depending on the surrounding sequence.



OS29-6 Numerical Study of the Correlation between Fish School Arrangement and Propulsive Performance

Kosuke Yoshida[1], Yoichi Ogata[1], Sota Hirai[1], and Kazunori Hosotani[2]
([1]Hiroshima University, Japan)
([2]National Institute of Technology, Tsuyama College, Japan)

In this paper, we focused on the distances in flow direction and vertical to that direction on three fish school arrangements, and made clear the correlation of between the affection to flow by fish school and fluid forces which were divided into two components: drag and thrust by three-dimensional simulations. As a result, we found that the distance in flow direction had greater impact on both two components comparing to the distance in vertical to that direction. And comparing to single fish swimming, drag and thrust were improved as the distance in flow direction became larger. We cloud also found forming pressure and velocity field favorable to propulsion with such conditions.

January 25 (Tuesday), 09:00-11:10

Room D

OS31 SWARM: Behavioral measurement and modeling technology to consider individual cognitive functions of organisms

Chair: Ryusuke Fujisawa (Kyushu Institute of Technology, Japan)
Co-Chair: Shunsuke Shigaki (University of Osaka, Japan)

OS31-1 Analysis of Negative Phototaxis in the Pill-bug (Armadillidium vulgare) Using Omni-directional servo-sphere

Akihiro Koubara[1], Kazuma Shirai[1], Kazushi Shimamura[1], Shunsuke Shigaki[2], and Ryusuke Fujisawa[1]
([1]Kyushu Institute of Technology, Japan)
([2]University of Osaka, Japan)

In recent years, automated systems and robots have been implemented in biological behavioral experiments to understand taxis behaviors. In this study, we propose a servo-sphere system (PSYCO-ANTAM), which is an extension of our previous studies. In the experiment, we will measure the negative phototaxis of the pill-bug (Armadillidium vulgare) as in previous studies. A photo-stimulus presentation system is placed around the sphere of PSYCO-ANTAM to control the presentation method of photo-stimuli. By measuring the behavior of the target organisms that receive these stimuli, we can measure the changes in phototaxis behavior. In this study, we used PSYCO-ANTAM, to clarify the conditions under which the negative phototaxis of the pill-bug occurs.

OS31-2 Development of a Behavioral Trajectory Measurement System (Bucket ANTAM) for Organisms Moving in a Two-Dimensional Plane

Kazuma Shirai[1], Kazushi Shimamura[1], Akihiro Koubara[1], Shunsuke Shigaki[2], and Ryusuke Fujisawa[1]
([1]Kyushu Institute of Technology, Japan)
([2]University of Osaka, Japan)

If we measure the global behavioral patterns of organisms in the real world, there is a concern that the observer may influence the behavior of the organisms. In order to solve the problem, several papers have reported attempts to measure and understand the global behavior of organisms based on experiments with a servo-sphere. However, this device locates the target organism on the curved surface of a sphere. Thus, it is unclear whether we are measuring the behavior of the organism on a two-dimensional plane or not. In this study, we develop a new device that can track an organism on a two-dimensional plane to answer the aforementioned concerns. In addition, we study the phototaxis of pill bug (Armadillidium vulgare) using the device.

OS31-3 Turn alternation response in pill bugs moving on omnidirectional treadmill ANTAM

Kentaro Fukai[1], Yusaku Ogai[1], Shuji Shinohara[2], and Toru Moriyama[1]
([1]Shinshu University, Japan)
([2]The University of Tokyo, Japan)

Turn alternation response is a behavioral pattern observed in a wide range of animals. By alternating left and right turns, animals can avoid obstacles and maintain a straight path. In the pill bugs, the turn alternation is one of the characteristic behaviors, and many research cases have been reported. In a recent experiment using an automatic turntable-type multiple T-maze device, the success rate of turn alternation in the subjects that continuously encountered T-junctions about 1,500 times reached about 65% (Shokaku et al., 2020). Additionally, Levy walk-like movement patterns suggestive of exploratory activity were found in about half of them (ibid). However, these results were obtained under the condition using T-maze which forced subjects to turn. In the present study, we use the omnidirectional treadmill ANTAM (Nagaya et al., 2017) to examine whether the pill bugs exhibit turn alternation response even when it moves under conditions without forced turn.

January 25 (Tuesday), 09:00-11:10

OS31-4 Behavioral analysis from the ventral side of pill bug using DeepLabCut

Ryohei Oka, Takumi Tanabe, and Naohisa Nagaya
(Kyoto Sangyo University, Japan)

Here, we show an example of how DeepLabCut was used to analyze a video of a walking bug (Armadillidium vulgare) from the ventral side and estimate the movements of its 14 legs.

OS31-5 Ants might perceive a visual landmark stereographically

Tomoko Sakiyama
(Soka University, Japan)

Here, I introduced a visual landmark to Japanese wood ants. That landmark had different patterns according to an observing angle. Individual foragers learnt a food position related with a one pattern of a landmark. They were allowed to explore around the food location and perceived another pattern of the landmark during the training phase. After the training phase, another pattern, which might be perceived by foragers during the training phase, was presented as ants could see that pattern from the direction of the start position (test phase). I found that ants in the test phase persisted in approaching the landmark more often compared with the control experiment test, where a landmark having a single pattern from any angle ants looked at it, was introduced on the field during the training phase. This result suggests that ants may connect several snapshots together into one and perceive a visual landmark sterically.

OS31-6 Speed Modulation Mechanism of Insect by Integrating Odor and Wind Sensory Information during Odor Source Localization

Mayu Yamada[1], Hirono Ohashi[1], Koh Hosoda[1], Daisuke Kurabayashi[2], and Shunsuke Shigaki[1]
([1]Osaka University, Japan)
([2]Tokyo Institute of Technology, Japan)

When localizing for females or food locations, insects use not only odor but also wind direction information to recognize their environment. In this study, we investigated the effect of wind direction information on insect odor source localization. For this purpose, we built a virtual reality system connected to a virtual environment on a PC, and measured the behavioral changes of insects in response to multisensory inputs. Biological experiments suggest that wind direction information has a significant effect on the localization success rate. We constructed an algorithm that includes this effect, and found that it has a higher localization success rate than conventional algorithms by simulation and robotic experiments.

OS31-7 Switch planning algorithms for odor source localization in obstacle region based on the entropy gain rate of information

Duc-Nhat Luong and Daisuke Kurabayshi
(Tokyo Institute of Technology, Japan)

In this study, we present a strategy for switching between Infotaxis, a probabilistic-based odor source localization algorithm, and the Dijkstra algorithm, to find an emitting gas source in the obstacle region. Under the assumption that the agent has prior knowledge of the environment, we performed simulations to evaluate the performance of the proposed method based on the success rate of the agent reaching the gas source and its search time. The proposed method solves the problem of deadlocking occurs when the presence of obstacles and walls affects significantly the wind flow. This study shows potential for implementation on autonomous robots for more efficient source localization compared to the traditional methods.

January 25 (Tuesday), 09:00-11:10

OS31-8 Development of Engineered Skeletal Muscle Tissue Under Geometric Constraint

Ryo Teramae, Hirono Ohashi, Shunsuke Shigaki, Masahiro Shimizu, and Koh Hosoda
(Graduate School of Engineering Science, Osaka University, Japan)

In recent years, robots driven by skeletal muscle tissue consisting of muscle cells has been developed. One of the major challenges for these biohybrid robots is to increase the contractile force of the engineered skeletal muscle tissue. Some studies have used the stimulus response of muscle cells to improve engineered skeletal muscle tissue. However, these methods require various equipments and complicated processes. In this study, we proposed a culture method of engineered skeletal muscle tissue under geometric constraint by pins and it simplified stimulation process. We observed the orientation of the muscle fibers in the engineered skeletal muscle tissue cultured with geometric constraint condition. This result suggests that our method may improve the contractile force of the engineered skeletal muscle tissue.

January 25 (Tuesday), 09:00-10:30

Room E

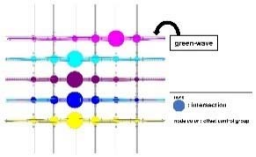
GS15 Intelligent control

Chair: Guang Yang (Kochi University of Technology, Japan)

GS15-1 A Dynamic Offset Control Method Based on a Multi-agent Model for Traffic Flow Facilitation

Ryu Fujimori[1], Satoshi Suga[1], Yuji Yamada[1], Daiki Takamura[1], Fumito Ihara[1], Ken Hayashi[1], and Satoshi Kurihara[2]
([1]Graduate School of Science and Technology, Keio University, Japan)
([2]Faculty of Science and Technology, Keio University, Japan)

This study proposes a dynamic offset control method utilizing a multi-agent model for wide-area control applicable to general road networks. In the proposed method, each intersection on the road network acts as an agent, negotiates among the other agents, connects with them, and builds a tree structure to construct an area for dynamic offset control. Inside the tree structure, agents perform green wave control based on the traffic at the edges. We evaluated the proposed method using a grid-like road network and a real road network constructed on a simulation and found that it can dynamically and flexibly form green waves in accordance with traffic conditions, thus leading to an excellent traffic flow facilitation effect.



GS15-2 Improving robustness via sharpness-aware deep reinforcement learning

Rintaro Imamura and Sachiyo Arai
(Chiba University, Japan)

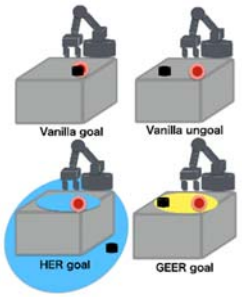
Deep reinforcement learning (DRL) has proved to achieve optimal control in a continuous environment without a model. Despite this, most of its applications still remain in a simulation or a game-based environment. To apply it to the real world we should improve the robustness of the attained control. This is difficult because DRL has a tendency to overfit to the training data. Overfitting is a major problem in DRL and it is the main reason why the attained control is not robust. We propose an algorithm that prevents overfitting by combining sharpness-aware optimization and current DRL algorithm. The results show that the proposed algorithm improves robustness with only negligible cost for optimality. We also empirically prove that the proposed algorithm does not overfit when converging to optimal control. In our future study, we intend to further improve the robustness by combining the proposed algorithm and model-based control.

January 25 (Tuesday), 09:00-10:30

GS15-3 Goal Expanded Experience Replay Method for Fast and Stable Reinforcement Learning

Takeru Matsumoto and Sadayoshi Mikami
(Future University Hakodate, Japan)

We proposed Goal Expanded Experience Replay (GEER) method to learn stable policy for the goal-oriented complex tasks. The idea is to expand the size of the goal instead of setting a virtual goal from experiences as in the Hindsight Experience Replay method. If a learner has unexpectedly ended up with dangerous situations, the previous method may force the agent to take the risk again. Instead, GEER method reduces tolerance to goal, so that the safe and stable original goal distribution will be learned. In some complex tasks, the initial goal tolerance tends to become too large and the goal size reduction process does not work well. Therefore, we proposed a mixed learning model with HER and GEER. In the initial phases, HER gathers positive rewards. Then GEER concentrates on the exploration around an actual goal. The experiments of sliding object problems by a manipulator showed effectiveness of this mixed learner.



GS15-4 Research on a simple recognition system using edge AI

Keita Murakami, Nobuo Iwasaki, and Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

In recent years, the concentration of data in the cloud has caused a variety of problems. For example, time lag, network bandwidth overwhelm, and information leakage. The importance of edge AI is rising because it can distribute the data processing space and solve the weaknesses of cloud AI by using edge AI. Conventional recognition systems have used edge AI to learn and discriminate between good and bad training data using only the good data. However, even with only good data, it required thousands of images per object, and the techniques used were complex. In this case, the previous problem is not so much solved, and additional learning, such as when expanding the variety of products, consumes time and cost. In this research, we reduced the amount of data used in the cloud, simplified the system, and confirmed the usefulness of edge AI.

GS15-6 A Study on Indoor Environment Monitoring Using Environmental Sensors

Ryoga Omoto, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Tehnology,Wakayama College, Japan)

In recent years, houses have become more airtight and insulated. As a result, houses have become less breathable, making them more susceptible to being filled with polluted air. In addition, infectious diseases caused by suspended particulate matter are becoming more prevalent in the corona, and ventilation is becoming increasingly important. In previous studies, equations for human CO2 exhalation have been developed with the aim of understanding the current state of CO2 exhalation in the Japanese population. However, we considered this equation to be inflexible because it requires human attribute data. In this study, we wondered if it would be possible to estimate CO2 concentration from temperature, humidity, and air pressure. First, we built a system to visualize the measurement results. After that, we built a system for predicting the carbon dioxide concentration using machine learning. As a result, we succeeded in predicting the carbon dioxide concentration.

January 25 (Tuesday), 09:00-10:30

GS15-7 Development of a Dialogue System Using a Voice Recognition Humanoid Robot

Kenji Iseya, Noriyuki Kimura, Kazuma Kobayashi, Toyoaki Tomura, Satoshi Mitsui,
Toshifumi Satake, and Naoki Igo
(National Institute of Technology, Asahikawa College, Japan)

Current dialogue systems don't pay attention to the speech style, gaze, or facial expressions of the person they are talking to. In this study, we participated in a competition called the "Dialogue Robot Competition" and tried to develop dialogue system that includes not only the content of speech but also the control of the robot's facial expression and gaze in order to realize a humanoid robot that can interact naturally with people. We also discussed the possibility of using the robot in customer service. In the Competition, participants developed dialogue system to guide tourists using a humanoid robot, and competed to see how natural the dialogue was. For the dialogue system we developed, we first created a language model from the Japanese version of Wikipedia using the library "gensim" to perform natural language processing in Japanese. Next, we used "Word Rotator's Distance" and cosine similarity to recognize the visitor's speech.

January 25 (Tuesday), 09:00-10:45

Room F

GS18 Mobile robots 1

Chair: Bahar Haghighat (Harvard University, United States)

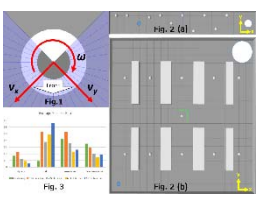
GS18-1 Use of haptic shared control to support the operation of an ROV in water flow

Mizuki Suka[1], Yu Kimura[1], Hirokazu Konishi[2], Norimitsu Sakagami[1], Takahiro Wada[3], Koichi Koganezawa[4]
([1]Department of Navigation and Ocean Engineering, Tokai University, Japan)
([2]Graduate School of Information Science and Engineering, Ritsumeikan University, Japan)
([3]Information Science, NARA Institute of Science and Technology, Japan)
([4]Department of Mechanical Engineering, Tokai University, Japan)

For this study, haptic shared control (HSC) was used to support operators of a remotely operated vehicle in flowing water. After conducting an experiment , we compared subjective and objective data of HSC and manual control. Subjective evaluation showed that HSC reduced the operators' weighted workload compared to the manual control and showed that operators devoted attention to counting tasks more than position-control tasks. Objective data indicate that the root mean square error of the ROV position in the case of HSC was less than that in the case of manual control.

GS18-2 Path Finding for Omni-Directional Mobile Robot Operating in Warehouse using DDPG with Hybridized Static-dynamic Learning Environment

Yuto Ushida[1], Hafiyanda Razan[1], Takuto Sakuma[1], and Shohei Kato[1,2]
([1]Graduate School of Engineering, Nagoya Institute of Technology, Japan)
([2]Frontier Research Institute for Information Science, Nagoya Institute of Technology, Japan)



Recently, workers are in short supply in the distribution industry. Therefore, the objective of this research is to develop an autonomous mobile robot that can search for paths to a goal while avoiding static and dynamic obstacles to support workers in a warehouse. In this study, as a preparation for learning experiment on an actual machine, we make the robot find paths to a goal while avoiding static and dynamic obstacles in a simulation environment. In this learning experiment, we apply five hybridized learning types of static and dynamic environments and verify the effectiveness of each learning method. The re-sults show that the hybridized learning type successfully finish the test episodes with above 50% rate of not hitting obstacles.

January 25 (Tuesday), 09:00-10:45

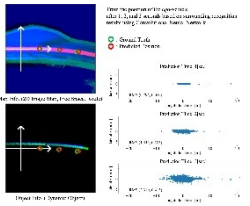
GS18-3 Detection of Cracks and Hotspots of Solar Panels Using Autonomous Multi-rotor Drone and Deep Learning

Atsushi Asatani, Shingo Okamoto, Jaehoon Lee
(Graduate School of Science and Engineering Ehime University, Japan)

This research focuses on the multi-rotor drone and the deep learning in order to develop technology to detect automatically failure and abnormality of solar panels in the power plants. Firstly, the experiment to measure the accuracy of RTK (Real-time Kinematic) -GNSS (Global Navigation Satellite System) was carried out. As the result, it was shown that RTK-GNSS occurs an error of around 1[cm]. Secondly, the multi-rotor drone capable of autonomous flight was developed by equipping the RTK-GNSS on it. As the result of flight experiment, it was also shown that the developed drone can fly autonomously and stably. Thirdly, the detection of solar panels in solar power plants and their cracks was carried out using package of object detection, YOLO v4. In addition, the detection of solar panels and their hotspots was carried out using YOLO v4 -tiny. The training to find the proper weights to detect the solar panels, their cracks, and hotspots was performed using the images taken by the visible light camera and the thermal one equipped on the drone. Then it was shown that the YOLO v4 and the YOLO v4 -tiny can detect the solar panels, their cracks, and hotspots.

GS18-4 Supervised Vehicle Trajectory Prediction for Urban Automated Driving

Keisuke Yoneda, Yusuke Takahashi, Tadashi Okuno, Lu Cao, Naoki Suganuma
(Kanazawa University, Japan)



In urban automated driving, it is important to generate appropriate behaviors according to surrounding circumstances. This study focuses on the trajectory generation for urban automated driving. The main approaches of trajectory generation are the mathematical model-based method and machine learning-based method. The former one is able to guarantee time continuity of velocity and acceleration. On the other hand, machine learning-based approaches have been developed to learn the driving behavior of experienced drivers. This paper develops the method to predict vehicle future states as a vehicle trajectory based on supervised learning. The driving dataset is generated using actual sensor data and smooth trajectories which are created by the mathematical model. The relationship between the prediction accuracy and the input information was analyzed by evaluating different input information. The evaluated results show appropriate behavior according to the surrounding situations.

GS18-5 Learning Control Parameters with Bayesian Optimization for AGVs in Factories

Akihito Tachibana and Kazuaki Yamada
(Toyo University, Japan)

When an automatic guided vehicle (AGV) is introduced into a factory, there are differences between the actual vehicle and the dynamics model. Therefore, it is necessary for engineers to adjust the control parameters by trial and error. In this study, we propose a method for automatically and quickly adjusting the control parameters of an AGV using Bayesian optimization, which is a black box optimization method. The proposed method uses Bayesian optimization to optimize the AGV's center of rotation as a control parameter. The cumulative error between the target trajectory and the center position of the AGV is used as an evaluation criterion for Bayesian optimization. In this paper, we use a dynamics simulator of an AGV created in MATLAB. Then, the effectiveness of the proposed method is verified by comparing the results without and with the control parameter obtained by Bayesian optimization in computer experiments.

January 25 (Tuesday), 09:00-10:45

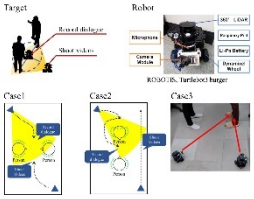
GS18-6 System Architecture of an Autonomous Drone for Inspection Tasks in Indoor Environment

Yudai Mizuta, Yohsuke Iguchi, Jae Hoon Lee, and Shingo Okamoto
(Ehime university, Japan)

In recent years, inspections of aging structures such as bridges, and industrial plants are essential for general safety and timely maintenance. However, typical inspections by human power are time-consuming, costly, and sometimes dangerous. Hence, researchers have been shifting their attention towards the use of drones for inspection tasks leveraging their maneuverability in the air to access high places. Such drones should not rely on Global Positioning System (GPS) for their localization and navigation as GPS fails near buildings or indoor environments. Therefore, the purpose of this study is to develop a drone that can fly to a specified destination safely in an environment where GPS is barely accurate. An autonomous drone system which employs the self-position estimation function of a tracking camera was proposed. In addition, flight experiments were conducted to verify the practicality of the system.

GS18-7 Unintentional dialogue collection by autonomous mobile robots

Shigetomo Sakuma[1], Akihiro Matsufuji[2], Eri Shimokawara[2], Toru Yamaguchi[2], Shoji Yamamoto[1]
([1]Tokyo Metropolitan College of Industrial Technology, Japan)
([2]Tokyo Metropolitan University, Japan)



Recently, a mainstream of spoken dialogue interfaces between robots and humans has been developed based on machine learning method. However, current communication patterns are limited to one question and one answer, and it is necessary to respond to a variety of dialogue situations with diversity. We believe that this dialogue interfaces can be improved by collecting many daily dialogues and enriching the conversation patterns. Therefore, in this study, we aimed to develop an automatic collection system to acquire as many conversations as possible in a living environment. Our system employed multiple autonomous mobile robots to quickly reach the vicinity of a conversation since the timing of conversation initiation is accidental. Also, we challenged to develop a method for speaker identification in order to acquire the conversation content of each speaker in a dialogue.

January 25 (Tuesday), 09:00-10:30

Room G

GS29 Sensor and multi-sensor data fusion

Chair: Shinichi Sagara (Kyushu Institute of Technology, Japan)

GS29-1 Distributed People Tracking Using Networked Multiple Ground LiDARs

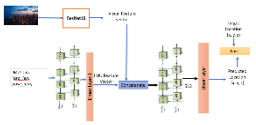
Naoki Murakami[1], Masafumi Hashimoto[2], Marino Matsuba[2], Kazuhiko Takahashi[2]
([1]Graduate School of Science and Engineering, Doshisha University, Japan)
([2]Faculty of Science and Engineering, Doshisha University, Japan)

This paper presents a cooperative people tracking using networked Light detection and rangings (LiDARs) allocated in an environment. After the position data of people are extracted from the LiDAR-scan data using a background subtraction method, poses and behaviors of people, such as stopping, walking, and suddenly rushing out, are estimated using a distributed interacting-multimodel (DIMM)-based method in a distributed manner without a central server. A rule-based detection and track managements are implemented to reduce false tracking in crowded environments with people close to each other. Simulation results reveal the tracking performance of the proposed DIMM-based method by comparison of conventional centralized interacting-multimodel estimator (CIMM)-based method.

January 25 (Tuesday), 09:00-10:30

GS29-2 Self-Localization of a Drone using Multi-Modal Data and Deep Neural Networks

Ahana Roy Choudhury[1], Praveen Palanisamy[2], Bimal Mehta[2], and Balinder Malhi[2]
([1]Department of Computer Science, Valdosta State University, United States)
([2]Autonomous Systems Group, Microsoft Corporation, United States)



In order to successfully execute activities such as navigation and landing of UAVs (unmanned aerial vehicles), it is essential to accurately perform self-localization of the UAV. However, unambiguous 3D self-localization in GPS-denied environments at high precision is a challenging problem that requires the utilization of data from multiple sensors. In this paper, we design a deep neural network architecture to exploit data from monocular camera and IMU for solving the problem of self-localization of a drone with respect to a known target (landing pad). Considering the importance of spatio-temporal processing of sensor data in localization and trajectory estimation, our deep neural network architecture utilizes both convolutional and LSTM layers. Our final deep learning framework is trained in an end-to-end manner using multi-modal data. Besides, we introduce the use of data augmentations to further improve the self-localization accuracy. By utilizing simulation data, we experiment with architectures for uni-modal and multi-modal data and develop a framework that achieves high accuracy.

GS29-4 Wi-Fi packet sensing method for obtaining the number of people

Ryoma Toyomi[1], Yusuke Fujino[1], and Atsuo Ozaki[2]
([1]Osaka institute of technology, Graduate School of Information Science and Technology, Japan)
([2]Osaka institute of technology, Department of Information and Computer Science, Japan)

In recent years, the outbreak of the new coronavirus has caused events to be cancelled or scaled back, and commercial facilities to refrain from operating, which has had a negative impact on economic activities. One of the reasons for this is that it is difficult for event and commercial facility operators to know where congestion occurs and to take adequate countermeasures against infectious diseases. In this paper, we propose a method for detecting the number of people in an area by using Wi-Fi packet sensors to detect and analyze Probe Requests issued by Wi-Fi terminals. As a result, the correlation coefficient between the number of packets and the number of visitors was about 0.5 before the application of the improvement method, and about 0.8 after the application of the improvement method, confirming the effectiveness of the improvement method.

GS29-5 Interactive Vital Measurement with Health Care Mobile Robots

Ryo Saegusa, Kensuke Ohno
(Kanagawa Institute of Technology, Japan)

The extension of health expectancy is getting a more important subject for developed countries with high rate of elderly population. In order to maintain the health of aged people living in care facilities, care staffs need to check the vital conditions of the residents frequently. For the facility staffs, however, taking vital signals of residents is one of the time-consuming tasks, and the operation is strongly expected to be supported by modern robot technologies. In this study, we propose an interactive vital measurement system with a health care robot. In the scenario of this interactive vital measurement, the health care robot operates its arm to reach the residents hand and requests the person to grab the handle, which we named as the haptic vital handle. The health care robot estimates the 3D positions of the body and the hand of the person based on the visual recognition. On the surface of the haptic vital handle, the vital sensors and pressure sensors are arrayed in order to detect physical gripping. The vital signals of the blood oxygen saturation (SpO2) and heart rate (HR) are recorded by the vital sensors, when the mobile robot is confident of the hand gripping based on the detection of pressure patterns. We performed experiments to measure vital and pressure signals from healthy adults and evaluated the reliability of the measurement in the different configurations of the body postures denoted as the stance, on-chair, on-wheelchair, and on-bed.

January 25 (Tuesday), 09:00-10:30

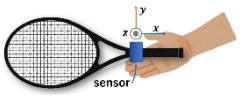
GS29-6 Research on tactile feedback using piezoelectric actuators

Takuma Iwamoto, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

Today, sports viewing is mainly done through TV broadcasting and the Internet. One of the trends in modern TV broadcasting is the shift to high definition. However, it is basically the same as conventional sports viewing, and remains "passive viewing". In the previous research, there are systems that use acceleration sensors and angular rate sensors for experiencing, but due to the high sensitivity taken up by the sensors, it is difficult to realize the experience of sports. In this study, we solved this problem by using a tactile microphone sensor in combination with the sensor to convert the magnitude of impact into sound. The sport can be filmed, and the video and sound can be connected to an interface, which can be connected to and extended by a haptic device. By doing so, we have developed a device that allows users to experience, a variety of sports.

GS29-7 Tennis Swing Form Evaluation Based on Swing Characteristics Related with Skillfulness Using Accelerometer and Gyroscopes

Shuto Ohshima[1], Shohei Kato[2], Takuto Sakuma[3]
([1]Creative Engineering Program, Dept. of Engineering, Graduate School of Engineering Nagoya Institute of Technology, Japan)
([2]Dept. of Engineering, Graduate School of Engineering Nagoya Institute of Technology and Frontier Research Institute for Information Science, Japan)
([3]Dept. of Engineering, Graduate School of Engineering Nagoya Institute of Technology, Japan)



In Japan, the environment for young people to start playing tennis is not as good. Therefore, this study develops a training support system that can measure swing motion and advise players on swing correction points. In this paper, we propose seven features for evaluating swing forms using a six-axis sensor, focusing on racket rotation, speed, timing, and ball spin. Also, to confirm the utility of the features, we measured the swing motions of tennis players at various levels with a sensor mounted on the racket and extracted the features. We defined skillfulness based on control and ball speed. Then, we analyzed the correlation between the features and the skillfulness and discussed the utility of the features. As a result, a correlation was found between several features and skillfulness, suggesting utilizing the features to evaluate swings.

January 25 (Tuesday), 10:45-12:15

Room B

OS16 AROB: Intuitive Human-System Interaction

Chair: Masao Yokota (Fukuoka Institute of Technology, Japan)
Co-Chair: Kenji Araki (Hokkaido University, Japan)

OS16-1 Construction and Analysis of Contextual Pun Database in Japanese Using Twitter

Ryoma Hanabusa[1] and Kenji Araki[2]
([1]Graduate School of Information Science and Technology, Hokkaido University, Japan)
([2]Faculty of Information Science and Technology, Hokkaido University, Japan)

There is the impact of the spread of Covid-19 infection, the number of single young people increasing rapidly. In consequence, Japanese society will face an unprecedented increase in elderly single-person household. Using a dialogue system to spread mental health care is an urgent task for future Japanese society. Therefore, improving response accuracy and developing a dialogue system with the same dialogue capability as human beings are essential. For this reason, the demand for humor processing is expected to increase rapidly in the future, but previous studies on humor processing have not focused on the factors affecting how interesting humor is. In this paper, we describe the construction and analysis of a contextual pun database for evaluating the fun of humor with contextual information.

January 25 (Tuesday), 10:45-12:15

OS16-2 A Study on Arm Motion Detection for Female Diver Virtual Experience Learning System

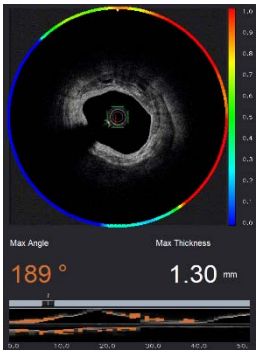
Yasushi Hosokawa[1], Shoi Higashiyama[1], Akio Doi[2], and Toyoo Takata[2]
([1]National Institute of Technology, Hachinohe College, Japan)
([2]Iwate Prefectural University, Japan)

We developed female diver virtual experience system “Amavia-WHB”. This system simulates the diving of female diver in a virtual space to convey the diving culture to the next generation. Then, we proposed the diving interface of Ama's glove form for this system. This interface can dive by inertial motion tracker detecting hand motion. This system has detected the stroke motion by template matching of the coordinate position a learner's hand. By this method, since a bodily size differs from the length of an arm for every learner, detection may be impossible. Low detection accuracy became a problem on the occasion of event exhibition for this reason. Then, we propose the system which obtains acceleration in the direction of a gaze using the shift vector and the gaze direction vector of a hand between frames. Therefore, we developed "Amavia-WHC", in order to improve arm motion detection, and we evaluated it.

OS16-3 Automatic extraction and visualization of coronary artery calcium using optical frequency domain imaging

Ryo Oikawa[1], Akio Doi[1], Masaru Ishida[2], and Basabi Chakraborty[1]
([1]Iwate Prefectural University, Japan)
([2]Iwate Medical University, Japan)

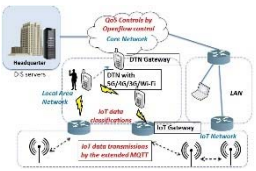
Imaging of coronary artery calcification using optical coherence tomography (OFDI) is an essential task in cardiac catheterization. Recently, many studies have been conducted to detect lesions from OFDI images, and diagnostic support systems equipped with these tools have been developed. However, the interfaces of existing diagnostic support systems pose difficulties in assessing thin areas of calcification, which are important for determining the presence of diastolic dysfunction. In this study, we created a deep learning neural network model that automatically extracts calcified areas from OFDI image of coronary artery. For the extracted calcified areas, to display the thickness of calcification more intuitively, we expressed the continuity as a ring shape and the thickness as color information.



OS16-4 QoS Control Methods with IoT Data Priority for Heterogeneous Wireless Networks in Disaster Information System

Noriki Uchida[1], Tomoyuki Ishida[1], and Yoshitaka Shibata[2]
([1]Fukuoka Institute of Technology, Japan)
([2]Iwate Prefectural University, Japan)

The recent developments of wireless and IoT technology expect us to realize the new kinds of Disaster Information systems. However, with the complexity of the wireless networks such as 3G/4G/5G mobile network, Wi-Fi, and LPWA, the QoS controls over the entire network become problems because of their different characteristics and protocols. Therefore, this paper proposes the QoS controls methods with IoT data Priority for heterogeneous wireless networks in the Disaster Information System. In detail, the QoS control methods are proposed in the core network layer by the four classifications of IoT data transmissions. Then, the routing functions with the Extend Dijkstra’s algorithm by the proposed QCI with these classifications. In addition, the extended MQTT method focus on the data priority is proposed for IoT network layer. Then, the paper reports the experimental results for the effectiveness of the proposed methods.



January 25 (Tuesday), 10:45-12:15

OS16-5 A consideration of VR Sickness by moving a sight of viewpoint

Kohei Soejima[1], Kaoru Sugita[2]
([1]Graduate School of Engineering, Fukuoka Institute of Technology, Japan)
([2]Department of Information and Communication Engineering, Fukuoka Institute of Technology, Japan)

In recent years, the VR (virtual reality) technology is introduced to various field such as entertainment, medical care, education and so on. However, the VR systems are caused to a VR sickness getting to health problems such as headache, dizziness, nausea, and even vomiting. This fact may cause the user to leave from the VR systems. Therefore, it is necessary to find conditions for appearing the VR sickness and decrease the effects of it. In this paper, we will show an implementation of prototype system and an evaluation of watching an omnidirectional video. From their evaluations, we found that the X-axis rotation and the Z-axis rotation are easy to get sick. Also, we found that the faster rotation is easier to get sic

OS16-6 Proposal of a Semiautomatic Interior Arrangement System using Mixed Reality Technology

Reiya Yahada and Tomoyuki Ishida
(Fukuoka Institute of Technology, Japan)

With the advancement of information and communication technology in recent years, virtual reality, augmented reality (AR), and mixed reality (MR) technologies have gained attention. Tablet terminals particularly smartphones, have made AR more familiar to us in our daily lives. In this study, to address the shortcomings of the previous study's AR mobile traditional craft application and MR furniture arrangement system, we created a semiautomatic interior arrangement system that superimposes three-dimensional computer graphics door objects on the door in real space. This system uses HoloLens2 as a platform. This system recognizes the wall and floor using the HoloLens2 camera, detects the location where the door object can be placed, and semiautomatically superimposes the door object on the real space.

January 25 (Tuesday), 10:45-11:45

Room C

OS25 ISBC: Chemical and biochemical complexity

Chair: Ken Naitoh (Waseda University, Japan)
Co-Chair: Shinjiro Umezu (Waseda University, Japan)

OS25-1 The weakest stability theory for stochastic momentum equation: revealing the sizes in biological and abiological particles having half-life periods

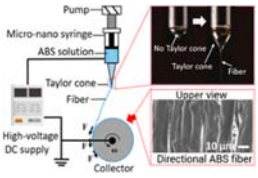
Tomotaka Kobayashi and Ken Naitoh
(Waseda University, Japan)

In the present report, we discuss whether or not the weakest stability theory for stochastic momentum equation can predict sizes of relatively stable particles like elements (atoms) smaller than Rn in periodic table, although inevitability of more unstable particles such as biological molecules and uranium were analyzed in our previous papers.

January 25 (Tuesday), 10:45-11:45

OS25-2 Enhancement effect of ABS fiber on electrospinning film -Preparation and research of directional ABS fibers film using electrospinning–

Kewei Song[1], Yue Cui[1], Kazuyoshi Tsuchiya[2], and Shinjiro Umezu[1]
([1]Waseda University, Japan)
([2]Tokai University, Japan)



Abstract: Electrospun nanofiber films are attracting increasing attention due to their applications in many frontier fields. Nevertheless, the low strength of electrospun film limits its application. In this study, acrylonitrile butadiene styrene (ABS) with excellent mechanical properties was used as the spinning solution, and a directional ordered ABS fiber film was prepared by controlling the rotation speed of the roller-like collector. By observing its surface morphology and mechanical properties test, we have studied the enhancement effect of ABS on electrospun films. The results show that as the rotation speed of the roller collector increases, the degree of order of the directional ABS fiber film increases, so as its strength increases. But as the rotating speed of the drum-like collector continues to increase (More than 7 m/s), the strength of the ABS fiber film decreased. The rotating drum will give a tensile force to the fibers to make the fibers grow directional in the collector, but when the speed is too fast, some fibers will be broken by this tensile force and reduce the tensile strength of the film. This research will provide directions for improving the mechanical properties of electrospun films. Keywords: ABS, Electrospinning, Fiber film, Mechanical strength.

OS25-3 Molecular Dynamics Study of Polymer-Water Interaction in Zwitterionic Polymer Brush-Water Interface

Yuya Fujinaga[1], Susumu Fujiwara[2], and Tomoko Mizuguchi[2]
([1]Graduate school of science and technology, Kyoto Institute of Technology, Japan)
([2]Faculty of Materials Science and Engineering, Kyoto Institute of Technology, Japan)

In the medical fields, zwitterionic polymer brushes have received considerable attention owing to their highly antifouling effect. The structure of hydrated polymer brushes and the dynamics of hydrated water have been recognized as important factors for antifouling in recent studies. Molecular dynamics simulations of the all-atom models composed of zwitterionic polymer brushes and water are performed to clarify the effect of polymer brush tacticity on the dynamics of interfacial water. Our simulations show that shape of polymer brushes and dynamics of water differ between syndiotactic zwitterionic polymer brushes and isotactic ones. It is also found that the lifetime for hydrogen bond of syndiotactic model is longer than that of isotactic model. It is concluded that there is certainly difference in the dynamics of interfacial water depending on the tacticity of polymer brushes.

OS25-4 Molecular Dynamics Simulation of Cluster Damaged DNA Composed of Apurinic/Apyrimidinic Sites

Kazushi Terakawa[1], Susumu Fujiwara[1], Tomoko Mizuguchi[1], Yoshiteru Yonetani[2], Hiroaki Nakamura[3]
([1]Kyoto Institute of Technology, Japan)
([2]QST, Japan)
([3]Nagoya University, NIFS, Japan)

DNA has susceptibility to alkylation, oxidation, and irradiation, which can produce damage of the molecular structures such as 8-oxoguanine, apurinic/apyrimidinic site (AP site), and strand breaks. These damages are usually repaired by enzymes in the cell. However, when the damages are locally crowded and cluster, the enzymatic repair cannot work adequately, which can lead to cell death and cancer. In this work, we carried out MD simulations of DNA with AP sites, and here we particularly focused on a situation in which two AP sites are positioned at the same strand. From the analysis of the DNA structural changes, we will clarify why effect of the AP sites is different between the same and complementary strands.

January 25 (Tuesday), 11:00-12:00

Room E

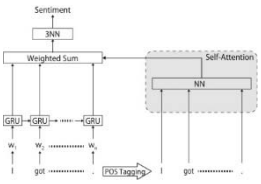
OS1 AROB: Advanced Applications of Machine Learning

Chair: Kiyota Hashimoto (Prince of Songkla University, Thailand)
Co-Chair: Hidekazu Yanagimoto (Osaka Prefecture University, Japan)

OS1-1 Attention in Terms of Part-of-Speech for Sentiment Analysis

Hidekazu Yanagimoto[1] and Kiyota Hashimoto[2]
([1]Osaka Prefecture University, Japan)
([2]Prince of Songkla University, Thailand)

Attention mechanisms have recently been employed in various tasks of machine learning, but its effective improvement and interpretability is to be investigated. This study compared Self-Attention and Part-of-Speech(POS) Attention for sentiment analysis of customer reviews with Gated Recurrent Unit (GRU) systems. Self-Attention employs feature values in the GRU layer while POS-based Attention employs frequency-based feature values. The result shows that Self-Attention performs best, POS Attention follows by approximately 1%, but both are 3-5% better than GRU without Attention. However, 40% of errors with Self-Attention were correctly predicted by POS-Attention, suggesting that Self-Attention does not capture some embedded linguistic features and that the selection of input of attention mechanism can be a key for adjusting the machine learning model to a particular task.



OS1-2 Introduction of Machine Learning for Handling Missing States in Particle Filter

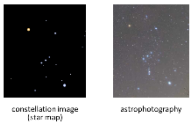
Takuya Fukushima[1], Tomoharu Nakashima[1], Yoshifumi Kusunoki[1], and Hidehisa Akiyama[2]
([1]Osaka Prefecture University, Japan)
([2]Okayama University of Science, Japan)

In this paper, we discuss a method for estimating the position of an unseeable object using a monte-carlo localization method Particle Filter. We propose a method to continue the state estimation based on past observations even when the observed information is missing by occlusion. Numerical experiments are conducted where we intentionally occlude an object while its true position is known. In the experiments, we show that the proposed method helps Particle Filter to track the object precisely even though the occlusion is happened. In addition, we confirm that our proposed particle filter has a belief distribution regardless of the observation.

OS1-3 Proposal of a Constellation Identification Method Using Point Set Data

Sayaka Nadamoto, Naoki Mori, and Makoto Okada
(Osaka Prefecture University, Japan)

In recent years, the rapid development of machine learning has made it possible to recognize images with high accuracy for a wide range of tasks. By contrast, constellations found through astrophotography are extremely difficult to identify because of a lack of data sets necessary for learning artificial intelligence and the fact that the appearances of stars vary significantly depending on the photographer and the equipment used, even in photographs of the same constellation. In this study, we propose a method for generating images of constellations that allow artificial intelligence to learn the characteristics of the constellations and use them to identify constellations found through astrophotography by viewing them as sets of points. The effectiveness of the proposed method was confirmed through numerical experiments.



January 25 (Tuesday), 11:00-12:00

OS1-4 Classification of Active and Inactive Corals in Phuket

Kiyota Hashimoto[1], Hidekazu Yanagimoto[2]
([1]Prince of Songkla University, Thailand)
([2]Osaka Prefecture University, Japan)

Corals are valuable marine invertebrates that form an underwater ecosystem of coral reef and that can survive only in clean seawater environments. From the viewpoint of nature preservation and environmental maintenance, it is important to know the survival situation of corals., for which machine learning classification can be employed. This study uses coral photos taken by divers in Phuket, Thailand, and tagged by experts. Those images were intentionally barely pre-processed and classified with a Convolutional Neural Networks (CNN). With small samples of such images without often time-consuming preprocessing, our model achieved 83.8% of accuracy and fragmental images used for classification is restructured as larger images to show coral survival conditions in an area. In pursuit of a fair balance between performance and human pre-processing efforts, the result of this study can be considered to be above practical requirements as information for experts and policy-makers.

January 25 (Tuesday), 11:00-11:45

Room F

GS4 Artificial life

Chair: Lana Sinapayen (Sony CSL Kyoto, Japan)

GS4-1 Evolution of Acoustic Signaling Generated by Movement of Artificial Creatures in Cooperative/Competitive Resource Acquisition Tasks

Takahiro Banno, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

This study aims at understanding the evolution of acoustic signaling generated by movement of artificial creatures in Cooperative/Competitive resource acquisition tasks in order to investigate the evolution of signaling behavior based on the dynamically changing situation and the emotional state (internal state) of the individual, which is discussed in social information theory. We set the task as follows: the more the agents participate in the acquisition from the source, the more the acquired resource for each agent becomes thanks to the synergetic effect of their cooperation. However, the competitiveness parameter defines amounts of individuals that can use the resource most efficiently, and if individuals over it share the resource, the fitness will decrease. We conducted experiments in high and low competitive settings by changing the competitiveness parameter and observed populations use the sounds generated by other individuals to search for resources, share resources with other individuals, and coordinate competition in high competition experiments.

GS4-4 Evolution of subjective incentive structure to encourage cooperative behaviors

Hiroto Yonenoh[1,2], Hiromichi Kimura[3]
([1]R&D Center for Smart Wellness City Policies, University of Tsukuba, Japan)
([2]Faculty of Health and Sport Sciences, University of Tsukuba, Japan)
([3]Mizonokuchi Institute of Technology, Japan)

We aim to examine if subjective incentive structure to encourage cooperative behaviors can evolve in the PD environment when the whole 2x2 subjective incentive structure can be mutated. Individuals are assumed to choose their behaviors rationally and, by using Fictitious Play, play a Nash equilibrium on their subjective incentive structures. Our analysis shows that subjective incentive structure to encourage cooperative behaviors can evolve by a similar mechanism to the one shown in the repeated Prisoner's Dilemma game by Axelrod. This result is very likely to be obtained even when we use any learning algorithms which realize Nash equilibrium as the learning result and which can solve coordination problems, other than Fictitious Play. This finding means that the evolution of subjective incentive structure naturally leads to the results shown in the repeated Prisoner's Dilemma game by Axelrod, under the assumptions of Nash equilibrium and coordination realizations on the subjective incentive structures.

January 25 (Tuesday), 11:00-11:45

GS4-5 Investigating the impact of free energy based behavior on human in human-agent interaction

Kazuya Horibe, Yuanxiang Fan, Yutaka Nakamura, and Hiroshi Ishiguro
(Osaka University, Japan)

Humans communicate non-verbally by sharing physical rhythms, such as nodding and gestures, to involve each other. This sharing of physicality creates a sense of unity and makes humans feel involved with others. In this paper, we developed a new body motion generation system based on the free-energy principle (FEP), which not only responds passively but also prompts human actions. The proposed system consists of two modules, the sampling module, and the motion selection module. We conducted a subjective experiment to evaluate the ”feeling of interacting with the agent” of the FEP based behavior. The results suggested that FEP based behaviors show more "feeling of interacting with the agent”. Furthermore, we confirmed that the agent’s gestures elicited subject gestures. This result not only reinforces the impression of feeling interaction but could also realization of agents that encourage people to change their behavior.

January 25 (Tuesday), 11:00-12:15

Room G

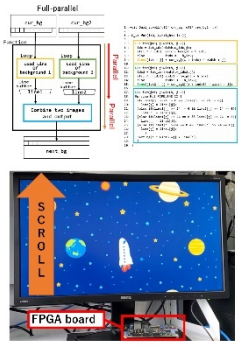
GS24 Parallel and distributed computing

Chair: Mario Köppen (Kyushu Institute of Technology, Japan)

GS24-1 An Investigation of Software Describing Method to Design Dual Background Scrolling Hardware in High-level Synthesis

Kilryong Lee and Akira Yamawaki
(Kyushu Institute of Technology, Japan)

We are developing a game programing library which can be converted to hardware modules by High-Level Synthesis, HLS technology to realize high-performance and low-power mobile terminals executing game applications. High-level synthesis is a technology that converts software into hardware automatically. The game software is executed by high-speed and low-power hardware on the reconfigurable devices in the mobile terminals instead of power-hungry software execution. To make high-level synthesis tool generate desirable hardware module, we must describe software program well considering the hardware organization. In this paper, we developed two software description methods for dual background scrolling processing as one of functions in high-level synthesis-oriented game software library. We also evaluate the execution time, resource usage and power consumption of hardware modules that high-level synthesis generated through the experiments and investigate which hardware module has better performance.



January 25 (Tuesday), 11:00-12:15

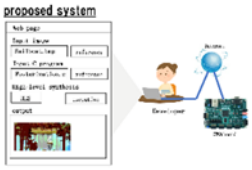
GS24-2 Instantiation System of Data-driven Framework for Multi-image Encryption Data-Archiving with Blockchain

Irawan Widi Widayat, Aprinaldi Mantau, and Mario Köppen
(Faculty of Computer Science and Systems Engineering (CSSE), Graduate School of Computer Science and System Engineering, Kyushu Institute of Technology, Japan)

Cloud computing has several constrain for computation on image processing, especially on communicating with edge computing devices such as IoT cameras. The high-resolution images produced by the camera intended to be saved in cloud storage will eventually be battlefield against limited bandwidth transport, time delay, vulnerability of image manipulation, and storage capacity issues. The INJETBLOCK is an instantiation system of data-archiving with InterPlanetary File System (IPFS) that is proposed and designed toward the invulnerability combating images manipulation for storing an encrypted image captured by IoT cameras. Multiple cameras were attached to the edge computing module in-which produced images captured of farming objects. The preceding process succeeds in producing an encrypted image is coded with a specific cryptographical hash in which becomes content identifier of the IPFS. The INJETBLOCK, therefore, levitates the resilience of the data-archiving method by combining the multi-image encryption and blockchain against the untrustworthiness of image authenticity.

GS24-3 Building Primitive Functionality of Web browser-based FPGA Hardware Verification System

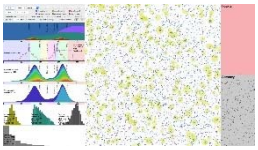
Tomomi Yoshizuka, Akira Yamawaki
(Kyushu Institute of Technology, Japan)



In general product development, developers repeat design, prototyping, and verification to make create their product better. Also, for rapid prototyping, FPGA which can make up circuit again and again has been used especially for building hardware processing . However, developers who use FPGAs need in-depth knowledge, skills, and experience. In addition, reducing load of designing and making product experimentally by using FPGA is a very important problem to face short product life cycle. To sort out these problems, this paper proposes a web-based generic verification environment. The proposed system installs a web server on the FPGA board. The hardware verification is done through web browsing. This paper attempts to build a web server on the commercial FPGA board. Some methods like HTML and CGI are developed to realize a primitive functionality of our proposed system.

GS24-4 Individual-based epidemic simulator with vaccination and virus variants for scenario analysis

Tatsuo Unemi
(Soka University, Japan)



The author extended his individual-based epidemic simulator so as to handle a number of different types of vaccination and virus variants. The main objective of the system is to analyze the possible sequences of events that would happen under a variety of assumed scenario. The features of virus variants, this system employ a reproduction rate of virus within an infected patient, that indicates how fast the virus reproduce themselves in his/her body. The algorithm is improved to manage one million individuals in a single two dimensional space utilizing a type of parallel processing by multicore CPU. By preparing the appropriate settings of parameters and scenario, it is possible to trace the trends of several indexes observed in the real world. Some cases of simulation results of this simulator have been reported in the meetings of governmental committee of the experts to suggest the strategy of countermeasures.

January 25 (Tuesday), 11:00-12:15

GS24-5 A Development of Fluidics Shape Design Using the Genetic Programming

Yuichi Hirokawa[1], Daisuke Matsuoka[2], Noriaki Nishikawa[3], and Toshiyuki Asano[4]
([1]Ashikaga University, Japan)
([2]Japan Agency for Marine-Earth Science and Technology, Japan)
([3]Okayama University of Science, Japan)
([4]Shonan Institute of Technology, Japan)

In recent years, earthquakes have been observed at an increasing rate, which may cause large-scale tsunamis. Since an evacuation from approaching tsunami is difficult because of too fast flow speed for pedestrian to evade from approaching flood, an evacuation in advance is very important. However, the situation might exist for pedestrian not to ensure sufficient time to evacuate. Therefore, we have developed the new shape design of fluidics to mitigate the speed of tsunami to ensure evacuation time. The shape of fluidics is designed accounting tide level: low tide and high tide. The shape design of fluidics is optimized by the genetic programming technique and three dimensional multi-phase CFD simulation of a dam break problem. To enforce the reinforcement learning, two ways of optimizations whether using the existing expertise or not are evaluated. The shape design of fluidics without the expertise can mitigate the flow speed only in low tide, but which can not mitigate the flow speed in high tide. On the other hand, the shape design with the expertise can decelerate the speed of tsunami to 1/3 in both low and high tide, furthermore, the shape design can decreases the number of generations required to obtain optimized genetics to almost half.

January 25 (Tuesday), 13:00-14:30

Room A

OS39 SWARM: Swarm and Bio-inspired Systems 1

Organizer: Masahito Yamamoto (Hokkaido University, Japan)
Co-Organizer: Yasumasa Tamura (Hokkaido University, Japan)
Chair: Jun Ogawa (Yamagata University, Japan)

OS39-1 Modification method of robot chain formation based on path integration for swarm robots with limited communication

Daiki Minobe, Ryo Takano, and Kohei Sonoda
(Ritsumeikan University, Japan)

Swarm robotics is an approach that uses simple rules and local communication between individual robots to generate desirable collective swarm behavior. These are expected to be applied to search and rescue activities in areas where people cannot invade, such as rubble and collapsed houses during a disaster. In this study, we tackle the task of swarm robotics that generates a path between NEST and FOOD. However, in previous study, robots like the Kilobot, which have very limited local communication and perception, frequently generate curved paths. Then, we have introduced the concept of path integration in the field of biology, in which animal returns home linearly by integrating the previous walking paths, to modify the redundant path. In this paper, algorithm for robot path generation is proposed and investigated by simulation experiments. The results show that the proposed method can correct redundant robot formations to the shortest possible formation using path integration.

January 25 (Tuesday), 13:00-14:30

OS39-2 Improving Generative Adversarial Network With Multiple Generators By Evolutionary Algorithms

Long Peng and Kazuhiro Ohkura
(Hiroshima University, Japan)

Generative Adversarial Network (GAN) is a novel class of deep generative models that has recently gained significant attention. GAN contains two models, one is a generator and the other is a discriminator. The task of the generator is to generate examples that look natural and real and are similar to the original data. The task of the discriminator is to judge whether a given instance appears to be natural or artificial (the real instance comes from the data set, and the fake instance comes from the generative model). In theory, Evolutionary algorithms can jump out of the local optimum and find the global optimum, therefore this paper shows that through Evolutionary Algorithms to achieve multiple generators to train GAN, in order to overcome the limitations of an individual adversarial training objective. An evaluation method is also applied to ensure that the samples generated by offspring from different parents are different, so as to avoid model collapse.

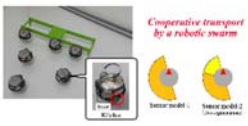
OS39-3 Generating Collective Wall-Jumping Behavior for a Robotic Swarm with Curriculum Learning

Gan Weng, Daichi Morimoto, Boyin Jin, and Kazuhiro Ohkura
(Hiroshima University, Japan)

Swarm robotics (SR) is a research field about how to design a large number of simple and homogeneous robots so that they can generate desired collective behaviors. Getting over obstacles like a high wall can be a task for a robotic swarm. Cubic robots jump onto top of each other to form a staircase-like structure, and the remaining robots can pass the wall with the help of it. However, when the wall is high, more robots serve as the motionless stepping-stones in the staircase-like structure and fewer robots can explore the environment, which makes the probability that robots can find the right behaviors to reach the goal becomes lower. This study describes how curriculum learning (CL) can be applied to guide robots by gradually increasing the wall height during the training process to achieve the wall-jumping task even with a high wall. We conduct computer simulation experiments where the cubic jumping robots have to generate collective wall-jumping behavior to pass the wall and reach the goal. The results show that the robotic swarm can achieve this task with the help of curriculum learning.

OS39-4 On reality gap of a miniature swarm robotic system in a cooperative transport scenario

Toshiyuki Yasuda[1], Mitsuru Jindai[1], and Shunsuke Ota[2]
([1]University of Toyama, Japan)
([2]Okayama Prefectural University, Japan)



This paper investigates a minimal approach for behavior generation of a group of small mobile robots in a cooperative object manipulation task. Besides, by utilizing pseudo-noise based on minimal simulation on the reality gap in swarm robotics, we investigate the effect of the implementation of the controller obtained in computer simulations on the physical robots. We confirmed that adding appropriate noise to the sensor input, which is difficult to model due to the structure of the robot itself and its positional relationship with other robots and objects to be transported, improves the reproducibility when the controller is transferred to a swarm of real robotic systems.

January 25 (Tuesday), 13:00-14:30

OS39-5 Largest Coverage Network in a Robot Swarm using Reinforcement Learning

Dalia Ibrahim and Andrew Vardy
(Memorial University, Canada)

Establishing a large adaptive connected network for decentralized swarms is useful for their behavior to share information about the working environment. A hard-coded implementation is time-consuming to achieve. Therefore, we are motivated to explore the benefits of reinforcement learning (RL) to learn a suitable adaptive policy. We also explore the combined use of a scalar field, which was inspired by template pheromones in social insects. In this paper, we investigate using RL with low and high-resolution scalar field to solve the largest covering network. Our results show that RL outperforms the hard-coded approach in the presence of the High-Resolution Scalar Field.

OS39-6 Message Expiration-Based Distributed Multi-Robot Task Management

Yikang Gui, Ehsan Latif, and Ramviyas Parasuraman
(University of Georgia, United States)

Distributed task assignment for multiple agents raises fundamental and novel control theory and robotics problems. A new challenge is the development of distributed algorithms that dynamically assign tasks to multiple agents, not relying on prior assignment information. This work presents a distributed method for multi-robot task management based on a message expiration-based validation approach. Our approach handles the conflicts caused by a disconnection in the distributed multi-robot system by using distance-based and timestamp-based measurements to validate the task allocation for each robot. Simulation experiments in the Robotarium simulator platform have verified the validity of the proposed approach.

January 25 (Tuesday), 13:00-14:45

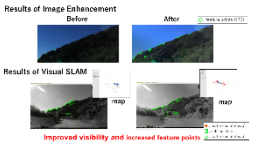
Room B

OS6 AROB: Autonomous Driving system and Control

Chair: Harutoshi Ogai (Waseda University, Japan)
Co-Chair: Kenichiro Nonaka (Tokyo City University, Japan)

OS6-1 Backlit Scene Image Enhancement for Improving the Accuracy of Visual SLAM

Yuga Yano[1], Yukiya Fukuda[1], Noriaki Suetake[2], Hakaru Tamukoh[1]
([1]Kyushu Institute of Technology, Japan)
([3]Yamaguchi University, Japan)



Simultaneously Localization And Mapping (SLAM) have become an important technique in autonomous driving. SLAM is a technique for simultaneously estimating self-position and creating surrounding 3D points environmental map. In recent years, Visual SLAM, which is SLAM based on the visual information acquired by camera systems, has been attracting attention because of its lower cost and easy implementation. However, Visual SLAM systems operate based on only image information. Thus, its performance is highly dependent on the illumination condition. Therefore, in the backlit scene situation, its accuracy may be significantly degraded. In order to address this problem, we use image enhancement method designed Visual SLAM. To evaluate the effectiveness of the image enhancement method, we use two types of backlit images taken indoors and outdoors. From our experimental results, it is shown that the accuracy of Visual SLAM in backlit images is improved.

January 25 (Tuesday), 13:00-14:45

OS6-2 Autonomous Navigation of Mobile Manipulator FUHGA3 and Evaluation in RoboCupRescue 2021

Xixun Wang, Tatsuya Takemori, Yuto Fukao, Ryohei Michikawa, Tsubasa Kitada, Ryosuke Koike, Shota Tanaka, Takumi Yamada, Takashi Tomiyama, Yuki Morimoto, Yushi Okuda, Takumi Shibuya, Fumitoshi Matsuno
(Kyoto University, Japan)

FUHGA3 is high mobility, high dexterity, and high searching ability robot to adapt to all required functions for rescue and inspection activities. An autonomous navigation of FUHGA3 is designed to navigate a robot to explore the complex environment safer and quicker than a human operator. FUHGA3 plans a local motion using potential energy on a local height map and local digital pheromone map. The autonomous navigation is tested in RoboCupRescue 2021 which is a worldwide competition for rescue robots. FUHGA3 won the Best in Class of Autonomous Mobility and it is the only robot that completed the c hallenge of Autonomous Mobility.

OS6-3 Trajectory tracking model predictive control with SLAM accuracy improvement by velocity information evaluation

Sota Wada, Kazuma Sekiguchi, and Kenichiro Nonaka
(Tokyo City University, Japan)

In this study, we consider autonomous mobile robot using SLAM technology in an unknown environment. The problem is the decrease of trajectory following accuracy due to the decrease of SLAM accuracy in the environment with low information. To solve this problem, we propose to improve the accuracy by controlling the robot's motion. The motion control is implemented by model predictive control which describes the evaluation of the estimation accuracy improvement. This evaluation is based on the terms of the velocity information of the robot as analyzed by the Fisher information matrix. The effectiveness of this method is verified by numerical simulation as compared with a trajectory tracking controller in the same environment.

OS6-4 Whole-Body Motion Generation using Model Predictive Control for Mobile Manipulators in Living Room Environment

Kento Misawa, Kenichiro Nonaka, and Kazuma Sekiguchi
(Tokyo City University, Japan)

To deal with works in the living room environment by mobile manipulators, a whole-body motion generation for a mobile manipulator is proposed in this paper by employing model predictive control. The whole-body model predictive controller combines the high mobility of the mobile robot with the high accuracy motion of the manipulator to achieve efficient motion. In this paper, we describe a method based on the kinematic model of the mobile manipulator for generating motions considering the characteristics of motions of the mobile robot and manipulator using variable velocity constraints. Then, the effectiveness of these controllers are demonstrated in the dynamics simulator.

January 25 (Tuesday), 13:00-14:45

OS6-5 Automatic driving system in a fixed route by using fusion algorithm

Yifei Dong and Harutoshi Ogai
(Department of IPS, Waseda University, Japan)

In order to achieve automatic transportation between factories, we make an automatic driving system based on fusion method and state machine that moves the car with a fixed route. The system includes functions such as route tracking, abstract avoidance, and emergency stop. During the design process, we improve the algorithm, design and optimize system functions with actual test conditions as feedback.This is a research for practical applications. So in the research process, we have encountered and solved many problems that are not in theoretical research or simulation. This process also helps us understand the algorithm more deeply and optimize it.

OS6-6 Learning-based Autonomous Driving Simulation and Real-time Test for Urban Scene

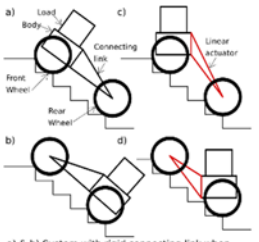
Shuwei Zhang, Yutian Wu, and Harutoshi Ogai
(Waseda University, Japan)

Urban roads are one of the most complicated applications in autonomous driving. The main bottleneck lies in perception and decision-making algorithms. In this paper, we propose a new learning-based autonomous driving system, including a novel Convolutional Neural Network (CNN)-based multi-sensor fusion object detector, and a novel Deep Reinforcement learning (DRL)-based decision planning system. Multi-sensor fusion object detector integrates two advanced CNN-based object detectors to separately detect objects from camera image and LiDAR point cloud with high precision and processing speed. Meanwhile, a stereo vision integrated Camera-LiDAR object fusion method is proposed to complementarily fuse two sensor detections. A DRL based decision and planning system is proposed by integrating DRL based tactical decision-making and spatiotemporal trajectory planning in dynamic urban driving scenarios with high efficiency and comfort. Finally, we train the algorithms in simulation scenarios and do joint testing in real scenarios.

OS6-7 Design and development of a 3-dimensional step climbing delivery robot

Nayan Jyoti Baishya[1], Li Jiandong[1], Bishakh Bhattacharya[2], Harutoshi Ogai[1], Tatsumi Kohei[1]
([1]Graduate School of Information, Production and Systems, Waseda University, Japan)
([2]Indian Institute of Technology Kanpur, India)

In this article, a novel yet simple slider-crank mechanism-based step climbing robot with two front wheels and two rear-wheel is proposed. During climbing up or down the steps, the inclination angle of the robot varies drastically which may lead to the toppling of the robot. The proposed mechanism is used to compensate for any change in the inclination angle by controlling the angle. An inertial measuring unit, comprising gyroscopes and accelerometers is used to sense the inclination angle of the robot during climbing up / down the stairs. The sensed inclination angle is then used by the microcontroller to control the Angle of the connecting link, which in turn reduces the variation of the inclination angle of the robot. A prototype is developed to demonstrate the working of the proposed system. Experiments with the prototype in ascending and descending cases are found to be satisfactory.



a) & b) System with rigid connecting link when ascending and descending of a stairs.
c) & d) Proposed system with altering the length of the connecting link when ascending and descending of a stairs.
*Link in red represents the links of slider-crank mechanism

January 25 (Tuesday), 13:00-14:00

Room C

OS30 ISBC: Medication based on big data and AI

Chair: Shingo Tsuji (The University of Tokyo, Japan, Japan)

OS30-1 Prognostic medicine: clarifying the various biological and economic catastrophes produced by COVID19

Ken Naitoh and Tsubasa Takizawa
(Waseda University, Japan)

Here, we mainly show a possibility for predicting manic situation, by the nonlinear differential equation with six variables which we previously reported. Moreover, the equation also reveals the economic catastrophe related to the COVID-19, if the six variables are redefined as those for macroscopic commercial products of three information ones including software programs and CAD data and three function ones including computers and automobiles.

OS30-2 A novel graph machine learning method for drug repositioning

Shingo Tsuji[1], Takeshi Hase[2], and Hiroshi Tanaka[3]
([1]The University of Tokyo, Japan)
([2]The Systems Biology Institute, Japan)
([3]Tokyo Medical and Dental University, Japan)

Machine learning algorithms, including deep learning, are now frequently used in life science research. It is widely known that biological phenomena are formed by complicated protein-protein and cell-cell interaction networks. In order to analyze the real data with such network structures, a methodology called graph neural networks(GNNs) has been attracting attention in recent years. We have recently developed and published a new method for drug repositioining using deep learning, in this presentation we will present the results of another improved version of this method using graph autoencoder. Graph autoencoder is the GNN version of autoencoder which is known as the classical application of the deep neural networks. We use protein-protein interaction networks(PPI) as the input graph structure and the ConnectivityMap as the gene expression data. Each node in the PPI has the fixed length feature vector. For example, the feature vector represents several different experimental conditions. Using the graph autoencoder, we could obtain the embedding vector representations of the compounds. The method is able to embed both the PPI-based structure and gene expression data of each gene. We will present the details of the method and how can we calibrate them. We will present the effectiveness of this method and the possibility of PPI-based drug repositioning.

OS30-3 Artificial intelligence based drug-target repositioning across diverse diseases

Takeshi Hase
(Tokyo Medical and Dental University, Japan)

Drug-target repositioning is to find new uses of established therapeutic-target genes of FDA-approved drugs outside their original target diseases and a key for boosting successful drug repositioning. However, experimental investigations of repositionable drug-targets require extremely large cost and time. Therefore, we need to develop powerful and efficient computational tools to infer potential repositionable drug-target genes. A promising resource to achieve the objective is a protein-protein interaction network in human, because the human protein-protein interaction network captures regulatory interactions between drug-target genes and their down-stream interacting partner proteins [1,2]. …

January 25 (Tuesday), 13:00-14:00

OS30-4 Identification of mild cognitive impairment subtypes predicting conversion to Alzheimer's disease using a heterogeneous mixture learning

Masataka Kikuchi
(Osaka University, Japan)

Background: Mild cognitive impairment (MCI) is a high-risk condition for conversion to dementias, including Alzheimer's disease (AD) dementia. However, individuals with MCI show heterogeneity in patterns of pathology, and MCI does not always convert to AD dementia. Detailed subtyping of MCI and accurate prediction of the patients in whom MCI will convert to AD dementia may support new trial designs and enable evaluation of the efficacy of drugs within small numbers of patients during clinical trials.
Methods: We constructed a decision tree model by the heterogeneous mixture learning (HML) method, integrating cerebrospinal fluid (CSF) biomarker data, structural MRI data, APOE genotype data, and a recorded age at examination. The decision tree model was applied to predict conversion to AD dementia and to identify subtypes of …

January 25 (Tuesday), 13:00-14:15

Room D

GS5 Bioinformatics and Medical informatics 1

Chair: Ryo Saegusa (Kanagawa Institute of Technology, Japan)

GS5-1 An effect of the exclusion criteria on the distribution of blood test values

Rina Kagawa[1], Masanori Shiro[2]
([1]University of Tsukuba, Japan)
([2]National Institute of Advanced Industrial Science and Technology, Japan)

Our objective is to clarify the most accurate distributions of the blood test items commonly used in health checkups. In this study, we used three data sets and assumed the LogNormal distribution with three parameters. We defined the distances between the distributions and tested whether the setting of the exclusion criteria or the Modified Box-Cox transformation had a greater effect on the shape of the distribution. From this analysis, it was found that the setting of the exclusion criteria had an important influence on the shape of the distribution of blood test values.

GS5-2 Characteristics of heart rate estimation method by sheet-shaped body vibrometer during sleep

Naofumi Ikeda[1], Takenao Sugi[2], Yoshitaka Matsuda[3], Satoru Goto[2],
Saori Toyoda[4], Takamasa Kogure[4], and Shuichiro Shirakawa[5]
([1]Graduate School of Advanced Health Sciences, Saga University, Japan)
([2]Faculty of Science and Engineering, Saga University, Japan)
([3]Institute of Ocean Energy, Saga University, Japan)
([4]PARAMOUNT BED Sleep Laboratory, Japan)
([5]Sleep Assessment and Research Institute, Japan)

Sheet-shaped body vibrometer (SBV), which is placed under a mattress, can measure the oscillations caused by body movement, respiration, and heartbeat during sleep. SBV records that information with non-contact and non-constraint for subjects and is usable for sleep state monitoring in daily life. We have been developing the estimation method of heart rate and respiratory rate by using SBV during sleep. The total accuracy of the estimation reached a certain level. However, the accuracy often deteriorated for some data. This study analyzed the estimation results of the heart rate, especially for low-accurate data. The data showed some specific characteristics and the point to be improved.

January 25 (Tuesday), 13:00-14:15

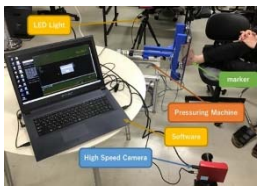
GS5-3 Smart device for measuring twisting motion in order to estimate low back load during nursing and care operations

Taiyo Yamamoto, Keisuke Ootsuka, Taku Itami, and Jun Yoneyama
(Aoyama Gakuin University, Japan)

In this research, we developed a smart device that can measure the twisting motion for the purpose of estimating the low-back-load during nursing and care operations, and the relationship between the twisting motion and the low-back-load was clarified by measuring the muscle load of the erector spinae muscles due to the twisting motion while gripping a heavy object. The low-back-load estimation was performed simply by calculating the torque assuming that the torque of the torsion spring of the spinal column increases linearly according to measured twisting angle. To verify the effectiveness of the developed device, we used surface electromyogram (EMG) of the erector spinae muscles by 3 subjects. From the experimental results, a positive correlation was confirmed between the twisting angle and the myoelectric potential, suggesting that it is possible to estimate and measure the low-back-load of nursing and care operations including a twisting motion using the developed device.

GS5-4 Simulation for Navicular Drop Test with OpenSIM and the differences between sitting and standing in diagnosing posture

YuEn Sung[1], Isao Abe[2], Takehito Kikuchi[2]
([1]Graduate School of Engineering, Oita University, Japan)
([2]Faculty of Sci. & Tech., Oita University, Japan)



OpenSIM is freely available biomechanical simulation software with musculoskeletal models of human bodies. By using this software as a simulation platform, we have developed a new way to simulate mechanical model of foot to diagnose flatfeet. A simulator was developed with the basis of Navicular Drop Test (NDt). To achieve this, we also proposed a mechanical model of a foot composed of thee bone groups and four tendons as spring units. Input data for inverse kinematic analyses were obtained by a normal foot with sitting / standing posture to evaluate the diagnose system. According to the results, we can sure that testing the NDt, there is almost not any difference between standing and sitting. And we valued this system to simulate the NDt.

GS5-5 Abnormal Heart Sound Detection using GANs Based on Normal Heart Sounds

Shumpei Takezaki[1] and Kazuya Kishida[2]
([1]Advanced Mechanical and Electronic Control Systems Engineering, National Institute of Technology, Kagoshima college, Japan)
([2]Department of Electronic Control Engineering, National Institute of Technology, Kagoshima college, Japan)

Cardiovascular disease (CVD) is the main cause of death of individuals worldwide; as a result, automatic CVD diagnosis to detect abnormalities in heart sounds (i.e., phonocardiograms (PCGs)) is being investigated. In recent times, deep learning models for automatic CVD diagnosis have been investigated, and several studies have reported that deep learning models perform efficiently. Most studies have investigated a supervised deep learning model (the learning of using normal and abnormal PCGs). We need to collect abnormal and normal PCGs for supervised learning, which incurs high cost with regard to time and inclusion of physicians. Therefore, we assume that an unsupervised deep learning model can reduce cost compared with a supervised deep learning model owing to learning based on normal PCGs. Therefore, in this study, we investigated the abnormal heart sound detection method based on an unsupervised deep learning model. We propose the abnormal heart sound detection method based on GANs.

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Room E

GS12 Human-machine interaction and collaboration 1

Chair: Viraj Muthugala (Singapore University of Technology and Design, Singapore)

GS12-1 Automatic Generation of Dialogue on Person's Preferences using WordNet

Ife-ebube Okoye[1], Yutaka Nakamura[2], Yuichiro Yoshikawa[1], and Hiroshi Ishiguro[1]
([1]Graduate School of Engineering Science, Osaka University, Japan)
([2]Guardian Robot Project, RIKEN Information R&D and Strategy Headquarters, RIKEN, Japan)

Personalized dialogue, which fosters human-robot relationships, can be realized through preference estimation. Dialogue systems still struggle with limitations in topic range, semantics and context-detection, and hence cannot easily conduct personalized conversations. Without requiring so much manual handcrafting or colossal data inputs as other chatbot systems, our proposed method aims to tackle these limitations by utilizing preference estimation and modular architecture to automatically generate semantic and contextually consistent dialogue, while still attaining dialogue length-scalability and multi-topic capabilities. We also demonstrate the positive impacts of our system's generated dialogue on human-robot interaction through a subjective experiment. The results from the experiment show that the chatbot system could conduct reasonable and interesting conversation, and deduce the interlocutor's preferences.

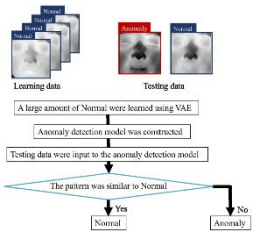
GS12-2 Impression investigation of 1-D restricted movement between two robots

Kohei YADA, Hirokazu MATSUI, and Norihiko KATO
(Mie University, Japan)

In this study, we investigate what kind of impressions subjects can get from the 1-D restricted movements between two robots. Each robot movement represents a position as a function of time on the same line in a screen. We experiment several movements to find some movements with impressions. This experiment is evaluated by asking the subject to write down their intuitive impressions after watching the movie. We found some impressionable movements such as like-model, dislike-model, notice-model. In order to check the stabilities of some models, we changed some model parameters such as movement start time of one robot against the other, and verified the stability by asking subjects to evaluate it to select radio buttons. As a result, we found what can express generally emotions even in one dimension.

GS12-3 An Optimization of Anomaly Detection Algorithms considering Diurnal Variation in Facial Skin Temperature using VAE

Masahito Takano, Yuki Iwashita, Kent Nagumo, Kosuke Oiwa, Akio Nozawa
(Aoyama Gakuin University, Japan)



It is well known as a general fact that it is important to objectively understand own stress state and physical condition and to deal with them appropriately. However, in many cases, it is difficult for a third party to detect stress or physical deconditioning, and there is a need to establish an objective method for estimating stress and physical condition. On the other hand, The distribution of facial skin temperature, an autonomic nervous system index, can be measured remotely using infrared thermography. We attempt to treat all states of physical deconditioning as a single anomaly state and detect anomaly based on facial skin temperature. In this study, we attempted to the accuracy of anomaly detection for facial skin temperature with a diurnal variation by optimizing anomaly detection algorithms.

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GS12-4 Estimation and Prediction of Walking Motions Employing Particle Filters

Takahiro Fukudome, Geunho Lee, and Naohisa Togami
(University of Miyazaki, Japan)

Currently, various robots and methods are being developed to provide care and support. In this study, we focus on assisting lower limb movements using robot technology. When assisting the lower limb movements of the elderly or people with disabilities, it is necessary to have an interface that can estimate and discriminate the user's intentions. In this study, we propose a method for estimating and recognizing walking motions using a particle filter, using only distance data obtained from proximity sensors. We also conduct experiments using the proposed method, and discuss the method and the possibility of predicting walking motion based on the data obtained from the experiments.

GS12-5 Development of an Experimental Platform for HRV Analysis in Human-robot Conversation

Masato Uehara and Nan Bu
(National Institute of Technology, Kumamoto College, Japan)

Conversational robot has made rapid progress in the field of human-robot interaction (HRI) in the last three decades to conduct verbal communication with human being. However, interactive robot with natural language capabilities is still faraway from its destination. This paper aims to investigate physiological response of heart rate variability (HRV) in users when they converse with a robot agent. Such response reflects emotional aspects of human users, and may be further developed into a measure in order to assess performance of an HRI system. An experimental platform has been proposed in this study including a robot agent, which has conversation capabilities using natural language. Characteristics of the robot agent can be changed to emulate different levels of communication abilities and various types of conversation. During human-robot conversation,electrocardiogram (ECG) signals are measured to derive HRV data for emotion and (mental) stress evaluation. Meanwhile,dialogues in the conversation are recorded so

GS12-6 The Gripping Force Enhancement Haptic Device for Hands with Wires and a Dial

Yuki FUKUDA, Dinh Tuan TRAN, and Joo-Ho LEE
(Ritsumeikan University, Japan)

Depending on the site of stroke, hemiplegia may occur as an after-effect of the stroke. Hemiplegic patients usually use the non-paralyzed hand and have difficulty using the paralyzed one to perform actions in their daily lives. In this work, we focus on the gripping action which has essential roles in our daily lives. Therefore, we propose an exoskeleton-type gripping assist device. There are two crucial points to developing a hand exoskeleton device for use in daily life. They are lightness and comfortableness which do not restrict the Degree of Freedom (DoF) of the user’s fingers. We resolved these issues with several mechanisms. More specifically, the proposed device consists of wires, a dial, and a motor. The number of actuators is reduced by using wires to lighten the device. In the experiment, this device allowed a user to grasp various objects.

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GS12-7 WebAPI Vulnerability Assessment Tool Based on Request and Response Sequences

Toru Taya[1], Masaki Hanada[2], Yoichi Murakami[2], Atsushi Waseda[2], Yuki Ishida[3], Takao Mimura[3], Moo Wan KIM[2], Eiji Nunohiro[2]
([1]Graduate School of Informatics, Tokyo University of Information Sciences, Japan)
([2]Department of Informatics, Tokyo University of Information Sciences, Japan)
([3]SecureBrain Corporation, Japan)

In recent years, Web APIs have been released to allow external access to Web services. On the other hand, there have been reported attacks that exploit vulnerabilities in WebAPIs. In order to reduce the damage caused by attacks that exploit WebAPI vulnerabilities, the Open Web Application Security Project (OWASP) has published a guidelines (OWASP API Security TOP 10) that describes ten vulnerabilities that pose a high security risk to WebAPIs. However, the guideline does not describe the specific attack methods and detailed countermeasures. Therefore, there are some vulnerabilities that are difficult to detect by existing vulnerability assessment tools. In this paper, we focus on the vulnerability No. 1 in the OWASP guideline, which is related to access control, one of the most threatening vulnerabilities on the Web, and propose a vulnerability assessment method using response information. In the evaluation experiment, we show that the proposed method can detect the vulnerability by using the WebAPI of Ghost CMS, which is difficult to detect by existing vulnerability assessment tools.

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Room F

OS21 AROB: System Sensing and Its Applications 1

Chair: Kosuke Oiwa (Aoyama Gakuin University, Japan)
Co-Chair: Tota Mizuno (The University of Electro-Communications, Japan)

OS21-1 Evaluation of Writing Motion by Using Principal Component Analysis and Scaling Analysis

Kotaro Hayashi and Masafumi Uchida
(The University of Electro-Communications, Japan)

The analysis data is a six-dimensional time element defined on a single task Chinese kanji character repetitive stroke motion. The six-dimensional data were compressed into three-dimensional data, and the Cumulative contribution ratio was examined. By doing so, we confirmed that principal component analysis is effective for dimensional compression. The evaluation value created in this study indicated proficiency in the task Chinese kanji character "den", “dai”. However, it did not show proficiency for "tsu". We think the reason for this is that the experimental system was constructed based on "den". In order to verify this hypothesis, we would like to examine the effect of constructing the experimental system based on the task Chinese kanji characters other than "den" in the future. As Future Work, we considered incorporating unlearned the task characters into experiments

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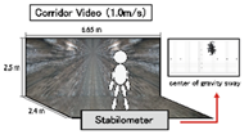
OS21-2 Standing Posture Evaluation Using Vection with Interior Corridor Textures

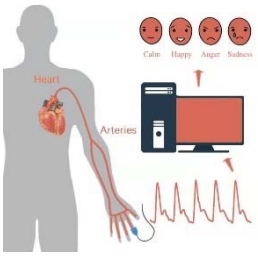
Riku Toriyama and Hisaya Tanaka
(Graduate School of Engineering Kogakuin University, Japan)



When an image moving in a fixed direction is observed, an illusion phenomenon called “vection” occurs in which the viewer perceives the image moving in the opposite direction. In this work, we assessed the sway of the center of gravity by inducing vection with images of corridors employing textures of various materials utilized in everyday activities to examine the effect of visual aspects of materials on the sway of the center of gravity. Furthermore, the subjective evaluation of the visual look of the images by the subjects, as well as the association with the amount of image information, was explored. The correlation coefficient was “-0.21,” indicating a modest negative correlation; however it was not discovered that the visual properties of the material directly influenced the sway of the center of gravity. Nevertheless, the effects of the visual features of the material on the center of gravity sway were examined based on the subjective evaluation of the examinees for the tatami with the largest rectangular area and the flooring with the smallest rectangular area, and it was suggested that the experienced sensations were recalled by the visual sense and might also affect the biological information.

OS21-3 Human Emotion Classification from Fingertip Photoplethysmogram Signals using Wavelet Analysis

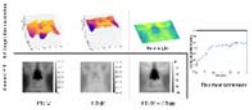
Boyao Zhang and Hisaya Tanaka
(Graduate School of Engineering Kogakuin University, Japan)



Emotional states have a significant impact on people’s professional and personal lives. Emotion classification can be beneficial in the treatment of mental disorders such as depression. This study developed a method based on photoplethysmogram (PPG) signals based on wavelet analysis to complete the emotion classification of four types of positive and negative emotions (calm, happy, sadness, and anger) in humans. First, we used the means of watching videos to induce the subjects’ target emotions and recorded their PPG signals. Next, the PPG signals were preprocessed by the wavelet transform to remove the effects of high-frequency and low-frequency noises. Then, the time-domain features of the PPG signals and the time-frequency domain features after the wavelet decomposition of the PPG signals were calculated. The normalized feature set was inputted into the LIBSVM (a library for support vector machines) classifier for emotion classification experiments. Experimental results show that the classification accuracy of the personal emotion classification model can reach more than 70%. The average emotion recognition rate of the valence emotion classification model of all subjects was 72.24%. The average emotion recognition rate of the four types of the emotions in the classification model is 61.13%.

OS21-4 Evaluation of the Effect of Environmental Temperature Variations on the Spatial Distribution of Facial Skin Temperature

Hiroaki Takahashi, Kent Nagumo, Kosuke Oiwa, and Akio Nozawa
(Aoyama Gakuin University, Japan)



In the Covid-19 disaster, fever detection using infrared thermography became widespread. A person with fever is detected based on the absolute facial skin temperature measured in a non-invasive and unrestrained method. Recent studies have pointed out that the absolute facial skin temperature, when measured immediately after entering a moderately warm environment from a cold environment, is not effective as a method for detecting persons with fever because it is greatly affected by the environmental temperature. Therefore, we focused on the spatial distribution of facial skin temperature, which is considered to be relatively unaffected by environmental temperature and is expected to be effective for correct fever detection, and evaluated the effect of environmental temperature variations on the spatial distribution of facial skin temperature. We also evaluated the same for the absolute temperature of the detailed areas of the face, which have not been evaluated in previous studies.

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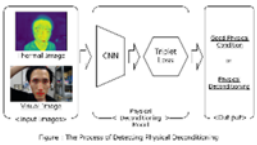
OS21-5 Physical Deconditioning Detection with the Spatial Distribution of Temperature and Color in the Face using Triplet Loss Function

Takato Hattori, Kent Nagumo, Kosuke Oiwa, and Akio Nozawa
(Aoyama Gakuin University, Japan)



With the COVID-19 epidemic, there is a growing need for remote detection of physical health conditions. Prior studies have examined the estimation of physiological and psychological states based on facial thermal images, which are long-term indicators of hemodynamics that can be measured by remote biometrics. Sensing of vital signs has also been performed based on facial visual images, a short-term measure of hemodynamics. In this study, we conducted an experiment to measure facial visual images, facial thermal images, and subjective sensory quantities related to body condition over an 11-month period. Based on the measured subjective sensory quantity related to the physical condition, visual and thermal images of the face in poor physical condition were regarded as abnormal data, and visual and thermal images of the face in good physical condition were regarded as normal data. By training Triplet Loss on only the normal data, an abnormality detection model was constructed.

OS21-6 Evaluation of Methods for Estimating Autonomic Nervous Activity Using a Web Camera

Miku Shimizu, Yu Matsumoto, Naoaki Itakura, Kazuyuki Mito, and Tota Mizuno
(The University of Electro-Communications, Japan)

In this study, we examined whether autonomic nervous activity can be estimated from color changes in real facial images acquired with a Web camera. In recent years, the need for emotion estimation has been increasing. Among them, the method using thermal images has revealed that skin temperature also changes due to changes in stress, making it possible to evaluate autonomic nervous activity. However, this method requires the use of a far-infrared camera, which is costly. In order to solve this problem, we will investigate an evaluation method that uses real images that can be easily obtained instead of thermal images. As a result, it was found that it is possible to evaluate autonomic nervous activity from real images with the same level of accuracy as the method for thermal images.

OS21-7 Study on Photoplethysmographic Amplitudes Obtained from Web Camera Acquired Images

Yu Matsumoto, Tota Mizuno, Kazuyuki Mito, and Naoaki Itakura
(The University of Electro-Communications, Japan)

With the increase in telecommuting, the number of patients with depression owing to mental stress is increasing. Therefore, a stress evaluation method for promoting stress release is required. We focused on photoplethysmographic amplitude (PPGA), which is a mental stress evaluation index of photoplethysmography (PPG) that can be measured by a web camera. However, previous studies have not investigated how to obtain PPGA information from RGB fluctuations. In this study, we studied a method for acquiring PPGAs from RGB signals. To accurately acquire the skin information of the face, with the proposed method, the face area is extracted from the RGB image through face detection and then converted from RGB into the HSV color space. As a result, it was found that, in comparison to a conventional approach, this method improves the acquisition accuracy of the PPG while also acquiring PPGA information.

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Room G

GS26 Robot vision and image processing 2

Chair: Noritaka Shigei (Kagoshima University, Japan)

GS26-1 Face image recognition resistant to posture fluctuations using intermediate template vectors and UMAP

Kenshiro Yamanaka[1], Noritaka Shigei[1], Hirofumi Miyajima[2], and Hiromi Miyajima[1]
([1]Kagoshima University, Japan)
([2]Nagasaki University, Japan)

This paper considers improving face recognition algorithms. The considered face recognition methods convert a face image into a feature vector by a deep neural network (DNN) and judge based on registered template images. To adapt to Japanese identification targets and low-quality images, the training data of our fine-tuning is a set of Japanese facial images to which blur processing is applied. As a countermeasure for posture fluctuations, a plurality of images with different orientations are used as the registered images. A pair of feature vectors of neighboring registered images are combined to generate an intermediate feature vector to reduce the number of registered images. Further, to improve the accuracy, it is considered to transform a high-dimensional feature vector to a low-dimensional one by using UMAP (Uniform Manifold Approximation and Projection). Finally, numerical experiments using images of ten persons taken over five days demonstrate the effectiveness of the proposed methods.

GS26-2 Positioning of Unmanned Surface Vehicle by Image Processing of Small ASV

Makoto Morito[1], Junichiro Tahara[1], Shun Fujii[1], Soutaro Ono[1], Shoichiro Baba[2], Yukihisa Sanada[3]
([1]Tokyo University of Marine Science and Technology, Japan)
([2]Japan Agency for Marine-Earth Science and Technology, Japan)
([3]Japan Atomic Energy Agency, Japan)

In this paper, we describe positioning using camera images for monitoring ASVs in mud sampling. We are currently working on the realization of automated mud sampling using ASVs. When unmanned ships extract mud in a narrow environment such as a harbor, there are problems such as the approach of other ships and obstacles. These are major problems in automating the mud sampling process. In order to solve this problem, multiple small ASVs are used to guard the surrounding area and monitor the mud collecting ASV. In this case, the small ASV to monitor needs to know the location of the mud mining ASV being monitored. For this purpose, a new positioning system that can compensate for the relative position of GPS and can be used even when communication is poor is necessary. As a means of satisfying these requirements, we are studying a visual positioning system using camera images.

GS26-3 3D reconstruction considering calculation time reduction for linear trajectory shooting

Keita Nakamura[1], Toshihide Hanari[2], and Kuniaki Kawabata[2]
([1]The University of Aizu, Japan)
([2]Japan Atomic Energy Agency, Japan)

In three-dimensional(3D) reconstruction from images, even if the number of images is small and each image captures the features of the target object for 3D reconstruction, highly accurate 3D reconstruction can be achieved in a short time. Therefore, in order to select effective images for 3D reconstruction, we consider that test data for image selection can be generated by constructing a virtual space using simulation and changing the shooting conditions. In this study, we focus on the case that a camera moves on a straight rail and obtains images, and investigate and verify the effective image selection conditions considering calculation time reduction for 3D reconstruction in this case by simulation.

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GS26-4 Cross-view Image Matching between UAV and Satellite using Attention-based Convolutional Neural Network

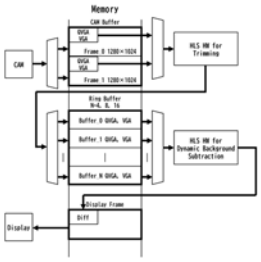
Duc Viet Bui[1], Tomohiro Shirakawa[2], Hiroshi Sato[1]
([1]National Defense Academy of Japan, Japan)
([2]Nagaoka University of Technology, Japan)

Cross-view image matching for geo-localization is the task of finding images containing the same geographic target in multi-views. For example, given a query image from UAV-view, a proposed matching model can find an exact image of the same location in a gallery collected by satellites. By using a UAV-view image to acquire the true-matched satellite-view image with geo-tag, the current geographic location of the UAV can be easily localized based on flight record. However, due to the extreme change of viewpoints across platforms, traditional image processing methods have met difficulties matching multi-view images. This paper proposes advanced neural network-based approaches, which apply the attention mechanism to the feature learning process to improve the ability to learn essential features from the input image. Our proposed models have significantly improved accuracy and have achieved competitive results on the University-1652 dataset.

GS26-5 Development of a real camera system with high-level synthesis hardware of median-based dynamic background subtraction

Kohei Shinyamada and Akira Yamawaki
(Kyushu Institute of Technology, Japan)

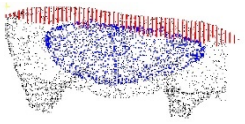
We have developed a software description of the median-based dynamic background subtraction method for high-level synthesis. In this study, we developed a real embedded system that combines carefully generated high-level synthesis image processing hardware, a real camera, high-level synthesis hardware for trimming the camera image, and a display. By using the concept of a ring buffer, we have reduced the amount of memory used and achieved a fast system. In the fastest case, when the image size was QVGA and the number of time series images used was four, the system achieved about 166 fps. The slowest case was about 16 fps when the image size was VGA and the number of time series images used was 16. Regardless of the image size, the hardware processing was found to be more power efficient than the software processing.



GS26-6 Volume-Based Pig Weight Estimation Using an RGB-D Sensor

Khin Dagon Win[1], Kikuhito Kawasue[1], Pwint Phoo Wai[1], Yusuke Iki[2]
([1]Faculty of Engineering, University of Miyazaki, Japan)
([2]Faculty of Agriculture, University of Miyazaki, Japan)

As the pig weight measurement requires a heavy labor work, pigs are shipped without measuring their weights in many cases. Although load cells are widely used in pig farms, it can easily lead to mechanical errors in messed farms. With these reasons, we have developed a robust image processing-based pig weight estimation system using an RGB-D sensor. Since the live weights and the carcass weights of pigs are important for the economic management of pig farm, the estimations of those weights with a single shot of pig image is desirable in the system. Intel Realsense D455 RGB-D sensor is used as a sensing device for weight estimation. The weight estimation is performed on 3D point cloud data of captured image. A standard 3D pig model is prebuilt pig shape, includes the internal organs for carcass weight calculation. That model is fitted to the captured image and that fitted model is used for volume estimation. The estimated volume is applied for carcass weight and live weight calculation. The experimental results can show the reliability of our system.


Fitted 3D data (side view)

January 25 (Tuesday), 13:00-14:45

GS26-7 Soft Gripper Using 3D Snap-Through Buckling for Perishable Fresh Fruits Handling

Hiroki Hanamori, Akihiro Kawamura, and Ryo Kurazume
(Kyushu University, Japan)

In this study, a soft gripper that grasps extremely perishable fresh fruits such as peaches and strawberries is proposed. To prolong the shelf life of the fruits, the contact forces must be minimized as much as possible. Thereby, the proposed gripper is specialized and designed for grasping of fruits though general conventional soft grippers designed to grasp objects with various shapes. This study focuses on peaches as a target for grasping, and optimized the shape of the gripper to match the peaches. Additionally, the gripper is actuated by a snap-through buckling system. This system enables the gripper to grasp the target without extra grasping forces by form closure. The gripper is integrally fabricated using silicone elastomers. The softness of the material is utilized to confirm the object shape and decrease contact forces. In this study, a performance comparison experiment was conducted using several prototypes to identify the important factors in grasping peaches.

January 25 (Tuesday), 15:00-16:00

Room A

OS34 SWARM: e-ASIA Joint Research Project 1: Informational system for management of flood and landslide disaster areas using a distributed heterogeneous robotic team

Chair: Jackrit Suthakorn (Mahidol University, Thailand)
Co-Chair: Fumitoshi Matsuno (Kyoto University, Japan)

OS34-1 Energy Optimized Path Planning and Decision Making for Multiple Robots in Rough Terrain

Branesh M Pillai[1], Dileep Sivaraman[1], Fumitoshi Matsuno[2], Mikhail Svinin[3], Evgeni Magid[4], and Jackrit Suthakorn[1]
([1]Center for Biomedical and Robotics Technology(BART LAB), Faculty of Engineering, Mahidol University, Thailand)
([2]Department of Mechanical Engineering and Science, Kyoto University, Japan)
([3]College of Information Science and Engineering, Ritsumeikan University, Japan)
([4]Higher School of Information Technology and Intelligent Systems, Kazan Federal University, Russian Federation)

This study defined the problem of motion planning for multiple unmanned tracked robots that minimize energy consumption in terrain with obstacles. The energy consumption of a DC motor is widely known to be dependent on its angular speed and acceleration. The transnational velocity and acceleration of a robot are controlled by the angular speed and acceleration of the driving DC motor. This study examines the method for estimation of a robot's path and velocity profile such that it uses the optimum energy while maneuvering. Moreover, the battery backup of UGVs is limited, and a robot's power supply has an impact on its performance and leads the robot to stop during the mission. This failure directly hinders the success of the assigned task and/or mission. In this paper, an algorithm for identifying the suitable robot for the instantaneous task during the rescue operations is proposed. In addition, using the optimal trajectory of each robot within a multi-robot system and monitoring the battery status of each robot.

January 25 (Tuesday), 15:00-16:00

OS34-2 Adaptive Coverage Control for Multiple Car-Like Vehicles

Keerati Fungtammasan[1], Yang Bai[1], Mikhail Svinin[1], Fumitoshi Matsuno[2], Evgeni Magid[3], and Jackrit Suthakorn[4]
([1]Ritsumeikan University, Japan)
([2]Kyoto University, Japan)
([3]Kazan Federal University, Russian Federation)
([4]Mahidol University, Thailand)

This paper studies an adaptive coverage control problem for for a system of multiple car-like mobile robots. The Centroidal Voronoi Tessellation (CVT) is applied to generate an optimal coverage configuration of the multi-agent system for a dynamic region. A function approximation technique based immersion and invariance (FATII) controller is proposed to drive the system to the generated optimal configuration while ensuring the output constraint. The stability of the proposed FATII controller is established and its validity is tested under experiments.

OS34-3 Area Surveillance by Multi-UAVs with Energy Support from a UGV

Hanqi Li[1], Fumitoshi Matsuno[1], Mikhail Svinin[2], Yang Bai[2], Evgeni Magid[3], and Jackrit Suthakorn[4]
([1]Kyoto University, Japan)
([2]Ritsumeikan University, Japan)
([3]Kazan Federal University, Russian Federation)
([4]Mahidol University, Thailand)

In this paper, we consider the problem of area surveillance by multiple Unmanned Aerial Vehicles(UAVs). The UAVs have limited battery capacity and they have to gain energy support from an Unmanned Ground Vehicle(UGV). A UAV can land on the top of the UGV and exchange its battery during a short constant time. The input is a 2D ground plane map. We apply Lloyd algorithm and BCD algorithm to make area decomposition. UAVs' paths should be determined to cover the whole area for gathering information from the area. Also, we propose a Diverse Multi-Population Genetic Algorithm (DMPGA) to make path planning for UAVs and the UGV to achieve three goals: 1. The whole area can be covered. 2. The time cost can be minimized. 3. All the UAVs can keep enough energy while traveling.

OS34-4 Flood and Landslide Disaster Response Support System using Multi-UAVs

Michinori Hatayama
(Disaster Prevention Research Institute, Kyoto University, Japan)

1. Introduction
Extreme weather events have become more frequent in Japan due to the effects of climate change. This has led to an increase in the number of floods and landslides caused by torrential rains. In order to achieve rapid disaster recovery from these disasters, it is necessary to handle information effectively. Unification of situational awareness is an important element in disaster response.

January 25 (Tuesday), 15:00-16:00

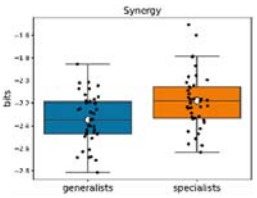
Room B

GS1 Agent-based modelling

Chair: Keita Nakamura (Aizu University, Japan)

GS1-1 Information Integration in Division of Labor: Validation of Earlier Findings

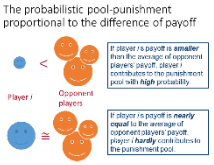
Soheil Keshmiri and Federico Sangati and Ekaterina Sangati
(Okinawa Institute of Science and Technology, Japan)



The present study focuses on evaluation of the underlying dynamics in two-agent, single-target pursuit within the context of division of labor paradigm. Specifically, it aims at clarifying which of the two tracking strategies viz. equipping agents with switching complementary roles versus designated specialization may result in increased information integration between agents. Although our previous findings on this topic hinted at significantly higher benefit of the first strategy, they suffered from the assumptions of linearity and independence of agents, imposed by our parametric Gaussian formulation of information integration. Here we address these shortcomings through adaptation of non-parametric multivariate information integration formalism. We show (1) that with this new formulation our previous results still hold, (2) that they also remain intact if target is taken into account for quantification of agents' information integration and (3) that the agents' relation with respect to the tracking task can be explained in terms of potential colinearity of their actions. We further discuss some of potential issues that require careful consideration while studying such dynamics and conclude by highlighting recent advances that can potentially help overcome such pitfalls.

GS1-2 The evolution of cooperation induced by the probabilistic pool-punishment proportional to the difference of payoff

Tetsushi Ohdaira
(Aoyama Gakuin University, Japan)



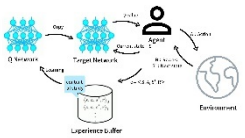
The public goods game is a multiplayer version of the prisoner's dilemma game. In the public goods game, punishment on defectors is necessary to encourage cooperation. There are two types of punishment: peer-punishment and pool-punishment. Pool-punishment is disadvantageous in comparison with peer-punishment because pool-punishment incurs fixed costs especially if second-order free riders are not considered. In order to eliminate such a flaw of pool-punishment, this study proposes the probabilistic pool-punishment proportional to the difference of payoff. In the proposed pool-punishment, each punisher pays the cost to the punishment pool with the probability proportional to the difference of payoff between his/her payoff and the average payoff of his/her opponents. As a result, more punishers and less cooperators coexist, and such state is more robust against the invasion of defectors due to mutation than those of previous pool-punishment and peer-punishment. The average payoff is also comparable to peer-punishment of previous studies.

January 25 (Tuesday), 15:00-16:00

GS1-3 Employment status simulation using multi-agent model

Ryuichi Matoba[1], Koshi Komai[1], Shingo Hagiwara[1], Makoto Nakamura[2]
([1]National Institute of Technology, Toyama College, Japan)
([2]Niigata Institute of Technology, Japan)

In recent years, the increase in the number of non-regular workers is one of the social problems in Japan. Since non-regular employment is a form of employment that can be dismissed at any time, the increase in non-regular employment leads to instability in the employment structure of Japanese. Since non-regular employment is a form of employment that can be dismissed at any time, the increase in non-regular employment leads to instability in the employment structure of Japanese society. For this problem, we implement a computer simulation using a multi-agent model to verify the effect of the revised law with Deep Q-Network. As a result, we were able to construct a model that is close to the employment status in the real world, and the simulation confirmed that the revised law is The simulation confirmed that the revised law is effective.



GS1-4 Emergence of the Neural Synchrony in the Multi-Agent simulation

Ivan Shpurov
(OIST, Japan)

In recent years Cognitive science begun to puzzle on the complexity of behaviors that arise from interactions between multiple agents. Social interactions between humans are associated with the emergence of neural and behavioral synchrony. In my work I propose a mathematical model for emergence of synchrony in a population of interacting agents. I use a modified version of the classical Kuramoto model of the coupled oscillators. Alterations to the model reflect the base assumption I incorporated into the model: “like attract like” – oscillators which have closer phases are more likely to bond. I show that such interaction create a population structure with distinct communities, simultaneously, making some agents “champions” of the social interactions and leaving others in “social anxiety” state in which agent struggles to synchronize with others

January 25 (Tuesday), 15:00-16:15

Room C

OS12 AROB: Computational intelligence and cognitive science for human biosignals and human well-being

Chair: Tomoyuki Hiroyasu (Doshisha University, Japan)
Co-Chair: Hiroshi Furutani (Doshisha University, Japan)

OS12-1 Dimensionality reduction methods for large-scale biomedical data: A survey of the state-of-the-art

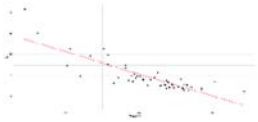
Kensuke Tanioka
(Doshisha University, Japan)

In recent years, due to the development of information technology, biomedical data has become increasingly large and complex. In order to extract useful information from such multivariate data, dimensionality reduction methods have been used. However, conventional dimensionality reduction methods such as principal component analysis (PCA) have become difficult to achieve the goal, and various dimensionality reduction methods have been proposed. Here, we focus on four types of difficult situations: high-dimensional data, contaminated data, heterogeneous data, and multi-block data. In this paper, we summarize the dimensionality reduction methods to deal with these problems and show the results of their application to actual biomedical data.

January 25 (Tuesday), 15:00-16:15

OS12-2 Analysis for COVID-19 of 47 regions in Japan

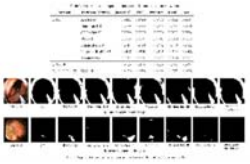
Hiroshi Furutani[1], Tomoyuki Hiroyasu[1], Satoshi Ikeda[2]
([1]Doshisha University, Japan)
([2]Miyazaki University, Japan)



We investigate the spreading of infections caused by COVID-19 epidemics in 2020 and 2021. The analysis uses the reported daily data of infections and deaths in each prefecture, and divides them into three periods; period in 2020, period in 2021 from January 1 to June 17, and 2021 June 18 to October 22. The last period is usually called as the fifth wave of outbreak in Japan. We treat the infection rate, the fatality rate, and the case fatality rate as objects of investigation. We note that two regional data, the rate of urbanization and the rate of aging, are useful for explaining the distributions of infection and fatality rates in 47 prefectures for three periods. However, the regression model cannot reproduce the case fatality rate in all periods. This suggests that it is necessary to approach the problem from another direction.

OS12-3 Performance Comparison of Deep Learning Architectures for Artifact Removal in Gastrointestinal Endoscopic Imaging

Taira Watanabe[1], Kensuke Tanioka[2], Satoru Hiwa[2], and Tomoyuki Hiroyasu[2]
([1]Graduate School of Life and Medical Sciences, Doshisha University, Japan)
([2]Department of Biomedical Sciences and Informatics, Doshisha University, Japan)



Endoscopic images typically contain several artifacts. The artifacts significantly impact image analysis result in computer-aided diagnosis. Convolutional neural networks (CNNs), a type of deep learning, can removes such artifacts. Various architectures have been proposed for the CNNs, and the accuracy of artifact removal varies depending on the choice of architecture. Therefore, it is necessary to determine the artifact removal accuracy, depending on the selected architecture. In this study, we focus on endoscopic surgical instruments as artifacts, and determine and discuss the artifact removal accuracy using seven different CNN architectures.

OS12-4 Analyzing the relationship between distracted driving and eye movement using multimodal data collected during car driving

Daigo Uraki[1], Kensuke Tanioka[2], Satoru Hiwa[2], Hiroshi Furutani[3], and Tomoyuki Hiroyasu[2]
([1]Graduate School of Life and Medical Sciences, Doshisha University, Japan)
([2]Department of Biomedical Sciences and Informatics, Doshisha University, Japan)
([3]AI x Humanity Research Center, Doshisha University, Japan)

Human error is the leading cause of traffic accidents and originates from the distraction caused by various factors, such as the driver's physical condition and mental state. One of the significant factors causing driver distraction is the presence of stress. In a previous study, multiple stressors were used to examine distraction while driving. Multiple stressors were given to the driver and the corresponding driver biometric data were obtained, and a multimodal dataset was published thereafter. In this study, we reiterate the results of existing studies and investigated the relationship between gaze variability while driving and stressor intervention, which has not yet been examined. We also examined whether biometric and vehicle information can estimate the presence or absence of secondary tasks during driving.

January 25 (Tuesday), 15:00-16:15

OS12-5 Reward enhancement and inhibition in auditory decision-making

Hidekazu Nagamura, Hiroshi Ohnishi, Momoko Hishitani,
Shota Murai, Yuma Osako, and Kohta I. Kobayasi
(Doshisha University, Japan)

In cognitive sciences, rewards, such as money and food, play a fundamental role in individuals' daily lives and well-being. Moreover, rewards that are irrelevant to the task alter individuals' behavior. However, it is unclear whether explicit knowledge of reward irrelevancy has an impact on reward priming enhancements and inhibition. In this study, an auditory change-detection task with task-irrelevant rewards was introduced. The participants were informed explicitly in advance that the rewards would be given randomly. The results revealed that while inhibition related to reward priming only occurred when the participants were explicitly informed about rewards, implicit instruction thereof resulted in enhancement and inhibition associated with reward priming. These findings highlight the contribution of explicit information about rewards associated with auditory decisions.

January 25 (Tuesday), 15:00-16:00

Room D

GS6 Bioinformatics and Medical informatics 2

Chair: Ken Naitoh (Waseda University, Japan)

GS6-1 Component decomposition of visual evoked potentials by using independent component analysis

Ayaka Narueda[1], Kazuhiko Goto[2], Takenao Sugi[3], Yoshitaka Matsuda[4], Satoru Goto[3], Takuro Ikeda[5],
Takao Yamasaki[6], Shozo Tobimatsu[7], and Yoshinobu Goto[8]
([1]Graduate School of Advanced Health Sciences, Saga University, Japan)
([2]Tokyo Metropolitan College of Industrial Technology, Japan)
([3]Faculty of Science and Engineering, Saga University, Japan)
([4]Institute of Ocean Energy, Saga University, Japan)
([5]Department of Physical Therapy, Fukuoka International University of Health and Welfare, Japan)
([6]Minohara Hospital, Japan)
([7]Department of Orthoptics, Fukuoka International University of Health and Welfare, Japan)
([8]Faculty of Medicine, International University of Health and Welfare, Japan)

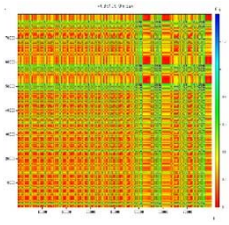
Visual evoked potentials (VEPs) are electrical responses evoked by visual stimuli in the visual cortical area. Reactivity of VEPs depends on the individual stimulus conditions and are usable for a wide range of applications. Complex stimulus pattern affects various portions of the brain. The VEP waveform consists of some components. We've been developing a system for assisting the VEPs analyses. The system had functions on detecting artifacts contaminated with records, estimating topographical mapping of each VEP peak, and the component decomposition of VEPs. The previous study showed a possibility for decomposing the VEP components by using an independent component analysis (ICA) by the limited number of data. In this study, we developed the quantitative signal decomposition method of VEPs by using ICA. The independent components related to the VEPs were selected according to the established evaluation function. The method was verified by using the VEP data recorded from 10 subjects.

January 25 (Tuesday), 15:00-16:00

GS6-2 Online and Offline Detections of Arrhythmia from ECG Signal Using Malthusian Parameter and Recurrence Plot

Hayato Ueno and Takami Matsuo
(Oita University, Japan)

In this study, a real-time estimator is presented for the detection of electrocardiographic changes in patients with cardiac diseases. We propose the adaptive estimator of the Malthusian parameter instead of the Lyapunov exponent and try to detect an onset of heart disease using two types of ECG beats including a premature ventricular contraction (PVC) in the MIT-BIH database. Moreover, we apply the AlexNet to the recurrence plot of ECG beats.



GS6-3 Improvement of an EEG analysis system for patients with dementia

Takahiro Fujimatsu[1], Takenao Sugi[2], Kazuhiko Goto[3], Yoshitaka Matsuda[4], Satoru Goto[2], Ayame Oishi[5], Takao Yamasaki[5]
([1]Graduate School of Advanced Health Sciences, Saga University, Japan)
([2]Faculty of Science and Engineering, Saga University, Japan)
([3]Department of Industrial Technology, Tokyo Metropolitan College, Japan)
([4]Institute of Ocean Energy, Saga University, Japan)
([5]Minohara Hospital, Japan)

The number of patients with dementia has been increasing, and it has become a severe problem in the current society. A definite diagnosis of dementia is possible in the present situation, but it requires special and expensive equipment. Therefore, the method for early diagnosis of dementia with simple and general is essential. Electroencephalographic (EEG) records provide a piece of important information on the clinical diagnosis of the brain. EEG is one of the candidate biomarkers for the early diagnosis of dementia, and many analyses on EEG characteristics related to dementia have been done in the past. We have been developing a system for extracting the characteristics of EEG related to the progress of dementia. The system was constructed based on the automatic EEG interpretation system that we had developed in the past. In this study, some improvements to the system were made to achieve a more detailed and efficient analysis.

GS6-4 Gait Measurement System for Health Care Mobile Robots

Ryo Saegusa[1], Misaki Gemma[2], Kayo Ogawa[2]
([1]Kanagawa Institute of Technology, Japan)
([2]Japan Women's University, Japan)

The extension of health expectancy is getting a more important subject for developed countries with higher rate of elderly population. In order to sustain their societies, aged people are encouraged to participate in the social activities, while the social participation requires them to keep their locomotive function high enough to accomplish their missions. From this reason, the easy and frequent assessment of the locomotive function thought the peoples daily lives is strongly expected. One of the promising methods to evaluate locomotive function is the Timed Up and Go test (TUG test), which is a widely used method in the field of physical therapy for locomotive rehabilitation in medical facilities. Throughout our research activities, we have been investigating robotic approaches to assess cognitive and motor functions of aged people in the purpose of their health expectancy extension. In this article, we will propose a novel method of a gait measurement system that will be incorporated with health care mobile robots developed previously. We demonstrated experiments to measure the walking patterns of 23 subjects of aged people in order to evaluate their locomotive functions using the proposed gait measurement system.

January 25 (Tuesday), 15:00-16:15

Room E

GS23 Neurocomputing technologies and its application for hardware

Chair: Toshiaki Omori (Kobe University, Japan)

GS23-1 Noise Shaping Quantization for Data Compaction of Graph Convolutional Networks

Soh Shiina, Yuki Minami, and Masato Ishikawa
(Osaka University, Japan)

Graph Convolutional Networks can handle a graph data structure as an input to a neural network. GCNs is known as a model with high classification accuracy in semi-supervised learning, which classifies nodes based on a large amount of unlabeled data and a small amount of labeled data. In general, the model size of a GCN for large and densely connected graphs may become large. Thus, reducing the model size when implementing a GCN in hardware is often necessary. This paper aims to compress the GCN model to be implemented in a microcontroller. In this paper, we proposed a quantization method that converts the continuous-valued weight coefficients of GCNs into coarse discrete-valued ones. Then, we confirmed the effectiveness of our proposed method from numerical experiments.

GS23-2 Simple Analog-Digital Sound Localization Circuit Based on Biological Auditory System

Chisato Numa, Nissho Yatagai, and Kimihiro Nishio
(National Institute of Technology, Tsuyama College, Japan)

In this study, we proposed simple circuit to detect the sound source direction based on the biological auditory system, which is characterized of the low power consumption. The proposed circuit consists of delay line and comparator. The basic circuit of delay line consists of eight metal oxide semiconductor (MOS) transistors and one capacitor. A NOR circuit is used as the comparator. The circuits were verified by the simulation program with integrated circuit emphasis (SPICE). Simulation results showed that the circuit operates at low current. The basic circuits of the delay line were fabricated on a breadboard by using discrete MOS transistors. The experimental results proposed delay line operated normally. It was found from the layout design that the area of one basic circuit of the delay line is 30 μm × 65 μm. We are expecting to realize the integrated circuits which is characterizing small area and low power consumption.

GS23-3 Data-Driven Super-Resolution for Rock Sample CT images Based on Sparse Modeling

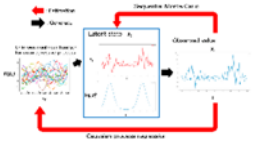
Shoi Suzuki[1], Atsushi Okamoto[2], Katsuyoshi Michibayashi[3], Toshiaki Omori[1]
([1]Kobe University, Japan)
([2]Nagoya University, Japan)
([3]Tohoku University, Japan)

In recent years, X-ray computed tomography (CT), which is also used in medicine, has been used to obtain continuous data on various structures of rocks (rock layers, sedimentary layers, fractures, pores, etc.). However, the resolution of such X-ray CT of rock cores is rather low to reveal the detailed structure of the rock. On the other hand, the resolution of X-ray CT in a normal laboratory is high. In this paper, we propose a method to increase the resolution of rock CT images by using sparse super-resolution, which uses sparsity in learning-based super-resolution. We show effectiveness of the proposed method by using low resolution CT images; the proposed method realizes super-resolution for rock samples CT images with various structures of rocks more accurately.

January 25 (Tuesday), 15:00-16:15

GS23-4 Self-Organizing Nonlinear State-Space Model Based on Gaussian Process

Takashi Terayama and Toshiaki Omori
(Kobe University, Japan)



Elucidating nonlinear systems underlying time-series data is an important subject for time-series analysis. In particular, many dynamic systems not only have nonlinearity but also have non-stationarity where the noisy elements included in latent variables dynamically increases in abnormal conditions. In this study, we propose an estimation algorithm based on the sequential Monte Carlo method for the nonlinear nonstationary state-space model based on Gaussian process regression. With the proposed algorithm, we can simultaneously estimate the underlying nonlinear dynamics and non-stationarity from the observed time-series data. In order to verify the effectiveness of the proposed method, we estimate latent variables including dynamically changing system noise from time-series data generated artificially and measured from the brain. The results show that the proposed method can properly estimate the nonlinear dynamics and non-stationarity behind the time-series data.

GS23-5 Identification and Interpretation of irony based on attention mechanism

Akinori Sato, Katsunori Shimohara, and Ivan Tanev
(Graduate School of Science and Engineering, Doshisha University, Japan)

Irony is a non-literal linguistic expression, and the automatic detection of Irony by machines remains a challenging task. We extend the framework of linguistic theories advanced to date and consider a case in which ironic sentences are classified into two types: responsive and self-contained. Using each corpus of Ironic/non-ironic sentences, a statistical irony/not-irony classifier was created through supervised machine learning and evaluated for accuracy. In addition, we used a model that extracts interpretable sentence embeddings by introducing self-attention to visualize the basis for the classifier's decisions, then discussed the results to gain new knowledge about the interpretation of irony. We achieved F-values of 0.76 for the responsive sentence corpus, and shows an improvement compared to previous research. additionally, we tried to push the frontiers of irony theory with the help of the well-studied linguistic theory of irony.

GS23-6 The generalized BP method of secret distributed processing with divided data

Hirofumi Miyajima[1], Noritaka Shigei[2], Hiromi Miyajima[2], and Norio Shiratori[3]
([1]Nagasaki University, Japan)
([2]Kagoshima University, Japan)
([3]Chuo University, Japan)

Much research has been done on AI processing in the cloud and edge systems. The purpose is how to efficiently process big data in real space in virtual space and bring valuable information to real space. One of the problems, in this case, is how to perform AI processing while preserving the privacy of big data in this cycle. So far, some learning methods are known in this field. In particular, the machine learning method by secretly distributed processing using divided data is a method for highly realizing privacy and utilization. However, this learning method assumes that communication between servers is always possible. Then, how should the learning method be realized when there exist any servers that cannot communicate? In this paper, we generalize the conventional learning method and propose a learning method that works well even if there exist servers that cannot communicate and demonstrate their effectiveness by numerical simulations.

January 25 (Tuesday), 15:00-16:30

Room F

OS22 AROB: System Sensing and Its Applications 2

Chair: Shogo Matsuno (Gunma University, Japan)
Co-Chair: Hironobu Sato (Kanto Gakuin University, Japan)

OS22-1 Blink State Classification Using 3D Convolutional Neural Network

Hironobu Sato[1], Kiyohiko Abe[2], Shogo Matsuno[3], Minoru Ohyama[2]
([1]Kanto Gakuin University, Japan)
([2]Tokyo Denki University, Japan)
([3]Gunma University, Japan)

We are developing blink measurement methods that can be applied to input interfaces. To use the eye-blinking information as an input trigger, it is necessary to automatically classify blink types into voluntary and involuntary. We are developing a method to measure the change of the open-eye area during the eye-blink process as a waveform by analyzing eye images. In our previous study, we used these shape feature parameters yielded from the waveform to achieve blink type classification. To realize this classification, the type of the conditional parameter needed to be determined manually by the developer. In this study, we introduce a new 3D convolutional neural network (3D CNN), which deals with spatial and temporal dimensional directions. This 3D CNN model is trained with a moving image dataset of the periocular area, including both voluntary and involuntary blinks. We report the classification results to evaluate its performance.

OS22-2 Study of Multiple Choice Input Method using the Motion Sensor on a Smartwatch

Kaito Hino, Tota Mizuno, Yu Matsumoto, Kazuyuki Mito, and Naoaki Itakura
(The University of Electro-Communications, Japan)

The main input methods for smartwatches are touch and voice. However, these conventional method has problems. In this study, we focused on a gesture input. We proposed three types of input methods: side tap, dial rotation, and band rotation operations, which can be easily applied without using a touch panel. For these operations, characteristic waveforms can be acquired using an acceleration sensor and an angular velocity sensor built into the smartwatch. A discrimination algorithm was created using the results of a waveform analysis, and experiments were conducted. The results showed that the average discrimination rate of the side tap operation was 88.6%, the dial rotation operation was 97.5%, the band rotation operation was 96.3%, and the average discrimination rate of all operations was 90.0%. Therefore, the proposed operation was shown to be useful as a new input method for smartwatches.

OS22-3 Development of tactile pictograms focusing on the symbol to support the movement of blind visually impaired

Kohei Kurakami, Aya Shirai, Tota Mizuno, Naoaki Itakura, and Kazuyuki Mito
(The University of Electro-Communications, Japan)

The tactile guide maps consisting with the tactile symbols and Braille are installed in the public facilities and the public transport to support the movement of the blind visually impaired. However, since the literacy rate of Braille is only about 10%, the use of tactile pictograms is proposed. Purpose of this study is to propose a tactile pictogram that reflects the image of a blind visually impaired and to verify its usefulness. We conducted a three-step experiment. (1)First, as a questionnaire survey for image extraction, images common to people were extracted using a raisewriter. (2)Then, based on the extracted images, we created sample tactile pictograms from images common to multiple people. (3)Finally, a comparison was made between the proposed new design and the existing design. From the experimental results, tactile pictograms with designs that reflect human images were found to be easier to understand than existing designs.

OS22-4 Comparison of perceptibility between the plane and the relief tactile pictograms

Daiki Suzuki, Tota Mizuno, Naoaki Itakura, and Kazuyuki Mito
(The University of Electro-Communications, Japan)

The names of the facilities on the tactile map are written in Braille, but most visually impaired people are unable to read Braille. Therefore, a method of using tactile pictograms to represent the names of facilities on tactile information maps has been attracting attention. However, previous research on tactile pictograms has shown that many pictograms are difficult to identify if they are simply convexified. On the other hand, previous research on "tactile identification" and "stereoscopic method" has shown that the discrimination time is shorter when figures are given a three-dimensional representation and the figures are raised. In this study, we applied these results to tactile pictograms and conducted a comparison experiment with conventional convex tactile pictograms. As a result of the experiment, the identification time was shorter for the tactile pictogram with three-dimensional expression.

OS22-5 Co-authorship Relationship with the Construction of a Research Laboratory: Consideration from a Network Perspective

Ayumu Miyakawa[1], Furi Kishimoto[1], Tsukasa Fujita[1], Masanao Ochi[1,2],
Masanori Shiro[1,2], Yuichi Iwasaki[1], and Tetsuo Yasutaka[1]
([1]National Institute National Institute of Advanced Industrial Science and Technology (AIST), Japan)
([2]The University of Tokyo, Japan)

We evaluated the effect of promoting interdisciplinary fusion by constructing an interdisciplinary research system based on the actual examples of real research institutes from the time evolution of the co-authorship network. We analyzed the results obtained by the members participating in the interdisciplinary research system (E-code), which was newly established at the National Institute of Advanced Industrial Science and Technology (AIST) for the realization of an environmentally harmonious society, and analyzed how the co-authorship relationship changed over time. While the number of members connected via the co-authorship relationship was 41 in 2014 and 55 in 2019, it was 68 in 2021 following the establishment of the lab in 2020. The co-authorship relationships among the members became stronger over the years, indicating that the discrete network clusters before the establishment of the lab had become more tightly knit with the establishment of the lab. Following the establishment of the laboratory, a co-authorship network was formed among the researchers from different backgrounds. While the impact factor (IF) between the studies with different backgrounds before the establishment of the lab was 2-4, the IF increased to 4-6 after the lab was established. High-impact results were obtained by combining the knowledge from different fields. The results of this study suggest that the establishment of a cross-disciplinary research system and measures such as budgetary measures and holding of seminars may contribute toward the improvement of productivity.

OS22-6 Effective Evolutionary Manipulation Setting in GNP-based rule mining method

Shogo Matsuno[1], Kaoru Shimada[1], and Takaaki Arahira[2]
([1]Gunma University, Japan)
([2]Kyushu Institute of Information Sciences, Japan)

The purpose of this paper is to evaluate the characteristics of association rule search using the GNP-based rule mining method (GNMiner), a method of evolutionary computation. GNMiner does not assume that the elite individuals in the last generation are the solutions to the problem as in general evolutionary computation methods, but adopts a strategy of generationally accumulating solutions that satisfy the given conditions. For this reason, the operation method of selection and reproduction during evolution and the method of setting parameter groups are different from those of conventional evolutionary computation. Therefore, we conducted simulation experiments in which we adjusted the mutation probability, the crossing probability, and the difficulty of rule acquisition for network connections and node attributes as parameters of the evolutionary operation. As a result, we confirmed that the parameters that are significantly affected by the progress phase of rule discovery are different.

January 25 (Tuesday), 15:00-16:00

Room G

GS28 Self-organization

Chair: Yukiko Yamaguchi (Kyushu University, Japan)

GS28-1 Self-Organization Scheme of Mobile Sensor Networks Toward Grazing Cattle Management

Kouki Ogata, Kota Okabe, and Geunho Lee
(University of Miyazaki, Japan)

Recently, there has been a lot of research on network construction for wireless communication in environmental monitoring and exploration activities, such as MANETs, as an application of swarm robots. Although much of the research has focused on the deployment and swarm movement of a large number of robots, the problem of building a robust and flexible network remains. In order to achieve these goals, it is necessary to generate self-configuring dynamic networks in which nodes can move freely and operate multi-hop. In this paper, we propose a method for constructing self-organizing networks through communication-based interaction. In this paper, we propose a method for constructing self-organizing networks using communication. Specifically, the method uses only local communication, and we verify its effectiveness against robot movement and disappearance by simulation.

GS28-2 Bridging Theory and Practice for Kilobots: The Case of Team Assembling

Run Tang[1], Yukiko Yamauchi[1], and Sébastien Tixeuil[2]
([1]Kyushu University, Japan)
([2]Sorbonne University, CNRS, France)

This paper considers the team assembling problem, that requires colored mobile robots to partition into small teams according to a given specification following A= (a_1,a_2, ldots ,a_k). That is, one team must contain a_i robots for each color i=1, 2, ldots, k. We first propose a theoretical model for mobile robots and provide a distributed team assembling algorithm. We then implement the proposed algorithm with Kilobots. Our experimental results showed that Kilobots form teams according to given specifications in spite of their asynchronous communication and local computation.

GS28-4 Change of the Feigenbaum point for two types of one-dimensional maps

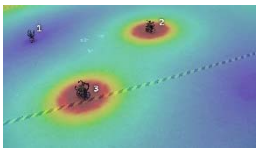
Masanori Shiro
(AIST, Japan)

For each of three map families—one defined in terms of a power of the sine function, one that is an intermediate map family between the tent map and shift map, and one that is an intermediate map family between the logistic map and a tent map—a time series recursively generated according to a parameter of the map is compressed as character strings, which is then used to detect the Feigenbaum point as a change point of the compression rate. It is shown that its transition can be approximated by an elementary function.

January 25 (Tuesday), 15:00-16:00

GS28-5 Potential Fields in Multi-Robot Systems with Rare and Delayed State Updates

Agata Barciś[1,2], Michał Barciś[1,2], and Christian Bettstetter[3]
([1]Karl Popper Kolleg on Networked Autonomous Aerial Vehicles, University of Klagenfurt, Klagenfurt, Austria)
([2]Autonomous Robotics Research Center, Technology Innovation Institute, Abu Dhabi, United Arab Emirates)
([3]Institute of Networked and Embedded Systems, University of Klagenfurt, Austria)



The concept of potential fields has been applied in multi-robot systems for collective behavior and other tasks. Such solutions, however, have problems in systems that must cope with rare and delayed state updates. These issues occur, for example, if robots exchange state information with each other. If the updates are too sparse, or the delays too long, it might result in undesirable behavior, like oscillations of positions of agents, which, in some cases, might become so severe that they lead to collisions or prevent agents from fulfilling their objectives. We analyze a method that adapts solutions based on potential fields to circumvent these issues. Simulations for swarm aggregation show successful execution even for a very low update rate. The practical feasibility is demonstrated by experiments with the ground and aerial robots.

January 25 (Tuesday), 18:10-19:25

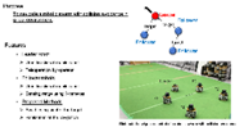
Room A

OS35 SWARM: e-ASIA Joint Research Project 2: Informational system for management of flood and landslide disaster areas using a distributed heterogeneous robotic team

Chair: Fumitoshi Matsuno (Kyoto University, Japan)
Co-Chair: Jackrit Suthakorn (Mahidol University, Thailand)

OS35-1 Experimental investigation of distributed navigation and collision avoidance for a robotic swarm

Takumi Shibuya, Takahiro Endo, and Fumitoshi Matsuno
(Kyoto university, Japan)



In this study, we focus on navigation control and perform an experimental investigation. In many previous studies, a decentralized control method using only local information has been proposed. However, since global coordinates are used and control input is calculated in a single PC in experiments, the system is regarded as partially centralized control. Thus, we first realize machines suitable for the distributed navigation control method. In conducting experiments using these machines, we encountered two problems. The first one is loss of connectivity due to the target's coordinates being momentarily out of the sensing range. The second is collisions between robots due to the target being in the blind spot of the camera's field of view and losing sight of the target. Here note that each robot has a target and moves by following it. To solve these problems, we proposed a method that removes unexpectedly output coordinates and adds rotational motion to each robot. The results show that distributed navigation control with collision avoidance can be achieved even in the actual machine experiment.

January 25 (Tuesday), 18:10-19:25

OS35-2 Stereo Vision-based Object Detection and Depth Estimation from 3D Reconstructed Scene for an Autonomous Multi Robotic Rescue Mission

Jackrit Suthakorn[1], Mayur Kishore[1], Songpol Ongwattanakul[1], Fumitoshi Matsuno[2], Mikhail Svinin[3], and Branesh M Pillai[1]
([1]Center for Biomedical and Robotics Technology (BART LAB), Faculty of Engineering, Mahidol University, Thailand)
([2]Department of Mechanical Engineering and Science, Kyoto University, Japan)
([3]College of Information Science and Engineering, Ritsumeikan University, Japan)

The 3D reconstruction of objects and depth extraction is inevitable for autonomous surveillance and mobile robot navigation in Safety, Security, and Rescue Robotics (SSRR) missions, which can be executed with the help of high-end sensors and cameras which elevates the overall operation cost. When it comes to hazardous unknown environment missions the risk factor of using these delicate sensors are at high risk, in which the malfunction of any of these is indispensable. Considering these aspects this project entails creating a stereo vision system comprising 2 low-cost HD cameras for SSRR that can extract depth from 3D reconstructed scenes and analyze performance by cross verifying with distance estimated by heat map generation. The reconstructed 3D view is used to estimate the depth of the target of interest. Depth-based object extraction is performed using binary masking and thresholding. The results are compared and assessed against the original distance. On evaluating the obtained distance with the location of Unmanned ground vehicle (UGV) the coordinates of the target are established, thereby allocating UGV with the target coordinates. When compared with the practical experiments it was found that the evaluated distance had an accuracy of more than 90% with the real-time distance.

OS35-3 Ceiling Wall Effect on Aerodynamic Characteristics of Rotor

Hiroaki Nakanishi
(Kyoto University, Japan)

Small-scale rotorcrafts, such as multi-rotor UAVs, are widely used for various purposes. In particular, aerial vehicles' inspections of infrastructures such as bridges or tunnels are highly demanded. In those situations, walls affect the airflow around the rotor and the rotor's aerodynamic characteristics. We focused on the ceiling wall effect in this paper. A horizontal velocity of the air is induced upstream due to air intake from the surrounding region if the rotor approaches the ceiling wall. A model of the change in induced speed, thrust, and required power due to the ceiling wall effect is developed based on momentum theory, considering the airflow in the direction parallel to the ceiling wall induced near and upstream of the rotor disk surface. The effectiveness of the proposed method was clarified by comparing the results of the thrust ratio derived with constant power with the experimental results.

Invited Talk 3 e-ASIA Joint Research Program: Recent progress in development of an international collaborative informational system for emergency situations management of flood and land slide disaster areas

Evgeni Magid (Kazan Federal University, Russia)

See page 17

January 25 (Tuesday), 18:10-18:55

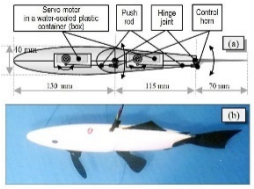
Room B

GS8 Bio-mimetics and Brain science

Chair: Kazushi Ikeda (Nara Institute of Science and Technology, Japan)

GS8-1 Evolving the Thrust of Undulatory Swimming Gaits of Fish Robot

Toshiki Komoto, Ivan Tanev, and Katsunori Shimohara
(Doshisha University, Japan)



Generally, autonomous underwater vehicles adopt screw propeller for their propulsion. However, the efficiency of such a propulsion is only about 40~50%, while the propulsion of fishes in nature is as much as almost twice more energy efficient. In this paper, we elaborate on the designed fish robot featuring two joints. Also, we explain how we optimize its undulating locomotion for maximum thrust by means of parametrical optimization of its controller (central pattern generator) via artificial evolution - genetic algorithms. Finally, we verify the superiority of the proposed two-joint morphology (over the single-joint morphologies) of the robot in that it yields a higher thrust of propulsion.

GS8-2 Locomotion Model for Pipe Inspection Robots Capable of Adaptability

Hiroki Yokoyama, Geunho Lee, and Kazuma Takemoto
(University of Miyazaki, Japan)

The problem to be addressed in this study is to improve the adaptability in the pipe. There are several elements that make up a robot, and among them, we focus on the area of the movement mechanism, which is considered to be the most active in the robot's interaction with the outside world. First, we set the necessary capabilities to achieve the objective. Although there are various possible necessary abilities, we set three goals to answer the problem of this research. In order to achieve these goals, we refer to two organisms. Based on the above, we developed the GI mechanism. We developed an experimental machine equipped with this mechanism and verified that the machine could carry out the three goals through experiments. As a result, the three goals were achieved and the effectiveness of the GI mechanism was confirmed.

GS8-3 A model of cell-group regeneration with the aid of log-periodic curves

Hiroshi Yoshida
(Kyushu University, Japan)

A log-periodic based model of leg-segment regeneration phenomena in multicellular organisms is proposed here. In this model, we take it that each cell has a value of a log-periodic curve. According to differences between the left-right dimers, a cell proliferates, moves, and dies.

January 25 (Tuesday), 18:10-19:25

Room C

GS30 Swarm intelligence

Chair: Dinh Tuan TRAN (Ritsumeikan University, Japan)

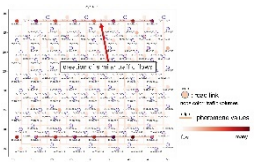
GS30-1 Swarm Diffusion-Taxis: Transport of spatial information for cooperative gradient-based navigation

Emma Milner[1], Mahesh Sooriyabandara[2], and Sabine Hauert[1]
([1]University of Bristol, United Kingdom)
([2]Toshiba Europe Limited, United Kingdom)

Swarm Diffusion-Taxis is a new algorithm for navigation of unknown environments to areas of interest. The algorithm disperses robots into an unmapped space using random walk and robots communicate locally how long ago they were in the area. Because the robots spatially diffuse, this timer estimates radial distance to the area. This creates a gradient of spatial information which can be used by robots to navigate. It is shown in simulation of ground-based robots that this creates a successful taxis effect. An intralogistics use case is simulated which requires the delivery of items to a user and compares the time taken with a fixed and dynamic area of interest. The time performance is similar to a global gradient algorithm (using a solar compass) and a connected communication algorithm (hop-based navigation). The benefits of minimal set-up and requirements, mean that robots could be cheap, simple to maintain and deployed out-of-the-box.

GS30-2 Interpolation of Traffic Information Based on Swarm Intelligence

Satoshi Suga[1], Ryu Fujimori[1], Yuji Yamada[1], Daiki Takamura[1],
Fumito Ihara[1], Ken Hayashi[1], and Satoshi Kurihara[2]
([1]Graduate School of Science and Technology, Keio University, Japan)
([2]Faculty of Science and Technology, Keio University, Japan)



Traffic congestion has become one of the most pressing social problems in today's society, so research into appropriate traffic signal control is actively underway. At present, most traffic signal control methods define traffic signal parameters based on traffic information such as the number of passing vehicles. Installing sensors at a vast number of intersections is necessary for more precise and real-time adaptive control, but this is unrealistic from the viewpoint of cost. As an alternative, we propose a swarm intelligence-based methodology that interpolates traffic information in the intersections without sensors in real-time. Our simulation results show that the proposed methodology can effectively create similar traffic routes for main traffic flows with high traffic volumes. The results also show that the proposed methodology has an excellent interpolation performance for heavy traffic flows and can adapt and interpolate to situations where traffic flow changes suddenly.

GS30-3 Optimizing Storage Allocation for Order Picking Considering Product Replacement Operations Using PSO

Minami Watanabe, Koya Ihara, Takuto Sakuma, and Shohei Kato
(Nagoya Institute of Technology, Japan)

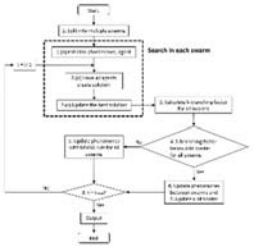
In recent years, many companies have introduced automated storage and retrieval systems or robots to their warehouses to improve efficiency, but it is difficult for small to medium businesses to install them due to their expensive price. Therefore, since order picking accounts for a large part of operations in the warehouse, rearranging products to shorten the picking distance is a low-cost and effective method. However, there are many products stored on the shelves and it is not easy to replace many of them. For such complex problems, this research proposes an optimization system for storage assignment by solving the shelf allocation problem, which determines the shelf for each product and limiting the number of replacing products using particle swam optimization.

January 25 (Tuesday), 18:10-19:25

GS30-4 A Proposal for an Island Model by Exchange of Pheromone Graph Between Swarms in MAX-MIN Ant System

Keiichiro Takashiba, Atsuko Mutoh, Koichi Moriyama, Tohgoroh Matsui, and Nobuhiro Inuzuka
(Nagoya Institute of Technology, Japan)

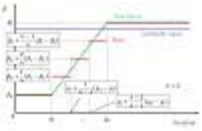
Combinatorial optimization problems (COPs) entail finding a combination of variables that best improves a certain index from numerous alternatives under various constraints. Approximate solutions to COPs include metaheuristics, such as genetic algorithm, particle swarm optimization, and ant colony optimization (ACO). ACO is an effective algorithm for the traveling salesman problem (TSP) - a COP. In metaheuristics, such as ACO, a tradeoff between intensification and diversification of search is crucial. This study proposes an island model for MAX-MIN ant system (MMAS) to escape a local solution for MMAS, a conventional method for ACO. Symmetric benchmark TSPs are used to evaluate the proposed MMAS.



GS30-6 Study on evolutionary performance of NC optimized by scheduled Cuckoo Search for rotary crane system

Kunihiko Nakazono, Naoki Oshiro, and Hiroshi Kinjo
(University of the Ryukyus, Japan)

In this study, we propose a neural network controller (NC) optimized by scheduled Cuckoo Search (CS) for the suppression of load swing in a crane system rotating around the vertical axis. The scheduled CS has the advantage that one of the design parameters is gradually changed and not fixed in the evolution process. It is possible to find the optimal solution by gradually narrowing the range of the searching solution while searching the solution space globally. Scheduling plans propose several cases in which one of the design parameters is fixed in terms of the number of steps required for each determined iteration or is curved like an exponential function. The validity of the proposed NC is verified through computer simulation.



January 26 (Wednesday), 09:00-10:30

Room A

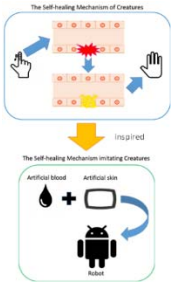
GS7 Bio-inspired robotics

Chair: Shunsuke Shigaki (Osaka University, Japan)

GS7-1 Bio-inspired self-healing mechanism imitating creatures

Aoi Uchino[1] and Mitsuharu Matsumoto[2]
([1]NTT Docomo, Japan)
([2]University of Electro-Communications, Japan)

Robots are made by human hands, and when they break down, they are repaired by human hands. Therefore, if it breaks, it takes time and effort to fix it each time. On the other hand, creatures have self-healing ability to cure their wounds by dropping their blood and congealing them when they are injured. This study focuses on the self-healing ability of living things, and aims to give robots the self-healing ability of living things. We conducted selection experiments to choose the materials for self-healing imitating creatures. Through the experiments, it was confirmed that self-repair is possible with some materials.



GS7-2 Development of bionic gannet with multiple degrees of freedom wings

Ranatchai Laosiripong and Hiroshi Ohtake
(Kyushu Institute of Technology, Japan)

Most bird robots that were built are usually lack of degrees of freedom such as fixed-wing or nondependent between two wings. In this paper, the robot that was inspired by the northern gannet was developed. The gannet has the ability to flap, pitch, plunge, and fold, these abilities make the robot have over ten degrees of freedom and make the robot look more realistic. The feathers are designed like a bird's feather (small section) not as usual bird-like robot that made wings from one-piece of material. Finally, the robot is tested by a 6-axis force sensor for evaluation for lifting and thrusting force and compared between section wing and one-piece wing.

GS7-3 A Swarm Robotic Approach to Inspection of 2.5D Surfaces in Orbit

Bahar Haghighat[1], Julia Ebert[1], Johannes Boghaert[1], Ariel Ekblaw[2], and Radhika Nagpal[1]
([1]John A. Paulson School of Engineering and Applied Science, Harvard University, United States)
([2]Media Lab Space Exploration Initiative, Massachusetts Institute of Technology, United States)

Robotic inspection is a robust, scalable and flexible alternative to deploying fixed sensor networks or human inspectors. In this work we investigate a multi-robot inspection solution. We perform simulation studies in Webots, a physics based robotic simulator, and present a distributed inspection algorithm based on the bio-inspired Particle Swarm Optimization (PSO) and Evolutionary Algorithm (EA) niching techniques to collectively localize an a priori unknown number of mechanical failure points. Our deployed robot swarm comprises up to 10 centimeter-scale bio-inspired crawling robots that move along a 3D surface using an inchworming gait and sense the vibration signal that is propagating through the surface, simulated in ANSYS software, as a cue to localize the vibration sources. We evaluate and validate the performance of our inspection algorithm deployed on the simulated robot swarm. The results show that our proposed algorithm allows a group of robots to collectively find all failure sources on 2D and 2.5D surfaces and reach the coverage threshold required to complete the inspection. This work demonstrates the viability of using a robot collective for inspection of potentially complex 3D environments.

January 26 (Wednesday), 09:00-10:30

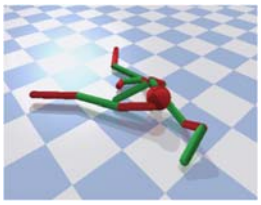
GS7-4 The effects of evolutionary selection methods for material types in soft robot design based on co-evolution of morphology, material, and control

Nanako Shimaoka, Reiji Suzuki, and Takaya Arita
(Graduate School of informatics, Nagoya University, Japan)

Soft robots are the robots which partly or totally consists of soft or elastic materials. Natural organisms are composed of various materials, and each material consumes energy in different ways, which enable efficient structure and movement. Also, energy efficiency is important to design robots in engineering application. In this study, we approached the material determination of soft robots from the viewpoint of evolutionary design. We used soft robots based on co-evolution of morphology, material type and control. The phenotype is encoded by CPPN (Compositional Pattern Producing Networks), and is represented as mass-spring system using LiquidFun: a 2D particle and rigid-body physics simulation environment. This study showed that the design of soft robots based on co-evolution of morphology, material, and control can evolve soft robots with unique behaviors utilizing the materials, which seems to be difficult to achieve with human hand design. It also showed the effect of evolutionary selection of materials on the generated soft robots. We believe that these results contribute to the methodology of automatic design of soft robots.

GS7-6 Automatic robot design inspired by evolution of vertebrates using population-based REINFORCE

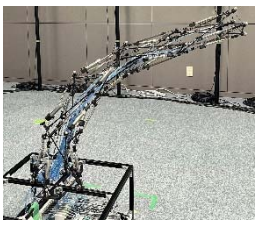
Ryosuke Koike[1], Ryo Ariizumi[2], and Fumitoshi Matsuno[1]
([1]Kyoto University, Japan)
([2]Nagoya University, Japan)



This paper proposes a novel method to design a robot by simultaneously improving its strucuture and controller. The number of rigid parts of the robot and the layout of joints connecting them are represented by a rooted tree, which is called a discrete parameter. Meanwhile, parameters that can be represented by real values are called continuous parameters; these parameters include properties such as the length and angle of each rigid part, as well as the weights and biases of the controller composed of multilayer perceptron. For the discrete parameters, we apply the efficient improvement rule, which was established based on the actual evolution of vertebrates. For the continuous parameters, we apply the population-based REINFORCE algorithm. By combining these two methods, we propose a method to simultaneously improve both the discrete and continuous parameters. Experiments confirm that the proposed method outperforms the conventional method.

GS7-7 Posture Control of Tensegrity Robot Arm based on Kinematic Model using Kernel Ridge Regression

Yuhei Yoshimitsu, Kenta Tsukamoto, and Shuhei Ikemoto
(Kyushu Institute of Technology, Japan)



Tensegrity is the three-dimensional structure composed of struts and cables, where the struts are not connected. This structure has been considered suitable as bioinspired musculoskeletal robots. Our laboratory has developed a tensegrity robot arm driven by pneumatic cylinders as an implementation of redundant and complex musculoskeletal robot structure. In this robot, changes in target pressures vary tensile force of cables and conduces the posture changes. Therefore, to control the posture of the robot, it is necessary to model the relationship between the target pressure and the robot's posture. In this study, we model the forward kinematics by machine learning and solve the inverse kinematics numerically by obtaining the Jacobi matrix from the acquired forward kinematics model. In this paper, we report this simple method for controlling the robot's hand-tip position and discuss how to improve it.

January 26 (Wednesday), 09:00-10:30

Room B

GS16 Machine Learning 1

Chair: Tomoharu Nakashima (Osaka Prefecture University, Japan)

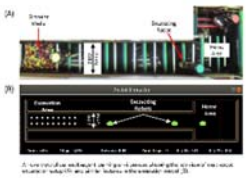
GS16-1 Estimating weight of each objective for multi-objective sequential decision-making in continuous state space

Naoya Takayama and Sachiyo Arai
(Chiba University, Japan)

Weights are used to measure priority in multi-objective reinforcement learning when linearly scalarizing the reward vector for each objective. The weights need to be set in advance; however, most real-world problems have many objectives. Therefore, many trials and errors by the designer are required to adjust the weights. In this paper, we propose a method for estimating the weights based on the rewards of each objective and the expert trajectories using the framework of inverse reinforcement learning. The effectiveness of the weight estimation method was verified through experiments comparing it with Bayesian optimization for a multi-objective sequential decision-making task in continuous state space.

GS16-2 Multi-Agent Deep Reinforcement Learning for Effective Coordination of Robot Swarms in Crowded Conditions

Kehinde Aina and Sehoon Ha
(Georgia Institute of Technology, United States)

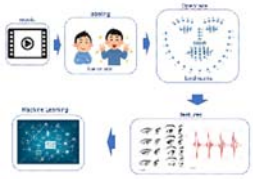


This paper studies a multi-robot collective excavation scenario where agents learn decentralized control strategies to cooperatively retrieve pellets in a narrow and confined passage. Inspired by coordinated behavior of ant colonies during nest construction, mediated by pheromone trails, we develop a multi-agent deep reinforcement learning framework for effective coordination of robot swarms in a simulated crowded and confined environment. The main challenge of the proposed multi-agent learning problem is that off-the-shelf baseline algorithms, such as Independent Q-Learning (IQL), suffer from convergence issues and perform poorly in finding an optimal policy under these conditions. To this end, we first introduce the concept of virtual pheromones to encourage indirect and decentralized communication among the agents. This communication scheme facilitates coordination in a small team size. Then, we further improve learning convergence by incorporating curriculum learning, which allows us to break the problem down into simpler sub-problems and offers better learning stability. Our results suggest that implicit or social interactions could be harnessed to achieve effective and scalable collective behaviors in multi-agent systems where complete state information or direct communication schemes cannot be employed. We demonstrate that the proposed framework can learn decentralized cooperative strategies for up to five agents that cannot be obtained with baseline algorithms. Further, we show that ``unequal workload distribution'' is an optimal strategy to mitigate ``jamming'' in crowded conditions, as observed in a group of social insects.

January 26 (Wednesday), 09:00-10:30

GS16-3 Deception Detection Using Machine Learning with Facial Expressions and Pulse Rate

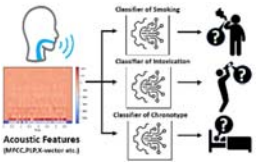
Kento Tsuchiya, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)



With the recent COVID19 pandemic, remote interviews have become increasingly popular in job-hunting activities. Unfortunately, remote job interviews allow job-hunting students to make deceptive statements more easily during an interview. According to a survey, nearly 70% of interviewers believe that deception during the selection process negatively affects the process, which implies that the ability of interviewers to detect deception among job-hunting students is important for their company. However, such ability has not been equalised in general; thus, there may be cases wherein interviewers cannot detect the deception of job-hunting students. In this study, we focus on the characteristics of remote interviewing, particularly the ability to handle the faces of job applicants as data on the screen, and propose a method for detecting deception from the facial expressions of job applicants to support the decision-making of the interviewers based on machine learning. Our model achieved an AUC of 0.89.

GS16-4 Estimation of habit information from male voice using machine learning methods

Takaya Yokoo, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)



In Japan, lifestyle-related diseases such as cancer and heart disease account for 56.9% of all diseases. The three habits of drinking, smoking, and sleeping are considered to be the most important factors in lifestyle-related diseases, but it is difficult to measure these habits easily and regularly by oneself. Therefore, we decided to use a classifier method using acoustic features and a speaker recognition method, X-vector, to estimate lifestyle habits from male voices. For the voice data set, we used the voice data set of Japanese speakers recorded at our university. As a result, we were able to show that the Cubic KNN method using acoustic features is effective for estimating sleep habits, and the X-vector method is effective for estimating smoking and drinking habits.

January 26 (Wednesday), 09:00-10:30

GS16-6 Deep Neural Network-based Framework for Estimation of Integrated Information

Ryo Omae and Toshiaki Omori
(Kobe University, Japan)

The integrated information of the brain is thought to be important for consciousness. However, to acquire the ground truth value of integrated information requires high computational cost, and it prevents us from applying to the real problems. In this research, we propose a deep neural network-based approach for estimating the integrated information. We tested our method in chimpanzee's brain activity data and achieved higher accuracy than conventional methods.

January 26 (Wednesday), 09:00-10:15

Room C

OS26 ISBC: Complexity underlying flows

Chair: Ken Naitoh (Waseda University, Japan)
Co-Chair: Tomohiro Yanao (Waseda University, Japan)

OS26-1 Consistency of twin stochasticity: stochastic Navier-Stokes equation with stochastic boundary condition revealing spatial transition point from laminar flow to turbulence in internal flows

Hiroki Kijima, Tomotaka Kobayashi, and Ken Naitoh
(Waseda University, Japan)

In our previous reports, the physical approach named "stochastic determinism" is proposed, in which the most important point is that the indeterminacy of physical quantities appears with decreasing spatial window of averaging done for particle systems in natural phenomena must match with indeterminacy at boundary condition. Indeterminacy exists because we cannot recognize the outside of the analytical domain, i.e., the boundary condition of analytical domain. Here, we solve the mysterious problem which has remained unsolved theoretically and numerically for over 100 years, the spatial transition point from laminar flow to turbulence in internal flows. Thus, the indeterminacy level for the stochastic Navier-Stokes equation obtained with a spatial window a little smaller than that for continuum approximation is decided by inlet disturbance intensity. The finite difference method based on the multi-level formulation using substantial derivative for nonlinear convection term is also included which can calculate spatial derivatives of physical quantities such as turbulence and integrated quantities accurately. The temporal process toward a transition to turbulence is especially discussed.

OS26-2 Fuel-mixing processes computed for autoignition engine having focusing compression based on colliding pulsed supermulti-jets of oxidant gas and high-pressure direct injection of liquid fuel

Zewei Zhang, Tomotaka Kobayashi, Ken Naitoh
(Waseda University, Japan)

We proposed a new compressive combustion principle leading to high thermal efficiency, air insulation, and noise reduction for various types of engines used on the ground and in aerospace. These effects are achieved by pulsed supermulti jets entering from inlet ports arranged on the combustion chamber wall, which collide at the center of the chamber. In this study, we conduct computational investigation of fuel atomization and air fuel ratio distribution in this new engine having a high pressure direct injection system with hollow cone or full cone spray pattern. We confirm improvement effects of atomization and vaporization when shock waves arising from pulsed supermulti jets pass by fuel droplets on both injection systems. The spatial distribution of air fuel ratio shows that relatively richer air fuel ratio region is generated at the center of the chamber despite extremely small amount of fuel injected. Meanwhile, high temperature in stoichiometric zone implies stability of autoignition.

January 26 (Wednesday), 09:00-10:15

OS26-3 Descriptions of vortex layer using periodic distribution function

Hiroshi Murayama, Yuya Taki, and Yoshio Ishii
(SOKA University, Japan)

In the two-dimensional flow, vortex becomes a singular point and this phenomenon is described by some unusual function which is against conventional function's definition but it can deal with calculation rules as conventional function. These functions were made possible by M.Sato's mathematical definition of unusual function called hyperfunction in the 1950s. Generally speaking, unusual function is called "generalized function" and, it means basically Schwartz's generalized function. Schwartz's generalized function is also called "distribution function". On the other hand, "hyperfunction" basically means the Sato's generalized function. Generalized function and hyperfunction facilitate the analysis of discontinuous functions and contribute significantly to the brief description of discrete phenomena in fluid dynamics. In this study, we have considered the application measures in the description of discrete fluid phenomena by using Sato's hyperfunction. We have concretely considered to describe a vortex sequence, shear layers and so on, by further expanding the description of singular points by hyperfunction. Furthermore, we have discussed to describe a singular line by expanding the description of singularity sequence by hyperfunction, and what singular lines mean in fluid phenomena.

OS26-4 Ultra-discretization of two dimensional vortex equation

Koichi Morita and Yoshio Ishii
(SOKA University, Japan)

By the method of Ultra-discretization, continuous systems become discrete systems called cellular automaton by a limit operation. For representative examples, the Ultra-discretization of Burgers equation and soliton equation. In the same way, diffusion equations and convection-diffusion equation are related to the Rule 250 and 252 of the elementary cellular automaton. Under a specific condition, there are seven rules that constitute diffusion phenomenon. We have obtained discrete equations that constitute some sort of phenomena by inverse Ultra-discretization of such a cellular automaton. In this paper, we would like to discuss the correlation between cellular automaton and PDE, and the difference and Ultra-discretization of equations called vortex equations

OS26-5 Honey Bees Find the Shortest Path: A Collective Flow-Mediated Approach

Dieu My Nguyen, Golnar Gharooni Fard, Ashley Atkins, Paul Bontempo, Michael Iuzzolino, Orit Peleg
(University of Colorado Boulder, United States)

Honey bees (Apis mellifera L.) are social insects that makes frequent use of volatile pheromone signals to collectively navigate unpredictable and unknown environments. Ants have been shown to effectively use pheromone trails to find the shortest path between two points, the nest and the food source. The ant pheromone trails are accomplished by depositing of pheromones which are then diffused passively, creating isotropic (i.e., non-directional and axi-symmetric) signals. In this study, we report the first instance of the honey bees' ability to solve the shortest path problem to localize the queen and aggregate around her by using a collective flow-mediated scenting strategy. In this strategy, individual bees not only emit pheromones, but also fan their wings to actively direct the flow of the signals, providing colony members with directional messages to the queen's location. We use computer vision and deep learning approaches to perform automatic and accurate image analysis. As a result, we quantify the number of bees in the short and long paths, and show that the short path is frequented by significantly more bees over time. We also reconstruct attractive surfaces using the positions and directions of scenting bees, and show that this surface is more attractive along the short path and around the queen as scenting bees send out directional messages and the swarm makes their way to the queen. Overall, we show that the honey bees can effectively use the collective scenting behavior to overcome local and volatile pheromone communication and find the shortest path to the queen.

January 26 (Wednesday), 09:00-10:15

Room D

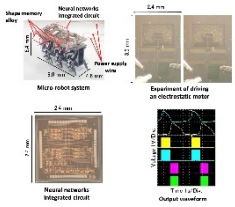
OS20 AROB: Robotics: Technologies and Intelligence

Chair: Maki K. Habib (The American University in Cairo, Egypt)
Co-Chair: Fusaomi Nagata (Sanyo-Onoda City University, Japan)

OS20-1 Development of Neural Networks Integrated Circuit Driving Electrostatic Motors for Microrobot

Hiroki Takayanagi[1], Arisa Sakaki[1], Yu Usami[1], Shinya Kato[1], Masato Ishikawa[1], Hotaka Ito[1], Noriyuki Yamada[1], Runa Enosawa[1], Sumire Furuya[1], Katsuyuki Morishita[1], Yuki Takei[1], and Ken Saito[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

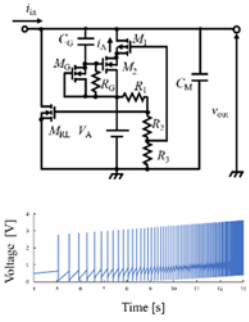
The authors are studying an insect-type microrobot using Micro Electro Mechanical Systems (MEMS) technology. The microrobot actuates by electrostatic motors that use electrostatic forces between electrodes. In the previous study, the waveform generator outputs the driving waveform of the electrostatic motor. Therefore, it is necessary to fabricate an integrated circuit capable of generating the driving waveform of the electrostatic motor to mount the driving circuit to the microrobot. This paper fabricated a Neural Networks Integrated Circuit (NNIC) as a driving circuit for an insect-type microrobot using an electrostatic motor. The NNIC generating pulse waveforms such as neural circuits of living organisms. As a measurement result, the constructed NNIC could generate the driving waveform of an electrostatic motor. Also, the NNIC could generate the anti-phase synchronization waveform that can actuate the insect-type microrobot by tripod gait.



OS20-2 Development of Pulse-Type Hardware Neuron Model with Wide Oscillation Frequency Range

Katsuyuki Morishita[1], Yu Usami[1], Isuke Okuma[2], Yuki Takei[1], and Ken Saito[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

This paper has developed a pulse-type hardware neuron model (P-HNM) with a wide oscillation frequency range. In the conventional P-HNM, charging and discharging of the capacitor were performed by a linear resistor element. In the newly developed P-HNM, we placed a new MOSFET as a nonlinear resistor parallel with the resistor. The circuit's simulation results and measurement results by discrete circuit confirmed that the newly developed P-HNM has a larger oscillation frequency variation than the conventional P-HNM. Also, we developed an integrated circuit of the P-HNM with a wide oscillation frequency range. As a result of the simulation, we confirmed that the oscillation frequency of the integrated P-HNM varies significantly, as does the P-HNM composed of a discrete circuit.

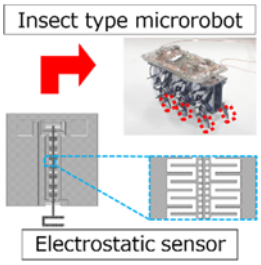


January 26 (Wednesday), 09:00-10:15

OS20-3 A Study on Capacitance Detection Circuit of Electrostatic Sensor for Microrobot

Runa Enosawa[1], Masato Ishikawa[1], Hotaka Ito[1], Noriyuki Yamada[1], Shinya Kato[1],
Katsuyuki Morishita[1], Yuki Takei[1], and Ken Saito[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

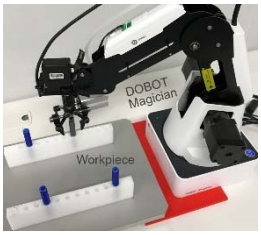
The authors studied the capacitance detection circuit of the electrostatic sensor. The capacitance detection circuit detects the force using the output frequency of the cell body model that changes depending on the capacitance. As a circuit simulation result, the authors confirm that the output frequency of the cell body model varies about 10 kHz for change in the capacitance of the electrostatic sensor. Also, the authors constructed the cell body model by the integrated circuit. The measurement result of constructed cell body model confirms that the output frequency changed due to the change of capacitance of the cell body model. As a result, the electrostatic sensor's force can measure by the frequency change with the capacitance detection circuit. By mounting an electrostatic sensor to the tip of the leg of the microrobot can respond to changes in the ground conditions.



OS20-4 Development of Control Interface for a Desktop-Sized Articulated Robot - Proposal of Hyper CLS data and Implementation of Basic functions -

Kohei Miki[1], Fusaomi Nagata[1], Kei Furuta[2], Koki Arima[1], Tatsuki Shimizu[1], Takeshi Ikeda[1], Hirohisa Kato[2],
Keigo Watanabe[3], Maki K. Habib[4]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Department of Mechanical Engineering, Sanyo-Onoda City University)
([3]Graduate School of Natural Science and Technology, Okayama University)
([4]The American University in Cairo, Egypt)

In designing and manufacturing process using CAD/CAM systems, cutter location source (CLS) data is generally used for intermediate data to finally generate numerical control (NC) data for various types of NC machine tools. In common CLS data, GOTO statements are mainly included to designate the position and orientation of a cutting tool. However, it is not supported by such standardized CLS data for industrial robots and mechatronics systems to have special or customized statements for handling an end-effector and a camera system, functioning visual feedback controllers and AI systems like convolutional neural networks (CNNs). In this paper, hyper cutter location source (HCLS) data and its control interface are introduced for a desktop-sized articulated robot to cope with such extended functions as required for automations in industrial production lines. HCLS data can include extended numerical commands, e.g., for gripper control, selection of joint or linear interpolation, camera snapshot control, for estimation of object's orientation using AI, and visual feedback control to approach to a target object for picking. The effectiveness of the proposed method is demonstrated through pick and place experiments using a small 4-DOFs articulated robot named DOBOT Magician.



OS20-5 Robot Autonomy and Adaptive Intelligent Behaviors

Maki K. Habib[1], Fusaomi Nagata[2]
([1]The American University in Cairo, Egypt)
([2]Sanyo-Onoda City University,, Japan)

The development of autonomous robots integrated with adaptive intelligent behaviors that function in a dynamic and unpredictable real-time environment still faces many challenges, such as hardware, architecture, software, algorithms and intelligence, computation, reconfiguration, scalability, communication, security challenges. In addition, such development demands developing creative thinking skills while drawing inspiration from nature as a model leading to creating new designs, systems, structures, materials, and functions supported by evolutionary technology and techniques. Autonomy also highlights the need for intelligent robotic systems having reliable and robust functional capabilities to resolve complex real-time problems associated with many applications across diverse domains. This paper introduces the concept of intelligent autonomous robots, cognitive robotics, autonomy, adaptive behaviors, and requirements. Also, it is trying to highlight the role of autonomy to shape intelligent adaptive behaviors of these robots to make their effective performance and safe, reliable decisions and act on them while assuring real-time functional requirements.

January 26 (Wednesday), 09:00-10:45

Room E

GS19 Mobile robots 2

Chair: Keisuke Yoneda (Kanazawa University, Japan)

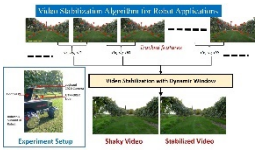
GS19-1 Development of an Inspection Drone Capable of Driving on the Ground

Takumi Watanabe, Yohsuke Iguchi, Keita Kohno, Jae Hoon Lee, and Shingo Okamoto
(Ehime University, Japan)

In recent years, factories and plants have been required to respond to the increasing number of inspections due to aging facilities. Therefore, inspections using drones have been attracting attention. Drones have the advantages of high mobility to high places and the ability to perform inspections without being affected by rough roads, but they have the disadvantage of being unsuitable for long-term operation due to high battery dissipation. A mobile vehicle with wheels, although it only travels on a flat surface, has the advantage of being able to reduce battery drainage and operate for a long time compared to a drone. Therefore, the purpose of this study was to create a drone that can move on the ground by attaching drive wheels to the drone to take advantage of both advantages. Both mobility functions in the air and on the ground of the developed system were verified through flight and drive experiments.

GS19-2 Video Stabilization Algorithm for Robot Applications

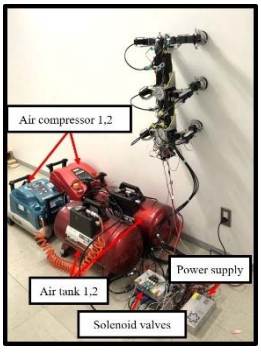
Abhijeet Ravankar[1], Ankit Ravankar[2]
([1]Kitami Institute of Technology, Japan)
([2]Tohoku University, Japan)



Service robots equipped with visual sensors have been used to automate several services. In many scenarios, these robots are tele-operated by a remote operator who controls the robot motion based on a live video feed from the robot's cameras. In other cases, like surveillance and monitoring applications, the video recorded by the robot is later analyzed or inspected manually. There could be jitters in the video due to a bumpy ground, or loose and vibrating mechanical frame on which the camera has been mounted. Jitters or shakes in these videos are undesired for tele-operation, and to maintain desired quality of service. In this paper, we present an algorithm to stabilize the undesired jitters in a shaky video. The algorithm works by tracking robust feature points in the successive frames of the camera, smoothing the trajectory, and generating desired transformations to output a stabilized video. We have tested the algorithm in practical robot applications, and found the algorithm to produce good results.

GS19-3 URARAKA VI: Multi-Legged Robot with Suckers -Climbing walls and pipes by improving leg-joint mechanism-

Kiyoaki Yoshizawa, Kazuyuki Ito
(Hosei University, Japan)



In our previous works, we focused on the advantages of a passive mechanism in realizing autonomous robots, and we developed a multi-legged robot that climbs unknown vertical walls with uneven surfaces. In this study, we improve on our previous robot to broaden its workable area to include vertical pipes and corner walls. To demonstrate the effectiveness of the developed robot, experiments that included climbing uneven walls, corner walls, a large pipe, and parallel small pipes were conducted. Our results confirmed that the developed robot could climb in these environments. We conclude that the proposed mechanism is effective for climbing such unknown complex environments. The proposed robot is expected to be used in the inspection of large-scale infrastructures.

January 26 (Wednesday), 09:00-10:45

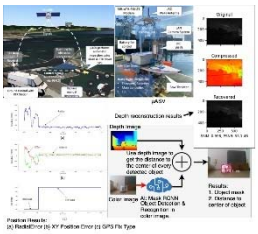
GS19-4 Mechanism of a Delivery Crawler-Type Mobile Robot Capable of Climbing Stairs

Junyan Yang, Dinh Tuan Tran, and Joo-Ho Lee
(Ritsumeikan University, Japan)

Nowadays, various delivery robots have been developed to decrease the delivery cost. In this research, a compact crawler-type mobile robot, UDOn (Ubiquitous Delivery On-demand robot), which is able to climb up and down stairs, is proposed. The robot is developed under three design concepts: low development cost, simple mechanism, and small size. To achieve the robot that satisfies the design concepts, UDOn has crawlers for climbing stairs up and down, and electrical cylinders to tilt the pose of UDOn. In this paper, we discuss and explore the feasibility of the proposed robot as well as the experimental results of its mechanical configuration.

GS19-5 Development of a Mapping System for a Small Unmanned Vessel

Kenneth Gideon, Shun Fujii, Makoto Morito, Sotaro Ono, and Junichiro Tahara
(Tokyo University of Marine Science and Technology, Japan)



We have been developing a small, uncrewed vessel to conduct ocean research and surveys at Soma port in Fukushima prefecture; we call this vessel the micro-Autonomous Surface Vehicle (μASV). This work investigated subsystems for the μASV that incorporates a Real-Time Kinematic Global Positioning System (RTK GPS), Cameras, and Light Detection and Ranging (LiDAR). The purpose is to improve the position accuracy of the μASV and to perform surveying and mapping of obstacles within its surrounding environment. We laid out the basics of the system configuration necessary for the safe operation of the μASV and conducted an operational test. The RTK position results show that at RTK Fixed: we can maintain a position residual of less than 50mm; a circular error probability (CEP) of 1.80cm; and a twice the distance root mean square (2DRMS) of 4.32cm. Furthermore, comparing the recovered depth image to the original depth image during the depth recovery process yields: a Structural Similarity Index Measure (SSIM) of 0.998 and a Peak Signal to Noise Ratio (PSNR) of 53.1.

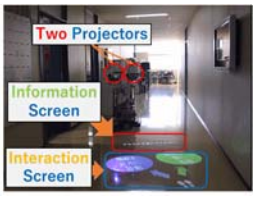
GS19-6 Research on into flight attitudes according to wing locations

Kota Okabe, Geunho Lee, and Haruka Noritake
(University of Miyazaki, Japan)

In recent years, aerial movement mechanism robots for the purpose of exploration and observation have been attracting attention. The aerial movement mechanism mainly flies using wings, and includes fixed wings, rotary wings, and flapping wings. Most of the insect mimicry robots among them imitate the number of wings and the composition of wings. On the other hand, there are differences in dragonflies and coleopterans in the position of the wings. From this difference, we think that the position of the wings may affect the flight attitude. Therefore, we will develop an experimental aircraft in which the position of the wings can be changed, and use this to clarify the presence or absence of influence.

GS19-7 Differences in Impressions of Projected Content and Projection Method in Dual-Ubiquitous Display

Kuniaki TAKAHASHI, Dinh Tuan TRAN, and Joo-Ho LEE
(Ritsumeikan University, Japan)



In the current information society, there are various ways to obtain information and the volume of such information has become enormous. As a result, it has become difficult for people to obtain appropriate information according to time and place. We developed the Ubiquitous Display (hereinafter referred to as "UD") to provide a service that enables users to obtain information even if users do not carry hardware. In addition, we are conducting research and development of a Dual-Ubiquitous Display(hereinafter referred to as "D-UD"), which is a conventional UD with one additional projector. In this paper, we propose new projection methods that include an interaction function by taking advantage of the two projectors of D-UD. Then, we evaluate the impressions that users receive from these projection methods and determine the best projection method.

January 26 (Wednesday), 09:00-10:30

Room F

GS21 Multi-agent systems

Chair: Hiroto Yonenoh (University of Tsukuba, Japan)

GS21-1 An Implementation of a Physarum Polycephalum Model on a Swarm of Holonomic and Non-Holonomic Robots

Henry Chance[1], Daniel Lofaro[2], and Donald Sofge[3]
([1]Georgia Institute of Technology, United States)
([2]U.S. Naval Research Laboratory, United States)

The slime mold Physarum Polycephalum is renowned for its perceived intelligence despite it being a unicellular organism. Some notable abilities of the true slime mold include exploring an area for food sources and establishing energy-efficient networks between them. The network progression of the slime mold can be quantized as an entropy of the system in combination with the nearest neighbor distance of each plasmodium. We leverage the use of a gradient field model to instruct individual agents, realized using simulated and real-world robots, within a multi-agent swarm to emulate the slime mold's exploratory and network establishing behaviors. Beginning with a holonomic simulation and ending with a non-holonomic deployable protocol, the entropy of the system and distance to the nearest neighbor are compared between the two implementations. We demonstrate the efficacy of this model for use in multi-agent swarms, highlighting its ability to autonomously form groupings and discover food sources.

GS21-2 Optimal Assignment Method for Mobile Assist Robot Using Matching Theory

Natsuki Shimada[1], Wenjing Cao[1], and Yu Zhang[2]
([1]Department of Engineering and Applied Science, Sophia University, Japan)
([2]Graduate School of Science and Engineering, Department of Science and Engineering, Sophia University, Japan)

In recent years, the aging of the population is accelerating, and the expectation for nursing care robots is increasing accordingly. Among the various types of robots, if we focus on mobile assistive robots, each kind of mobile assistive robot has different characteristics, such as passenger-type mobile assistive robots and mobile assistive robots. When introducing such a wide variety of robots into a nursing home, it is necessary to assign them appropriately to fulfill the demands of multiple elderly people. In this study, we consider a scenario in which multiple elderly people press the nurse call at the same time, and multiple robots are assigned so that each elderly is served by one robot. To realize long-term use of the same nursing home, we solve the problem of assigning a mobile assistive robot using matching theory. Assignments based on matching theory take into account the interest of the manager of the nursing home, the urgency of the tasks, and the elderly's preferences in the robots. Precisely, we proposed an assignment method that aims for total optimization by evaluating the urgency of the task and the distance from the robot to the elderly person, considering the preference of the elderly in the robots. Through numerical simulations, we confirmed that the average waiting time of the elderly with high urgent tasks is reduced, and that type of robot, years of use of the robot, and the usage fee of the robot match the preferences of the elderly.

GS21-3 Energy-Aware Multi-Robot Task Allocation in Persistent Tasks

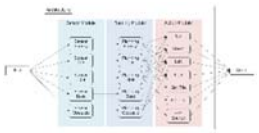
Ehsan Latif, Yikang Gui, Aiman Munir, Ramviyas Parasuraman
(University of Georgia, United States)

The applicability of the swarm robots to perform foraging tasks is inspired by their compact size and cost. A considerable amount of energy is required to perform such tasks, especially if the tasks are continuous and/or repetitive. Real-world situations in which robots perform tasks continuously while staying alive (survivability) and maximizing production (performance) require energy awareness. This paper proposes an energy-conscious distributed task allocation algorithm to solve continuous tasks (e.g., unlimited foraging) for cooperative robots to achieve highly effective missions. We consider efficiency as a function of the energy consumed by the robot during exploration and collection when food is returned to the collection bin. Finally, the proposed energy-efficient algorithm minimizes the total transit time to the charging station and time consumed while recharging and maximizes the robot's lifetime to perform maximum tasks to enhance the overall efficiency of collaborative robots. We evaluated the proposed solution against a typical greedy benchmarking strategy (assigning the closest collection bin to the available robot and recharging the robot at maximum) for efficiency and performance in various scenarios. The proposed approach significantly improved performance and efficiency over the baseline approach.

January 26 (Wednesday), 09:00-10:30

GS21-4 Proposal for automatic parameter learning method of agent activation spreading network by evolutionary computation

Daiki Shimokawa[1], Naoto Yoshida[1], Shuzo Koyama[1], Satoshi Kurihara[2]
([1]Graduate School of Science and Technology, Keio University, Japan)
([2]Faculty of Science and Technology, Keio University, Japan)



There has been a lot of research on so-called Narrow AI, but the study of Artificial General Intelligence (AGI) is still in the beginning phase. To construct AGI, a high degree of adaptability in dynamic and complex environments is necessary, and to achieve this, multi-agent planning has been proposed. However, the agent network structure and the parameters have been determined manually in most conventional methods. Therefore, in this paper, we propose a method to adjust these parameters by using evolutional computation automatically. As a result, we found that the agent activation propagation network can learn parameters by using evolutionary computation and that it acquires parameters appropriate to their environment even when the environment is changed.

GS21-5 Policy-oriented Goal Selection in Multi-Agent Reinforcement Learning for Dynamic Environments without Communication

Fumito Uwano
(Okayama University, Japan)

This paper focuses on advanced issues out of general situations of multi-agent reinforcement learning to simulate the real world. Concretely, the cooperative learning in the situation of the reward function does not have the cooperative factor, that is, the reward function evaluates only the agent's own profit, not the cooperation contribution. In addition, the environment changes dynamically and the agents cannot communicate with each other. To solve this issue, this paper proposes a noncommunicative and cooperative control method for policy-based deep reinforcement learning. Concretely, the proposed method expands profit minimizing reinforcement learning with the oblivion of memory (PMRL-OM) to replace the learning mechanism with asynchronous advantage actor-critic (A3C) and improve the goal selection to balance between exploration and exploitation of reinforcement learning and overcome the previous method's limitation of implementing only value-based reinforcement learning. This paper investigates the effectiveness of the proposed method on a dynamic environment in a maze problem to result as follows: (1) the proposed method can learn optimal policy along dynamism of other agents and environment; (2) the proposed method performs over the baseline methods as A3C and PMRL-OM; and (3) the proposed mechanisms can control the exploration and exploitation of the goal selection of agents cooperatively without communication. The findings suggest that noncommunicative cooperation can be learned by agents on the problems with different resolutions of agents' input.

GS21-6 Distributed Reinforcement Learning that Emerges Teamwork between Agents with Different Abilities

Yuki Hyodo, Takuto Sakuma, and Shohei Kato
(Nagoya Institute of Technology, Japan)

Most of real-world problems can be defined in multi-agent environments, and cooperative behavior among agents is required to solve the problems. Therefore, we approach problem-solving in a multi-agent environment using deep reinforcement learning. Lowe et al. proposed Multi-Agent Deep Deterministic Policy Gradient (MADDPG), which is a typical method of multi-agent reinforcement learning. However, MADDPG uses the information acquired by all agents during learning, so it cannot apply to real world problems where agents cannot get observation obtained by other agents. In this research, we approach this problem. We assume an air rescue using a fixed-wing aircraft and a helicopter as an example of a real-world problem. The fixed-wing aircraft and the helicopter have different capabilities, and the air rescue system aims to accomplish the task in cooperation that takes advantage of the difference in the abilities of these agents.

January 26 (Wednesday), 09:00-10:45

Room G

GS25 Robot vision and image processing 1

Chair: Ahana Roy Choudhury (Valdosta State University, USA)

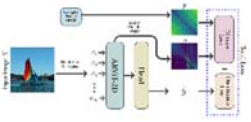
GS25-1 Unsupervised joint learning of depth, camera pose and optical flow with geometric relationship

Takuro Kojima, Michifumi Yoshioka, and Katsufumi Inoue
(Osaka Prefecture University, Japan)

In unsupervised learning of depth estimation in monocular videos, it is difficult to estimate depth due to the negative effect of the non-rigid region in the video. To solve this problem, we use optical flow to reduce the negative effect. To jointly train a network for estimating optical flow with networks for estimating depth and camera pose, we use the geometric relationship between depth, camera pose, and optical flow and define a new loss function. We conducted experiments to validate the effectiveness of our proposed method on KITTI dataset, as a standard benchmark. The results show that the proposed method provides more accurate depth estimation performance than the conventional method for all seven quantitative indices.

GS25-2 Regularizing self-attention on vision transformers with 2D spatial distance loss

Luiz Henrique Mormille, Clifford Broni-Bediako, and Masayasu Atsumi
(Soka University, Japan)



The vision transformer (ViT) achieved remarkable results on computer vision tasks. However, ViT lacks the inductive biases present on CNNs. Overcoming this deficiency usually comes at high cost, with networks with hundreds of millions of parameters trained on large-scale datasets. We propose a novel approach to tackle the vision transformer's lack of inductive biases: a self-attention regularization mechanism based on two-dimensional distance information on an image with a new loss function, denoted Distance Loss, formulated specifically for the Transformer encoder. Furthermore, we propose ARViT-2D, a small-scale architecture in which the self-attention regularization method is deployed. The baseline ARViT-2D pre-trained on the ILSVRC-2012 ImageNet dataset on a self-supervised pretext-task outperforms a similar capacity Vision Transformer by large margins on all tasks. By introducing the self-attention regularization method, ARViT-2D's performance was further improved. When comparing with large-scale self-supervised vision transformers, ARViT-2D outperforms the SiT, but still underperforms MoCo and DINO.

January 26 (Wednesday), 09:00-10:45

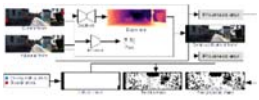
GS25-3 Human Detection on Unmanned Aerial Vehicle Perspective with NVIDIA Jetson Nano For Surveillance System

Aprinaldi Mantau, Irawan Widi Widayat, and Mario Köppen
(Graduate School of Computer Science and Systems Engineering, Kyushu Institute of Technology, Japan)

At this time, there have been many illegal activities carried out, such as illegal mining, illegal hunting, illegal logging, and forest burning. These things can have a substantial negative impact on the environment. The limited number of officers and the high cost required to carry out monitoring are the reasons why these illegal activities are increasingly rampant. One possible solution is to create a surveillance system that utilizes artificial intelligence to monitor the area. Unmanned Aerial Vehicle (UAV) and NVIDIA Jetson modules (general-purpose GPUs) can be relatively inexpensive and efficient because they use small resources. The problem from the object detection field using the drone's perspective is that the objects are relatively small compared to the observation space, also illumination and environmental challenges. In this study, we will demonstrate the use of the state-of-the-art object detection method You Only Look Once (YOLO) v5 using a dataset of visual images taken from a UAV (RGB-image) along with Thermal infrared information (TIR). There are seven scenario training methods that we have done in this research with RGB and Thermal Infrared data to find the best model that we will deploy on the Jetson nano module later. The experimental result shows that a new model with pre-trained model transfer learning from the MS COCO dataset can improve YOLOv5 to detect the human object in the RGBT image dataset

GS25-4 Self-Supervised Visual Odometry Based on the Projection of Reliable Pixels

Shi Zhou[1], Zijun Yang[1], He Li[2], Seiichi Serikawa[1], Mitsunori Mizumachi[1], Lifeng Zhang[1]
([1]Kyushu Institute of Technology, Japan)
([2]Northeastern University, China)

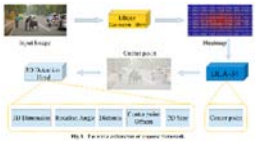


Complex outdoor environment includes variable lighting, moving objects and direct sunlight, visual odometry in outdoor environments remains a challenging problem. In this work, a self-supervised pose estimation network is trained based on the projection between adjacent frames. The pose between two adjacent frames is a 6D vector. It can be solved with a part of effective pixels instead of all the pixels. Thus, only reliable pixels are under consideration when training. To eliminating the influence of unreliable pixels, outside mask and poor projection mask are proposed to check them out. Furthermore, we evaluated the proposed method on the KITTI datasets and compared it with other deep learning-based visual odometry methods. The result shows that the proposed method can detect poor projection and outside pixels well. Moreover, it achieves higher accuracy pose estimation.

January 26 (Wednesday), 09:00-10:45

GS25-5 A Keypoint-Based and Anchor-Free 3D Detection for Autonomous Driving Using Monocular Camera

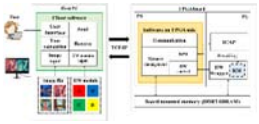
Zhen LI[1], Yuliang Gao[1,2], Qingqing Hong[2], Yuren Du[2], Seiichi Serikawa[1], Lifeng Zhang[1]
([1]Kyushu Institute of Technology, Japan)
([2]Yangzhou University, China)



Autonomous driving technology has received great attention from scientific research and social marketing. 3D object detection technology is the core research topic of autonomous driving. Nowadays, most 3D object detection researches heavily depend on lidar and radar sensors, which could directly offer depth information. However, inspired by human driving experiences, 3D world perception can be obtained by pure visual scheme. This paper proposed an anchor-free and keypoint-based 3D object detection framework using a monocular camera. Our work took CenterNet as baseline and made several improvements to achieve better 3D detection performance. First, we utilized the rotation angle regression method in polar coordinate system, which has simplified the original framework greatly. Then, we proposed the ellipse Gaussian Filter method to fit the ground truth rectangular boxes much more better. Finally, this paper also improved the backbone network of DLA-34, the more complex neural network performances better in complex 3D detection task. Our proposed framework can improve 3D detection by $6.9%$ in pedestrian classification. And the whole detection performance, including 2D detection, also improved to $97.8%$ for vehicles.

GS25-6 Development of a general purpose verification environment for high-level-synthesis image processing hardware with support for dynamic partial reconfiguration

Atsushi Shojima and Akira Yamawaki
(Kyushu Institute of Technology, Japan)



The verification of image processing hardware using FPGAs requires various peripherals. Although commercial FPGA boards include peripherals, it is necessary to develop interface circuits in order to use them. Furthermore, since each board has different peripherals, new interfaces have to be designed. Also, these are not generated by HLS. Therefore, we are developing a verification environment that is independent of the peripherals of FPGA boards. The verification environment we proposed last time consists of a general-purpose FPGA board, a PC, and server/client programs running on the PC and on the FPGA board. By virtualizing the peripherals to be installed in the product on the PC, verification can be performed regardless of the peripherals on the FPGA board. However, the hardware must be compiled on the FPGA implementation tool each time. Therefore, we aim to create a verification environment in which hardware can be replaced dynamically during verification by implementing DPR.

GS25-7 Visual inspection based on PCA analysis of higher-order local autocorrelation features

Taiga Eguchi, Valentin Grave, Osamu Fukuda, Nobuhiko Yamaguchi, Hiroshi Okumura
(Saga University, Japan)

Our research group has been developing an image inspection system based on higher-order local autocorrelation (HLAC) as a high- speed processing technique. The goal of this study is to improve the efficiency of feature representation and the accuracy of anomaly detection. We use principal component analysis (PCA) to summarize a large number of correlated features into a small number of uncorrelated synthetic variables. We reduce the number of dimensions to determine the local components that contribute to anomaly detection. We conduct a verification experiment using plastic parts, which are misjudged by a conventional image inspection system based on HLAC with small changes, and confirm the usefulness of anomaly detection using PCA. The experimental results show that PCA can robustly detect anomalies even for small changes.

January 26 (Wednesday), 13:15-14:45

Room A

OS14 AROB: Human-Centered Robotics-I

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Mohan Rajesh Elara (Singapore University of Technology and Design, Singapore)

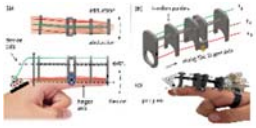
Invited Talk 4 Haptic Information Systems in XR Horizons

Ali Israr (Research Scientist, Facebook Inc., USA)

See page 19

OS14-1 Human-Centered Design of A Wearable Kinesthetic Haptic Device for Surgical Teleoperation

Farhad Shabani[1] , Sajid Nisar[2] , and Fumitoshi Matsuno[1]
([1]Kyoto University, Japan)
([2]Kyoto University of Advanced Science, Japan)



The current method of providing haptic feedback by integrating it into the master device (of a surgical robot) is not fully compatible with the safety requirements of robot-assisted surgery (RAS), mainly due to control stability issues. To avoid dealing with the above-mentioned issue, we propose a new teleoperation scheme that separates the control and haptic feedback with the help of a wearable haptic device. This paper focuses on the design of a lightweight semi-flexible wearable device that is expected to be fully compatible with RAS. The device can provide 3-D kinesthetic feedback (flexion-extension, abduction-adduction, and along the finger-axis) to the user's fingertip and keeps the palmar side of the user's hand free, which enables them to handle a master device concurrently. In the future, the device will be integrated with a surgical robot for performance evaluation and characterization.

OS14-2 Design of Tele-Haptic Simulators for Two-Channel Control Architectures

Falaq Qureshi and Riaz Uddin
(Haptics, Human-Robotics and Condition Monitoring Lab (affiliated with National Center of Robotics and Automation - NCRA HEC/PC Pakistan, Pakistan)

In this paper, the design of different models for teleoperation control by presenting the significant benchmark results for various important force reflecting control architectures used in single-DOF bilateral teleoperation are discussed. They are used to analyze the results of force and position tracking profiles in free motion and contact mode obtained from various control models by varying dynamics of master, slave, environment, and communication channel. In this regard, different force reflecting teleoperation control architectures are simulated via proposed model design, such as two-channel (2C) architectures for position error-based force reflection (PE) architecture and direct force reflection (PF) architecture. These benchmark results are presented for each architecture via MATLAB/Simulink-based simulator.

January 26 (Wednesday), 13:15-14:45

OS14-3 Training for Fine-Manipulation Tasks using A Wearable Interface With and Without Haptic Feedback

Kumar Mahadayya Swami[1], Farhad Shabani[2], Alireza Mesbah[2], Kiona Hosotani[2], Belal Ahmed Elsyed[2], Fumitoshi Matsuno[2], Sajid Nisar[1]
([1]Kyoto University of Advanced Science, Kyoto - Japan, Japan)
([2]Kyoto University, Japan)

This research investigated the feasibility of using a wearable haptic-enabled robotic interface to train human operators for fine manipulation tasks in robotic teleoperation. For that purpose, a haptic-enabled robotic glove has been used with a custom-designed Unity-based VR training environment to perform two fine manipulation tasks: (i) pegs-transfer, and (ii) zigzag path-following. A user study has been conducted to evaluate the user performance and experience for the above-mentioned tasks with and without haptic feedback using the wearable glove. The 'number of mistakes' and 'task completion time' were recorded as the evaluation metrics and user's subjective ratings were obtained through a questionnaire. The results showed that all subjects had fewer number of mistakes when haptic feedback was provided, also the task completion time was improved. In the future, we plan to conduct a full-scale user study to validate these findings.

OS14-4 An Adaptive Neuro-Fuzzy Inference System to Solve Perceptual Aliasing for Autonomous Mobile Robots

Syeda Madiha Qamar[1], Fahad Iqbal Khawaja[1], Sara Ali[1], Ahmed Hussain Qureshi[2], Yasar Ayaz[1], Naveed Muhammad[3], and Abdul Ghafoor Abbasi[1]
([1]National University of Sciences and Technology(NUST), Pakistan)
([2]Purdue University, United States)
([3]University of Tartu, Estonia)

The ever increasing applications of mobile robots have made it one of the most active fields of research. Simultaneous Localization and Mapping (SLAM) is one of the core problem of this area in which the robot has to keep track of its current position and orientation while it configures its environment at the same time. Perceptual aliasing is a sub-problem of SLAM in which a robot has difficulty in distinguishing between two similar places. In this paper, we present a novel solution for perceptual aliasing by using an Adaptive Neuro-Fuzzy Inference System (ANFIS) model based on first order Sugeno model with 5 layers. Our proposed ANFIS model combines the advantages of both neural networks and fuzzy logic based systems. The experimental results show that the proposed ANFIS model is trained correctly and it presents an excellent solution to the perceptual aliasing problem under consideration.

January 26 (Wednesday), 13:15-14:30

Room B

OS33 SWARM: Control for Open Swarm Intelligence

Chair: Shun-ichi Azuma (Nagoya University, Japan)
Co-Chair: Kazunori Sakurama (Kyoto University, Japan)

OS33-1 Verification of Drone that Learned Maneuvering Skills of Drone Operator

Shinnosuke Ito, Yushiro Hayakawa, Manabu Suzuki, Keiko Yamamoto, and Yuji Mishima
(National Institute of Technology, Hakodate College, Japan)

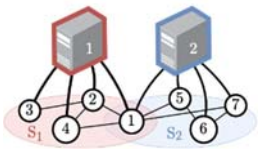
Drones are currently in a period of global exuberance to create new industries, expanding the field of application from hobby to industry. This research focuses on drone inspections of mega-solar facilities, and aim to reduce the number of personnel by automating the inspections through autonomous control using AI that mimics human thinking. As a preliminary step, this research measures the information used by humans during drone operations and verifies whether it is possible to predict drone operations performed by humans using deep learning.

January 26 (Wednesday), 13:15-14:30

OS33-2 Implementation of Consensus Control Using Encrypted Distributed Controllers

Hiroaki Kawase[1], Kazunori Sakurama[2], and Kiminao Kogiso[1]
([1]The University of Electro-Communications, Japan)
([2]Kyoto University, Japan)

A multi-agent system, one of the distributed systems consisting of multiple agents with privacy data, is used for large-scale network systems with many customers. However, the conventional computation scheme cannot protect private data with access control and encrypted communication under cyber attacks. This paper proposes a secure consensus control algorithm that conceals the graph structure, controller parameters, and agent states. We achieve secrecy by dividing the distributed controller into multiplication with a multiplicative homomorphic cryptosystem and addition. For the computation of the controller, we introduce third-party computers (servers) and provide the condition for server placement to achieve consensus. Furthermore, we confirm that the multi-agent system with proposed encrypted controllers almost achieves consensus while keeping the graph information secret in numerical examples.



OS33-3 Wolf–Raven Cooperative Hunting: A Multi-Agent Model

Dinh Hoa Nguyen
(Kyushu University, Japan)

This paper proposes a novel mathematical model of cooperative hunting inspired from the realistic behaviors of a wolf and a raven in their joint hunting trips. The unique characteristics of the proposed model, which makes it different from other existing models in the literature, are twofold. First, there is a collaboration of the two predators, instead of their competition. Second, positions and velocities of the two predators are time-varying, due to their movement in different spaces, the environmental conditions, and the prey movement. Owing to such features, the proposed model has a great potential of applicability in a variety of applications and systems such as the cooperation of aerial and ground vehicles and robots for surveillance, search and rescue, exploration, etc. Finally, simulations are carried out to illustrate the dynamics of the proposed model.

OS33-4 Characterization of feedback vertex sets in consensus networks

Daiki Sugiyama, Shun-ichi Azuma, Ryo Ariizumi, and Toru Asai
(Nagoya University, Japan)

Feedback vertex sets are known to be key vertices in the observation and control of network systems. Meanwhile, in leader-follower consensus control, which is one of the basic control methods for multi-agent systems, the leader selection problem is an important issue to obtain high performance. Motivated by the above facts, we are interested in the relationship between feedback vertex sets and leader-follower consensus control. This paper addresses a leader selection problem and shows that, for the fastest convergence of consensus, the leaders should be selected so that the leader set is equal to a feedback vertex set. To the best of our knowledge, this paper is the first result to disclose the relationship between feedback vertex sets and leader-follower consensus control.

OS33-5 Performance Analysis of Vehicle Platooning at Intersection Based on Pinning Consensus Control

Ayaka Tanaka, Koichi Kobayashi, and Yuh Yamashita
(Hokkaido University, Japan)

In this paper, a new method of vehicle platooning at an intersection is proposed based on self-triggered pinning consensus control. Using the proposed method, collision avoidance is achieved without vehicles stopping nor backing. First, the outline of self-triggered pinning consensus control is explained. Next, the problem setting of vehicle platooning is given, and virtual merge and split of vehicle groups are proposed. Finally, performance analysis of self-triggered pinning consensus control for vehicle platooning at an intersection is conducted.

January 26 (Wednesday), 13:15-14:15

Room C

OS27 ISBC: Human and virtual systems

Chair: Hideo Miyachi (Tokyo City University, Japan)
Co-Chair: Ken Naito (Waseda University, Japan)

OS27-1 Current Status of xR Technology Application in Manufacturing Industry and Demand for Quantitative

Kodai Tsushima[1] and Hideo Miyachi[2]
([1]Ebara.co.ltd, Japan)
([2]Tokyo City University, Japan)

One of the challenges in the industrial application of xR technology is that it is easy to evaluate qualitatively, but difficult to back it up with quantitative evaluation. Therefore, we attempted to evaluate the work time with and without the AR remote support tool by conducting training on the disassembly procedure of our products. In this experiment, the operator disassembled the pump following the instructions of the support person. This was done with and without the AR tool. The time required was measured and the contribution of the AR remote support tool to the time reduction and stability was analyzed. The results showed that the time could be reduced by 20% on average, and the time variance could be controlled. We believe that this is due to the fact that the instructions are easily conveyed.

OS27-2 Process Visualization and Verification of Improvement Methods and Effects

Takumi Yamane, Mami Kimura, Minagi Miyokawa, Koshiro Murakami, Hideo Miyachi
(Tokyo City University, Japan)

We have been working with companies that dismantle automobiles and home appliances to improve their processes by using material flow cost accounting (MFCA) to obtain information on the amount of materials entering and leaving each dismantling process. In addition, we have also conducted video analysis to improve work-level procedures in each process, but we have not been able to find an effective method because of the limitations of manual video analysis only. Therefore, in this study, we attempted to improve the efficiency of work analysis by using image processing technology based on machine learning, which has been widely used in recent years, to develop software. The object of this study was the process of removing CFC gas from the outdoor unit of an air conditioner. Based on this video, we developed software that automatically extracts characteristic tasks from the movements of the right forearm by acquiring skeletal information of the worker using Openpose, a machine learning software that estimates human posture. The software automatically extracts the "hoist" task of moving five or six units from the pool of waste equipment to the dismantling line with a chain hoist, the "socket" process of connecting the hose for removing CFC gas, and the "moving" task of moving units on the line. In the conventional, we used ELAN software to manually annotate the video with the name of the task type, but we verified the reduction of workload by using this automatically extracted information. It was found that by applying the image processing technology to five types of videos and obtaining hints for the video positions of "hoist," "socket," and "moving," the outline of the task cycle could be recognized without watching the videos, which was expected to reduce the missed rate by reducing the time spent manipulating the videos. We also found some improvements in the proposed method, such as the inclusion of errors in the start and completion times of the extracted tasks.

January 26 (Wednesday), 13:15-14:15

OS27-3 Affective Interaction Between Human and Agent via Inverse Bayesian Inference

Kazuto Sasai and Ryo Hanazaki
(Graduate School of Science and Engineering, Ibaraki University, Japan)

Spinoza claimed a notion of Affectus as a solution for the mind-body problem. Affectus suggests an inseparable and contradictive representation of body and mind. In this paper, We propose a communication scheme based on Affectus, named the affective interaction, and demonstrate by using an inference model representing the creation and de-creation process. The experiment uses the rock-paper-scissors (RPS) game. The three types of algorithms are applied to the computer player. The first type of player selects the hand with uniform random, Bayesian inference, BO (Bayesian-Only) player, and Bayesian and Inverse-Bayesian (BIB) inference. The results of the BIB case shows the power-law distribution of the duration of successive win or lose and of the successive hand patterns. The power-law of the successive decision-making process is known as levy walk, a type of random walk that realizes the duality of exploration and exploitation.

OS27-4 Intensive Transformation of Agitated Humans in Collective Collaboration Game

Ryo Hanazaki and Kazuto Sasai
(Ibaraki University, Japan)

In the cooperative behavior of human groups, scattered partial optimizations may occur and the whole group may fall into a stalemate. Shirado et al. prepared a graph network that imitates a social network, and had humans interact with noisy bots in the network. The results showed that the optimization of the population was enhanced when the noise parameter of the bots had a certain value. However, the strength of the noise depends on the system, making it difficult to find an appropriate noise parameter. In this paper, we put humans inside a population of noise agents and verified the cooperative behavior of the population. As a result, the ability of the group to reach a solution improved with optimal parameters and the human choice changed depending on the intensity of the noise, and we confirmed the change in the behavioral model of the human in the group.

January 26 (Wednesday), 13:15-14:30

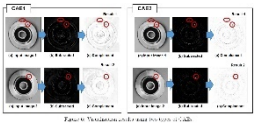
Room D

OS9 AROB: Biomimetic Machines and Robots I

Chair: Keigo Watanabe (Okayama University, Japan)
Co-Chair: Fusaomi Nagata (Sanyo-Onoda City University, Japan)

OS9-1 Visualization and Location Estimation of Defective Parts of Industrial Products Using Convolutional Auto Encoder

Koki Arima[1], Fusaomi Nagata[1], Tatsuki Shimizu[1], Kohei Miki[1],
Hirohisa Kato[1], Akimasa Otsuka[1], Keigo Watanabe[2]
([1]Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)



The authors have been developing a design and training application with a user-friendly operation interface for CNN (Convolutional Neural Network), CAE (Convolutional Auto Encoder) and SVM (Support Vector Machine), which can be used for the defect detection of various types of industrial products even without deep skills and knowledges concerning information technology. The application is required to have a visualization ability of small defects which would be the causes of classification results, however, it seems to be not easy to provide such a promising function as clearly identifying the position of defect. In this paper, CAE is applied to the visualization and position detection of such small defects included in images of industrial products. The effectiveness and promise are evaluated through visualization experiments of defective areas included in test images.

January 26 (Wednesday), 13:15-14:30

OS9-2 Image Processing to Improve Visualization Function of Defect Areas Included in Mechanical Parts Using Grad-CAM

Tatsuki Shimizu[1], Fusaomi Nagata[1], Koki Arima[1], Kohei Miki[1],
Hirohisa Kato[1], Akimasa Otsuka[1], Keigo Watanabe[2]
([1]Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)

The authors have been developing a design, training and evaluation application with a user-friendly operation interface for CNN (Convolutional Neural Network), CAE (Convolutional Auto Encoder) and SVM (Support Vector Machine), which can be used for the defect detection of various kinds of industrial products even without deep skills and knowledges concerning information technology. When Grad-CAM (Gradient-weighted Class Activation Mapping) is applied to visualizing interested areas affecting classification results, different areas not relating to target defects are sometimes mapped majestically. In this paper, visualization performance of defective regions using the Grad-CAM is tried to be enhanced. Before learning process, all images in training data set are preprocessed by a proposed masking method, in which not-interested areas in each image are replaced with randomly generated mask patterns. The effectiveness and promise of proposed method are evaluated through visualization tests of defective areas using the Grad-CAM.

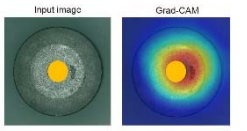


Figure 6: An example of visualization result obtained by applying Grad CAM to GNC.

OS9-3 A study of 3D and AR transformation of spectral data

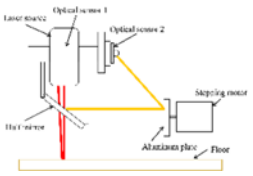
Yuma Furuichi, Shogo Nonaka
(NIT, Tsuyama College, Japan)

In recent years, many systems have been developed to support the user's work with augmented reality (AR). On the other hand, spectral information is mainly used for detailed analysis of invisible information, and in recent years, 3D analysis data of the individual to be analyzed has been required. In this study, we aim to develop a system that can support and improve the efficiency of the analysis work by analyzing the spectral information in parallel with the site visit and data acquisition for the analysis, and providing the information immediately by AR. In this paper, we first propose and construct a correction algorithm for spectral information, and compare and verify it with the output images. Next, we select several region extraction methods for AR, and compare and examine the methods that are useful for our system.

OS9-4 Development of a Precise Speckle Odometer for Enduring to Wavelength Changes of Light Source

Sotaro Nakata, Isaku Nagai, and Keigo Watanebe
(Okayama University, Japan)

For the coexistence of autonomous mobile robots and humans, accurate self-positioning is essential. In order to solve these problems, a speckle odometer was developed for use as a sensor for detecting the amount of movement of a mobile robot. The speckle odometer can measure the two-dimensional displacement of a moving surface contactlessly by detecting the laser beam reflected at the moving surface using a light receiving sensor. However, this system suffers from a problem of large measurement errors due to temperature changes of the laser light source when used for a long time. This is thought to be caused by mode hopping, in which the semiconductor laser jumps to another wavelength nearby due to temperature changes during emission. In this study, we propose a new high-precision speckle odometer with a half-mirror and an additional light receiving sensor for detecting the accuracy change.



January 26 (Wednesday), 13:15-14:30

OS9-5 Multi-scale modeling method of worn surfaces using wavelet transformation

Akimasa Otsuka and Fusaomi Nagata
(Graduate School of Engineering, Sanyo-Onoda City University, Japan)

Recently, digitization in the manufacturing field has been significantly developing. In the design stage of products, the geometrical models of the products are desired to follow the digitization and higher prediction for product performance. When designers consider product life in the design stage, worn surface models are desired to predict its life accurately. The mechanism of wear is complicated, and the worn surface is usually plateau structure as wear progress by cutting surfaces' peaks locally. A multi-scale method is suitable to model the worn surface because wear progress appears locally. In this study, we propose a primary profile modeling method that takes wear into consideration using wavelet transformation. The effectiveness of the method is verified by comparing the experimental results based on several primary profile parameters. The results showed that differences of parameters between the actual surfaces and the simulated surfaces were less than 20%.

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Room E

OS23 AROB: Vehicle Control

Chair: Shinichi Sagara (Kyushu Institute of Technology, Japan)
Co-Chair: Masahiro Oya (Kyushu Institute of Technology, Japan)

OS23-1 Development of Robust Braking Controller for Autonomous Vehicles to Achieve Any Ride Comfort Performance

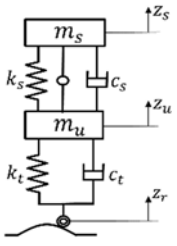
Hiraku Komura and Masahiro Oya
(Kyushu Institute of Technology, Japan)

The number of automobile accidents has been decreasing year by year in Japan, but the number of accidents still exceeds 300,000 as of 2020. People have paid attention to the automatic driving technology as one technology for reduction of the number of accidents. To achieve this goal, the various automatic driving control methods have been developed. However, these automatic driving systems have some problems, such as the passengers' ride comfort. To overcome this problem, we developed a robust brake controller that can realize the ride comfort desired by the passenger even through the vehicle parameters are different from the nominal values. To develop this system, we designed an ideal vehicle brake model that can easily achieve the ride comfort and developed a robust braking controller. As a result of numerical simulation, we confirmed that our brake system satisfies the requirement of the ride comfort and braking performance simultaneously.

OS23-2 A New Active Suspension Controller for Vehicles

Yi Wang[1], Yuichiro Taira[2], Masahiro Oya[1]
([1]Kyushu Institute of Technology, Japan)
([2]Sojo University, Japan)

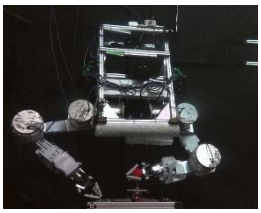
In general, if handling stability of a vehicle with an active suspension system is further improved for hard road bumps, ride comfort may deteriorate considerably in some range of road bump frequencies. To overcome the problem, we will develop an active suspension controller based on a quarter vehicle model so that LQ controller can work in almost cases, and handling stability can be improved only in the case when the absolute value of the relative tire load becomes large. At first, we develop an active suspension control system using LQ controller. Next, we will develop a nonlinear controller so that handling stability can be improved only in the case when the absolute value of the relative tire load becomes large. Then, we will propose a new active suspension controller in which the nonlinear controller is added to the LQ controller.



January 26 (Wednesday), 13:15-14:30

OS23-3 Impedance control experiments of a dual-arm underwater robot

Ryouma Mizoguchi[1], Yuta Hanazawa[1], Shinichi Sagara[1], Yuichiro Taira[2], and Radzi Ambar[3]
([1]Kyushu Institute of Technology, Japan)
([2]Sojo University, Japan)
([3]Universiti Tun Hussein Onn Malaysia, Malaysia)



Underwater robots equipped with multiple robotic manipulators, called UVMS (Underwater Vehicle-Manipulator System) are becoming important in ocean development for a variety of purposes such as construction and deep-sea mineral mining. UVMS can be utilized to substitute humans in underwater operations especially related to underwater intervention tasks. However, intervention tasks require the robot to interact with surrounding environment or tools using manipulators which can destabilize the control of robot.As a solution, the authors have developed a force-impedance control system and have verified its effectiveness by simulation and experiment. In this paper, we propose an improved force control system that incorporates the external force acting on the hand into the equations of motion of UVMS. To demonstrate the effectiveness of the system, we show experimental results using a 3-link dual-arm underwater robot.

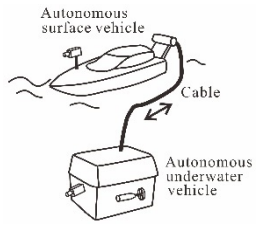
OS23-4 Experimental comparison of position control methods for UVMS using a dual-arm underwater robot

Yuu Matsuo[1], Kenta Yamamoto[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

Most of the control methods for Underwater Vehicle-Manipulator Systems (UVMS) have been proposed based on the configuration consisting of vehicle position and attitude, and manipulator joints displacement. The authors have proposed a Resolved Acceleration Control (RAC) method for UVMS based on the task-space consisting of the position and attitude of both the vehicle and manipulator end-tips. In this paper, we compare the performance of the RAC control method with joint-space control methods namely, Computed Torque and Sliding Mode Control methods through position control experiments using a 3-link dual-arm underwater robot.

OS23-5 Modeling and Control of an Underwater Robotic System Composed of Two Different Types of Autonomous Vehicles

Yuichiro Taira[1], Shinichi Sagara[2], and Masahiro Oya[2]
([1]Sojo University, Japan)
([2]Kyushu Institute of Technology, Japan)



This paper deals with an underwater robotic system that consists of two different types of autonomous vehicles (i.e., an autonomous underwater vehicle and an autonomous surface vehicle), connected to each other through a cable. Its mathematical model is required for developing its control scheme. However, this model is complicated, because the surface vehicle of this system has nonholonomic constraints, and the cable of this system is a flexible object. Furthermore, this system has the dynamic coupling between its components (i.e., the two vehicles and the cable). In general, a complicated model leads to a motion controller with complex structure. In this paper, we propose a simple mathematical model for this type of underwater robotic system. Its feature is that the cable of this system is regarded as a rigid rink system with all unactuated joints (i.e., an underactuated arm).

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Room F

GS11 Evolutionary computations (Genetic algorithm)

Chair: Ekaterina Sangati (Okinawa Institute of Science and Technology, Japan)

GS11-1 Multi-objective coevolutionary algorithm based on preference direction

Dan Zhou, Jiqing Du, and Sachiyo Arai
(Chiba University, Japan)

As the number of objectives increases, nondominated solutions surge. Considering the preferences of decision makers (DMs) in evolutionary algorithms, DM's region of interest (ROI) can be found, which is very important in practical applications. A multi-objective coevolutionary algorithm based on preference direction (MOCA-PD) is proposed. According to the non-dominant relationship and preference level, the whole population will divide into the elite and common populations. The elite solutions build teams by selecting team members from the two populations based on preference ratios, using coevolution mechanisms to drive team evolution towards DM's ROI. The external elite population retains the solutions in DM's ROI. The dominance mechanism maintains the diversity of the external elite population. The experimental results show that the proposed method can efficiently search for the preferred solution using preference information. MOCA-PD has good convergence and diversity for two objectives ZDT and three to eight objectives DTLZ problem.

GS11-2 Solution to the Polygon Packing Problem Rotation Using Adaptive Distributed Genetic Algorithm

Ryoto Minami, Shudai Ishikawa, and Hirokazu Shimada
(National Institute of Technology, Oita College, Japan)

The polygon packing problem is a combinatorial optimization problem that requires placing a given set of polygons within a rectangular strip with a fixed height and an arbitrary length. And, we aim to minimize the width. However, each polygon must not overlap. In most of the previous research, rotation is not allowed or is fixed. In this paper, we propose a new method for converting the irregular strip packing problem into the rectangular packing problem using an adaptive distributed genetic algorithm. The proposed method combines several pieces and approximates them into a rectangle. Consequently, the rotation pattern of the rectangle can be narrowed down to two types: 0 degrees and 90 degrees. The algorithm is based on DGA which is capable of global search. Experiments were conducted on the ECCUP dataset to compare the spreading rate with existing methods. The final result was inferior to the existing method.

GS11-3 Deep Learning Security Breach by Evolutionary Universal Perturbation Attack (EUPA)

Neeraj Gupta[1], Mahdi Khosravy[2], Olaf Witkowski[2], Antoine Pasquali[2], Khalid Mahmood Malik[1]
([1]Oakland University, Rochester, USA)
([2]Cross Labs, Japan)

The potential for sabotaging Deep Convolutions Neural Networks (DCNN) classifiers by Universal Perturbation Attack (UPA) has proved itself as an effective threat to fool deep learning models. For sensitive applications such as Autonomous vehicles, clinical diagnosis, face recognition, and etc. It exploits the Deep CNN classifiers to mislead for wrong responses. Prospective application of UPA is for adversarial training of DCNN against attacks but, literature has very limited exploration on evolutionary UPA (EUPA) using evolutionary algorithms that have already been shown their tremendous ability in solving non-convex complex problems. Thus, UPA needs to be explored on powerful evolutionary algorithm to minimize the perturbation (magnitude and numbers) while maximizes the misclassification on maximum data samples. In this research, we light on the novel multi-objective NSGA-II evolutionary framework by Real Coded Genetic Algorithm (RCGA) to evolve the UPA. The efficacy of the methodology is analyzed on state-of-the-art Deep Convolution Neural Networks (DCNN)s for its effectiveness on the Imagenet data set. The comparative results enhance the state-of-the-art methodology significantly to analyze the vulnerabilities of deep models

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GS11-4 A constructive approach toward the evolution of co-representation

Yusuke Yamato, Reiji Suzuki, and Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

The ability of co-representation allows humans to understand action goals and tasks of others, to predict actions of others, and even to coordinate one's own actions. It is a very important property for humans to live in a society in which they interact with others. We aim to evolve artificial neural networks with neuromodulation, which have the co-representations ability in order to deepen the understanding of it. For this purpose, we propose a cooperative task that extends DMTS task, which was used to detect metamemory in animals, as a framework for evolving neural networks with the ability to jointly represent the metacognition of the other agent in this paper. We introduce the whole framework, and report on the progress of experiments towards the evolution of co-presentation.

GS11-5 Investigating the Effect of Survival Selection Policy in Surrogate-assisted Genetic Programming

Sohei Kino[1], Tomohiro Harada[2], and Ruck Thawonmas[2]
([1]Ritsumeikan University, Japan)
([2]Tokyo Metropolitan University, Japan)

In this paper, we investigate the effect of different policies of survival selection to select the next generation in genotype-based surrogate-assisted genetic programming (G-SAGP), which uses tree structure similarity to estimate the fitness value of each individual. Specifically, we compare the (μ, λ)-type and the (μ+λ)-type, which are commonly used in evolutionary computation methods. The experimental results show that, in the (μ + λ)-type, G-SAGP can obtain the optimal solution in a smaller number of generations while maintaining a higher success ratio than the standard GP.

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Room G

GS14 Identification and Estimation

Chair: Hee-hyol Lee (Waseda University, Japan)

GS14-1 Human arms' compliance properties based on upper limb posture and muscle activity analysis in steering wheel operation

Honoka Sugimoto[1], Toru Tsumugiwa[1], Ryuichi Yokogawa[1], Mitsuhiro Narusue[2],
Yusaku Takeda[2], and Toshihiro Hara[2]
([1]Doshisha University, Japan)
([2]Mazda Motor Corporation, Japan)

Humans manipulate the steering wheel of a car by changing their arm motion properties while perceiving the mechanical properties of automobiles. This study aims to present the effect of upper limb posture and muscle activity on the arms' compliance properties in the steering wheel operation and to clarify the steering mechanism of the left and right arms. The steering system, capable of measuring the left and right arms' steering torque, was constructed to identify the compliance values of the left and right arms. The analysis results show that there is a significant difference between the left and right arms' compliance values. The compliance value of the left arm in the counterclockwise direction and the right arm in the clockwise direction increases with an increase in the steering angle. Additionally, the compliance values change with changes in joint angles and muscle activity of the upper limbs.

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GS14-2 Research on the tuning of Tannkin production

Kazuha Yamamoto, Nobuo Iwasaki, Kazuya Okamoto, and David Marsh
(National Institute of Technology Wakayama College, Japan)

Kishu Bincho charcoal from Wakayama prefecture is famous throughout Japan. “Tannkin” a musical instrument using Kishu Bincho charcoal, is made in Akitsugawa. The tuning work is done by the craftsman by cutting the charcoal with a hatchet, which takes a lot of time be-cause it depends on the intuition and experience of the craftsman. In this study we consider a system for producing charcoal with an accurate pitch. In this study, accurate pitch judgment is an important factor. We consider pitch judgement by frequency analysis. We obtain the frequency characteristics of charcoal by frequency analysis of the sound observed by hitting it. Next, we obtain the shape, density, and Young's modulus of charcoal in order to process charcoal to the de-sired pitch. From this information, we calculated the amount of charcoal processed. As a result, we succeeded in efficiently processing charcoal with a natural frequency close to the desired pitch.

GS14-3 Estimation Scheme for Behavioral Intentions of Underarm Throwing Based on Visual Data

Naohisa Togami, Geunho Lee, and Takahiro Fukudome
(University of Miyazaki, Japan)

To estimate ball-throwing intentions based on the swinging motion of people with upper-body disabilities when throwing a ball, in this paper, an appropriate body part is determined and its relationship to release angles in multiple people is investigated. As a result, a correlation between shoulder movement and release angle was observed in many subjects, but it was confirmed that there were individual differences in the slope of the correlation. In the future, our goal is to use this correlation to construct an algorithm for estimating throwing intention. This paper is expected to expand the means of support for people with upper body disabilities in boccia.

GS14-4 Behavioral Recognition Considering Multiple Possession Positions Using Smartphone Accelerometers by Transfer Learning

Rui Kitahara and Lifeng Zhang
(Kyusyu Institute of Technology, Japan)

With the widespread use of smartphones and wearable devices in recent years, various applications have been developed to use their built-in sensors.Among them, HAR (Human Activity Recognition) using accelerometers has the advantage of privacy protection compared to camera-based data acquisition.Therefore, it is thought a good approach to watch over the elderly who live alone in the coming elder society.However ,most of the behavior recognition has been done by fixing the possession position of the smartphone in one place, measuring the data, and recognizing the behavior.However, this is not according to the actual situation because people carry smartphones around in different places.Therefore, the purpose of this study is to recognize behavior by considering various possession positions.

GS14-5 The Hilbert Curve-based Speech Signal Visualization for Speech Emotion Recognition

Zijun Yang, Lifeng Zhang, Shi Zhou, and Seiichi Serikawa
(Kyushu Institute of Technology, Japan)

This paper proposed a method to convert the one-dimensional speech signal into two-dimensional image signal, so that the mature image processing skills can be used to analysis speech signal and implement speech emotion recognition. The article uses the Hilbert Curve which can fill the entire space and give a mapping between one-dimensional and two-dimensional space. Moreover, to better illuminate the effectiveness of the proposed method, we use the proposed method convert the six emotion language signals dataset into the images, and a neural network is trained on the created dataset. The result shows that the trained model can achieve an accuracy rate of 51.7%. It means use the method that convert the speech signal into image signal implement speech emotion recognition is well. In the follow-up, we will further optimize the algorithm to improve the accuracy.

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GS14-6 Development of Estimation Scheme for Direction of Signal Arrival in Concrete Structures

Takeshi MIZUGUCHI, Geunho LEE, and Chunhe LI
(University of Miyazaki, Japan)

In this paper, we develop a "signal arrival direction estimation model" in concrete as one of the techniques used to estimate the direction of internal defects in concrete. This model estimates the direction of arrival of signals from the difference in arrival times of multiple signals. After preparing the equipment and implementing the model, we conducted validation experiments of the developed model using concrete specimens. As a result, it was confirmed that the model can detect the direction of arrival of elastic waves in concrete. In the future, we will work on further improving the accuracy and developing a method to estimate the direction of internal defects in concrete.

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Room A

OS11 AROB: Brain Theory from ALIFE

Chair: Hiroyuki Iizuka (Hokkaido University, Japan)
Co-Chair: Takashi Ikegami (The University of Tokyo, Japan)
Keisuke Suzuki (Hokkaido University, Japan)

Invited Talk 5 Bayesian agents in a physical world

Nathaniel Virgo (Tokyo Institute of Technology, Japan)

See page 20

OS11-1 The shared-module neural network for self/other differentiation and symbol grounding

Hiroyuki Iizuka
(Hokkaido University, Japan)

This paper introduces our new hypothesis that our brain has a shared module that reuses part of the neural network as a basic mechanism. Based on this hypothesis, we performed simulations using a deep learning model. Our results showed that the learning constraints imposed by the shared module structure led to the differentiation of self/other representations and the acquisition of basic skills necessary for social cognition. In the simulation of sensory integration, we showed that symbol grounding can be achieved by associating common representations of shared module with external symbols. From these findings, the validity of the shared module hypothesis is discussed.

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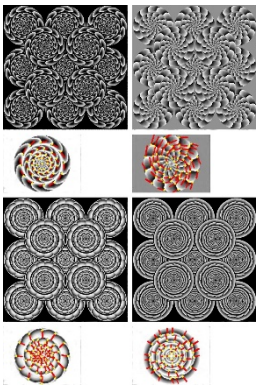
OS11-2 Evolutionary Generation of Visual Motion Illusions

Lana Sinapayen[1] and Eiji Watanabe[2]
([1]Sony CSL Kyoto, Japan)
([2]National Institute for Basic Biology, Japan)

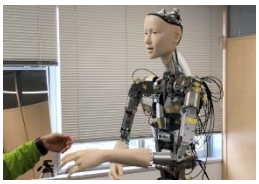
Why do we sometimes perceive static images as if they were moving? Visual motion illusions enjoy a sustained popularity, yet there is no definitive answer to the question of why they work. We present a generative model, the Evolutionary Illusion GENerator (EIGen), that creates new visual motion illusions. The structure of EIGen supports the hypothesis that illusory motion might be the result of perceiving the brain's own predictions rather than perceiving raw visual input from the eyes. The scientific motivation of this paper is to demonstrate that the perception of illusory motion could be a side effect of the predictive abilities of the brain. The philosophical motivation of this paper is to call attention to the untapped potential of "motivated failures", ways for artificial systems to fail as biological systems fail, as a worthy outlet for Artificial Intelligence and Artificial Life research.



OS11-3 Experiments on Generating Self-Image for Robots Using Piezoelectric Networks and Transformers by Android Robot Alter3

john smith, Kenichi Tomeoka, Atsushi Masumori, Norihiro Maruyama, Takashi Ikegami
(University of Tokyo, Japan)

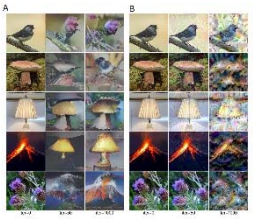
In this study, we propose to use transformer, a form of deep learning, to create a self-image of a robot's body from a network of sensors. We compare the angle-based posture recorded by the potentiometer with the posture inferred by the transformer from the network of piezo sensors as a body posture body surface sense, and discuss whether such an attempt can acquire a higher-order self-image than a simple vector and angle.



OS11-4 Modelling Perceptual Phenomenology of Visual Hallucinations using Deep Neural Networks

Keisuke Suzuki
(Hokkaido University, Japan)

Visual hallucinations (VHs) are the perception of objects or events in the absence of the sensory information. While there are broad similarities between etiologically distinct VHs such as the suggested major dopaminergic system involvement, there are also substantial phenomenological differences. Here, we address this challenge in the field of computational modeling by leveraging recent advances in visualizing the learned representations of a coupled deep convolutional neural network and deep generator network. By selectively manipulating the image optimization parameters of the network, we simulated several aspects of hallucinatory phenomenology based on reports of neurological VHs and VHs induced by psychedelic substances. We assessed the accuracy of our synthetic VHs by surveying neurological and psychedelic groups, and the appropriate synthetic VHs were reported as being representative of the hallucinatory phenomenology. These results suggest that neurological and psychedelic VHs may involve different computational mechanisms in their underlying visual processing.



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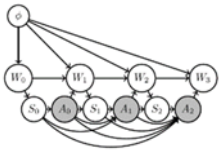
OS11-5 Designer uncertainty and agent uncertainty in partially observable Markov decision processes

Martin Biehl[1] and Nathaniel Virgo[2]
([1]Cross Labs, Cross Compass, Japan)
([2]ELSI, Tokyo Tech, Japan)



Consider the problem of designing an agent to interact with an environment, which might have some hidden state. There are in general two kinds of uncertainty that might be considered in this situation: uncertainty that the designer might have about the environment that the agent will face, and the uncertainty that the agent might have about the hidden state. We use the framework known as planning-as-inference to explore these issues, and we show how both kinds of uncertainty can be modeled. Designer uncertainty can be added simply by treating it as part of the hidden state. The agent will act to gather information about the environment if this is needed in order to achieve the goal, without any changes needed to the algorithm. To model the agent's uncertainty we extend the planning as inference framework with an explicit model of the agent's subjective probabilities. This allows the agent's knowledge to be used as part of an objective function, for example in order to implement curiosity.

OS11-6 A new look at neural entropy from the perspective of enactive cognitive science

Tom Froese
(Okinawa Institute of Science and Technology Graduate University, Japan)

I propose that we need a less rigid naturalistic framework that makes conceptual room for the efficacy of subjectivity. An essential step is to remove complete physical determinism from our concept of nature, a shift that occurred in the natural sciences in the first half of the last century. Accepting this shift in cognitive science entails that an agent's bodily behavior can in principle be influenced by subjective factors that are shaped by, yet underdetermined by, the previous physical state of the complete organism-environment system.

OS11-7 Do Androides ape?

Takashi Ikegami, Norihiro Maruyama, John Smith, and Atsushi Masumori
(The University of Tokyo, Japan)

We are studying the mimetic behavior of a new humanoid robot called Alter 3. Alter-3 imitates human poses by using a camera eye and a built-in simulator to pre-simulate and execute its own actions. Alter-3 also stores the behavioral sequences in its memory layer. The purpose of this study is to investigate what happens to this imitation ability in the case of reciprocal imitation, versus Alter, versus human, and to quantify it using techniques such as transfer entropy and UMAP compression. One of the key observations of this study is that Alter 3 is able to produce a greater variety of movement patterns by mutual imitation with humans than imitation with other Alter.

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Room C

OS28 ISBC: Human system

Chair: Toru Ohira (Nagoya University, Japan)
Co-Chair: Hideo Miyachi (Tokyo City University, Japan)

OS28-1 On the Backtracking of the Lin-Kernighan Traveling Salesman Problem Heuristic

Yuta Kodama
(Graduate School of Mathematics, Nagoya University, Japan)

This report discusses the backtracking of the Lin-Kernighan heuristic, which is one of the most effective heuristics for the symmetric traveling salesman problem. To return a 3-opt tour, this heuristic uses the five-levels-backtracking method. This restricted backtracking enumerates all proper closed alternating walks of lengths 4 and 6. During the iteration, however, this backtrack often searches the neighborhoods that are unlikely to be improved, leading to the increase of search time. Here, we propose a new method to invoke the fifth level of backtracking before the regular backtrack to solve this shortcoming of the heuristic and demonstrate that the search time decreases.

OS28-2 On the upper and lower bounds of the Metric Traveling Saleman Problem

Hiroaki Maruo
(Graduate School of Mathematics Nagoya University, Japan)

The traveling salesman problem is one of the critical problems in the combinatorial optimization problem. It is being researched because it can be applied to various issues in the real world. This study describes an approximation algorithm that can calculate theoretical values in the traveling salesman problem. The behavior of the upper bound algorithm Christofides and the lower bound algorithm Held-Karp in the benchmark path was considered. As a result, the calculated values of each algorithm for TSP of 46 types of 2D Euclidean distances were found, and the behavior with the increase in the number of points was considered.

OS28-3 A Study on Measuring Human Skills on eSports by using Eye Tracking System

Koshiro Murakami and Hideo Miyachi
(Tokyo City University, Japan)

Human skills improvement has been studied for years and it is clarified that skilled players in each sports category have been shown to have different and superior sensory cognitive abilities. For example, karate athletes can respond significantly faster and more accurately than novices in choice reaction time. However, anything human skills improvement in eSports field is not clarified. Therefore, we started to study of measuring human skills which are improved from eSports. In our previous study, we measured relationship between refresh-rate of display and simple reaction time by playing simple game, and it is suggested that using display with high refresh-rate is mostly advantageous on eSports. It is because, human reaction time become faster when refresh-rate of display gets higher but, specific skills improved from eSports have not clarified yet. In this study, we measure the score of a music game and track players gaze by using eye tracking system when playing the game, and it is clarified difference between experts and beginners.

January 26 (Wednesday), 16:15-17:15

OS28-4 A Study on Motion Analysis of Disassembly Work of Home Appliances Using Arm Posture Information Obtained by Openpose

Minagi Miyokawa, Mami Kimura, Takumi Yamane, Koshiro Murakami, and Hideo Miyachi
(Tokyo City University, Japan)

In the process improvement of line work in factory, the work procedures and work assignments are proposed to be improved by analyzing the work from the videos taken at the line. Then, the process of recording the time chart of the work categories from the video taken is called coding. This work requires repeated observation of the video, which places a heavy burden on the coding staff, and this fatigue can easily lead to missed work. Although many researches have been conducted to automate the task by using image processing, it is still difficult to develop a general-purpose system because the tasks vary from site to site. In this study, we support coding of videos of dismantling home appliances by applying a human posture recognition system based on machine learning, which has been put to practical use in recent years. First, we use OpenPose to extract the worker in the video and obtain the posture information of the worker. Next, we develop a system that extracts the projection length and orientation of the worker's right forearm, converts it into audio waveform, and outputs it as wav data in storage. With this system, the movement of the right forearm can be imported as a waveform into ELAN, a free software that is widely used for coding work. By using the waveform as a supplemental information, it is expected to reduce the time required for coding and also reduce the number of errors.

January 26 (Wednesday), 16:15-17:30

Room D

OS10 AROB: Biomimetic Machines and Robots II

Chair: Keigo Watanabe (Okayama University, Japan)
Co-Chair: Fusaomi Nagata (Sanyo-Onoda City University, Japan)

OS10-1 Development of Robot to Arrange Chairs Using 2D Markers

Keitaro Matsunaga[1], Isaku Nagai[1], and Keigo Watanabe[1,2]
([1]Okayama university, Japan)
([2]BAICIRS, Beijing Institute of Technology, Beijing, China)

In recent years, a variety of cleaning robots have been developed to automate the cleaning process of indoor spaces and enrich our lives. Today, the introduction of these cleaning robots is automating the cleaning of indoor spaces and enriching our lives. However, at present, the environment in which these cleaning robots can work is limited to spaces that are not narrow. Therefore, it is necessary to create an environment by humans before the robots can operate. Therefore, in order to solve these problems and increase the versatility and automation quality of cleaning robots, it is considered effective to have other robots carry out the environment creation in cooperation with the cleaning robots. In this study, we will develop a robot that can automatically and inexpensively realize environment creation for cleaning robots.

OS10-2 Teleoperation System for a Mobile Robot Using 360-degree Camera and HMD

Kiyotaka Izumi, Shogo Nakamura, and Takeshi Tsujimura
(Saga University, Japan)

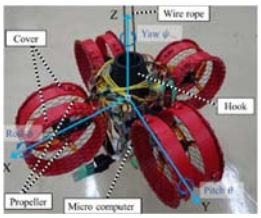
In this research, we developed a teleoperation system for mobile robots using a spherical images and voice instructions that are easy for ordinary people to handle.

January 26 (Wednesday), 16:15-17:30

OS10-3 Load-Sway Suppression Control Using a Robust Backstepping Method with a Horizontally Movable Multi-Rotor

Ryusei Kira[1], Ryota Mino[2], Keigo Watanabe[1,3], Shinsuke Kanda[2], Isaku Nagai[1], and Kazuya Miyamoto[1]
([1]Okayama University, Japan)
([2]TADANO LTD., Japan)
([3]BAICIRS, Beijing Institute of Technology, Beijing, China)

The sway and rotation of suspended loads by a crane may lead to a decrease in work efficiency and an accident. If the crane boom is controlled, then only the load sway can be suppressed, but it needs to directly control the movement of the load if both the sway and rotation are suppressed. Therefore, a horizontally movable multi-rotor, which can be attached to a suspended hook and move in any plane direction, is developed, and a method for controlling this is also proposed by using the robust backstepping approach that is based on a MIMO nonlinear model with an input time-delay. Then, this multi-rotor is controlled in a simulation environment, which is assumed to conduct an actual machine experiment, and it is demonstrated that the suspended hook can be controlled in transrational and yaw motions.



OS10-4 Backstepping sliding mode control based on exponential reaching law for an omnidirectional quadrotor manipulator

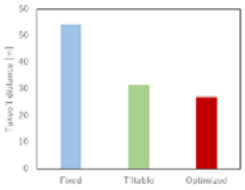
Shilin Yi[1], Keigo Watanabe[1,2], and Isaku Nagai[1]
([1]Okayama University, Japan)
([2]BAICIRS, Beijing Institute of Technology, Beijing, China)

In this paper, the stabilization problem of an omnidirectional quadrotor manipulator with four tiltable rotors is investigated. The quadrotor manipulator consists of a quadrotor with four tiltable rotors and a 2-DOF serial manipulator. Unlike the conventional sliding mode controller, an integral backstepping sliding mode controller with an exponential reaching law is proposed to directly improve the dynamic characteristics of the reaching phase of sliding mode for alleviating the chattering phenomenon. The integral backstepping sliding mode controller proposed in this research is a combination of an integral backstepping controller and a sliding mode controller. The stability of the proposed controller is proved by applying the Lyapunov stability theory. The effectiveness of the controller is validated by a simulation on stabilization problem of the quadrotor manipulator.

OS10-5 Improvement of Takeoff of Wing-In-Ground Effect Vehicles by Nonlinear Optimal Control using the Steepest Descent Method

Yutaka Hiruma[1], Keigo Watanabe[1,2], and Isaku Nagai[1]
([1]Okayama University, Japan)
([2]BAICIRS, Beijing Institute of Technology, Beijing, China)

Wing-in-ground (WIG) effect vehicles are aircraft that use the ground effect to fly at altitudes of tens of centimeters to several meters above the ground or water surface. By using such an effect, it is possible to fly with less energy than a normal aircraft, so that by using this, it is possible to load much more luggage than an aircraft and cruise at a higher speed than a ship. However, the long takeoff distance is thought to be an issue for WIG effect vehicles. In this research, such a problem is improved by introducing four tiltable rotor mechanisms. In this paper, a model that considers the thrusts due to such tiltable rotors is derived, and try to optimize the tilt angle of the tilt rotor by using nonlinear optimal control. Finally, its effectiveness is verified by simulation.



January 26 (Wednesday), 16:15-18:40

Room E

OS36 SWARM: Heterogeneity in Collective Systems

Chair: Takashi Shimada (The University of Tokyo, Japan)
Co-Chair: Hiraku Nishimori (Meiji University, Japan)

OS36-1 Collective Compensation of Task Flow by Response Threshold Dynamics

Hiraku Nishimori, Masashi Shiraishi
(Meiji Institute for Advanced Study of Mathematical Sciences, Meiji University, Japan)

Using a master equation corresponding to the response threshold model for social insects, we discuss the non-uniform and the compensatory characters of the task engagement of ants in a colony. The analysis of the master equation indicates that the equation, with some assumptions, is effective to describe characteristic features of the collective task engagement of Camponotus japonicus; i) Frequency of involving brood-carrying task is not uniformly distributed but highly skewed among ants in each colony. ii) The division of colony into two groups; the half consisting of the highly active ants in the brood-carrying task and the alternative half, causes different level of compensatory characters of the task engagement. Namely, in the former half, the distribution of the activity was not remarkably changed after the division, whereas, a significant increase of their brood-carrying-task activities was observed in the latter half.

OS36-2 Effect of Interaction Network Structure in Response Threshold Model

Masashi Shiraishi, Osamu Yamanaka, and Hiraku Nishimori
(Meiji University, Japan)

Task allocation is a characteristic feature in social insects and is the self-organized phenomenon by workers in a colony without central instructions. The ant workers take the necessary tasks while communicating with each other and determine their colony's local colony situations or outside environments. In order to explain the self-organized phenomenon, we have to develop the theoretical model, which includes the local interaction mechanism among the workers. The Fixed Response Threshold model, a well-known mathematical model, explains the task allocation phenomenon, but it does not consider the interaction of local workers. Therefore, we extend the Fixed Response Threshold model by introducing the interaction network among workers, and we name the new model the Interaction Network Response Threshold model. We analyze the effects of the interaction network structure on the task allocation mechanism by the Gini coefficient in the new model. We found that the network structure has affected the information diffusion process, and the network features affect task allocation. The results mean that communication among the workers in a colony is an essential system for task allocation.

OS36-3 A comparison of metrics for measuring the complexity of Wikipedia articles

Fumiko Ogushi[1,2] and Takashi Shimada[3,4]
([1]Center for Mathematical Modeling and Data Science, Osaka University, Japan)
([2]JST PRESTO, Japan)
([3]Mathematics and Informatics Center, The University of Tokyo, Japan)
([4]Department of Systems Innovation, Graduate School of Engineering, The University of Tokyo, Japan)

Self-consistent metrics of the editor’s scatteredness and the article’s complexity based on the editor-article bipartite network mapped from the edit relationship reflect the indirect effect from the network and more sensitive to the network structure than the local characteristics like degree or strength. When the editors and the articles are uncorrelated, the article’s complexity and the editor’s scatteredness on a binary editor-article network are asymptotically equivalent to relative degree of corresponding editors and articles. Using the empirical data, we test the rewiring effect on the scatteredness and the complexity measures. As the binary Wikipedia editor-article network is randomized, the scatteredness and the complexity become closer to the relative degree of the editors and the articles, respectively. This result suggests that the self-consistent metrics of the editor’s scatteredness and the article’s complexity reflect not only the degree distributions but also local structure of the network.

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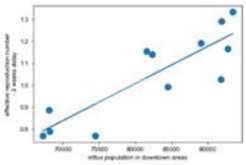
OS36-4 Hot-spot analysis of Covid-19 infection using mobile-phone location data

Yu Kimura[1], Tatsunori Seki[1], Satoshi Miyata[1], Yusuke Arai[1], Toshiki Murata[1],
Hiroyasu Inoue[2], and Nobuyasu Ito[3]
([1]SoftBank, Japan)
([2]University of Hyogo, Japan)
([3]Riken, Japan)

It is widely accepted that restrictions on activities outside of the home are required to suppress the pandemic of Covid-19. To monitor social risks and aide in controlling the pandemic through sustainable restrictions, here we focus on the relationship between the influx population and the effective reproduction number. In this paper, we report the correlation between the influx population data, in Tokyo, during the pandemic with the effective reproduction number, taking into account the associated time delay. We expect this and future studies to enable us to monitor the social risk of pandemics through changes in the influx population in downtown areas and business districts.



OS36-5 OD analysis of Hanshin Expressway ETC statistics

Daigo Umemoto and Takashi Kamihigashi
(Kobe University, Japan)

In order to obtain realistic artificial Origin Destination (OD) pairs that can be used in multi-case parallel traffic simulations, we analyzed ETC statistics provided by Hanshin Expressway Co., Ltd. including only the number of cars and trucks per hour with personal information removed. The statistics spans over a period from September 1, 2013 to August 1, 2020, with daily and weekly periodic increases and decreases and entire peak demand of about 50,000 vehicles per hour. It was found that each OD demand can be approximately predicted by specifying season, date, and day of the week, and shown it is possible to generate typical OD set by obtaining the ratio of one OD demand to another. We also observed disturbances in the traffic demand due to disasters: Northern Osaka Earthquake and COVID-19. We successfully constructed a simulator using the above OD as input and ran it on a cluster.

OS36-6 Revisiting the functional form of real ecological and social contacts

Takashi Shimada
(The University of Tokyo, Japan)

Our framework for real data analysis of the relation between the size of active population and the speed of the spread of infections is reviewed. From the mobile phone data at the major stations in Tokyo area in 2020 and the number of new cases of COVID-19, the functionality form of the human-human contact rate to the population is found to be deviated from that of the conventional SIR model or the Lotka-Volterra equation. The obtained scaling exponent of the modified interaction term is rather consistent with our previous theoretical models to explain the persistence of the system against big disturbances. The modified interaction term is essential and natural to explain the spread of COVID-19 in various cities and areas, which can have drastically different average population density.

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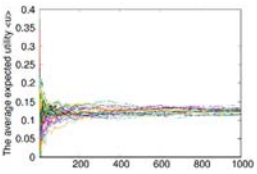
OS36-7 Analytical and simulational approaches to the relation between the stock market liquidity and the traders' utility

Shota Nagumo[1], Shingo Ichiki[2], and Takashi Shimada[3]
([1]Department of Systems Innovation, Graduate School of Engineering, The University of Tokyo, Japan)
([2]Research Center for Advanced Science and Technology, The University of Tokyo, Japan)
([3]Department of Systems Innovation, Graduate School of Engineering, The University of Tokyo, Japan,
Mathematics and Informatics Center, The University of Tokyo, Japan)



In stock markets, it is often argued that increased liquidity contributes to the public benefit of the market as a whole, but it is not self-evident. In this study, we analyze the impact of increasing market liquidity on traders' utility mathematically. We calculate an exact solution of an average expected utility for one trader by using a simple model in which we assume orders follow independent uniform distributions. However, even when we assume more complicated models where orders follow general distributions and interact with each other, we obtain the result consistent with the first simple model in the limit of infinite number of orders.

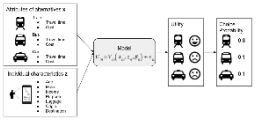
OS36-8 Toward a simulation of business-establishment supply chains

Hiroyasu Inoue
(University of Hyogo, Japan)

A disaster is a threat for our society and economy and the negative shocks propagate through other regions even if the shocks occur in some limited regions. This is because the society and economy is connected via interactions. This study focuses on supply chains, or supplier--customer networks. However, not only we consider the supply chains of firms, but business establishments. Then, we examines how production losses caused by natural disasters propagate to regions not directly hit through supply chains. We apply an agent-based model to the actual supply chains of nearly one million firms in Japan in 2011 to estimate the direct and indirect effects of the 2011 Great East Japan earthquake. We find that a new model can replicate the economic behavior better than the literature based on a model considering only firms.

OS36-9 Neural Choice Model for Representing Heterogeneous and Nonlinear Utility

Ryo Nishida[1], Ryo Kanamori[2], Masaki Onishi[3], Itsuki Noda[4], and Koichi Hashimoto[1]
([1]Tohoku University, Japan)
([2]Nagoya University, Japan)
([3]National Institute of Advanced Industrial Science and Technology, Japan)
([4]Hokkaido University, Japan)



Discrete choice models (DCMs) are based on random utility maximization theory. This theory assumes that when people make a choice, they choose the option that maximizes their utility. In recent years, neural networks (NNs) techniques have been developed in the field of artificial intelligence to model human information processing with high accuracy. Therefore some DCMs incorporating NNs have been proposed. NNs make it possible to more accurately represent the heterogeneity of preferences in decision making. On the other hand, learning a model using NNs requires a large number of data. In this study, we apply semi-supervised learning to learn DCMs using NNs from a small amount of data. We use positive and unlabeled (PU) learning which is one of the semi-supervised learning methods, and which can be used for datasets containing unlabeled data. Using a transportation mode choice dataset, we experimentally show that PU learning is also useful in choice modeling.

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Room F

GS2 Artificial intelligence 1

Chair: Hideo Miyachi (Tokyo City University, Japan)

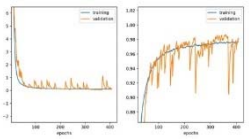
GS2-1 Exploiting a belief structure in deep neural network-based Monte-Carlo tree searc partially observable Markov decision processes

Satoshi Hiraki, Hideaki Itoh, Hisao Fukumoto, and Hiroshi Wakuya
(Electrical and Electronic Engineering Course, Department of Science and Engineering, Graduate School of Science and Engineering, Saga University, Japan)

The combination of Monte-Carlo tree search and deep neural network has been used successfully in decision making problems in which an agent can fully observe the state of its environment. However, little study has been done on how to use it in partially observable Markov decision processes (POMDPs). To address this issue, in our previous study, we have modified AlphaZero algorithm to make it applicable to POMDPs. In the modified AlphaZero algorithm, we used a belief, which is the posterior distribution of the hidden state, to represent the knowledge of the agent regarding the hidden state. However, our algorithm did not take advantage of the structure that the belief has. Thus, in the present study, we improve our previous method by changing the structure of the neural network to exploit the structure of the belief. We show the validity of the provided algorithm through numerical experiments.

GS2-2 A Proposal of Indoor Location Estimation by Neural Network Using Wi-Fi Access Points

Ryuichi Matoba, Tetsuya Hiromitsu, Hiroshi Oguma
(National Institute of Technology, Toyama College, Japan)



In this research, we used Received Signal Strength Indicator (RSSI[dBm]) strength from Wi-Fi access points to estimate the position by learning with a simple perceptron model using neural networks. The RSSI strength is measured every 5 seconds for 500 seconds per point. This data is measured at 15 points every 1 meter for 3 floors. Therefore, the values from 0 to 45 are converted to a one-dimensional array. Therefore the values from 0 to 45 are converted a one-dimensional array. The results of location estimation using the trained model showed a correct response rate of about 98%. The correctness rate of the location estimation was about 98% for the data of 45 points on three floors. This indicates that it is possible to estimate the Therefore, location estimation using neural networks is considered to be effective.

GS2-3 A Model for Estimating Emotions from Face Images Using Deep Learning

Ryuichi Matoba, Yuma Tanbo
(National Institute of Technology, Toyama College, Japan)

Recently, research on interactive robots has been conducted. These robots are expected to be able to communicate with people in a more natural way by being able to estimate human emotions. As a research to estimate emotions from face images, "happy", "sad", "angry", "disgust , "surprise", and "no emotion", "fear", and "no emotion". In this study, the emotion recognition rate for two emotions, "angry" and "fear," did not reach even 30 percent. In an emotion classification experiment, the recognition rates of "angry," "fear," "sad," and "disgust" were less than 30 percent. In this experiment, we used a face-specific model called VGGFace, which can be used with VGG16 and ResNet50 models. we fine-tuned each of the two models. As a result, the recognition rate of "angry" and "fear" in ResNet50 exceeded 50%, which is the objective of this research.

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GS2-4 Deep-Learning Method for Handwritten Numeral Recognition Utilizing Force and Inertial Sensors

Tsige Tadesse Alemayoh, Masaaki Shintani, Jae Hoon Lee, and Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

Present notetaking methods utilize the combination of two or more devices. In this paper, however, a single and compact smart digital pen is developed for Arabic numeral recognition. The pen utilizes a deep-learning algorithm to recognize its own numeral character writings from the sensor signals. Its prototype comprises an ink chamber of ordinary ballpoint pens for writing, three force sensors, an IMU (Inertial Measurement Unit), an Arduino, and a barrel structure. A handwritten numeral characters' data was recorded from six male volunteers. Collected time-series data was later segmented into smaller data chunks that contain only a single character's data. Three neural network configurations were used during the training. These include DNN (Deep Neural Network), CNN (Convolutional Neural Network), and LSTM (Long Short-Term Memory). After training these networks, it was confirmed that CNN excelled, with a prediction accuracy of 96.53%, over the others. This will be extended in the future to include more characters.

GS2-5 Proposal for a system for visually impaired people to identify products in stores

Tomoyuki Zaizen, Rui Kitahara, and Lifeng Zhang
(Kyusyu Institute of Technology, Japan)

In recent years, Japan has been facing the problem of an aging population due to the aging of society. In addition, many elderly people are visually impaired, and the number of visually impaired people is expected to increase in the future. However, the aging society is also facing a shortage of caregivers, as the elderly must care for the elderly. Therefore, the problem of not having enough people to care for the increasing number of visually impaired people will arise in Japan in the future. The shortage of caregivers may lead to the tendency of the elderly visually impaired to refrain from going out. Therefore, the purpose of this study was to create a system that allows visually impaired people to identify products in stores without receiving care.

GS2-6 Solar panel fault detection in photovoltaic power plants using drones

Kenneth J. Mackin[1] and Tatsuya Katada[2]
([1]Tokyo University of Information Sciences, Japan)
([2]Nichizo Tech Inc., Japan)

In light of the increased attention towards global warming and sustainable development, the importance of renewable energy has been reevaluated. Solar power plants are one of the growing fields of renewable energy sources. The photovoltaic cells used in the solar panels have a long lifespan, but for various reasons, faults or hot spots can occur in the cells or panels and decrease the electricity production. This paper describes the use of drones to automatically detect faults in solar panels for large scale solar power plants. Both thermal and visible-range cameras onboard the drones are used for fault detection. In the developed system, computer vision methods are used to locate and retrieve panels from the rows of solar panels within the video image. Using the retrieved panel images, intelligent algorithms are applied for fault detection. Actual video footage of large scale photovoltaic solar power plants is used for verification.

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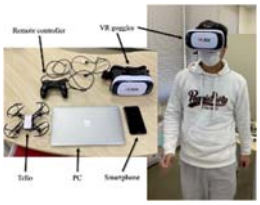
Room G

GS13 Human-machine interaction and collaboration 2

Chair: James Wilson (University of Bristol, United Kingdom)

GS13-1 Drone Operations by Natural Human Movements using Machine Learning

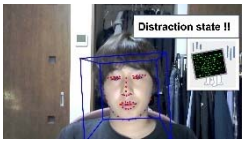
Hironori Hiraishi
(Ashikaga University, Japan)



This paper proposed drone operations by natural human movements. An operator just wears virtual reality (VR) goggles in which a smartphone is inserted. An operator can watch image of a drone's camera in the goggles. A smartphone in the goggles detects movements by acceleration and magnetic field sensors. If an operator makes his/her face or body turn right and left, a drone turns right and left respectively. If an operator makes his/her face turn up and down, a drone goes up and down. Moreover, if an operator takes walking steps on the spot, a drone goes forward. Compared to an operation with a remote controller, a remote controller was better in early stages. However, when subjects got used to an operation of this study, the difference became little, and it is found that an operation of this study has advantage in the case of flight of narrow area.

GS13-2 Distraction Detection of Lectures in E-learning Using Machine Learning Based on Human Facial Features and Postural Information

Iku Betto, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)



While e-learning lectures allow students to learn at their own pace, it is difficult to manage students' concentration, which prevents them from receiving valuable information from lectures. Therefore, we propose a method for detecting student distraction during e-learning lectures using machine learning, based on human face and posture information that can be collected using only ordinary web camera. In this study, we first collected video data of the faces of subjects taking e-learning lectures and used the OpenFace and GAST-Net libraries to obtain face and posture information. Next, from the face and posture data, we extracted features such as the area of the eyes and mouth and the angle of the neck and shoulders. Finally, we used various classifiers, such as XGBoost, to detect states of distraction during e-learning lectures. The results show that our binary classifier models trained only on the individual's data achieved more than 90% recall.

GS13-3 Infusing prior knowledge into topological representations of learning robots

Kana Ogawa and Pitoyo Hartono
(Chukyo University, Japan)

While robots equipped with AI, are applied to various fields, their learning costs and intransparency remain as problems. In this research, we propose a method for intuitively transferring human knowledge into a layered neural network in an intuitive way. To make this idea possible, a hierarchical neural network containing a topological map is adopted as the adaptive controller for physical robots. This map allows the robots to topologically organize the high dimensional sensory inputs and to relate them with their actions, and allows humans to hand-organized the map for infusing relevant knowledge for the robot's further autonomous learning. The proposed method enables a two-way transfer learning between humans and robots in an intuitive manner, in that humans can infuse common sensical prior knowledge while the robots provide visual information on their internal representations to give human understanding on how the prior knowledge is further developed during the learning process.

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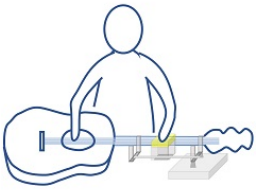
GS13-4 Support Device for Playing Guitar “F-ready” -Confirmation Regarding Measurement of Rehabilitation Effect of Hand Position

Yukiko Nishinohira[1], Hirokazu Matsui[2], Takahiro Nakayama[3], and Koichi Nakayama[3]
([1]Saga University, Japan)
([2]Mie University, Japan)
([3]N-Robotics, Japan)

We are proposing F-Ready, a support device that enables people with upper limb disabilities to immediately realize their desire to play the guitar. F-ready consists of a pressing device that assists with the movement of pressing the strings with the hand and a slide device that assists with moving the hand along the guitar’s neck. Comparing the beginners and the advanced learners in playing the guitar, there are differences in the movement of the pressing device, the position, the moving speed, and whether it is pressed or not. In this paper, we attached an encoder to F-Ready and investigated whether these differences can be grasped by the measured values of the encoder by appropriate sampling and resolution. As a result, it was found that F-Ready can graspe the differences of movement between the beginners and the advanced learners when playing the guitar.



GS13-5 Evaluation of behavior detection and investigation of sound noise of a drone with an infrared camera at night

Ryosuke Kakiuchi, Dinh Tuan Tran, and Joo-Ho Lee
(Ritsumeikan University, Japan)

Security work is known for its heavy labor due to night shifts and long working hours. In recent years, the number of security guards needed has been on the rise, and the labor shortage of security guards has become a problem in Japan. In this study, a drone called "Aerial Ubiquitous Display" was proposed to provide night security. In this paper, in order to explore the possibility of noise reduction, how the loudness of the sound received by humans changes depending on the flight altitude of the drone was examined. Furthermore, by running the action detection on the edge computer mounted on the drone, it was confirmed the detection accuracy changed with the difference in altitude. Based on these two results, a flight altitude that can reduce the discomfort caused by the drone’s flight sound noise while maintaining high accuracy in behavior detection was studied.

GS13-6 Bimodal control of a walk-assist robot for a person tracking

Ryosuke Miyata, Wen Liang Yeoh, Osamu Fukuda, Nobuhiko Yamaguchi, and Hiroshi Okumura
(Saga University, Japan)

In recent years, Japan has been facing serious problems with its aging society and declining birthrate. In this study, we propose a new control method for a robot that assists an elderly person with reduced muscle strength to walk while following a younger person. A unique feature of this system is that the user and the robot interact with each other via a handle equipped with a camera to select a person to be tracked. In addition to recognizing a person from the camera image using deep learning, the user turns the handle to communicate their intention to the robot to determine the target. The robot approaches and follows the person based on the user's intention and the image recognition result of its camera.

January 26 (Wednesday), 16:15-18:00

GS13-7 Probability distribution teaching materials using Python programs for students

Nobuo Iwasaki, Ryusei Okawa, Kazuya Okamoto, and David Marsh
(National Institute of Technology, Wakayama College, Japan)

Probability distribution is an essential concept in probability statistics. In general probability statistics textbooks, probability distributions are explained with mathematical formulas, sentences, and figures. For many students, it is difficult to understand the probability distribution only with mathematical formulas, sentences, and figures. If students can create the probability distribution based on examples, they will be able to understand the probability distribution well. From the above, this paper introduces a program that allows students to create probability distributions. The probability distributions that students can create with Python described in this paper are uniform distributions and normal distributions. Students can create various uniform distributions and normal distributions by changing the variables in the Python program in this paper. The programming language used in this paper is Python.

January 26 (Wednesday), 18:00-19:30

Room B

OS15 AROB: Human-Centered Robotics-II

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Yasar Ayaz (National University of Sciences and Technology (NUST), Pakistan)

Invited Talk 6 Novel devices for microsurgery and challenging medical operations

Leonardo De Mattos (Italian Institute of Technology, Italy)

See page 21

OS15-1 Area coverage variation of a tiling robot per polyform: An analysis to assist users in selecting a robot

Viraj Muthugala, Bhagya Samarakoon, and Mohan Elara
(Singapore University of Technology and Design, Singapore)

Floor cleaning robots could be seen in residential, public, and industrial premises. Complete area coverage is one of the essential features expected from these robots. However, robots with fixed shapes lack the ability to access narrow spaces yielding to lower area coverage performance. A class of reconfigurable floor cleaning robots known as tiling robots has been introduced to overcome the limitations of fixed-shape floor cleaning robots. Tiling robots with different polyforms robots have been proposed in this regard, and the area coverage performance of these robots may vary with both robots and environment characteristics. Therefore, this paper conducts a comparative analysis on the variation of area coverage performances of the tiling robots constructed with different polyforms to assist user in a robot selection process. Area coverage performances of three tiling robots with the same number of blocks and hinges and a comparative size have been compared in a set of test environments through Simulations. According to the observations, the considered set of tiling robots can achieve a considerably higher area coverage compared to a fixed-shape robot. However, a notable variation of area coverage among the considered tiling robots could not be observed.

January 26 (Wednesday), 18:00-19:30

OS15-2 Basic Experiments for Erasing from Memory of Audio and Visual Data based on Somatosensory Imitation by Integrated Sensors

Yoshihiro Sato
(Kyoto University of Advanced Science, Japan)

In this study, we propose a technique for summarizing memories using multiple integrated sensors. We put a video camera and microphones with various environmental sensors, for example, barometric pressure, humidity, temperature, acceleration, gyro, illumination, etc. Each sensor detects events based on simple classifiers, such as hierarchal one-class SVM that divides conditions into two states, which are labeled as usual or unusual. The results of detection are combined as a vector that explains the circumstances of the audio-video recorded system. The time-sequential audio and visual data is divided based on the vector obtained above. As the result, summarized data is acquired with low calculation cost. We put the experimental device into a condition and evaluate the quality of summarized results. The purpose is to obtain indications for the biological memory system and consciousness. As a result, we reconfirmed that parameters related to time have a critical impact.

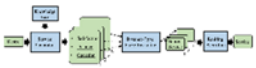
OS15-3 Effect of display YOLO's object recognition results to HMD for an operator controlling a mobile robot

Yuichi Sasaki, Tetsushi Kamegawa, and Akio Gofuku
(Okayama University, Japan)

An operator feels a burden when he/she controls a rescue robot remotely because he/she has to keep watching camera images to find the target object. We think that this burden can be reduced by the combination of Head Mounted Display (HMD) and object recognition by deep learning. In the first half part of this study, we examine effect that how presentation method by You Only Look Once (YOLO), a deep learning algorithm, and its recognition results to an operator wearing HMD. In the experiment, three methods of presentation were set. The results of the experiment showed that the method to present only one object recognition result was useful. In the second half part of this study, we develop a system to present 3D images with YOLO added, to further ease the burden of object search. Additionally, we consider the use of rescue robots in object search after we have conducted the experiment.

OS15-4 Identification of the Physiological Needs of Bedridden Elderly People based on Distance-Type Fuzzy Reasoning Method

Guang Yang[1], Shuoyu Wang[1], Junyou Yang[2], and Peng Shi[3]
([1]Kochi University of Technology, Japan)
([2]Shenyang University of Technology, China)
([4]University of Adelaide, Australia)



In this paper, we propose a method to reason about care services to meet the physiological needs of bedridden individuals. By introducing the distance-type fuzzy reasoning method, we present an approach that allows (i) representing the required knowledge, and (ii) reasoning for the most reasonable services. Considering common desires (hunger and thirst), we evaluated the proposed method in simulations, and the results showed that satisfactory service could be produced that best satisfy the desires of the care recipients.

January 26 (Wednesday), 18:00-19:45

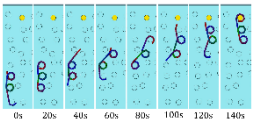
Room C

OS38 SWARM: Snake Robots

Chair: Tetsushi Kamegawa (Okayama University, Japan)
Co-Chair: Motoyasu Tanaka (The University of Electro-Communications, Japan)

OS38-1 Obstacle-aided locomotion of snake robots utilizing coiling in a known environment

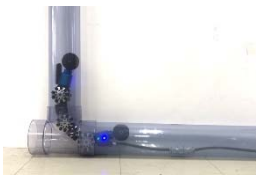
Takashi Tomiyama, Tatsuya Takemori, Belal Elsayed, and Fumitoshi Matsuno
(Kyoto University, Japan)



A living snake has a highly flexible body that can adapt to a variety of environments. Snake robots, inspired by biological snakes, are expected to move through a wide range of environments. Among various types of locomotion, obstacle-aided locomotion of snake robots has been studied to obtain propulsion force by pushing against the obstacle. However, sometimes the robot cannot propel itself due to unexpected contacts with the obstacles. To solve this problem, we propose an optimal trajectory planning method for snake robot obstacle-aided locomotion, where the snake robot coils around obstacles to achieve the desired motion. Thanks to the proposed coiling approach, the snake robot can be geometrically constrained to the environment, and thus it generates a stable movement. Simulation results have shown the effectiveness of the proposed approach to achieve effective obstacle-aided locomotion for a snake robot moving over flat environments that are inclined with different angles.

OS38-2 Automatic T-branch Travel of a Multi-link In-pipe Inspection Robot based on Joint Torque Value

Atsushi Kakogawa, Yutaro Kushitani, and Shugen Ma
(Ritsumeikan University, Japan)

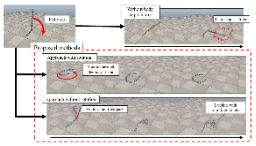


Previously, we have developed a four-linked wheeled in-pipe inspection that can pass through not only bends but also even vertical T-branches. The robot is comprised of three drive wheels, two passive compliant joints, and a single active joint by using a specially designed series elastic actuator. The active joint is located at the middle of the robot and can control both angle and torque. In straight and bend sections, slippage of the drive wheels can be avoided by only controlling the joint torque at constant. However, in T-branches, the joint angle needs to be controlled along with a trajectory predetermined by the pipe geometry. Therefore, it is necessary to switch from the torque control to the angle control at the appropriate timing when the robot encounters T-branch sections. This operation can be executed manually. However, operator's skill should be sophisticated through multiple trainings and it is time-consuming and costly. To achieve this challenge, in this study, the way of switching between the joint torque control and the joint angle control for automatic T-branch travel is presented. The switching timing is determined by a change of the joint torque value when the front wheel detaches from the pipe wall and moves into the next pathway of the T-branch. In this paper, the principle of this torque value change is explained, then the validity of the proposed control method is verified by experiments.

January 26 (Wednesday), 18:00-19:45

OS38-3 Shape control of a snake robot to reduce damage from rollover accidents on step climbing

Mizuki Nakajima, Masahiro Honda, and Motoyasu Tanaka
(The University of Electro-Communications, Japan)



This paper presents the shape control method of the snake robot to reduce damage from rollover accidents when the robot climbs a high step. If the robot rolls over, a large impact force acts on the robot and it causes damage of the robot. This paper presents two approaches: one is to rotate the entire robot along its body shape, and the other is not to use rotation. In the approach using the rotation, the body shape of the robot is controlled to be circular and the robot rotates along its body shape like precession. In the approach that does not use rotation, the part of the body that is lifted to climb the steps is folded. The effectiveness of the proposed methods was verified by using a physics simulator. Both approaches reduced the impact force, but the approach using the rotation required too large joint torques.

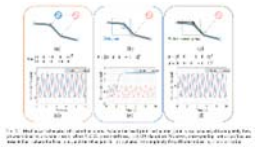
OS38-4 Hybrid Force-position Control Method for a Snake Robot Climbing in Crowded Pipes

Yongdong Wang, Tetsushi Kamegawa, and Akio Gofuku
(Okayama University, Japan)

The movement capabilities of snake robots make them useful in various situations. Making the snake robot travel in various places by precise position control is the solution to most recent studies in this field. The snake robot movement performance can improve further by hybrid force-position control. In this paper, we propose a hybrid force-position control scheme to establish joint level dynamics equations for the snake robot to enhance the low robustness of the snake robot due to pure position control. Furthermore, we conduct crawling experiments with the proposed hybrid force-position controller for the snake robot in an environment with crowded pipes. The experimental results show that the proposed method is effective. The snake robot can move efficiently in crowded pipes without additional sensors and only through feedback information from the motor proprioception.

OS38-5 Rhythm generation and coordination of a three-link snake robot with torsion spring

Yiming Cao, Longchuan Li, and Shugen Ma
(Ritsumeikan University, Japan)



Undulation gait of snake-like robots is ordinarily realized through full-actuated joints, which is inspired by biological snakes. Recently, passive buckling has been revealed to assist natural snakes in transiting the array without actively modifying body curves. Given the particularity of passive properties, the paper takes a three-link snake robot as an example to preliminarily investigate the realization of its undulation gait. Different configurations are presented to illustrate that installing spring constraints for passive joints can assist the robot to generate continuous oscillations and phase differences between adjacent joints. Moreover, through the evaluation of locomotion performances, we find that proper spring coefficients exist, so the snake robot can generate high locomotion velocity with small energy consumption.

Invited Talk 7 Robust undulatory swimming generation in lampreys, eels and Robots.

Kamilo Melo (KM-RoBoTa Sarl, Renens, Switzerland and EPFL, Biorobotics Laboratory, Lausanne, Switzerland)

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January 26 (Wednesday), 18:00-19:30

Room D

GS3 Artificial intelligence 2

Chair: Kazuyuki Ito (Hosei University, Japan)

GS3-1 AI player creation for the picture-guessing card game Dixit: Four research questions related to human cognition

Koki IWATA, Reiji SUZUKI, and Takaya ARITA
(Nagoya University, Japan)

Dixit is one of the imperfect-information communication games. Players need to associate images with appropriate words, guess the intentions of others, and grasp tendencies to score successfully. We designed and created AI players that have associative capabilities by quantifying both words and images and computing their similarity. We conducted mixed-play experiments with humans and AI, followed by a questionnaire survey on human recognition. We then discussed four research questions regarding the following: an AI player with which humans enjoy playing, the key parameters which adjust the appeal of the game, the major differences between AI and human players in terms of the properties of image-text associations, and how to distinguish between humans and AI by looking at their behavior, based on the results of the experiment and questionnaire. The survey and our discussion showed that different people find pleasure differently, the appeal of Dixit can be adjusted by strengthening the associative ability of AI so that it plays more like humans, and that the difference in associative ability between AI and humans tended to be greater when the images were more abstract.

GS3-2 Automation of the generation of an emotional intensity measurement lexicon

Julien Pierre Edmond Ghali and Nobuhiro Inuzuka
(Nagoya Institute of Technology, Japan)

The emergence of artificial intelligence (AI) in every domain such as self-driving cars, chatbot, face recognition, etc., have help them improve their capabilities to understand and handle situations by and while collecting data. Among all those progress, one is focusing on interpretation of natural language by AI, Natural Language Processing (NLP). While working on the capability to understand a context and answered it, a field of NLP is also to give the ability to understand a subject through his language. This article is seeking on a way to generate a lexicon able to measure defined categories of emotions, which will be one of the first step for an overall understanding of a subject. To do so, we established a human-made lexicon using words labelled with chosen emotions and their intensity associated in order to compare it with generated lexicons. We later compared the emotion analysis of those lexicons in order to see the accuracy and differences of our generated lexicons.

GS3-3 Identification of Rice Disease with Shuffle Attention & Inception

Yuliang Gao[1], Zhen Li[1], Lifeng Zhang[1], Seiichi Serikawa[1], Xiangying Xu[2], Bin Li[2]
([1]Kyushu Institute of Technology, Japan)
([2]Yangzhou University, China)

This paper presents an identification algorithm of rice diseases and insect pests based on a convolutional neural net work. It aims to solve the problems of a large number of parameters and the low accuracy of the traditional algorithm. The Inception-ResNetV1 module and the shuffle attention module are combined. It achieves the effects of significantly reducing parameters and improving accuracy. And this model is trained by SAM optimizer to get a better result. Compared with tradi tional models ResNet50 & Inception-ResNetV1, the highest accuracy reaches 95.66%, the parameters in the self-made dataset decreased by 47.6% and 34.02%, and the accuracy increased by 1.91% and 1.32%, respectively.

January 26 (Wednesday), 18:00-19:30

GS3-4 Real-time detection of suspicious behavior based on estimated value of ordinary's in public space

Ayumu Mimata and Sachiyo Arai
(Chiba University, Japan)

This study focuses on the automated real-time detection of suspicious persons using activity records from surveillance cameras in public spaces. Our method quantitatively evaluates the “standard-intention” from trajectories of ordinary people using Inverse Reinforcement Learning to detect suspicious behaviors. Our method can quantify the degree of suspiciousness in real-time with an accuracy that depends on each trajectory’s length and action time. To demonstrate the influence of the length and action time of trajectories on the detection accuracy of our method, we present experiments conducted using two grid worlds of different sizes and discuss the advantages and disadvantages of our method and its applicability in the real world.

GS3-5 Person Re-identification for Real-time Video Surveillance Based on Deep Learning

Miaomiao Zhu[1], Shengrong Gong[1], Zhengjiang Qian[1], Seiichi Serikawa[2], and Lifeng Zhang[2]
([1]Chang Shu Institute of Technology, China)
([2]Kyushu Institute of Technology, Japan)

Person re-identification (ReID), as an instance-level recognition problem, aims at automatically retrieving a person-of-interest across multiple non-overlapping camera views, which is considered as a sub problem of image retrieval. Unlike the traditional ReID research, the proposed system aims to combine pedestrian detection and ReID to perform one-step pedestrian detection and search. For real-time video surveillance obtained by cameras distributed in different locations, given a person-of-interest to be queried, the goal of our method is to search a person from the whole scene images or videos directly instead of matching them with manually cropped pedestrians in the existing datasets. To further verify the effectiveness of the proposed method in the real scene, many experimental datasets of complex scenes are collected respectively. Finally, the experimental results show that our method is effective in commonly used datasets and has achieved good results for real-time video surveillance in the real scene.

GS3-6 3D Deep Learning-Based Computer-Aided Diagnosis for Drowning Diagnosis Using Post-Mortem Computed Tomography

Yuwen Zeng[1], Xiaoyong Zhang[1,2], Yusuke Kawasumi[3], Akihito Usui[1],
Kei Ichiji[1], Masato Funayama[1], and Noriyasu Homma[1]
([1]Tohoku University, Japan)
([2]National Institute of Technology, Sendai College, Japan)

The drowning diagnosis in the forensic field is difficult because of the shortage of forensic specialists who have radiology knowledge to give diagnosis via autopsy and autopsy imaging. Therefore, computer-aided diagnosis systems were introduced to solve these problems. Previous studies developed 2D methods that trained models with a single image of post-mortem computer tomography cases for drowning diagnosis. In this study, we presented a CAD system based on 3D convolutional neural networks (CNNs) to include spatial information between slices. To evaluate the performance of 3D-CNNs on a small-scale dataset, a shallow and a deep 3D-CNN were trained and tested on 313 cases and compared with 2D-CNNs. Experimental results have shown the superiority of 3D method. In addition, the shallow model had a better performance than the deep model when trained with a small amount of 3D data, but the deep model can be more effective when learning from 2D data.

January 26 (Wednesday), 18:00-19:00

Room F

GS31 Swarm robotics

Chair: Daisuke Kurabayashi (Tokyo Institute of Technology, Japan)

GS31-3 Decentralized Avoidance Control Method for Robot Swarms in 3D Space

Kouki Ogata and Geunho Lee
(University of Miyazaki, Japan)

In this paper, we propose a distributed navigation scheme for robot swarms that controls how the robots swarm in a three-dimensional (3D) space environment. In many applications using robot swarms, it is expected that the swarm will move toward its goal while adjusting its movements to the environmental constraints. Therefore, we apply swimming patterns learned from fish schools to the collective motion of robot swarms. Specifically, we propose a swarm control scheme that dynamically selects three neighboring robots within the sensing range and forms a tetrahedron shape with the selected robots. Depending on the environmental conditions, the robots can be separated into smaller swarms or integrated into a single swarm. From a computational point of view, we assume that anonymous robots with no assigned leader cannot broadcast to each other and cannot remember their past states. The effectiveness of the proposal will be verified by extensive simulations.

GS31-4 Connectivity Maintenance for Robotic Swarms by Distributed Role Allocation Algorithm

Kazuho Kobayashi, Takehiro Higuchi, and Seiya Ueno
(Yokohama National University, Japan)

Swarm robotics requires a practical scheme to maintain supervision by human operators or managers, especially in complicated or life-threatening situations. For this purpose, this paper proposes an algorithm to maintain connectivity between robot swarm and fixed base station during missions. The main idea of the algorithm is maintaining connectivity by role allocation and switching among robots without centralized control by the base station. Our simulation studies have shown no significant inequality of computational cost among robots over the emulated patrol missions. Furthermore, as the total number of robots in the swarm increase, computational cost per robot does not increase significantly. These results have shown the distributed nature and scalability of the proposed algorithms.

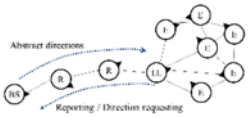


Fig. Typical state of the robotic swarm in the proposed algorithm (BS: base station, R: repeater, LL: local leader, F: explorer).

GS31-5 Information Transport in Communication Limited Swarms

James Wilson and Sabine Hauert
(University Of Bristol, United Kingdom)

Users and operators of swarms will, in the future, need to monitor the operations of swarms in a distributed way, without explicitly tracking every agent, and without the need for significant infrastructure or set up. Here we present a method for swarm self-monitoring that enables the aggregate display of information about swarm location by making use of physical transport of information and local communication. This method uses movement already exhibited by many swarms to collect self-reflective information in a fully distributed manner. We find that added swarm mobility can compensate for limited communication and that our self-monitoring swarm system scales well, with performance increasing with the size of the swarm in some cases. When developing systems such as this for real-world applications, individual agent memory will need to be taken into consideration, finding effective means to spread swarm knowledge among robots while keeping information accessible to users.

January 26 (Wednesday), 18:00-19:00

GS31-6 Polygon-Wall based Obstacle Avoidance for Swarm Robots in Column Formation

Shotaro Shibahara and Kenji Sawada
(The University of Electro-Communications, Japan)

This paper proposes an obstacle avoidance method for swarm robots in column formation based on polygon-wall of fluid analysis. The potential function is often utilized as an obstacle avoidance method for autonomous robots. Such a method designs a potential function with high energy at the location of the obstacle. On the other hand, it is not easy to design a straight wall with this method. The objective of this study is to incorporate the polygon-wall used in fluid analysis into the Multi-Agent System (MAS) control so that swarm robots can perform the obstacle avoidance of the straight wall in column formation. The problem setting for this study is to set up a narrow passage with the polygon-wall and have swarm robots move in column formation. The numerical experiment shows the behaviors of swarm robots when the polygon-wall is applied as obstacles.

January 27 (Thursday), 09:10-11:40

Room B

OS32 SWARM: Collective Intelligence in Living/Non-Living agents

Chair: Takashi Ikegami (The University of Tokyo, Japan)

Invited Talk 8 Variation among ant colonies in collective behavior

Deborah M. Gordon (Stanford University, USA)

See page 23

OS32-1 Emergence and collapse of frozen clusters in experimental ant (Pristomyrmex punctatus) groups

Shigeto Dobata, Norihiro Maruyama, Itsuki Doi, and Takashi Ikegami
(University of Tokyo, Japan)

We report successful individual tracking of experimental colonies of the Japanese ant Pristomyrmex punctatus undergoing aggregation in artificial environments. This species shows dense aggregation even without dark cavities. As a pilot study, we detail the experimental procedure that facilitated video recording and subsequent image analyses. We tracked groups comprised of 64 individuals. Individuals were typically divided into two extremes in their activity levels: stopping (“frozen”) in an aggregation vs. frequent moving in the arena. This polarization might or might not reflect nurse-forager differentiation in their life history.

OS32-2 Macro Vitality in Tetrahymena collectives

Akiko Kashiwagi[1], Itsuki Doi[2], Hiroki Kojima[2], Mana Ohashi[1], Rikuya Saito[1], and Takashi Ikegami[2]
([1]Hirosaki University, Japan)
([2]The University of Tokyo, Japan)

It is thought that by forming a group, new traits emerge that are not found in each individual. In this study, we investigated how the behavior of groups of genetically identical Tetrahymena thermophila, and each individual within a group, changes as the scale of the group increases. In particular, we will use swimming speed, rotation angle, and kinetic energy as a way to measure the "vitality" (genki) of the group. The vitality of each group differs even though they are genetically identical and have the same culture conditions. The pattern of vitality of each individual in the group tends to be similar. In particular, the locomotion trajectory of each individual within a group tends to become more similar as the group size increases. Also, we found that some groups of individuals remain in close proximity for a longer period of time than the chance rate.

OS32-3 Emergence of Multiple Types of Swarms in a Large Scale Boids Model

Norihiro Maruyama and Takashi Ikegami
(The University of Tokyo, Japan)

Swarms of some type of animal change their behavior depending on the size, and such phenomena have also been studied in simulation models. On the other hand, it is not uncommon to find swarms of millions of individuals gathering together, and it is challenging to simulate such as scale. We have been performed simulations of boids models with a half-million population and reported the hierarchical structure of swarms and the differentiation of their characteristics which can be observed on such a large-scale. Here, we report the results of a boids simulation that is about 20 times larger than those previous studies and discuss the type of behavior that is first observed at that scale.

January 27 (Thursday), 09:10-11:40

OS32-4 A study on the ephemeral nature of knowledge shared within multiagent systems

Sanjay Sarma O.V., Ramviyas Parasuraman, and Ramana Pidaparti
(University of Georgia, United States)

Achieving knowledge sharing within an artificial swarm system could lead to significant development in autonomous multiagent and robotic systems research and realize collective intelligence. However, this is difficult to achieve since there is no generic framework to transfer skills between agents other than a query-response-based approach. Moreover, natural living systems have a ”forgetfulness” property for everything they learn. Analyzing such ephemeral nature (temporal memory properties of new knowledge gained) in artificial systems has never been studied in the literature. We propose a behavior tree-based framework to realize a query-response mechanism for transferring skills encoded as the condition-action control subflow of that portion of the knowledge between agents to fill this gap. We simulate a multiagent group with different initial knowledge on a foraging mission. While performing basic operations, each robot queries other robots to respond to an unknown condition. The responding robot shares the control actions by sharing a portion of the behavior tree that addresses the queries. Specifically, we investigate the ephemeral nature of the new knowledge gained through such a framework, where the knowledge gained by the agent is either limited due to memory or is forgotten over time. Our investigations show that knowledge grows proportionally with the duration of remembrance, which is trivial. However, we found minimal impact in knowledge growth due to memory. We compare these cases against a baseline that involved full knowledge precoded on all agents. We found that the knowledge-sharing strived to match the baseline condition by sharing and achieving knowledge growth as a collective system.

OS32-5 Stimulus Avoidance and Informational Closure in Spiking Neural Networks

Atsushi Masumori and Takashi Ikegami
(The University of Tokyo, Japan)

One of the most important aspect of living system is trying to organizing self and maintaining self. We previously found that simply embodied spiking neural networks show primitive such a property in cognitive scale, where spiking neurons with spike-timing dependent plasticity (STDP) spontaneously learn to avoid stimuli from environment. The ways for avoiding stimuli seem consistent with ways to form informational closure proposed by Bertschinger, 2008. Our preliminary results showed that the networks not only avoids stimuli but also tends to form informational closure. It is interesting that STDP, which strengthens the causal network coupling with the environment, cause informational closure. In this presentation, we also discuss about how these idea of stimulus avoidance and information closure can be extended to multi agent collective system.

OS32-6 Evolutionary Dynamics in Web-Service

Yasuhiro Hashimoto[1], Hiroki Sato[2], and Mizuki Oka[3]
([1]The University of Aizu, Japan)
([2]The University of Tokyo, Japan)
([3]The University of Tsukuba, Japan)

We study the evolutionary dynamics of hashtags, widely used in various web services as a social annotation to user-generated content, such as photos, movies, and texts. We consider hashtags as actors in a kind of cultural evolution. The vocabulary of hashtags, or their combination, and their amount of usage, or popularity, correspond to biological species and populations, respectively. The emergence of new hashtags and their spread within social groups is modeled by the networked Yule–Simon process, introducing correlations between co-occurring hashtags into the ordinary Yule–Simon process. Using this model, we investigate the origin of open-ended novelty production in combinatorial usage of hashtags, observed in data from the real photo-sharing service.

January 27 (Thursday), 09:10-11:40

OS32-7 A New Concept for Collective Intelligence: a Coupling-Decoupling Hierarchy

Takashi Ikegami
(The University of Tokyo, Japan)

A living system is a system that opens by closing. Using oil droplets, Boids, and honey bees as concrete examples, I will develop the theory of living systems that open by closing as a new approach to collective intelligence.

January 27 (Thursday), 09:00-10:30

Room C

OS3 AROB: AI in Life Sciences 1

Organizer: Kazushi Ikeda and Junichiro Yoshimoto
(Nara Institute of Science and Technology, Japan)
Chair: Toshitaka Yamakawa (Kumamoto University, Japan)

OS3-1 Predicting Time-to-Event of Depression Relapse from Daily Activity Lifelog

Felan Carlo Garcia[1], Aran Tajika[2], Toshi Furukawa[2], Kazushi Ikeda[1], and Junichiro Yoshimoto[1]
([1]Nara Institute of Science and Technology, Japan)
([2]Kyoto University Graduate School of Medicine, Japan)

In this work, we present a method of predicting the onset of relapse ahead-of-time using an individual patient's smartphone lifelog activity data as a sensing modality. We frame the prediction of relapse as a time-to-event problem where we use a 14-day sliding window of a patient's historical activity data to determine how likely their risk of relapse will happen in the future. We present an approach towards predicting the time to relapse with a deep learning-based probabilistic regression approach using gated recurrent units and a log-likelihood loss to predict a probability distribution on when their relapse is likely to happen. We applied and evaluated our model on a depression relapse dataset consisting of 87 patients in depression remission. Compared to state-of-the art probabilistic regression models such as Natural Gradient Boosting (NGBoost), we showed that our model outperforms the said model with a Relative Mean Absolute Error (RMAE) of 0.22. Lastly, we also show that using the predicted distribution, we can derive further insights such as the survival curve and survival median of a patient's relapse, both of which are important factors in clinical diagnosis.

OS3-2 The classification of PAC based machine learning in West syndrome for prediction of long term prognostic

Tatsuki Saito[1], Koichi Fujiwara[1], Jun Natsume[2], and Ryosuke Suzui[2]
([1]Department of Materials Process Engineering, Nagoya University Graduate School of Engineering, Japan)
([2]Department of Pediatrics, Nagoya University Graduate School of Medicine, Japan)

The phase amplitude coupling (PAC) represented the strength of the coupling between high frequency oscillations (HFOs) amplitude and slow-wave activity (SWA) phase in scalp EEG is useful to localize epileptic sources and to evaluate severity in children with West syndrome (WS). In order to predict long-term prognosis in WS following treatment, we used features extracted from PAC as input to a support vector machine (SVM). The highest accuracy rate was found to be 70.5% , and an average accuracy of 64.8% was obtained from each subject.

January 27 (Thursday), 09:00-10:30

OS3-4 Negative Emotion Recognition using Multimodal Physiological Signals for Driving Automation Systems

Tomoaki Yamamoto, Chie Hieida, Takatomi Kubo, Junichiro Yoshimoto, and Kazushi Ikeda
(Nara Institute of Science and Technology, Japan)

Driving automation systems (DAS) are being developed actively, and the system is currently put into actual use under specific conditions. In this research, we aim to recognize negative emotions when driving a vehicle using multimodal physiological signals. The physiological signal is considered to be an important signal in emotion recognition, and it can be expected that the accuracy of emotion recognition will be improved by handling multiple modalities instead of a single modality. To recognize negative emotions, we implemented sparse logistic regression using a multimodal physiological signal dataset with negative emotion labels when driving a vehicle. By recognizing the driver's negative emotions through this research, it will help to reduce the environmental factors which cause negative emotions and develop a better driving system.

OS3-5 A Computer Vision Approach Towards the Analysis of Social Interaction Among Multiple Monkeys

Riza Rae Pineda[1], Takatomi Kubo[1], Masaki Shimada[2], and Kazushi Ikeda[1]
([1]Nara Institute of Science and Technology, Japan)
([2]Teikyo University of Science, Japan)

Social behaviors of animals have been actively studied to unveil the evolution process of communication and socialization. These studies, however, have a significant bottleneck in the data processing stage since this commonly requires a labor-intensive visual inspection of the acquired data. Recent studies using computer vision methods have only been successful in completely tracking small animals such as rats and insects and single animal detection of larger species such as monkeys. To date, there is no well-established method to track multiple instances of large animals from videos. In this study, we propose a robust multi-animal tracking system using a cascade of two deep neural networks that can handle tracking in different complex environments. Our results show a high tracking accuracy of our system with a MOTA score of 91.52%. We also present the possibility of a quantitative evaluation of social behaviors by performing the social network analysis.

Invited Talk 9 Learning from Intelligence of Insects ~ Odor Source Orientation Robot Based on Insect Sensory and Neural System ~

Ryohei KANZAKI (Research Center for Advanced Science and Technology,
The University of Tokyo, Japan)

See page 24

January 27 (Thursday), 09:00-11:25

Room D

OS37 SWARM: Motion Analysis and Control of Advanced Robotic Systems

Chair: Fumihiko Asano (Japan Advanced Institute of Science and Technology, Japan)

OS37-1 Development of Small and Lightweight Rimless Wheel Robot

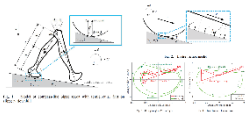
Yuta Hanazawa, Haruka Nishinami, and Shinichi Sagara
(Kyushu Institute of Technology, Japan)

In this paper, we show a novel rimless wheel robot for easily build and making experiment. We have studied rimless wheel robots that consist of a rimless wheel and a torso. To evaluate the walking performance of the robots, We needed a rimless wheel robot that can be developed quickly and easily, and easy to use for experiments. Therefore, we have developed the small and lightweight rimless wheel robot with a simple structure. We show some of the important points of the design of the robot. Moreover, we conduct a walking experiment to show that our robot is capable of walking on level ground.

OS37-2 A Modeling Method of Passive Dynamic Walking with a Rigorously Constraint Model

Yanqiu Zheng[1], Longchuan Li[2], Fumihiko Asano[1], and Cong Yan[1]
([1]Japan Advanced Institute of Science and Technology, Japan)
([2]Ritsumeikan University, Japan)

It has been proven that the well-known model of passive dynamic walking contains redundant assumptions in terms of ground-contacting conditions. To deepen the investigation of passive dynamic walking, this paper presents a modified mathematical model for it. The original requirement of “a fixed grounding point during the leg-swing motion” is removed, and a rigorous LuGre friction model that specifies the static and dynamic friction force at the grounding point is adopted. To illustrate the LuGre friction model, a compass-like passive dynamic walker with semicircular feet is proposed. By using semicircular feet, not only the energy loss from collisions is reduced, but also the effect on friction is amplified, making it possible to better observe the movement of the robot subjected to different frictions on a fixed grounding point. By numerical simulation, it can be observed that the robot appears period-1 gait and period-2 gait with different frictions. The corresponding simulation results and phase-plane diagrams are presented respectively. Our mathematical model and numerical simulation results provide an additional understanding of passive dynamic walking, which contributes to positively utilizing the natural dynamics of the legged locomotion system in control design.



OS37-3 Modeling and Analysis of Bipedal Robot Walking Uphill by Hybrid Control

Cong Yan[1], Yanqiu Zheng[2], Longchuan Li[3], Fumihiko Asano[4]
([1]Japan Advanced Institute of Science and Technology, Japan)
([2]Japan Advanced Institute of Science and Technology, Japan)
([3]Ritsumeikan University, Japan)
([4]Japan Advanced Institute of Science and Technology, Japan)

During walking, dynamics arise from the biomechanical properties of the body and its mechanical interaction with the environment. An adaptive hybrid control strategy is proposed for the bipedal robot walking uphill. That is, the traditional pure angle control is abandoned and reasonable torque control is utilized instead. First, we introduce the modeling and control method of the compass-like robot with point feet, and we add a flywheel to the hip joint for postural feedback control of the stance leg. Depending on the mass of the robot and the angle of the slope, we can calculate the magnitude of each input. Second, we conduct numerical simulations to observe the typical gait and analyze its results. Furthermore, we investigated the effect of hybrid control on walking performance.

January 27 (Thursday), 09:00-11:25

OS37-4 High-speed Motion Generation of Crawling-like Locomotion Robot Based on Adjustment of Amplitude and Elastic Coefficient in Simple Vibration of Passive Wobbling Mass

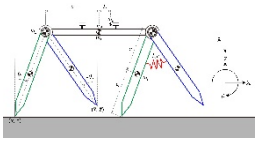
Fumihiko Asano and Shotaro Yamaguchi
(Japan Advanced Institute of Science and Technology, Japan)

One of the authors proposed a novel crawling-like locomotion robot that consists of two identical units with a passive wobbling mass moving up and down. Through numerical simulations, it was shown that forward or backward motions can be generated on a low-friction road surface by appropriately adjust the phase difference between the two wobbling masses. This paper reports more detailed analysis results of the moving speed with respect to the phase differences, the amplitude of the wobbling motion, and the elastic modulus of the spring. The simulation results show that the moving speed of the generated motion monotonically increases as the amplitude and angular frequency increase.

OS37-5 Improving the Stability of Quasi-Passive Dynamic Walking by Utilizing Spring Mechanism

Keiichiro Ueno[1], Cong Yan[2], Keiya Osuga[1], Takahiro Fuseya[1], Longchuan Li[1], and Isao Tokuda[1]
([1]Ritsumeikan University, Japan)
([2]Japan Advanced Institute of Science and Technology, Japan)

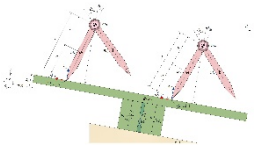
Quasi-passive dynamic walking enabled underactuated legged robots to walk extremely efficiently on level ground by choosing suitable initial conditions and providing external forcing with active wobbling mass. However, it did not overcome the low stability of passive dynamic walking. Since the trajectory of the wobbling mass is sinusoidal and the cyclic stability is guaranteed by the entrainment effect, we hypothesize that adding a torsion spring to the walker's inter-leg joint will smooth the coupling dynamics and further improve the walking stability. Through numerical simulation, we show the expansion of the entrained walking frequency compared with the original work. In addition, we show that the damping effect induced by spring does not significantly descend the energy efficiency.



OS37-6 Motion Analysis of Two Identical Passive Compass-like Biped Robots Walking on Vibrating and Slippery Downhill

Fumihiko Asano
(Japan Advanced Institute of Science and Technology, Japan)

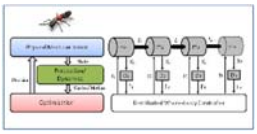
This paper discusses the possibility of generation of stable passive dynamic gaits of two identical compass-like biped robots on vibrating and slippery downhill, and analyzes the fundamental gait properties through numerical simulations. First, we develop a mathematical model consisting of two compass walkers and passively vibrating tilted stage, and numerically investigate the passive-dynamic gaits generated on the vibrating and non-slippery downhill. Second, we modify the previous model appropriately, and numerically investigate the generated gaits on the vibrating and slippery downhill. In either case, it is shown that the generated overall motion is a stable multi-period motion, and that the phase relationship between the two walkers develops while alternating with each other.



January 27 (Thursday), 09:00-11:25

OS37-7 Motion analysis of coupling dynamics and coordinated control for modular robot

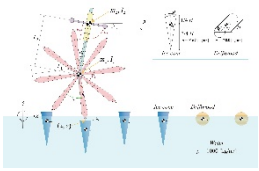
Muhammad Irfan and Fumihiko Asano
(Japan Advanced Institute of Science and technology, Japan)



In this paper, a method of distributed motion control and analysis for a multi-modular robot is proposed and stability analysis is performed under several environmental conditions. The motivation behind this work is taken from real world scenarios where a multi-agent system exhibits its total behavior depending upon the individual behaviors of its comprising units or members. In specific cases like centralized systems, if individual behavior of single entity is not sensed/controlled or coordinated, then the total impact on the system can collapse the whole system. Inspired from this phenomenon, a distributed approach to corporate the autonomous units of a multi-modular robots is suggested to achieve the stable motion behavior which allows the single module of a robot to sense the terrain conditions and coordinate its state with the total system response in an efficient manner. The proposed system follows the three-layered system components as physical layer, perception/dynamics layer and optimization layer. First, physical layer represents the physical modular robot which consists of 'n' modules set represented as $M=\{m_1,m_2,\ldots m_n\}$ linked with each other 'n-1' links set represented as $L=\{l_1, l_2 \ldots l_{n-1}\}$. Second layer, the perception/dynamics block takes the input as of individual modular states set X and computes its dynamics parameters as in set D. After some required preprocessing of system parameters, desired motion for each modular block as set F is generated. Third layer, a distributed whole-body controller is responsible to process the desired motion parameters as of set F sent by each module. The distributed wholebody controller optimizes the received information in the form F sets and an optimal feedback response, or motion command is advised to the individual system modules. Such mechanism works like early warning system in danger zone. The objective is to achieve stable system mobility through distributed mechanism and to avoid the non-desired system load on specific single module, mostly the leading module in the direction of mobility. system collapse in situations like abrupt changes in terrain conditions during the robot's mobility such as instant stoppage or rapid moving away. To evaluate proposed system under variety of terrain conditions as system parameters, extensive simulations are performed in MATLAB. …

OS37-8 Stable Limit Cycle Walking on Small Floating Islands Considering Density and Shape

Fumihiko Asano and Yuetong He
(Japan Advanced Institute of Science and Technology, Japan)



The authors have investigated the possibility of achieving stable limit cycle walking of a 6-DOF legged robot on an infinitely-long floating island, and numerically analyzed the basic gait properties. In this paper, as a more realistic road surface situation, we consider individually separated floating islands that move up and down according to buoyancy and gravity, and numerically investigate the basic properties of the generated limit cycle gaits on them. We also discuss that instantaneous stance-leg exchange may not be possible depending on the density of floating islands.

OS37-9 Analysis of Synchronization between Active and Passive Bipedal Walkers on Tilted Vibrating Stage

Runyu Liu, Cong Yan, and Fumihiko Asano
(Japan Advanced Institute of Science and Technology, Japan)

This paper discusses the walking of an active and a passive bipedal walking robot walking on a downhill with vibrating horizontally along an inclined direction and numerically analyzes the gait characteristics of the robot. Both of the two robots are identical compass bipedal robots. First, we establish the dynamics model of the system, including the equations of motion and collision. Second, we investigate the effect of the viscosity coefficient of the road surface on the gait properties. Third, we investigate the effect of the period of the input of the active walker on the synchronization between the two robots.

January 27 (Thursday), 09:00-10:15

Room E

OS18 AROB: Robotics with Intelligence and/or Informatics 1

Chair: Tetsuya Kinugasa (Okayama University of Science, Japan)
Co-Chair: Mamoru Minami (Okayama University, Japan)

OS18-1 Space sensing system using photo/projection combined method

Yejun Kou[1], Lujie Wang[2], Yuichiro Toda[1], and Mamoru Minami[1]
([1]Okayama University, Japan)
([2]Hiroshima University, Japan)

The technologies of space sensing have been advancing nowadays. Many researches have resorted to making a recognition model in advance to estimate the target's pose and detect the target object. Although it can provide pose recognition results, preparing a correct recognition model is time-consuming and complicated. For this problem, our research group has proposed a 3D space sensing method named Projection-based 3D perception (Pb3DP), which can estimate an arbitrary target's pose without prior knowledge if the target is designed by some procedure. However, without the designation of a specific target, the Pb3DP method is functionless because the Pb3DP cannot understand which target's pose should be measured. To this problem, our research group combined the Pb3DP method with the photo-based method, which is a method that can distinguish a specific target from the background and estimate its pose through a 2D photo-model. Then the combined method can specify the target whose pose is required to measure, then Pb3DP can output the pose of the target.

OS18-2 Shortening calculation by Introducing Field Programmable Gate Array For 3D Space Sensing

Shiyu Wang, Jieyuan He, Takahiro Nida, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

In order to perform a given function, a robot needs to have a basic knowledge of its environment and a processor that can handle huge amounts of computation. This paper mainly introduces the application of FPGA in 3D space sensing to accelerate recognition speed. the AUV (Autonomous Underwater Vehicle) in use now When is working under the water, it sometimes appears the situation of inaccurate cognition. We use FPGA to accelerate the computation speed of fitness and we let different location information be processed at the same time, and greatly accelerate the calculation speed. Lay a foundation for increasing the number of individuals and the number of evolution in the future. We describe our approach for arbitrary objects pose recognition system with FPGA technology, the proposed system is implemented on Zynq UltraScale+ MPSoC ZCU104.

OS18-3 Installation and Experiments of Visual Space Sensing Underwater Robot -BlueRov2-

Fumiya Yamaoka, Renya Takahashi, Horng-Yi Hsu, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

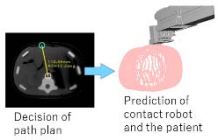
Recently, a number of researches related to underwater vehicle has been conducted worldwide with the huge demand in different applications. In the previous study, we proposed an underwater robot vision servo using a compound eye camera. 3D Model-based Matching Method is proposed for real-time attitude tracking applied to autonomous underwater vehicles (AUV).Real-time Multi-step Genetic Algorithm (RM-GA) is utilized in searching process of pose in term of optimization, because of its effectiveness, simplicity and promising performance of recursive evaluation, for real-time pose tracking performance. The proposed system is implemented as software implementation and Remotely Operated Vehicle (ROV) is used as a test-bed. In the simulation experiment, visual servo experiment in which the underwater robot recognized the target, estimated the relative attitude on the basis of the proposed system, and controlled it to the desired attitude, and docking experiment on the assumption of the automatic power supply from the submarine power supply equipment in the actual sea area were carried out.

January 27 (Thursday), 09:00-10:15

OS18-4 Contact prediction with patient using projection of point cloud before robotic IR surgery

Takayuki Matsuno, Nanako Sakai, Tetsushi Kamegawa, Takao Hiraki,
Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

There is a surgical method called Interventional Radiology (IR) in which needles are inserted into the body using image diagnostic ways such as CT fluoroscopy and X-ray images to perform treatments. IR has been applied to various treatments including lung cancer treatment, liver cancer treatment, and biopsy. IR surgery has been receiving attention in recent years, because it is less invasive for patient than conventional surgery. Surgeons are currently exposed to strong radiation in the case of under CT-guidance. In order to overcome this problem, we developed remote-controlled IR assistance robot named as Zerobot. During the surgery, the contact of Zerobot with the patient should be avoided. For the purpose of reducing the load of operator, we have been studying an assistance system for alarming the contact between the robot and the patient. In this paper, a method to predict the contact between Zerobot and the patient with projection of point cloud is proposed.



OS18-5 Efficiency and improvement of parallel calculation structure in Field Programmable Gate Array

Jieyuan He, Shiyu Wang, Takahiro Nitta, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

Nowadays, robots that can explore and investigate in dangerous and unknown environments (such as the deep sea) have attracted extensive attention. When a robot works in a changing environment, it must respond to the changes of the environment in real-time. Therefore, the visual servoing system is widely used in various scenes. However, in the past, robots equipped with visual servoing systems often cannot achieve accurate recognition in complex environments such as turbid seawater. Therefore, we developed a visual servoing system using a luminous 3D mark (3-dimension mark) to solve the above problems. However, in previous research, the system has always relied on CPU to realize computing, which not only brings a great burden to CPU but also the calculation speed of general CPU is not satisfactory. To realize high-speed visual servo, we transplant the evaluation function which consumes a lot of calculation resources to the FPGA (Field Programmable Gate Array) module. Different from CPU, parallel calculation using FPGA only needs to be realized through the circuit designed by the designer, to improve the efficiency. In the past, FPGA design was developed by hardware designers, but now the circuit can also be designed in C through High-Level Synthesis (HLS) tools. Now, we have successfully realized the fast calculation of the evaluation function and output the correct results. In this paper, I will explain how to quickly calculate the evaluation function using FPGA. The development system adopts the Zynq UltraScale + MPSoC ZCU104 evaluation board provided by Xilinx. The evaluation board is equipped with an ARM CPU and programmable logic units.

January 27 (Thursday), 09:00-11:10

Room F

OS2 AROB: Advanced Technology in Rescue Robot Competition

Chair: Noritaka Sato (Nagoya Institute of Technology, Japan)

OS2-1 Development of a snake robot manipulator and image processing application for the World Robot Summit 2020 Disaster Robotics Category: Plant Disaster Prevention Challenge

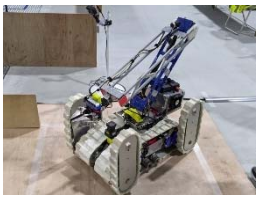
Hajime Tamura, Tetsushi Kamegawa, Yongdong Wang, Taiga Teshima, Sota Nakano, Yuki Tada, Daiki Nakano, Yuichi Sasaki, Taiga Sekito, Yuya Shimizu, Keisuke Utsumi, Rai Nagao, and Mizuki Semba
(Okayama University, Japan)

We have developed a snake robot manipulator and an image-processing application to read analog meters for the World Robot Summit 2020 Disaster Robotics Category: Plant Disaster Prevention Challenge. The snake robot manipulator can be mounted to a mobile robot and perform tasks of manipulating. Furthermore, it can also be separated from the mobile robot and inspect narrow spaces by itself. A robot system using the snake robot manipulator is expected to have higher inspection capabilities than conventional robots. We implemented this robot system with our snake robot YATSUME and mobile robot DANIEL. We also developed an image-processing application that reads the numerical values of an analog meter from the camera mounted on the snake robot manipulator. We participated in the World Robot Summit competition with the developed robot system and demonstrated the possibility of using this system in the actual field.

OS2-2 Improvement of Robot Performance from World Robot Summit 2020 to RoboCup Asia Pacific 2021

Akihiro Fukuda, Kyosuke Ushimaru, Sota Sumikama, Kotaro Kanazawa, and Noritaka Sato
(Nagoya Institute of Technology, Japan)

Our team, NITRo, participated in World Robot Summit (WRS) 2020 Fukushima with a new robot developed for the competition. Because of various reasons, our robot could not achieve our expected results. After WRS 2020, we made several improvements and adjustments to the hardware and software of the robot for RoboCup Asia Pacific (RCAP) 2021 Aichi. Because of these improvements, the robot performed better in RCAP 2021, leading our team to achieve second place. This paper describes the improvements we have made to the robot, including adjustments for individual tasks, as well as improvements we are planning to make going forward.



OS2-3 Safety management of a robot competition in a robot competition - Lessons Learned from World Robot Summit 2020 Fukushima, Plant Disaster Prevention Challenge -

Yudai Hasumi[1], Hideki Masago[2], and Tetsuya Kimura[3]
([1]Polytechnic University, Japan)
([2]Japan Agency for Marine-Earth Science and Technology Institute for Marine-Earth Exploration and Engineering, Japan)
([3]Nagaoka University of Technology, Japan)

The World Robot Summit (WRS) "Plant Disaster Prevention Challenge" is a realistic mock-up built according to actual plant design standards to simulate routine inspections and emergency response to disasters through robotic operations. The authors participated in WRS as safety managers. Plant Disaster Prevention Challenge involves many non-routine and irregular factors because various people and robots participate in outdoor plants. In addition, it was necessary to manage safety well with limited material and human resources during the competition. In this paper, we discuss the issues of safety management in robotics competitions by giving examples of safety management measures that have been implemented in the competition.

January 27 (Thursday), 09:00-11:10

OS2-4 Development of FUHGA2, FUHGA3 and YAGURA for Inspection and Rescue activity and evaluation in World Robot Summit 2020

Tatsuya Takemori, Xixun Wang, Ryosuke Koike, Yuto Fukao, Tsubasa Kitada, Ryohei Morita, Takumi Yamada, Yushi Okuda, Ryohei Michikawa, Shota Tanaka, Yuki Morimoto, and Fumitoshi Matsuno
(Kyoto University, Japan)

Development of the robot for inspection and rescue activity is needed. For that purpose, robots are required to have more variety of functions, such as mobility, dexterity, and autonomy. We developed three robots. FUHGA2 and FUHGA3 are robots with multiple functions and can be used for various task. YAGURA is a small mobile robot with the long arm whose reachable height is over three meter. We participated in ``Plant Desaster Prevention challenge'' of Disaster Robothics Category in the World Robot Summit 2020 in October 2021 at Fukusima Robot Test Field. We describe the development of the robots and the evaluation with the result of the conpetition.

OS2-5 Machine Vision for Reading Pressure Gauges in Industrial Environments

Dariusz Witek vel Witkowski, Agnieszka Pukacz, Damian Szewczyk, and Grzegorz Granosik
(Lodz University of Technology, Poland)

The article describes the concept and performance of the vision system used by the Raptors team during the World Robot Summit 2020. The system is based on raw image processing. Its purpose is to automatically detect pressure gauges in the analyzed frame and read the indicated value according to the dial scale. Algorithm is resilient to noise, low bitrate and blurriness of the analyzed image. It was designed to work in changing lighting conditions. As part of the tests, real-time data obtained from unmanned ground and aerial vehicles were used. Developed algorithm met the initial assumptions with given limitations, becoming a robust solution to the gauge reading task. It can be adjusted for cooperation with autonomous robots as well as for locating gauges in 3D space.

OS2-6 Modular Robotic System for Various Environments and Tasks

Adrianna Rosiak, Ewelina Rosiak, Radoslaw Marciniak, and Grzegorz Granosik
(Lodz University of Technology, Poland)

This paper presents a concept and evaluation of the modular robotic system for various environments and tasks, which is developed under the Raptors project. Modularity of the proposed system refers to all aspects of the design – it contains interchangeable mechanical, electronic and software component to fulfill various tasks found in robotics competitions: inspections performed by Mars rover, search & rescue actions or maintenance in industry. The Raptors team is working on implementation of different suspension types to the rover. We have also developed algorithms to control these individual suspensions. All the proposed suspensions, manipulator drives and additional sensors (e.g. vibration sensor based on accelerometer) are using the same structure and communication, therefore, adding new modules (required by new application scenarios) is easy, just adding new control messages to the protocol and plugging-in to the CAN network.

OS2-7 Object recognition by RealSenseD435 using ROS and object holding with 6 DoF manipulator

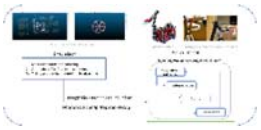
Jaefun Seo and Yoshiaki Yamazaki
(Meisei University, Japan)

Disaster rescue robots need to be equipped with manipulators with cameras mounted on their hands in order to look through the rubble to find victims. In addition, in recent years, various advanced tasks are required depending on the situation at the site, such as turning valves and removing debris, so versatility of functions is an issue. In addition, understanding the distance information between the robot and the target object is an important issue at disaster sites. Therefore, we combined the RealSense D435 depth camera with a manipulator. By programmatically linking them, we aim to automatically measure the distance to the valve and automatically control the robot such that the gripper grabs the valve and rotates it. For this purpose, we measured the accuracy of the distance measurement.

January 27 (Thursday), 09:00-11:10

OS2-8 A Novel Development Process of a Robust Software Module of Manipulation of a Mechanical Device Incorporating with Robot Simulator

Udaka Manawadu, Kakeru Abe, Hiroaki Ogawa, Keitaro Naruse
(The University of Aizu, Japan)



Due to the hardware availability and rapid software development processes, robotic automation has been growing rapidly in the past few years. Mainly, when it comes to factory automation, safety can be ensured by substituting robot automation for various tasks. In this research, a novel software engineering process that is fast and robust was implemented for research-grade algorithms to a practical robotic software system. Currently, the software engineering process for robotic systems is often case-specific, without fully following established engineering approaches. Since the system integrations are varied in conventional robotics, it is difficult to maintain and develop software systems in real-time. The proposed architecture is related to a test case which includes object recognition and pose estimation using an RGB-D camera attached to the robot arm. The test case was to build automated opening and closing valves in factory automation and embed the system into a robot. The suggested approach in this research included three main stages. The preliminary stage focuses on implementing and testing the software using simulations. Then implement a research algorithm to practical software and integrate it into the robot. Finally, continuously tuning the software in a testing environment using the robot.

January 27 (Thursday), 09:00-10:00

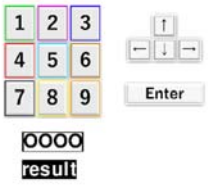
Room G

OS7 AROB: Bio-inspired theory and applications (1)

Chair: Kunihito Yamamori (University of Miyazaki, Japan)
Co-Chair: Hisaaki Yamaba (University of Miyazaki, Japan)

OS7-1 Development of an anti-peeping passcode keypad using color/shape cursors

Ryo Masuzawa, Kentaro Aburada, Hisaaki Yamaba, Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)



Traditionally, in smartphones and ATMs, the method of entering a 4-digit passcode into the keypad is used to check passcode match. However, in this method can easily steal passcode by a third party peeping or by analyzing the fingerprints left on the keypad. There are solutions such as biometric authentication and the use of special screen protector but they face problems such as high cost and difficulty of using. To date, various methods have been proposed to solve these problems. There are many methods proposed in different studies such as using sight-line input devices, distance sensors, and winks. However, all of them choose the user to use. In addition, it costs money and time to introduce special equipment. Therefore, in this research, we propose a keypad that leaves no trace and does not use special materials or equipment and allows people to enter their passcodes with peace of mind even if other people are next to them.

January 27 (Thursday), 09:00-10:00

OS7-2 An Attempt at Data Augmentation for Realizing User Authentication Using s-EMG Signals

Soichiro Ishibashi, Yuya Yamamoto, Hisaaki Yamaba,
Kentaro Aburada, Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)

In our present era, mobile devices such as tablet-type personal computers and smartphones have penetrated deeply into our daily lives. We report on a new user authentication method for mobile devices that uses surface electromyogram (s-EMG) signals rather than screen-touch operations. These s-EMG signals, which are generated by the electrical activity of muscle fibers during contraction, can be used to identify who generated the signals and which gestures were made. Our method uses a technique called "pass-gesture", which refers to a series of hand gestures, to achieve s-EMG-based authentication. In this paper, generative adversarial network is introduced for data augmentation. To improve the performance of identification of gestures, many data of s-EMG signals are required. Since measurement of the signals is time-consuming, we adopted data augmentation techniques to supplement shortage of the data. The results of experiments show that the performance of identification was improved by increase of learning data.

OS7-3 Driving trajectory optimization by reinforcement learning for motorsports

Akinobu Iwai[1], Masaru Aikawa[2], Kunihito Yamamori[3]
([1]Graduate School of Engineering,University of Miyazaki, Japan)
([2]Technical Center Faculty of Engineering,University of Miyazaki, Japan)
([3]Faculty of Engineering,University of Miyazaki, Japan)

The objective of this paper is to obtain a time-optimal driving trajectory for a car using reinforcement learning(RL). RL is one of the machine learning algorithm to learn policies which choose an action of agent at the specific situation in virtual simulation environment. The RL agent learns which action will give the largest reward to agent at the specific situation. In usual, this kind of research try to drive a car without collisions among other cars. Meanwhile, racing cars in motorsport have to drive the car with the fastest lap, tolerating with some small collisions. In this research, we use actor-critic model and proximal policy optimization (PPO) for the RL algorithm, and evaluate our method in the virtual environment ”CarRacing-v0” in ”gym” that is a toolkit for developing RL. The experimental results will compare with the trajectories proposed by a professional racing driver.

OS7-4 Heuristic base music arrangement suppressing on discord progression

Kosuke Yoshida[1], Masaru Aikawa[2], Kunihito Yamamori[3]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Technical Center, Faculty of Engineering, University of Miyazaki, Japan)
([3]Faculty of Engineering, University of Miyazaki, Japan)

In this paper, we aim to propose a method for music arrangement aided by computer and evaluate it by questionnaire. We focus on cadences and discord in music arrangement. Cadences are musical heuristics and rules of transition easiness from a chord to the other one. However, chord selection from cadence only is not enough to create suitable chord progression for a given melody. Our method inserts a new music arrangement rules to exclude discord notes in the chords. To evaluate our method, we take a questionnaire which asks audiences about naturalness of the arranged music with or without our new rules.

January 27 (Thursday), 10:45-11:45

Room C

OS5 AROB: AI in Life Sciences 3

Organizer: Kazushi Ikeda (Nara Institute of Science and Technology, Japan)
Chair: Koichi Fujiwara (Nagoya University, Japan)

OS5-1 Development of an Epileptic Seizure Prediction Algorithm Using R-R Intervals with Self-attentive Autoencoder

Rikumo Ode[1,2], Koichi Fujiwara[1,4], Miho Miyajima[2], Toshitaka Yamakawa[3],
Manabu Kano[4], Taketoshi Maehara[2]
([1]Nagoya University, Japan)
([2]Tokyo Medical and Dental University, Japan)
([3]Kumamoto University, Japan)
([4]Kyoto University, Japan)

Epilepsy is a neurological disorder which may affect the autonomic nerve system (ANS) from 15-20 minutes before seizure onsets, and the alternation in ANS affects R-R intervals (RRI) on electrocardiogram (ECG). This study aims to develop an algorithm using a Self-attentive Autoencoder (SA-AE) based method for predicting focal epileptic seizures by monitoring R-R interval (RRI) in real time. The results of applying the developed seizure prediction algorithm to the clinical data demonstrated that it functioned well in most patients. In the future work, we will investigate the causes of FPs, and optimize the developing seizure prediction algorithm for further performance improvement.

OS5-2 Relationships between Environmental Sound and Sleep Quality Based on Sleep Spindles

Shota Saeda[1], Koichi Fujiwara[1], Yukiyoshi Sumi[2], Hiroshi Kadotani[2]
([1]Nagoya University, Japan)
([2]Shiga University of Medical Science, Japan)

Insomnia is a highly prevalent sleep disorder. A simple way to improve sleep quality has great importance. In this study, we analyzed EEG data recoded from subjects during sleep in three types of sound environments: silence, environmental noise, and relaxing music. We used an automatic sleep spindle detection algorithm to detect the spindle. And we evaluated the sleep quality from the viewpoint of spindle occurrence. The results showed that in seven of eleven subjects, the number of spindles increased more when listening to relaxing music than when listening to environmental noise. Among five subjects with poor sleep efficacy, four subjects had increased number of spindles under the relaxing music environment. This study indicated that the relaxing music environment may improve the sleep quality, particularly in subjects with insomnia.

OS5-3 Development and Validation of an Optimal Attachment Position Choice System for a Patch Type Wireless R-R Interval Telemeter

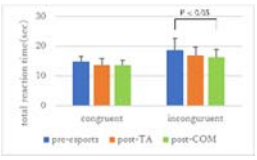
Aoi Noguchi, Mayu Nishio, and Toshitaka Yamakawa
(Kumamoto University, Japan)

A patch type R-R interval (RRI) telemeter, which is highly accurate, compact and inexpensive, is being developed to monitor heart rate with a smartphone application. To perform stable RRI measurements for a long time using such devices, finding the optimal electrode placement is essential. It, however, can be difficult for people with little or no expertise in analyzing heart rate variability (HRV) to place the electrodes in the appropriate positions according to individual differences. This paper pro-poses a system to choose the optimal position of the patch type measurement device to improve usability for non-experts. The RRIs of 10 male subjects in four posture were measured by attaching the device at the position determined by an optimal attachment position choice system. The RRIs were compared with those of the reference ECG measurement system, and the measurement accuracy of the proposed device was confirmed to be sufficient for HRV analysis.

January 27 (Thursday), 10:45-11:45

OS5-4 Changes in cognitive skills and heart rate variability associated with playing esports

Toshihide Otsuki, Kazuki Hisatsune, and Toshitaka Yamakawa
(Kumamoto University, Japan)



Electronic sports (esports) is becoming an increasingly popular subject of research with progress in the video game industry. However, few studies have been conducted on the relationship between playing electronic sports (esports), cognitive skills, and heart rate variability (HRV) indices. In this study, 20 healthy adult males were monitored to examine the changes in cognitive skills and HRV indices using the Stroop test and RR intervals while playing esports. The results suggest that playing esports could temporarily improve cognitive skills, and the changing LF/HF ratio could provide insight into the trend of improvement. Further investigation, including other HRV indices, is therefore warranted.

January 27 (Thursday), 10:30-12:00

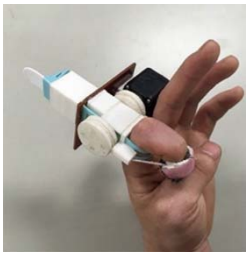
Room E

OS19 AROB: Robotics with Intelligence and/or Informatics 2

Chair: Mamoru Minami (Okayama University, Japan)
Co-Chair: Tetsuya Kinugasa (Okayama University of Science, Japan)

OS19-1 Development of Automatic Rehabilitation Equipment for Flexor Tendon

Takeshi Ikeda[1], Miyuki Serino[1], Yuki Matsutani[2], Masanori Sato[3], Seiji Furuno[4], and Fusaomi Nagata[1]
([1]Sanyo-Onoda City University, Japan)
([2]Kindai University, Japan)
([3]Nagasaki Institute of Applied Science, Japan)
([4]National Institute of Technology, Kitakyushu College, Japan)



An existed medical appliance bend by pulling the rubber on the patient, but since they do not pull up to places where they do not hurt themselves, the degree of the bending angle depends on the patient. Therefore, there are cases where rehabilitation does not enough. The limit of the bending of the finger using this orthosis, and there is a problem that it cannot be brought up to the shape of the bending which the therapist carries out during rehabilitation. In addition, it is necessary to customize medical equipment for each patient, it is expensive and lacks versatility. In this study, we aim to support rehabilitation for patients early postoperatively. Therefore, we will focus on emerging flexion method and its automation, emphasis on having versatility so that anyone can use it, and develop rehabilitation orthosis for effective flexor tendon.

OS19-2 Target detections using AI for carrying operations of drones with manipulators

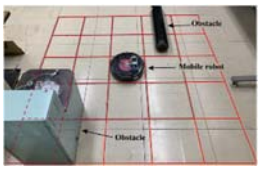
Makoto Yamashita and Masatoshi Hatano
(Nihon University, Japan)

The purpose of this research is to develop a detection system for aerial carrying operations of a drone with a manipulator with AI (Artificial Intelligence) and SLAM (Simultaneous Localization And Mapping). In the system, AI and SLAM were employed in order to detect target objects from a complex environmental information. A drone having a manipulator was constructed. Experimental results that the drone detected and carried a target object are shown.

January 27 (Thursday), 10:30-12:00

OS19-3 Proposal and Experiment of Coverage Algorithm for Fall Risk Prediction System for Elderly

Seiji Furuno[1], Hayate Oe[1], Masanori Sato[2], Takeshi Ikeda[3]
([1]National Institute of Technology, Kitakyushu College, Japan)
([2]Nagasaki Institute of Applied Science, Japan)
([3]Sanyo-Onoda City University, Japan)



In this study, we are developing a robotic system that can predict the risk of falling by having a mobile robot autonomously detect the three causes of falling indoors: slipping, stumbling, and falling, and quantitatively and visually evaluate the degree of danger. If this system is put to practical use, it can not only clarify the danger of falling, but also lead to advice on how to eliminate the danger. In order for a mobile robot to detect indoor fall hazards, it must have coverage within the work environment. In this paper, we propose a new coverage algorithm that enables a mobile robot to efficiently and completely traverse the environment in an unknown environment where information such as the size of the indoor area, the size and number of stationary and moving objects are not given, and confirm the effectiveness of the algorithm through operational experiments.

OS19-4 Exhibiting Various Gait Patterns in Quadrupedal Locomotion via Passive Inter- and Intralimb Coordination

Kii Oba, Shoichi Miwa, Tetsuya Kinugasa, Takumi Ishihara,
Jialun Zhang, Koji Yoshida, and Ryota Hayashi
(Okayama University of Science, Japan)

Some studies attained the passive quadruped gaits such as a pace with a rigid trunk and a trot with a roll joint. In addition, the quadruped gait by the decentralized phase oscillator was reported, which exhibited a gait transition due to the intrinsic oscillator frequency. However, the robots had a relatively short leg, which provides stable upright posture, and the latter one could be ignored the limb dynamics. In this study, the quadruped RW06-Duo based on the passive dynamic walking mechanism, of which CoM is located at a high position, is developed and attains quadrupedal locomotion. The limb joints except the knee can rotate freely or passively; therefore, the intralimb coordination is attained passively, and the interlimb coordination is given by the decentralized phase oscillator and backbone stiffness. The robot exhibits some gaits and demonstrates the gait transition for the frequency of the oscillator and the stiffness.

OS19-5 Growing Neural Gas based Space Perception for Semi-autonomous Teleoperation System

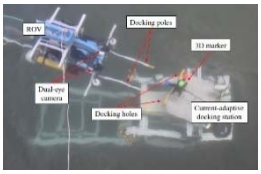
Yuichiro Toda, Hikari Miyase, Keisuke Nagao, Qi Li, Takayuki Matsuno, and Mamoru Minami
(Okayama University, Japan)

Teleoperation systems for mobile robots have been expected in many fields such as rescue robot, entertainment robot, and navigation robot. One of the problems in the teleoperation system is operation loads of the operators since the operator needs to control the teleoperation robot and monitor the surround environment simultaneously. For reducing the heavy burden of the operators in such fields, we have to realize a semi-autonomous teleoperation system. This research proposes a Growing Neural Gas (GNG) based topological environmental map building method from a metric map with high resolution map using for the self-localization in order to realize the semi-autonomous teleoperation system. In the learning algorithm of our proposed GNG, the geometric feature and occupancy information can be correctly learned by our proposed distance measurement. Next, the path planning method in unknown environments is proposed by utilizing the topological map, and the subgoal selection of the topological map is proposed by utilizing the contour node information for realizing the path planning in unknown environment. Finally, we conduct on an experiment for evaluating our proposed method in real environments for verifying our proposed method.

January 27 (Thursday), 10:30-12:00

OS19-6 Repeated docking/releasing experiments utilizing current-disturbance-adaptive undersea system.

Horng-Yi Hsu, Yuichiro Toda, Takuya Monden, Keigo Watanabe, and Mamoru Minami
(Okayama University, Japan)



Many studies have been performed worldwide to extend the persistent operation time of an Autonomous Underwater Vehicle (AUV). The underwater battery recharging system with a docking function is an effective method to extend the operation time of the AUV. The function of the underwater docking is a key role not only in battery recharging but also in other advanced applications. In our previous studies, our research team proposed a stereo-vision-based visual system to fulfill an automatic docking operation of an underwater vehicle. The stability of the proposed system was verified, and the docking operation was successfully conducted. However, the proposed system showed its limitations when docking operations were conducted in a real-sea with current direction fluctuating. The proposed docking system can be docked, on the premise of little environmental changes and few external forces during the experiments. Our research team designed a current-adaptive docking station to overcome these limitations. Subsequently, a real-sea experiment has been carried out to verify the effectiveness of the current-adaptive docking station. Successful real-sea experiment demonstrates the effectiveness of the proposed docking system in the real-sea environment.

January 27 (Thursday), 10:45-11:30

Room G

OS8 AROB: Bio-inspired theory and applications (2)

Chair: Kunihito Yamamori (University of Miyazaki, Japan)
Co-Chair: Masaru Fukushi (Yamaguchi University, Japan)

OS8-2 A GPU Acceleration Method for Moving Object Extraction Based on Superpixels

Yuki Manno[1], Masaru Fukushi[1], and Toru Abe[2]
([1]Yamaguchi University, Japan)
([2]Tohoku University, Japan)

As a method for performing robust extraction of moving objects from image sequences, a background subtraction method based on superpixels has been proposed. In this method, perceptually meaningful atomic regions called superpixels are generated for an input image and they are used in background subtraction between the input image and reference images. This makes it possible to extract moving objects robustly even if appearance of the background fluctuates. However, this method has a disadvantage that it requires a large amount of calculation in generating superpixels and extracting moving objects, and thus requires a large amount of processing time. In this paper, we propose an acceleration method for this method using a GPU. A GPU consists of a number of Streaming Multiprocessors (SMs), a cluster of processor cores, and thus enables fine-grained parallel processing. In the proposed method, the target method is divided into two parts, superpixel generation part and moving object extraction part, and different parallel processing strategies are applied. Experimental results show that the processing time can be reduced by about 70% compared with the sequential processing on a CPU.

January 27 (Thursday), 10:45-11:30

OS8-3 A GPU acceleration method for voxel-based multiview stereo

Naoki Shojima[1], Masaru Fukushi[1], and Toru Abe[2]
([1]Yamaguchi University, Japan)
([2]Tohoku University, Japan)

This paper deals with the issue of accelerating voxel-based multiview stereo methods by a Graphics Processing Unit (GPU). The voxel-based methods reconstruct a 3D scene as a set of voxels corresponding to object surfaces in a subject 3D space from a set of images taken at different viewpoints; however, its processing time is enormous. In this paper, we propose an acceleration method using a GPU. One problem when using a GPU is the limitation of global memory space. To overcome this problem, we focus on the fact that the calculation required for each voxel can be decomposed into several subcalculations with one image, and we replace the data on the GPU image-by-image to reduce the total memory usage. Experimental results show that the proposed method reduces the processing time by about 81% compared with previous parallel method [8] and also reduces memory usage of voxel-based multiview stereo by about 91%.

OS8-4 An implementation of checkpoint function for the realization of parallel volunteer computing

Keiichi Inohara and Masaru Fukushi
(Yamaguchi University, Japan)

Volunteer computing (VC) is a type of distributed computing paradigm, which constructs a large-scale parallel computing environment on the Internet by collecting computational resources (nodes) provided by volunteer participants. Due to the volatility of nodes, current VC supports only distributed computing which does not require communication among nodes. For the realization of parallel VC, we propose a source-code-level checkpoint mechanism that can restore computation status of a node to another node with different computational environment. Experimental results show that write/read time of a checkpoint file is less than 6 ms for the array of 10,000 elements.

January 27 (Thursday), 13:00-14:30

Room B

OS40 SWARM: Swarm and Bio-inspired Systems 2

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Hokkaido University, Japan)
Chair: Yasumasa Tamura (Hokkaido University, Japan)

Invited Talk 10 DNA nanotechnology for soft micromachines and molecular robots

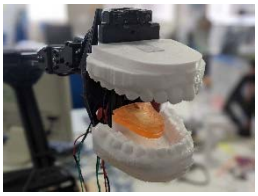
Masahiro Takinoue (Tokyo Institute of Technology, Japan)

See page 26

January 27 (Thursday), 13:00-14:45

OS40-1 Composed Soft Matter Learning of Subtle Texture Identification of Food products in Artificial Mouth

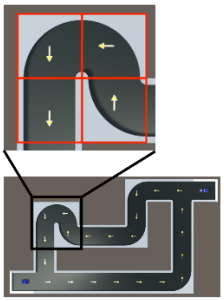
Kosuke Hirose, Ikuma Sudo, Jun Ogawa, Yosuke Watanabe, MD Nahin Islam Shiblee, Ajit Khosla, Masaru Kawakami, and Hidemitsu Furukawa
(Yamagata University, Japan)



The methodology to evaluate the reproducibility of cooked food texture has not been established. We focus on the high texture perception by the mouth. This study develops an artificial mouth "Gel Biter" that can detect the subtle differences in food texture by creating an oral structure made of polymeric materials with different physical properties. This study verifies whether it is possible to achieve superior food texture recognition by applying three clustering algorithms to the sensor data obtained from each material. The Gel Biter can achieve a complete classification of the material composition for five different types of sweets, with an average classification rate of up to 93.7% for five different types of hard crackers, up to 88.7% for five different types of cream sandwiches, and up to 85.4% for five crackers of the same type.

OS40-2 Emergent Rule Discovery for Automated Driving Using Multi-Agent Simulation

Tomohiro Harada[1], Johei Matsuoka[2], and Kiyohiko Hattori[2]
([1]Tokyo Metropolitan University, Japan)
([2]Tokyo University of Technology, Japan)



With improved AI technology and sensor performance, researches on automated driving have become more and more popular. However, Most of these studies are designed based on human driving styles. In this research, we consider the environment where only autonomous vehicles drive. In such a case, developing an appropriate control method is essential that actively utilizes the characteristics of autonomous vehicles, i.e., dense information exchange, highly accurate vehicle control. To address this issue, we investigate the emergence of automatic driving rules using reinforcement learning based on the information of surrounding vehicles obtained by many vehicles using inter-vehicle communication. This study investigates rewarding design for achieving cooperative automatic control and analyzes the behavior of the control obtained by reinforcement learning.

OS40-3 Collision Avoidance Design with Asymmetric Decentralized Control Barrier Function for Robotic Swarm

Hiroki Etchu, Yuki Origane, and Daisuke Kurabayashi
(Tokyo Institute of Technology, Japan)

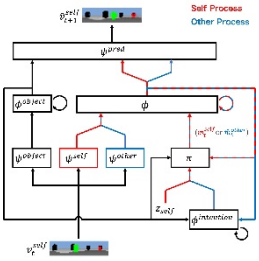
In this study, we propose a method to solve the problem of no input solution in distributed collision avoidance for swarm robots. Swarm robots are superior to individual robots in terms of system flexibility, scalability, and fault tolerance. Therefore, they are expected to be used in various fields, such as disaster rescue and exploration of inaccessible areas. Collision avoidance is a major historical problem in the implementation of swarm robots. Recently, the control barrier function (CBF) has been attracting attention as a collision avoidance design method for swarm robots. However, the inequality constraint of the CBF sometimes leads to an unsolvable state in the conventional design. To solve this problem, we introduced inequality constraints using asymmetric CBF among robots.

January 27 (Thursday), 13:00-14:45

OS40-4 Understanding intention of others through visual predictive learning based on superposition mechanism

Katsuki Auchi[1], Wataru Noguchi[2], Hiroyuki Iizuka[2,3], Masahito Yamamoto[2,3]
([1]Graduate School of Information Science and Technology, Hokkaido University, Japan)
([2]Faculty of Information Science and Technology, Hokkaido University, Japan)
([3]Center for Human Nature, Artificial Intelligence, and Neuroscience, Hokkaido University, Japan)

Understanding the intentions behind others' actions is an important ability for social interactions, but it is still unclear how these abilities are acquired. In a recent simulation study using a deep neural network model with a mechanism called the superposition mechanism, it was shown that, through visual predictive learning, the model acquired shared internal representations of self and other. In this study, we propose a model based on the superposition mechanism that can estimate the intentions behind the others' actions through only visual predictive learning. We performed visual predictive learning with the proposed model in a simulation in which agents move with their intentions. Our proposed model was able to internally generate the intentions behind the actions of others, even though it only predicted the future vision. The results showed that the superposition mechanism could be a fundamental mechanism for acquiring the ability to understand others' intentions.



January 27 (Thursday), 13:00-14:15

Room D

OS17 AROB: Learning and Control

Chair: Hee-hyol Lee (Waseda University, Japan)

OS17-1 Auto-splitting D* lite with Frenet Frame Path Planning for Large Road Network

Shin-nyeong Heo[1], Huimin Sun[1], Ji-sun Shin[2], and Hee-hyol Lee[1]
([1]Graduate School of Information, Production, and Systems, Waseda University, Japan)
([2]Graduate School of Information, Production, and Systems, IPSRC, Waseda University, Japan)

This paper proposes an auto-splitting D* lite to achieve the dynamic path and faster global path planning in large road networks. The auto-splitting D* lite path planning reduces expanded nodes of the grid map for calculation time. The map is divided by a k-means clustering algorithm and the divided map influence to reduces the total number of the expanded nodes according to the auto-splitting procedure. The A* based paths require the entire road network map, and the progress is slow because the road network map is loaded every time. On the other hand, the D* based path is partially updated to execute the global path planning, but both A* and D* based paths are difficult to generate an actual moving path for the autonomous vehicles. Therefore, this paper applies the auto-splitting D* lite algorithm and a Frenet frame algorithm to make an actual moving path for the autonomous vehicles, and assist in sudden changes of the path.

OS17-2 A Fast Path Planning Algorithm in Dynamic and Narrow Environments

Yuan Huang and Hee-hyol Lee
(Graduate school of IPS, Waseda University, Japan)

As a remarkable sampling-based algorithm for path planning problems, Rapidly-Exploring Random Trees Star (RRT*) is widely used for its simplicity and efficiency. However, a uniform sampling strategy makes it inefficient in solving dynamic path planning problems with narrow passages. In this paper, we propose a novel algorithm, called Informed Triple RRT* (IT-RRT*). Three trees and a new sampling strategy are adopted to identify and explore the narrow configuration space rapidly. Operations for pruning the path are carried out to reduce the calculation. Also, trees reconnect and regrow in the replanning procedure to solve the dynamic environment. Finally, simulations based on different scenarios verified the advantages of IT-RRT* in initial path length, searching time, and replanning performance over other path planning algorithms.

January 27 (Thursday), 13:00-14:15

OS17-3 An Improved Drowsy Driving Detection Method by Removing Abnormality using iForest with DBSCAN

Qiushi Feng and Hee-hyol Lee
(Graduate School of Information, Production, and Systems, Waseda University, Japan)

Drowsy detection is needed to prevent accidents caused by driver drowsiness. Nevertheless, the accuracy of drowsy detection is reduced due to abnormal data generated by measurement error when collecting data by sensors. Meanwhile, traditional outlier detection algorithms cannot distinguish the abnormal data from the anomalous data caused by driver events. To deal with the issue of the original algorithm, a new preprocessing method based on the Isolation Forest (iForest) with the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) is proposed in this research. A modified Gated Recurrent Unit (GRU) combined with abnormality detection is used to determine that the driver's state is normal or drowsy. The experiments results demonstrate that the proposed method can accurately detect driver drowsiness.

OS17-4 Driver’s Drowsiness Detection based on Long Short-Term Memory with Whale Optimization Algorithm

Yang Su and Hee-hyol Lee
(Graduate School of Information, Production and Systems, Waseda University, Japan)

Nowadays, drowsy driving behavior becomes one of the major factors which cause fatal vehicle crashes. Previous researches detected driver’s drowsiness by machine learning. But in these methods, the adjustment of hyper-parameters in these models is very difficult in practice since it is usually adjusted by experience. Some optimization approaches like Genetic Algorithm and Particle Swarm Algorithm are applied on these models in some researches, but there remain some issues just like local optimum or low convergence rate. So, a new drowsiness detecting method based on Long Short-Term Memory with Whale Optimization Algorithm is proposed in this paper to solve the issues.

OS17-5 Prediction of Financial Time Series using a Hybrid RNN approach with the ARMA-GARCH model

Yu-chi Liao, Hee-hyol Lee
(Graduate School of Information, Production, and Systems, Waseda University, Japan)

Forecasting financial time series is challenging due to its unique properties. In order to further overcome the difficulties of the existing models in dealing with the phenomenon of volatility clustering and the nonlinear characteristics of financial time series data, this paper proposes a hybrid model combining the autoregressive moving average (ARMA) and generalized autoregressive conditional heteroskedasticity (GARCH) variance (ARMA-GARCH) time series model with a recurrent neural network (RNN) model. The proposed model is not only able to capture the linear properties with the ARMA-GARCH model but also characterize the nonlinear properties by the RNN model. The experimental results show that the proposed hybrid model can achieve better performance than other traditional methods while applying on several different financial time series.

January 27 (Thursday), 13:00-14:30

Room E

GS10 Control techniques

Chair: Wenjing Cao (Sophia Uiversity, Japan)

GS10-1 Automatic balancing of cost functions in an optimization-based motion imitation system for humanoid robots

Harunobu Ishii, Hideaki Itoh, Hisao Fukumoto, and Hiroshi Wakuya
(Saga University, Japan)

To control humanoid robots easily, in our previous study, we have built a motion imitation system by formulating the imitation problem as an optimization problem. However, there was a problem in the previous system; two cost functions in the optimization problem, i.e., a function that takes a larger value as the robot's motion is more different from the human motion and a function that takes a larger value as the robot's center of mass (COM) deviates more from its neutral position, had to be balanced manually. Finding a good balance between them required significant human efforts. To address this issue, in the present study, we implement a new method for automatically balancing the two cost functions. We show the validity of our method through experiments with a real humanoid robot.

GS10-2 Real-time Model Predictive Control using Artificial Bee Colony Algorithm with Vector and Multi-thread Computation

Teppei Hirotsu
(NSITEXE, Inc., Japan)

In Model Predictive Control (MPC) , a control input that minimizes a cost function representing a control objective can be obtained. Thus, the MPC can improve the control performance compared to conventional controls. However, when the MPC is applied to an actual control system, the cost function becomes a nonlinear function, so a conventional solver such as the gradient method cannot stably obtain a global optimum solution within a control period due to a local minimum problem. In this paper, we apply the Artificial Bee Colony (ABC) algorithm as an optimization solver to minimize the nonlinear cost function and obtain a stable global optimal solution. Furthermore, by implementing the ABC algorithm on a processor equipped with a vector and multi-thread computation mechanism, the optimal solution can be obtained at higher speed. Finally, we demonstrate that MPC with nonlinear cost functions can be applied to real-time systems.

GS10-3 Development of autonomous control system for automatic search and transportation of an object by a mobile manipulator with obstacle avoidance motion

Yuya Wada[1], Yoshitaka Matsuda[1], Takenao Sugi[1], Satoru Goto[1], and Naruto Egashira[2]
([1]Saga University, Japan)
([2]National Institute of Technology, Kurume College, Japan)

In this research, using image processing and distance measurement, we develop a system for automatic grasping control and obstacle avoidance of mobile manipulator. The control method of mobile manipulator is autonomous. First, it searches an object by turning until it is reflected in camera image. Next, when the object is reflected in camera image, the mobile manipulator approaches the object. If an obstacle in front of the object exists, the mobile manipulator avoids the obstacle by a specific movement. After avoiding the obstacle, the mobile manipulator turns to search for the object again. When the mobile manipulator approaches the target sufficiently, it grasps or releases the object. The usefulness of the control system for the mobile manipulator was verified through experiments. As a result, advanced control system could be developed compared with an existing control system.

January 27 (Thursday), 13:00-14:30

GS10-4 Multi-Agent Surveillance Considering Equitability of Travel Costs

Kyohei Murakata, Koichi Kobayashi, and Yuh Yamashita
(Hokkaido University, Japan)

The surveillance problem is to find optimal trajectories of agents that patrol a given area as evenly as possible. In this paper, we study the surveillance problem considering the equitability of travel costs. When multiple mobile robots are used, such equitability is important from the viewpoint of age deterioration. In the proposed method, the surveillance problem is reduced to a mixed integer linear programming problem.

GS10-5 Domain of Attraction Estimation for Nonlinear Systems with Parametric Uncertainty via State Transformation

Kazuki Umemoto[1], Takahiro Endo[2], and Fumitoshi Matsuno[2]
([1]Nagaoka University of Technology, Japan)
([2]Kyoto University, Japan)

In this study, a method for estimating the domain of attraction (DoA) for autonomous nonlinear systems with a parametric uncertainty is proposed. By using the DoA estimation, it is possible to locally stabilize a control system that cannot be globally stabilized, and to obtain an available state for control system operation. The proposed method estimates the DoA as a region based on the level of the Lyapunov function. Using a state transformation determined by evaluating the eigenvalues of the matrix comprising a Lyapunov function, we attempt to expand the region from the DoA estimation in the absence of a state transformation. Asymptotic convergence of the system to the equilibrium point is guaranteed if the initial state is contained within the region obtained by this method. By numerical examples, we show that an appropriate state realization can significantly improve the estimated DoA.

GS10-6 Adaptive Cruise Control to reflect driver individuality via Human-In-The-Loop System

Haruka Matsushita and Kenji Sawada
(The University of Electro-Communications, Japan)

The main autonomous driving system is a human-machine cooperative system in which the system intervenes in the driver's operation. Their drivings are one-size-fits-all because existing autonomous driving systems lost driver's individualities. We consider that autonomous driving which reflects the driver's individuality is comfort. In this research, we consider a human-machine cooperative driving system balancing safety with driver’s individuality using the Human-In-The-Loop System (HITLS). The target system is the Adaptive Cruise Control (ACC). In this paper, we propose an implementation method of HITLS using the primal-dual algorithm and the vehicle straight-line model with driving force control. Additionally, we verify the relationship between driver individuality and stability of the control system from the perspective of small gain theory

January 27 (Thursday), 13:00-14:45

Room F

GS17 Machine Learning 2

Chair: Keigo Watanabe (Okayama University, Japan)

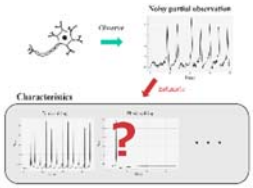
GS17-1 Market prediction aids using machine learning based on Social Media specific features

Satoshi Sekioka, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

In recent years, unspecified messages posted on social media have had a significant impact on the price fluctuations of online traded products such as stocks and virtual currencies. In this study, we investigate whether information on Twitter and natural language expressions in tweets can be used as features for predicting market information such as price changes of virtual currencies, and for predicting sudden price changes. Our method is based on features created using Sentence-BERT for tweet data. We use these features to train LightGBM, with the target variable being a sudden change in the closing price (sudden drop, sudden rise, or no sudden change). We set up a classification task with three labels, using the features created by the proposed method for prediction. We compare prediction results with and without using these new features, and we discuss the advantages of linguistic features for predicting changes in cryptocurrency trends.

GS17-2 Data-driven Method for Estimating Neuronal Nonlinear Dynamics from Noisy Partial Observation

Hiroaki Inoue and Toshiaki Omori
(Kobe University, Japan)



In this study, we propose a data-driven approach to estimate the neuronal dynamics from the noisy partial observation. We formulate a state-space model based on neuronal dynamics and the observation process and estimate the latent variables and the parameters governing the neuronal dynamics by employing the replica exchange particle-Gibbs with ancestor sampling method. In the proposed method, an extended variable corresponding to temperature and exchanging process between samples at different temperatures are introduced to simultaneously realize local precise search at low temperatures and global search at high temperatures from the viewpoint of statistical physics. By allowing the samples to pass through various temperatures, the samples can avoid falling into local optima in estimating neuronal dynamics. In order to verify the effectiveness of the proposed method, we show that the proposed method can estimate the latent variables and the parameters to represent 20 typical neuronal responses using simulated data.

GS17-3 Ensemble Method using Real Images, Metadata and Synthetic Images for Control of Class Imbalance in Classification

Rogers Aloo[1], Atsuko Mutoh[1], Koichi Moriyama[1], Tohgoroh Matsui[1], and Nobuhiro Inuzuka[2]
([1]Nagoya Institute of Technology, Japan)
([2]Chubu University, Japan)

Binary classification and detection of anomalies face the problem of class imbalance in datasets. Research studies have implemented ensemble models in two directions to improve the dataset balance. First, ensemble between images and metadata, and secondly injection of synthetic images and real images data. The paper's contribution is to introduce an unpaired image-to-image generation to add to the minority classes of imbalanced datasets. We propose an ensemble classifier of three binary classifiers (using real images, synthetic images, and patient-related metadata) to control the class imbalance in datasets. We train the ensemble with real images and metadata integrated with synthesized results of the generated minority pneumonia class. We use sensitivity as the measure for metric performance. We observe differences in classification recall on our ensemble across different classification benchmark models and infer it to the balance introduced on the minority classes and application of ensemble classifiers.

January 27 (Thursday), 13:00-14:45

GS17-4 Comparison of Loss Functions in Contrastive Learning for Latent Space Unification and Emotion Recognition on Multimodal Deep Learning

Seiichi Harata[1], Takuto Sakuma[1], Shohei Kato[1,2]
([1]Dept. of Engineering, Graduate School of Engineering, Nagoya Institute of Technology, Japan)
([2]Frontier Research Institute for Information Science, Nagoya Institute of Technology, Japan)

This study aims to acquire a shared representation of emotions (an emotional space) across modalities for modality-independent emotion recognition. We propose a DNN model that fuses audio-visual modalities on the latent space defined as the emotional space and trains it by combining the emotion recognition and unification tasks. The unification task derives a shared emotional space from different modalities expressed simultaneously. This paper introduces the Contrastive Representation Learning paradigm to the unification task and compares loss functions from state-of-the-art works. In the experiments, we trained models on the audio-visual dataset and varied dimension sizes of the emotional space. We evaluated the robustness of the emotion recognition performance against modality ablation. We also compared the emotion recognition performance and error tendency between the proposed model and the human raters. The results suggest that the loss of contrastive learning for the unification task effectively acquires the emotional space shared across modalities.

GS17-5 Improvement of the Method for Detecting Makeup Mistake Areas and Proposal of a Feedback Method for the Visually Impaired People

Tomoyuki Hatakeyama, Dinh Tuan Tran, and Joo-Ho Lee
(Ritsumeikan University, Japan)

People with visual impairments have difficulty applying makeup on their own. Currently, blind makeup classes are being held so that visually impaired people can makeup properly. However, when they apply makeup alone, there is concern about whether the makeup is properly applied or not. To solve the problems mentioned above, we propose a makeup check system using computer vision and machine learning. In our previous study, we proposed a method for detecting where makeup was applied incorrectly. In this study, we improved our method and proposed a method for visually impaired individuals to receive feedback on the detected result via sound.

GS17-6 Detection of Abnormal Fish by Image Recognition Using Transference Learning

Ryusei Okawa, Nobuo Iwasaki, Kazuya Okamoto, and David Marsh
(National Institute of Technology, Wakayama College, Japan)

Fishermen need to remove dead or abnormal fish due to infection to prevent viral diseases. Particularly, aquaculture is prone to the effects of infectious diseases on other healthy fish. However, abnormal fish are harder to find than dead fish because it is difficult to judge whether a fish is infected. Removal of abnormal fish by observation is costly in terms on both time and labor. Therefore, we need automatic detection of abnormal fish. We discuss appropriate preprocessing for abnormal fish detection. After, we took the photographs, a computer utilizes preprocessing to make the characteristics of the abnormal fish easier to distinguish. The amount of training data in fish is not enough to automatically abnormal fish. Therefore, we will attempt to detect abnormal goldfish by Transfer Learning using VGG16 in this research. As a result, the preprocessing showed that accuracy is good. By pretreatment, we obtained high accuracy.

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GS17-7 Smart Voice Recognition Based on Deep Learning for Depression Diagnosis

Sukit Suparatpinyo and Nuanwan Soonthornphisaj
(Kasetsart University, Thailand)

Depressive disorder is a kind of mental illness with a high incidence rate due to the stress from the environment or social impact. Depression affects mood and behaviour that lead to various problem domains such as education, family, and workplace problems. Suicide attempt is found in severe depression cases as well. However, depression is a treatable condition if diagnosed by psychiatrists. In Thailand, many people who aware of mental disorders are do not seek help from psychiatric hospitals due to long waiting services and high fees. Therefore, we aim to create an application for a user to do self-assessment by collecting user voice signal data. In our experiment, we define the data from the depressive patient as a positive class obtained during a therapy session in a psychiatric hospital. At the same time, negative class is the data from regular people from the interview session with university students. Each audio file has been rendered to a spectrograph, a visual representation of mel frequency-spaced cepstral coefficients (MFCCs) extracted from the human voice that changes over time. Fast Fourier Transform and discrete cosine transform are performed on input signals to create a spectrograph. From 1,476 spectrographs, 70% of instances are assigned as a training set, whereas the rest 30% is the test set for machine learning. Deep learning models based on the deep residual network (ResNet) are explored to see its potential for classification. We select ResNet because it is a well-known deep learning model for the computer vision domain. Different numbers of convolution layers such as ResNet-34, ResNet-50, and ResNet-101 are also examined, respectively. As a result, we found that ResNet-50 can provide the best performance above other approaches with 74.22% sensitivity, 72.48% specificity, and 73.36% accuracy. They are showing that deep learning shows promising results in this problem domain. To the best of our knowledge, our approach gives the higher sensitivity when compared with the state of the art that uses logistic regression method [McGinnis et al., 2019]. In contrast, its sensitivity and specificity are 62.63% and 63.33% respectively, when using the same dataset.

January 27 (Thursday), 13:00-14:00

Room G

OS24 AROB: Vision and robot control

Chair: Masahiro Yokomichi (University of Miyazaki, Japan)
Co-Chair: Nobuya Takahashi (University of Miyazaki, Japan)

OS24-1 Gradient-based Redesign for the Optimal Regulator with Considering Nonlinearity

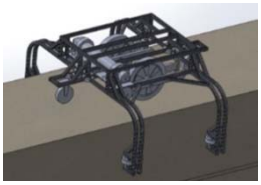
Nobuya Takahashi, Masahiro Ikeda, and Masahiro Yokomichi
(University of Miyazaki, Japan)

In recent years, with the development of the soft computing filed, automatic differentiation is attracting attention, which is the technology that supports an optimization problem. This is an algorithm for finding the gradient of the cal-culation performed according to the computer program, consisted of a series of processes including branching and iter-ative processing. This paper proposes a new robust controller design method by utilizing automatic differentiation in control engineering field. The effect of a nonlinearity to the system performance is evaluated by the objective function, and a controller of the linear optimal regulator is redesigned to be robust to the nonlinearity, by a gradient based meth-od for an objective function in the initial value problem. Through the numerical experiments, the validness of our pro-posed method is shown.

January 27 (Thursday), 13:00-14:00

OS24-2 Development of the inspection robot for monorail girder

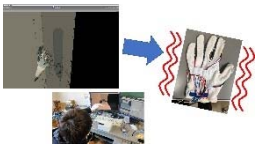
Yasunobu Hitaka, Shu Goto, and Rintaro Nonaka
(National Institute of Technology, Kitakyushu College, Japan)



In this paper, the inspection method for monorail girder with a mobile robot and development of this robot are presented. This robot has cameras for check the top and side surfaces of the girder and is remote controlled by the worker who checks underside of the girder and support pillars from the ground. To simplify the handling of the robot, the steering control is automated by the nonlinear tracking control method. The reference trajectory for the tracking control is generated by using a RGB camera and a depth sensor. The experimental results of tracking control using the scale-down model of the inspection robot are represented.

OS24-3 Reproducing the haptic feedback of soft objects and fluids by particle-based simulation methods.

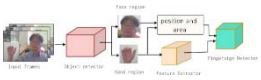
Yuki Komatsu, Nobuya Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)



The purpose of this paper is to reproduce the haptic feedback when touching a virtual soft object or fluid created using "Nvidia Flex for Unity", a particle-based simulation method in virtual space, by vibration. In the case of soft bodies, we compared in two objects with different stiffnesses were placed. In another case of a fluid, we compared a situation where the object was falling and a situation where the object was placed on the ground. These situations were experienced by multiple people and conduct a questionnaire survey to them. The results showed that the system was able to reproduce the falling fluid.

OS24-4 Video-based Japanese finger-spelling recognition using CNN

Masahiro Yokomichi and Nobuya Takahashi
(University of Miyazaki, Japan)



In this paper, a CNN-based JFS (Japanese Finger-Spelling) recognition system is proposed. The proposed system has a two-stage structure. The first stage is hand and face detector and the second is JFS recognizer. From each retrieved frame, the hand region and the face region are extracted. The face region is used to compute the relative position and the area of hand region. The relative position is used to estimate the up-down and the left-right movement of the hand, and the relative area is used to estimate the front and back movement, and these quantities are sent to the second stage with the extracted hand region. The second stage consists of the hand feature extractor made by CNN and RNN-based sign language recognizer. In this paper, as a fundamental experiment, the hand and face region detector is designed and its performance is examined with real dataset. The several up-to-date object detection CNN's including CenterNet and EfficientDetare examined with WIDERFACE and VOC dataset, and CenterNet is chosen by its detection accuracy and computational cost. Furthermore, the effectiveness of using the face region is also realized.

January 27 (Thursday), 15:00-17:00

Room B

OS41 SWARM: Swarm and Bio-inspired Systems 3

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Hokkaido University, Japan)
Chair: Toshiyuki Yasuda (University of Toyama, Japan)

Invited Talk 11 Penguin-mimetic robotic wing mechanism

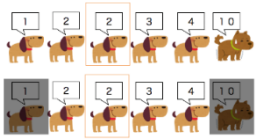
Hiroto Tanaka (Tokyo Institute of Technology, Japan)

See page 28

OS41-1 Guidance by multiple sheepdogs including abnormalities

Midori Tashiro[1], Masao Kubo[2], Hiroshi Sato[2], and Akihiro Yamaguchi[3]
([1]Japan Maritime Self-Defense Force, Japan)
([2]National Defense Academy of Japan, Japan)
([3]Fukuoka Institute of Technology, Japan)

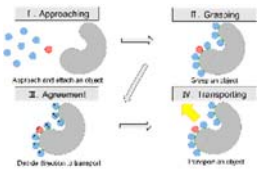
In this paper, we propose a method for efficiently guiding a large flock of sheep agents through the cooperation of multiple sheepdog agents even in the presence of anomalies, and verify its performance in computer experiments. The results show that the proposed MSR algorithm[LeBlanc13] can guide a group of sheep agents more efficiently and reliably than an efficient extension[Tashiro21] to multiple sheepdogs of the conventional single shepherd method[Sueoka13], even when abnormal sheepdogs are included.



OS41-2 Distributed cooperative transportation control of swarm robot with grasping mechanism in the two-dimensional environment

Yuto Fukao, Naoya Kubo, Takahiro Endo, and Fumitoshi Matsuno
(Kyoto University, Japan)

In this study, we focus on a transportation method in which swarm robots cooperatively transport an arbitrary shape object. We consider robots which have grasping mechanism to grasp an object for transportation. To transport the object, we propose a distributed control method. In particular, robots approach the object, grasp the object, and transport the object while maintaining the connectivity of the entire robots, based only on local environmental information within their own sensing range. Furthermore, robots do not attach to the object at an initial state. We also verify the effectiveness of the proposed method through Open Dynamic Engine simulation.



OS41-3 A Strategy of Recruitment of Rest Robots at the Nest for Cooperative Transportation

Yushi Okuda[1], Tomohiro Hayakawa[2], and Fumitoshi Matsuno[1]
([1]Kyoto University, Japan)
([2]Toyama University, Japan)

Many strategies for task allocation of swarm robots have been studied in order to collect prey efficiently. On the other hand, little research has been focused on cooperative foraging. In this study, inspired by ants that perform cooperative transport, we assume that a robot finding an object recruits robots in the resting area. Then, we performed multi-agent simulations to investigate the influence of the number of following robots per recruitment on the time to finish the foraging task. The results showed that it is the small number of following robots, that is, repeated recruitment contributes to fast foraging. The repeated recruitment strategy is consistent with that of ants in nature.

January 27 (Thursday), 15:00-17:00

OS41-4 Trade-Off Between Coverage Area and Connectivity Robustness of Networked Multi-Robot Systems

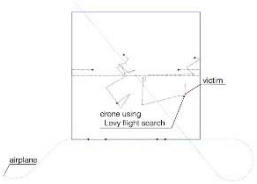
Toru Murayama
(National Institute of Technology, Wakayama College, Japan)

This paper analyses a relation between a connectivity robustification and a coverage control of multi-robot systems. A coverage control is a cooperative task of the system to cover a given area by sensors equipped by the robots, and it requires network connectivity to share the sensing information each other. The network robustification against robot failure is important since the robots may fail during their team-task. Since the network robustification restricts the configuration space of the robots, we have to pay attention the quantitative trade-off between coverage area of a networked multi-robot system and robustness of the network connectivity. Here we report an analysis result of the trade-off using a simple network model.

OS41-5 Combination of Search Methods for Multi-Drone in Sea Rescue

Kazuaki Yamada
(Toyo University, Japan)

This paper investigates the optimization combination of search methods for multi-drone in sea rescue through simulation experimentations. In sea rescue, it is more difficult to find out a victim or a life raft over the wide area. Probability finding out a victim reduces by a variety of factors such as weather, midnight, backlight, and so on. In addition, the survival probability of victims reduces with the passage time due to hypothermia by seawater. Thus, we need to find out the victim as soon as possible. A goal of our research is to increase the possibility and decrease the time to find out victims by using multi-drone. This study investigates that the combination of conditions such as the number of drone, the places to drop drones scatter, search methods, and so on affect the probability and the time finding out victims through multi-agent simulations.



OS41-6 Evolutionary acquisition of collective behavior for a multi-legged robotic swarm

Daichi Morimoto[1], Motoaki Hiraga[1], Naoya Shiozaki[1], Kazuhiro Ohkura[1], and Masaharu Munetomo[2]
([1]Hiroshima University, Japan)
([2]Hokkaido University, Japan)

This paper focuses on generating a collective behavior of a multi-legged robotic swarm based on evolutionary computation. Most studies in swarm robotics are conducted using mobile robots with wheels. In this research, a multi-legged robot is utilized to expand available collective behaviors or environments in which a robotic swarm can be applied. The evolutionary robotics approach is employed for designing joint control which realizes a collective behavior of a multi-legged robotic swarm. Additionally, intuition-based constraint factors are incorporated into the fitness function to make the gait similar to natural organisms. The experiment on the task of forming a line similar to an ant trail is conducted in computer simulations using the PyBullet physics engine. The experimental result shows that proposed constraint factors successfully designed the robot's gait. The result also shows that the evolutionary robotics approach achieved to generate a collective behavior of a multi-legged robotic swarm.

January 27 (Thursday), 15:00-16:15

Room C

GS27 Robotic Mechanism

Chair: Min Cheol Lee (Pusan National University, Republic of Korea)

GS27-1 Development of a Remotely Controlled Elbow Joint Assist Suit with a Velocity-Based Mechanical Safety Device - Proposal of the Assist Suit -

Jinsik WANG, Atsushi KANETA, Shoichi HASEGAWA, and Yoshihiro KAI
(Tokai University, Japan)

In the field of rehabilitation, it is expected that patients can conduct their rehabilitation using a remotely controlled assist suit. In the design of the assist suit, safety consideration for patients is one of the important issues. In this paper, we propose a remotely controlled elbow joint assist suit with a velocity-based mechanical safety device (VBMSD). The VBMSD is intended to stop the assist suit if it detects an unexpected high joint angular velocity. The VBMSD works even when the assist suit's computer breaks down, because it consists of only passive mechanical components such as springs. First, we introduce the features of the remotely controlled assist suit. Second, we describe the VBMSD. Third, we explain the remotely controlled assist suit which we designed. Finally, we consider the control method of the assist suit.

GS27-4 Research on Vibration Signal Analysis and Control of SCARA Manipulator

Chengqian Li, DongHyun Kim, and MinCheol Lee
(Pusan National University, Korea, Republic of)

SCARA robot manipulators have unavoidable vibration and noise due to inherent design problems or working conditions. This vibration problem reduces the working accuracy and efficiency of the SCARA robot, resulting in failed desired operation. Therefore, these vibrations need to be calculated, and their effect must be reduced to avoid possible disturbance. This research studies the vibration signal, which is analyzed for the 4-DOF SCARA robot manipulator to reduce the impact of vibration on robot manipulators. The measured signals were spectrum analyzed through Fast Fourier Transform (FFT) to extract the vibration parameters of the robot manipulator. However, in the spectrum obtained by the Fourier transform, the value of any frequency point is contributed by the time process in the whole-time domain. The vibration of the robot manipulator is not a stationary signal because of its complex trajectory. Therefore, it is necessary to analyze the change of signal spectrum with time. In contrast to FFT, the Joint Time-Frequency Analysis (JTFA) describes signals' energy density and intensity at different times and frequencies by designing the joint function of time and frequency. Through joint time-frequency analysis of non-stationary signals such as Short-time Fourier transform (STFT) and Wavelet analysis, the time-frequency distribution of signals is obtained, and the time-frequency characteristics of vibration signals of the robot in different motion states are analyzed, which lays a theoretical foundation for subsequent research on vibration suppression control of the robot.

GS27-5 Rotational Force Based Ball-Collection Mechanism and Its Implementation

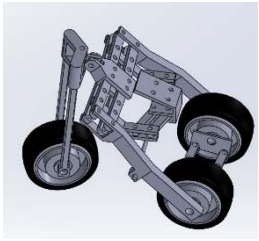
Kazuma Takemoto, Geunho Lee, and Hiroki Yokoyama
(University of Miyazaki, Japan)

In recent years, parasports have become popular. As a support method for these competitions, a ball collecting device can be mentioned. However, it is difficult for these existing devices to collect the balls used in parasports. The cause is that there are large changes in the size of the ball and the properties of the surface material. In this research, we propose a ball collection mechanism that can respond to changes in properties. We also developed an experimental equipment using the proposed mechanism and conducted an evaluation experiment. In addition, an experimental device was mounted on the mobile robot to verify the collecting work associated with the movement. As a result, it was confirmed that multiple balls can be collected continuously and that collection activities at the actual site are also possible.

January 27 (Thursday), 15:00-16:15

GS27-6 Development of transformable three-wheel drive mobility VDR without using transforming actuators

Takuma NAGAOKA, Hirokazu MATSUI, and Norihiko KATO
(Mie University, Japan)



The purpose of this study is to develop a three-wheel drive mobility with two running modes, a low velocity mode and a high velocity mode. Two running modes are changed mutually by transformation. This proposed mobility VDR has three in-wheel motors and doesn't have any actuators only for transformation. Transformation is made by the differential force of the three in-wheel motors. We also consider the condition that we don't use any liquid devices and any wires. Instead of them, we aim to use only link mechanisms to design VDR. A design of only link mechanism has problems like complex structure and stopping transform. To solve these problems, we focus on the moving distances of links, the points of effort and points of load. And we can design mechanisms that can work precisely. We verified the transformation of 3D miniature model of VDR.

GS27-7 Six-legged soft robot using crawling motion

Susumu Yamashita, Keisuke Kuboi, and Kazuyuki Ito
(Hosei University, Japan)

In recent years, soft robotics composed of soft silicone rubber have attracted significant attention, as they can adapt to various unknown environments owing to their flexible bodies, resulting into a variety of robots. In our previous work, we focused on robots that operate in real complex environments, such as rescue robots, agriculture robots, and contracting robots, and developed various flexible robots such as octopus-like manipulators, pipe-climbing robots, and wall-climbing robots. In this study, we aimed to develop a multi-legged soft robot that can move in various environments. We developed an actual robot and conducted experiments to confirm its mobility in three environments: a horizontal board, pebbles, and water. As a result, we confirmed that the desired crawling motion was realized and the proposed robot could move in various types of environments by using the dynamics of its soft body.

January 27 (Thursday), 15:00-16:45

Room D

GS20 Motion planning and navigation

Chair: Hideo Miyachi (Tokyo City University, Japan)

GS20-1 PCD map creation from factory design drawing for LiDAR self-localization of autonomous mobile robot

Ryutaro Kaneko[1], Yuji Nakamura[2], Ryosuke Morita[2], and Satoshi Ito[2]
([1]Graduate School of Natural Science and Technology, Gifu University, Japan)
([2]Faculty of Engineering, Gifu University, Japan)

This paper proposes a method for creating the point cloud data (PCD) map required to the LiDAR localization in autonomous driving. For utilizing an AMR, we must prepare an environmental map in advance. Our method creates the map from the design drawings. For the objects not depicted in the drawings, we introduce tablet scan data, which is merged to the map created from the drawing. Three factors at the map creation affecting the accuracy of self-localization are investigated. The effect of these factors is evaluated by the simulations with the actual scan data. Consequently, the existence of the optimal gap size as well as the accuracy enhancement by both the tablet-scan data and the random point alignment are clarified. In addition, autonomous driving using the PCD map created by our proposal system is successfully achieved.

January 27 (Thursday), 15:00-16:45

GS20-2 Merging Trajectory Generation Based on Rule-based Control in Situations with Emergency Vehicle

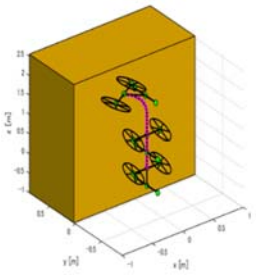
Wenjing Cao and Hanqing Zhao
(Sophia university, Japan)

When an emergency vehicle approaches behind, the driver must slow down and pull over to avoid the emergency vehicle. However, in most cases, this will also cause traffic congestion, and the emergency vehicles must decrease as a result. To avoid the above situation, we designed a lane change algorithm based on a look-ahead concept, which allows the self-vehicle to quickly choose a lane from the lanes on both left and right side lanes, and change lanes safely without affecting the surrounding vehicles. Therefore, the emergency vehicle can pass smoothly without decelerating. A computer simulation was conducted to validate the effectiveness of the proposed method. The simulation results of 1000 initial conditions show that 720 of the proposed method manages to merge the ego vehicle effectively without collision, and the emergency vehicle does not need to slow down.

GS20-3 Trajectory Tracking Simulation of a Dual-wheeled Robot Running on Slippery Surfaces

Akira Ishibashi[1], Kiyoshi Ioi[2], Yoshikazu Ohtsubo[2], and Haruto Yano[3]
([1]Graduate school of Kindai University, Japan)
([2]Kindai University, Japan)
([3]Hitachi Zosen Corporation, Japan)

This paper presents the trajectory tracking simulations of a dual-wheeled robot running on slippery surfaces. The robot has been actually developed to inspect the surface properties of hydroelectric dams. In such environments, wheel slips often result between the wheel and the dam surface because the wet algae cover the dam surface in places. Although we plan to apply a nonlinear control to the wheel-typed robot with non-holonomic constraints, the control performance is not evident under slippery conditions. Applying the nonlinear control to a dynamic simulator of the robot, we estimate the tracking errors caused by the slippery conditions. Finally, we propose a compensator that is effective against the return to the desired trajectory and show the usefulness by simulations.



GS20-4 Route planning algorithm based on dynamic programming for Electric vehicles used to delivery electric power for an isolated area

Yu ZHANG[1], Wenjing CAO[1], Hanqing ZHAO[1], Shuang GAO[2]
([1]Sophia University, Japan)
([2]Tianjin University, China)

In this paper,we consider the electric power transmission problem for multiple household located in a remote or isolated region by disasters using electric vehicles (EV). Two methods which yield the optimal paths that minimize the overall traveling distance of the EVs and the overall electric power consumption respectively are compared. We assume the number of households requiring power transmission and the number of EVs used for power transmission in the area are specified constant numbers Then we divided families into groups and assign the electric power of the households in each group to one EV, respectively. optimal path that minimizes the overall traveling distance is calculated by dynamic programming method. In the optimization problem the EVs are required to return to the initial position after transporting electricity to the all households in the assigned group. The electric power consumption of all the EVs is calculated according to the traveling distance. However, due to the traffic congestion condition of the roads, optimal path that minimizes the overall traveling distance does not necessarily yields the minimum overall electric power consumption. optimal path that minimizes the overall traveling distance does not necessarily yields the minimum overall electric power consumption. Therefore, another method that minimizes the overall electric power consumption considering the traffic congestion is proposed. The compare of the results for the two different methods shows that the optimal path method only needs distance to calculate an optimal solution, but this solution is not a global optimal solution in terms of energy consumption. Although the minimum energy consumption method can calculate all the optimal solutions, this method requires more map information, and these parameters are often difficult to determine.

January 27 (Thursday), 15:00-16:45

GS20-5 Real-time dynamic obstacle detection using a line laser and camera in the dark

Shingo Totoki, Souta Akamine, Shinya Kobayashi, Taku Itami, and Jun Yoneyama
(Aoyama Gakuin University, Japan)

In this paper, we obtain the information of one camera from an autonomous mobile robot equipped with a line laser, and estimate the distance to obstacles in real time and in a dynamic environment by using OpenCV and python together. Because of this method, the robot is not affected by material, color, or sound, and is easy to miniaturize and improve durability. In the proposed algorithm, if there is an obstacle while a line laser is being emitted from the top of the robot at an angle to the direction of travel, the laser light will be projected onto the obstacle. Then, after binarizing the laser light and removing noise, the laser coordinates are extracted and the distance is calculated from the triangle similarity.

GS20-6 Developing a handwriting humanoid robot with low-precision hardware

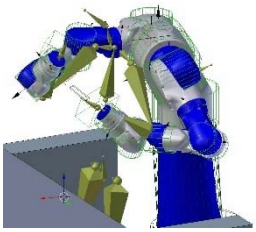
Yoshiki Ninomiya, Hideaki Itoh, Hisao Fukumoto, and Hiroshi Wakuya
(Electrical and Electronic Engineering Course, Department of Science and Engineering, Graduate School of Science and Engineering, Saga University, Japan)

Recently, Robotic Process Automation (RPA) that automates various kinds of office job processes is attracting much attention in many companies. As a step towards extending the RPA systems to automate various physical job processes, we have been developing a handwriting humanoid robot that can draw line drawings, such as signatures, on paper documents. A technical challenge that we tackle in this study is that we use inexpensive but low-precision servo motors to reduce the cost of the system. To cope with the imprecision of the servo motors, we put a pressure sensor on the pen and measure the pressure between the pen and the target document. We also use a proportional-integral (PI) controller to move the tip of a pen along a desired trajectory. We show the validity of our method through experiments with a real robot.

GS20-7 Applying Motion Capture Data of a Laboratory Biologist to a Dual-Arm Robot by Rigid Body Dynamics for Collision Avoidance

Yutaka Ueno[1], Natsuki Miyata[1], Natsuki Yamanobe[2], Shungo Adachi[3], Totai Mitsuyama[1]
([1]Artificial Inteligence Research Center, AIST Tokyo, Japan)
([2]Industrial Cyber-Physical Systems Research Center, AIST Tokyo, Japan)
([3]Cellular and Molecular Biotechnology Research Institute, AIST Tokyo, Japan)

As it is a formidable task to teach a dual-arm robot collision-free motions, there is great demand for novel software tools and algorithms to transfer human motion to robots. To prevent collisions, we developed a method to simulate robot arm trajectory using the rigid body dynamics model by the Bullet Physics Engine. A kinematic robot model with constraints between the joint arms and collision barriers was constructed to generate robot motions, as if guided directly by a human hand. The method was tested with publicly available motion capture data, and it also worked for our original data obtained from a cell culture study at a biological laboratory. We also discuss our plan to apply these robot teaching methods to the automation of biological experiments.



January 27 (Thursday), 15:00-16:30

Room E

GS22 Neural networks

Chair: Fumito Uwano (Okayama University, Japan)

GS22-2 Unsupervised Plant Disease Detection Using Generative Models with Deep Neural Networks

Yoshihisa Kamohara, Takuto Sakuma, and Shohei Kato
(Nagoya Institute of Technology, Japan)

As a way to cope with the global food problem, an increase in crop production is being aimed at, and an increase in production by reducing losses is attracting attention. To reduce losses, early detection of plant diseases and control measures are important. However, disease symptoms of plant diseases are generally difficult to diagnose, and visual judgment by technicians is considered important. On the other hand, the technicians are heavily burdened by the human and time costs during diagnosis. In this paper, we propose the construction of an unsupervised detection system using deep learning models and aim at the automatic diagnosis of plant diseases with low cost and less burden on technicians by learning only with normal data.

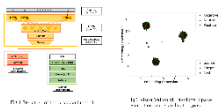
GS22-3 Investigation of Representation Learning to Disentangle Style and Content for Polyphonic Music

Shota Furukawa, Katsufumi Inoue, Michifumi Yoshioka
(Osaka Prefecture University, Japan)

Prior research on music style transfer has confirmed that disentanglement of style and content information from music may be required to achieve music style transfer. However, to our best knowledge, in studies on music style transfer, which modifies genre-related information of the original music to another one while keeping its music information except for genre-related information, the disentanglement method has not been proposed yet. In this research, we construct a new network based on a representation learning method for polyphonic music and attempt to disentangle style and content by adversarial learning. As a result of our experiment, we confirmed that the style representation of the proposed method does not include content information. In the subjective evaluation of music style transfer with 14 subjects, 70% of them answered that the style of the music generated by the proposed method is successfully transferred to the target style.

GS22-4 Personalized Emotion Recognition Model Based on Few-shot EEG Learning: Effect of Domain Adaptation in Emotional Feature Space

Shoya Furukawa, Takuto Sakuma, and Shohei Kato
(Nagoya Institute of Technology, Japan)



Systems for recognizing human emotions have been attracting attention to realize smooth communication between humans and computers in recent years. In particular, this study focuses on EEG-based emotion recognition, because it can recognize the emotional states of users who cannot express their emotions by facial expressions or voice. However, it is difficult to construct an effective emotion recognition model using data from an unspecified number of users because of individual differences in EEG. In the previous study, it was necessary to build the model each time using the data to be recognized to deal with individual differences. In this study, we aim to reduce the burden of data collection for the target subject, while effectively recognizing the subject's emotions. Therefore, we propose a method to pseudo-extend the target subject data using domain adaptation. We discuss the impact of domain adaptation on Emotional Feature Space in experiments and show its effectiveness.

January 27 (Thursday), 15:00-16:30

GS22-5 Prediction of Topic Sentiment Polarity of Customers' Reviews from Business Attributes using Dual-head MLP

Etwi Barimah Appiah, Clifford Broni-Bediako, Koichi Nagatsuka, Masayasu Atsumi
(Soka University, Japan)

Discovering customer sentiment towards topics is an important task in sentiment analysis. Currently, most studies focus on using customers' reviews to understand user sentiments at the topic sentiment level. In this study, we develop a framework with a topic modelling technique and neural network to predict the topic sentiment polarity of customers' reviews from business attributes. The proposed framework is based on latent Dirichlet allocation (LDA) and a dual-head multilayer perceptron architecture. The experimental results suggest that the business attributes as predictors have predictive power and the potential to predict the topic sentiment polarity of customers' reviews.

GS22-6 Exploiting global features for monocular depth estimation

Koji Ariizumi, Michifumi Yoshioka, and Katsufumi Inoue
(Osaka Prefecture University, Japan)

Monocular depth estimation has become a popular research topic in computer vision. Though depth estimation accuracy has improved with deep learning, there is a problem that inaccurate detection of target object results in decreasing the depth estimation accuracy. In this paper, we propose two approaches that utilize global features to improve the object detection accuracy. The first one is resolving the object detection ambiguity by adopting the attention module adjusted for each feature map size. The second one is increasing the filter size for image comparison performed in the CNN training step to reduce the dependency on specific image features for object detection. To verify the effectiveness of the proposed model, we conducted experiments on the KITTI dataset. On the 200 images test set, the RMSE between the estimated depth and the ground truth decreased from 4.954 in the baseline to 4.905 in the proposed method.

GS22-7 Pulse-Type Hardware Neural Networks for Biped Gait Control That Generates Gait Locomotion Control Signals by Synaptic Weight Changes

Kenji Takeda[1], Mikihito Hayakawa[1], Motokuni Ishibashi[1], Takumi Ishihama[2], Minori Ishihara[2], Megumi Aibara[2], Minami Kaneko[2], and Fumio Uchikoba[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

In this paper, we report on a bipedal walking switch circuit that uses analog circuits instead of the conventional digital system. We have been studying a system using pulse-type hardware neural networks (P-HNNs) to control the motion of robots with a small number of control signals, such as a living organism. In particular, it has been mimicking the Central Pattern Generator (CPG), which is localized in the spinal cord and patterns the control signals of motion. In this paper, we fabricated a new circuit of P-HNNs that can switch walking and running in bipedal gait from external inputs. Bipedal gait control circuits using analog circuits instead of conventional digital systems are reported.