ABSTRACTS

Plenary Speech 1 (Room G)

January 24 (Wednesday), 11:00-11:50

Chair: Ken Naitoh (Waseda University, Japan)

Collective behaviors emerging from chases and escapes

Toru Ohira

Graduate School of Mathematics, Nagoya University, Japan

"Chases and Escapes" is a traditional mathematical problem. Recently, we proposed a simple extended model where one group chases another group, called "Group Chase and Escape". This extension connects the traditional problem with current interests in collective motion of animals, insects, and cars. In this presentation, I will introduce our basic model and discuss its rather complex emergent behaviors.

Each chaser approaches its nearest escapee, while each escapee steps away from its nearest chaser. Although there is no communication within each group, aggregate formations are observed. I will discuss how these behaviors appear as a function of parameters, such as densities.

Furthermore, we have considered different expansions of this basic model. Firstly, we introduced a fluctuation where players now make errors in taking their step directions with some probability. We found that some level of fluctuations works better for more effective catching.

Secondly, we introduced a delay in the reaction of chasers in catching a target. Distance-dependent reaction delay can cause quite complex behaviors. We will also provide an overview of various extensions of the model by other groups and recent developments.

Biography:

Toru Ohira is currently a vice dean and professor at the Graduate School of Mathematics at Nagoya University. He graduated from Hamilton College, New York in 1986, and after a year at Christ's College, Cambridge University, he moved on to the University of Chicago for his Ph.D. studies. After receiving his Ph.D. in Physics in 1993, Toru Ohira worked for a private company, as well as teaching basic mathematics courses for the School of Engineering at the University of Tokyo. Toru Ohira joined Nagoya University as a professor of mathematics in 2012.

Toru Ohira has been working on three topics: stochastic delayed feedback dynamics, the problem of pursuit and evasion from singles to groups, and the foundation of quantum mechanics. In this talk, he will discuss various aspects of pursuit and evasion with a focus on emerging collective behaviors.

Plenary Speech 2 (Room G)

January 24 (Wednesday), 14:30-15:20

Chair: Hideki Hashimoto (Chuo University, Japan)

AI Robots and Moon Shot Program

Toshio FUKUDA

Nagoya University and Waseda University, Japan

There are many ways to make research and development of intelligent robotic systems. I have been working on the Multi-scale robotics systems for many years, based on the Cellular Robotics System, which is the basic concept of the emergence of intelligence in the multi-scale way from Organizational Level, Distributed robotics to Biological Cell engineering and Nano-robotics. It consists of many elements how the system can be structured from the individual to the group/society levels in analogy with the biological system.

Focusing on the coevolution and self organization capabilities, I will show a new initiative on AI and Robot, one of the Moon Shot Programs started by Japanese Government, since 2020. Based on the Society 5.0, it is a new and challenging program aiming at the AI robotic system in 2050. I will introduce some of the projects in this program for realization of the Society 5.0 by back-casting technologies from the 2050 to the current ones. Then I will show the progress and current status of several projects of the Program.

Biography:

Toshio Fukuda is Professor Emeritus of Nagoya University and University Professor Waseda University. He is mainly engaging in the research fields of intelligent robotic system, micro and nano robotics, bio-robotic system and industry applications in robotics and automation. He was the President of IEEE Robotics and Automation Society (1998-1999), and IEEE President (2020). He was Editor-in-Chief of IEEE/ASME Trans. Mechatronics (2000-2002). He was chairs of many conferences, such as the Founding General Chair of IEEE International Conference on Intelligent Robots and Systems (IROS, 1988), International Symposium on Micro/Nano Mechatronics and human Science(MHS, 1989), IEEE Conference on Advanced robots and Social Impact(2005), System Integration International(2008), IEEE Conference on Cyborg and Bionic Systems (CBS, 2017), IEEE Conference on Intelligence and Safety of Robots (ISR, 2018). He has received many awards such as IEEE Robotics and Automation Pioneer Award (2004), IEEE Robotics and Automation Technical Field Award (2010), Medal of Honor on Purple Ribbon (2015), The Order of the Sacred Treasure, Gold Rays with Neck Ribbon (2022). IEEE Fellow (1995), SICE Fellow (1995), JSME Fellow (2002), RSJ Fellow (2004), VRSJ Fellow (2011), member of the Japan Academy of Engineering (2013).

Plenary Speech 3 (Room G)

January 25 (Thursday), 11:00-11:50

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

Soft Robots for Humanity

Allison M. Okamura

Stanford University, USA

Traditional robotic manipulators are constructed from rigid links and localized joints, which enables large forces and workspaces but creates challenges for safe and comfortable interaction with the human body. In contrast, many soft robots have a volumetric form factor and continuous bending that allows them to mechanically adapt to their environment — but these same mechanical properties can hinder forceful interactions required for physical assistance and feedback to humans. This talk will examine robotic systems and haptic devices that achieve the best of both worlds by leveraging softness and rigidity to enable novel shape control, generate significant interaction forces, and provide a compliant interface to the human body.

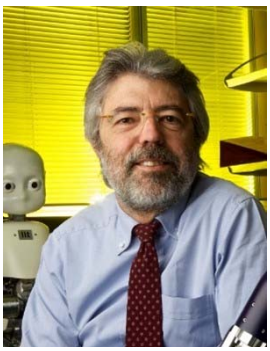
Biography:

Allison M. Okamura is the Richard W. Weiland Professor of Engineering at Stanford University in the mechanical engineering department, with a courtesy appointment in computer science. She received the BS degree from the University of California at Berkeley in 1994, and the MS and PhD degrees from Stanford University in 1996 and 2000, respectively, all in mechanical engineering. She is currently Director of Graduate Studies for her department, a Deputy Director of the Wu Tsai Stanford Neurosciences Institute, and PI of the Collaborative Haptics and Robotics in Medicine (CHARM) Lab (http://charm.stanford.edu). Her awards include the 2020 IEEE Engineering in Medicine and Biology Society Technical Achievement Award, 2019 IEEE Robotics and Automation Society Distinguished Service Award, and 2016 Duca Family University Fellow in Undergraduate Education. She is an IEEE Fellow. Her recent research service includes co-general chair of the 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems, editor-in-chief of the journal IEEE Robotics and Automation Letters, and associate editor of the IEEE Transactions on Haptics. Her academic interests include haptics, teleoperation, virtual environments and simulators, medical robotics, soft robotics, human sensorimotor control and rehabilitation, and education. Outside academia, she enjoys spending time with her husband and two children, running, and playing ice hockey.

Plenary Speech 4 (Room G)

January 25 (Thursday), 15:00-15:50

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)



Anthropomorphic Cognition and Artificial Life

Giulio Sandini

Robotics, Brain and Cognitive Sciences
– Istituto Italiano di Tecnologia – Genova - Italia

The use mathematical models to describe human perceptual and motor functions has a very long and successful history while the design and implementation of embodied artificial systems to investigate human sensorimotor and cognitive abilities is a relatively recent endeavour still struggling, to some extent, to go beyond a superficial, technology-driven, biomimetic approach. Besides its intrinsic scientific and engineering value in our quest to study the unity of body and mind in artificial embodied systems, the view emerging is on the “body side” the implementation of very athletic robots and on the “mind-side” the implementation of a fragmented collection of individual functional abilities and cognitive skills missing the opportunity to exploit the origin and timeframe of human adaptive abilities stemming from the mind-body unity and the role and complementary contribution of evolutionary, epigenetic, developmental and learning processes.

Stemming from these considerations the need of a more convergent approach is emerging conceptually based on a reference cognitive architecture. Along this line I will focus my presentation on how to exploit the use of robots to advance our knowledge of the mechanisms at the basis of human-human interaction and in particular in our ability to anticipate our own actions and those of others. I will argue that robots as physical models of biological systems are effective experimental platforms to investigate aspects of social interactions and can be exploited to investigate kinematic and dynamic signatures of behaviour such as biological motion and motor contagion, as well as cognitive skills such as intention reading, turn taking, vitality forms and emotions . All essential ingredients of anthropomorphic cognition and artificial life.

Biography:

Giulio Sandini is a Founding Director of the Italian Institute of Technology where in 2006 he established the department of Robotics, Brain and Cognitive Sciences. As a research fellow and Assistant Professor at the Scuola Normale in Pisa and Visiting Researcher at the Neurology Department of the Harvard Medical School he investigated visual perception and sensorimotor coordination in humans and technologies for Brain Activity Mapping in children with learning disabilities. In 1996 he was Visiting Scientist at the Artificial Intelligence Lab of MIT.

As a professor of bioengineering at the University of Genova in 1990 he founded the LIRA-Lab (Laboratory for Integrated Advanced Robotics) which was to become the birthplace of a family of humanoid robots up to the “open sources” iCub platform which has later become a reference humanoid platform of the Italian Institute of Technology and adopted by more than 40 research centers in the word to study and share results on different aspects of cognitive robotics.

Giulio Sandini research activity is characterized by an engineering approach to the study of natural intelligent systems with a focus on the design and implementation of artificial systems to investigate the development of human perceptual, motor and cognitive abilities (and viceversa).

Invited Talk 1 (Room A)

January 24 (Wednesday), 15:35 - 16:05

OS10 AROB: Integration of AI and Robotics for Highly Versatile Robots

Chair: Tetsuya Ogata (Waseda University / AIST, Japan)
Co-Chair: Kenichi Ohara (Meijo University, Japan)

Deep Learning for Robotics: Enhancing Adaptive Perception a Action through Predictive Models

Tetsuya Ogata

Waseda University/AIST, Japan

Traditional deep learning faces challenges in labeling and doesn't account for physical factors like friction. We explore "deep predictive learning," inspired by predictive coding, which adapts the model's state and generates motions to reduce prediction errors. This approach is crucial for self-reliant, responsive agents. Our work has already enabled a humanoid robot to fold towels, leading to industry collaborations. Our moonshot project, "AIREC," aims to create a versatile smart robot for care, blending AI and robotics. Unlike existing robots, AIREC won't require a dedicated end-effector, enhancing adaptability. We plan to integrate the deep predictive learning framework to equip AIREC with diverse capabilities, revolutionizing how robots generalize tasks. This strategy aligns with how smartphones consolidate functions, creating new value. Our goal is to empower AIREC to excel in various tasks, marking a significant step in expanding robots' capabilities.

Biography:

Tetsuya Ogata received the B.S., M.S., and D.E. degrees in mechanical engineering from Waseda University, Tokyo, Japan, in 1993, 1995, and 2000, respectively. He was a Research Associate with Waseda University from 1999 to 2001. From 2001 to 2003, he was a Research Scientist with the RIKEN Brain Science Institute, Saitama, Japan. From 2003 to 2012, he was an Associate Professor at the Graduate School of Informatics, Kyoto University, Kyoto, Japan. Since 2012, he has been a Professor with the Faculty of Science and Engineering, at Waseda University. Since 2017, he is a Joint-appointed Fellow with the Artificial Intelligence Research Center, National Institute of Advanced Industrial Science and Technology, Tokyo. He is currently a member of the director board of the Japan Deep Learning Association (JDLA) since 2017, and a director of the Institute of AI and Robotics, at Waseda University since 2020.

Invited Talk 2 (Room A)

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

OS24 SWARM: Lunar bases construction and lunar exploration by modular and swarm AI-robots

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)
Co-Chair: Jun Morimoto (Kyoto University, Japan)

Challenge to Modular and Heterogeneous AI Robot System for Lunar Exploration and Outpost Construction

Kazuya Yoshida

Tohoku University, Japan

In this talk, an ongoing advanced research project under the framework of the Japanese “Moonshot R&D Program” for collaborative heterogeneous multi-robot systems for resource exploration and human outpost construction is introduced.

Our proposed project involves the development of a group of diverse robots with modular designs. This is particularly useful for space missions where it may be difficult to deliver new hardware parts and components. With modular designs, the mechanical configuration of the robots can be easily changed by rearranging the components. This allows for on-site self-update of the functionality of the existing robots.

However, this presents a challenge as the controllers need to evolve with the reconfiguration of the robot system to meet up-to-date task requirements in different environments. We will be utilizing state-of-the-art AI technologies to address this challenge.

The project will bring robust and sustainable robotics-based solutions to exploring the Moon and beyond.

Biography:

Kazuya Yoshida received B. E., M. S. and Dr. Eng, degrees in Mechanical Engineering Science from Tokyo Institute of Technology, Japan, in 1984, 1986, and 1990, respectively. He served as Research Associate at Tokyo Institute of Technology from 1986 to 1994, and Visiting Scientist at Massachusetts Institute of Technology, U.S.A. in 1994. From 1995 to 2003 he was appointed as Associate Professor, and since 2003 he is Full Professor in Department of Aerospace Engineering, Tohoku University, Japan. He is also a co-founder, and current Technology Advisor, of ispace Inc., a start-up company for the lunar resource exploration business. In addition, he has been contributing to space robotics education for international students at International Space University in Strasbourg, France (for Master of Space Studies) and various locations in the world (for Summer Study Programs) as well as in the Interdisciplinary Space Master program at the University of Luxembourg.

Invited Talk 3 (Room B)

January 25 (Thursday), 13:00 - 13:30

OS1 AROB: Adaptable AI-enabled Robots to Create a Vibrant Society

Chair: Kazushi Ikeda (Nara Institute of Science and Technology, Japan)
Co-Chair: Tetsunari Inamura (Tamagawa University, Japan)

Adaptable AI-enabled Robots to Create a Vibrant Society

Yasuhisa Hirata

Tohoku University, Japan

This talk introduces our Moonshot project which is a project in the National Research and Development (R&D) program in Japan. The Moonshot program promotes high-risk, high-impact R&D aiming to achieve ambitious Moonshot Goals and solve issues facing future society such as super-aging populations. Our project aims to create adaptable AI-enabled robots available in a variety of places. We are now developing a variety of assistive robots called the Robotic Nimbus which can change their shape and form according to the user's condition, environment, and the purpose of the task, and provide appropriate assistance to encourage the user to take independent action. Especially, in this talk, we focus on the human-assistive/human function-enhancing robots in the fields of nursing care and healthcare.

Biography:

Yasuhisa Hirata is a Professor in the Department of Robotics at Tohoku University, Japan, and a Project Manager of the Moonshot R&D program in Japan. He received his B.E., M.E., and Ph.D. degrees in mechanical engineering from Tohoku University in 1998, 2000, and 2004, respectively. He formerly worked as a research associate and an associate professor at Tohoku University. He was also a visiting researcher at The Universite de Versailles Saint-Quentin-en–Yvelines, France in 2006 and 2012. He served as an AdCom member and vice president of TAB in IEEE RAS. For more than 20 years, he has been doing research on the control of multiple mobile robots in coordination, human-robot cooperation systems, assistive robots, haptics, industrial robots, etc. He has over 200 technical publications in the area of robotics. He received the Best Paper Awards in Advanced Robotics, JSME Journal, RSJ Journal, Fanuc FA Foundation, ROBIO 2004, ICMA 2020, etc.

Invited Talk 4 (Room A)

January 25 (Thursday), 16:05 - 16:35

OS6 AROB: Collaborative AI robots for adaptation of diverse environments and innovation of infrastructure construction (Moonshot program Goal-3)

Chair: Keiji Nagatani (The University of Tokyo, Japan)
Co-Chair: Kenji Nagaoka (Kyushu Institute of Technology, Japan)

Innovations in Earthworks: A 3-Year Progress Report on Collaborative AI Robots for Adapting to Diverse Environments and Innovating Infrastructure Construction

Keiji Nagatani

The University of Tokyo, Japan

We are actively involved in research and development, focusing on 'collaborative AI robots' capable of adapting flexibly to unexpected situations in hazardous environments, such as lunar surfaces and disaster sites. Our vision is that by 2050, these 'collaborative AI robots' will be capable of replacing humans, enabling emergency restoration in natural disasters, and aiding in the construction of lunar bases. This technology will also find applications in constructing and maintaining infrastructure on Earth. To achieve this objective, we have identified three key research and development pillars:

1. Robot Hardware for Earthwork Innovation,
2. Dynamic Collaboration System for Multiple Robots, and
3. Sensor Pod System for Environmental Data Collection.

During this presentation, I will provide a 3-year progress report on our project and discuss the future of innovations in earthworks in the context of robotics.

Biography:

Keiji Nagatani received his PhD from the University of Tsukuba in 1997. He was a postdoctoral fellow at Carnegie Mellon University from 1997 to 1999, a lecturer at Okayama University from 1999 to 2005, and an associate professor at Tohoku University from 2005 to 2019. Currently, he is a professor at the University of Tokyo since 2019 and also one of the project managers of objective #3 in the Moonshot Research and Development program. His research interest is field robotics, which includes improving traversal ability for all-terrain robots, the autonomy of inspection robots, and intelligent functions for construction machines. He is a Member of the RSJ, SICE, JSME, JSASS and IEEE.

Invited Talk 5 (Room A)

January 26 (Friday), 13:00 - 13:30

OS9 AROB: Human-Centered Robotics

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Zonghe Chua (Case Western Reserve University, USA)

Human-Centered Haptic Devices for Social Communication

Cara M. Nunez

Cornell University, USA

During social interactions, people use auditory, visual, and haptic (touch) cues to convey their thoughts, emotions, and intentions. Current technology allows humans to convey high-quality visual and auditory information but has limited ability to convey haptic expressions remotely. However, as people interact more through digital means rather than in person, it becomes important to have a way to be able to effectively communicate emotions through digital means as well. As online communication becomes more prevalent, systems that convey haptic signals could allow for improved distant socializing and empathetic remote human-human interaction. Due to hardware constraints and limitations in our knowledge regarding human haptic perception, it is difficult to create haptic devices that completely capture the complexity of human touch. Wearable haptic devices allow users to receive haptic feedback without being tethered to a set location and while performing other tasks, but have stricter hardware constraints regarding size, weight, comfort, and power consumption. In this talk, I will present how I address these challenges through a cyclic process of (1) developing novel designs, models, and control strategies for wearable haptic devices, (2) evaluating human haptic perception using these devices, and (3) using prior results and methods to further advance design methodologies and understanding of human haptic perception.

Biography:

Cara M. Nunez is an Assistant Professor in the Sibley School of Mechanical and Aerospace Engineering at Cornell University. She received a B.S. degree in Biomedical Engineering and a B.A. degree in Spanish as a part of the International Engineering Program from the University of Rhode Island, Kingston, RI, USA, in 2016 and a M.S. degree in Mechanical Engineering and a Ph.D. degree in Bioengineering from Stanford University, Stanford, CA, USA, in 2018 and 2021, respectively. She was formerly a Deutscher Akademischer Austauschdienst (DAAD) Graduate Research Fellow at the Max Planck Institute for Intelligent Systems, Stuttgart, Germany, a Robotics Research Intern at the Honda Research Institute, San Jose, CA, USA, and a Cornell Provost Faculty Fellow and Postdoctoral Research Fellow at the Harvard John A. Paulson School of Engineering and Applied Sciences, Cambridge, MA, USA. Her awards include the National Science Foundation Graduate Research Fellowship, the Stanford Centennial Teaching Assistant Award, and the Stanford Community Impact Award. She was a finalist for Best Technical Paper at the 2020 IEEE Haptics Symposium and was named a Rising Star in Mechanical Engineering in 2020. She previously served as the Student Activities Committee Chair and AdCom member and currently serves as the Student Activities Committee Senior Chair and Associate Vice President of the Media Services Board for the IEEE Robotics and Automation Society. Her recent service also includes associate editor for IEEE Robotics and Automation Letters, IEEE Haptics Symposium 2024, and IEEE Robosoft 2024. Her research interests include robotics, haptics, and human-centered design for human-machine interaction, medical applications, augmented and virtual reality, and STEM education, among others.

January 24 (Wednesday), 09:00-10:00

Room A

GS1 Agent-based modelling

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

GS1-1 Evolution of the sensitivity to social state change and the ability to modify social relationships in the social particle swarm model

Kota Ishigami, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

Recent socio-ecological approaches recognize the importance of the psychological effects of residential mobility. Ishii et al. recently found that high residential mobility enhances sensitivity to signs of disapproval, such as the disappearance of happiness. The purpose of this paper is to consider the diversity and evolution of the ability to change social relationships and the sensitivity to detect social states by extending the social particle swarm model, which is known to exhibit the three different social dynamics with different mobilities of interacting agents. We conducted experiments with different settings of the diversity and evolution of these properties. The results showed that high sensitivity tends to evolve in high-mobility environments, which supports Ishii et al.'s claim. It was also suggested that more dynamic social interactions occur in societies composed of more sensitive individuals. These findings suggest that dynamic environments lead to the evolution of higher sensitivity, and groups with such heightened sensitivity in turn create dynamic environments, implying synergistic effects between the sensitivity and mobility.

GS1-2 Distributed Cooperative Evacuation Guidance Model Based on Self-Driven Autonomous Agents

Mayuko Asano, Ryoma Toyomi, Atsuo Ozaki
(Osaka Institute of Technology, Japan)

In recent years, natural disasters have become increasingly serious both in Japan and abroad. When a disaster occurs, it is essential for multiple guides to cooperate with each other to efficiently evacuate people to safety. For this reason, we have been studying efficient evacuation guidance methods by using multi-agent simulation (MAS) technology. In this paper, we proposed a distributed cooperative search method that assumes virtual forces of attraction and repulsion among multiple evacuation guidance agents and conducted a basic evaluation of the proposed method in a simple environment. The results confirm the effectiveness of the proposed method and the effect of changing the parameters.

GS1-3 Urban scale pedestrian evacuation scenario in Kobe City center

Daigo Umemoto[1], Maiko Kikuchi[2], Ayako Terui[2], Koutarou Abe[2], Nanako Doi[2], Miki Kobayashi[2], Nobuyasu Ito[1], Itsuki Noda[3,1]
([1]RIKEN R-CCS, Japan)
([2]NTT DOCOMO, INC., Japan)
([3]Hokkaido University, Japan)

Since 2021, we have been constructing a pedestrian simulation framework of Kobe City center, under the collaboration with Kobe City, NTT Docomo, INC., and RIKEN R-CCS, in purpose of policy evaluation. There are many offices in the central region of Kobe City with lots of commuters. If a disaster occurs in the neighborhood city, it is expected that trains will suspend its service and people commuting by train from distant areas will have difficulty returning home, in which we estimated 14,049 people would be stranded. Kobe City is planning to direct them to shelters and assign them on each individuals in the park located at the center of downtown. We verified which gates of the park would minimize the congestion, and obtained the best results when the gates located at the south and east are used as entrances while the others as exits, otherwise severe or relatively moderate congestion was observed.

January 24 (Wednesday), 09:00-10:10

GS1-4 Does the Risk-sensitive Satisficing model predict choices and the risk attitudes under uncertainty?

Takaomi Yokosuka[1], Keigo Ishikura[1], Hiroko Nakamura[1,2], Tatsuji Takahashi[1]
([1]Tokyo Denki University, Japan)
([2]Japan Society for the Promotion of Science, Japan)

The Risk-sensitive Satisficing (RS) model predicts that the risk attitude in decision-making under uncertainty switch depending on whether one is satisfied with the expected value of choice behaviour (Takahashi et al., 2016). We studies the ex- plaratory tendencies and risk attitudes in decision-making using a gambling choice task. The results of the experiment supported the model's prediction that participants would become more risk-oriented and make more exploratory choices when more losses were expected.

January 24 (Wednesday), 09:00-10:15

Room B

OS21 ISBC: Quantum leaps after IIAS I

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

OS21-1 Structural balance of alliance and rivalry networks in international relations

Koji Oishi[1,2], Kentaro Sakuwa[3]
([1]Indiana University, United States)
([2]Japan Society for the Promotion of Science, Japan)
([3]Aoyama Gakuin University, Japan)

Does the enemy of my enemy become my friend? A growing literature on structural analysis of interstate relationships has tackled this old question from the network perspective. However, the mechanism of long-term change in the structure of cooperation and enmity has yet to be fully understood. In search for a general explanation for the long-term evolution of interstate structure, we empirically examine the structural balance theory which predicts that a signed network evolves toward a more "balanced" structure where in many triangular relationships (i.e., triads) two states tend to share a common enemy or three states cooperate with each other. We investigate the network of alliances (positive edges) and rivalries (negative edges) between sovereign states and examine whether its evolution from 1816 to 2009 can be explained by the structural balance theory. We find the consistency with the structural balance theory drastically changes over time. The empirical pattern follows the prediction by the theory before the German unification in the nineteenth century and after World War II while inconsistent in the middle period. This result reveals the impact of the two historical events on the underlying mechanism of network evolution. Moreover, the contrast with previous studies of signed social networks that generally support the structural balance theory indicates that international alliance and rivalry networks can be a promising material to study novel mechanisms behind the time evolution of signed networks.

January 24 (Wednesday), 09:00-10:15

OS21-2 Theoretical analysis of dopamine chemical reaction network and effects of tyrosine hydroxylase using structural sensitivity analysis

Shun Sawada, Kei Tokita
(Nagoya University, Japan)

Dopamine is one of the neurotransmitters necessary for organisms with nervous systems to live, and it is also the precursor to the noradrenaline of the adrenal medullary hormone. Neurotransmitters such as dopamine play a major role in memory, learning, and behavior. In recent years, the number of patients with dopamine-related disorders has been increasing. For example, psychiatric disorders such as attention deficit hyperactivity disorder are caused by excess or deficiency of dopamine. Investigating the dynamics of dopamine has become one of the most important research topics in modern molecular biology. In this study, we applied the structural sensitivity analysis of Mochizuki et al. to the dopamine chemical reaction network of Janet et al. to examine the effect of increasing the enzymatic activity of tyrosine hydroxylase. The results showed that the concentration of dopamine increased when the enzymatic activity of tyrosine hydroxylase was increased.

OS21-3 The Possibility of Optimization for Bayesian Network's Structure Search

Hiroto Kurokawa
(Nagoya University, Japan)

A Bayesian Network is a method for analyzing data casual relationships, assessing causality strength based on the magnitude of conditional probabilities, and expressing various event causality using a directed graph. Understanding the structure unveils causal relationships among variables. To apply to real-world problems, knowledge of constructing Bayesian Networks is crucial. One method for estimating the network structure formulates the graph's structure estimation as a shortest path search problem. The algorithm proposed involves heuristic search, but this can lead to high computational complexity. Therefore, considering the use of weighted heuristic search as an alternative, simulations with three variables show varied exploration paths. However, the structure of the Bayesian Network itself sometimes aligns.

OS21-4 Training Methods for Spiking Neural Networks Using Surrogate Gradient and Spike Accumulation

Tomoya Shirakawa
(Graduate School of Mathematics, Nagoya University, Japan)

Spiking neural networks (SNNs) have garnered attention as energy-efficient third-generation neural networks. Due to the non-differentiability of the loss gradient, training SNNs has been challenging. Backpropagation through time with surrogate gradient (BPTT with SG) approximates non-differentiable terms with surrogate gradients, enabling supervised learning in SNNs. However, the issue of increased memory usage with the growth of time steps persists. Recently, I and co-workers have proposed spike accumulation forwarding (SAF), where spike accumulation is propagated instead of spike trains. SAF is a variant of BPTT with SG, but due to the temporal independence of gradients, it maintains constant memory consumption regardless of the number of time steps. Additionally, SAF is compatible with traditional SNNs that propagate spike trains. This paper provides an brief overview of SNNs, the SG method, and introduces SAF as a SG + SA method.

OS21-5 Spike Train Generations from Simple Delay Differential Equations

Kenta Ohira, Toru Ohira, Hideki Ohira
(Nagoya University, Japan)

In living organisms, various pulsatile rhythmic behaviors exist, as represented in neural circuits and heartbeats. Additionally, in engineering, pulse packets and similar patterns have been utilized in communication, and it has been recently noted that similar behaviors also exist in consumption activities. The mechanisms that generate such pulsatile behaviors are believed to be diverse, and one potential factor is delays in self-feedback. In this context, we aim to discuss models that exhibit such pulse behaviors, particularly focusing on a recently proposed simple feedback delay system as a specific example. We hope to engage in a discussion regarding its relevance to real-world data.

January 24 (Wednesday), 09:00-10:00

Room C

GS13 Human-machine interaction and collaboration I

Chair: Ekaterina Sangati (Okinawa Institute of Science and Technology, Japan)

GS13-1 Human Pulse Wave Detection with Consumer Earphones and Headphones

Xing Yi[1], Samith S. Herath[1], Hiroshi Ogawa[2], Hiroki Kuroda[1], Kosuke Oiwa[1], Shusaku Nomura[1]
([1]Nagaoka University of Technology, Japan)
([2]SaLusTek Inc., Japan)

Dynamic earphones/headphones and microphones can detect sounds below the human audible frequency. Based on this principle, we propose a new method of human pulse measurement using consumer earphones and headphones. It is a simple signal separation-based method utilizing pressure changes inside the ear canal and around the tragus caused by heartbeats. As a result of feasibility evaluation using an electrocardiogram, the pulses derived by the earphone/headphone were highly feasible in terms of accurate peak-to-peak determination. Furthermore, we estimated the frequency characteristics of the audio devices at the frequency of interest, the center frequency of the heart rate (around 1.4 Hz), which enables us to reproduce the original, non-distorted pulse waveform. Although this is an entirely different methodology from photoplethysmography, it is promising because heart rate can be measured while listening to music.

GS13-3 The Impact of Confidence Information in AI Image Recognition on Decision Making

Ryo Yoshizawa, Osamu Fukuda, Wen Liang Yeoh, Nobuhiko Yamaguchi, Hiroshi Okumura
(Saga University, Japan)

Artificial intelligence (AI) is increasingly active in today's society. However, the current AI decisions have the problem that the basis for such decisions is difficult to understand. The problem is how humans can judge and accept AI proposals. This study investigates and analyzes how AI proposals affect human decision-making. Specifically, we use the results of image recognition and their confidence levels and analyze the effects on people's decision-making when presented to them. The task using image recognition was to classify the quality of strawberries. Since strawberry quality criteria are complex, it is predicted that AI-based image classification results and confidence levels will influence the worker's decision-making. The experiment examined the impact of confidence levels on strawberry quality classification. In conclusion, it is clear that providing confidence levels in addition to AI suggestions changes human decisions, and that these changes may depend on the AI's confidence levels.

GS13-4 Human augmentation device for physical and cognitive assistance

Kyohei Yoshida, Wen Liang Yeoh, Hiroshi Okumura, Nobuhiko Yamaguchi, Osamu Fukuda
(Saga University, Japan)

Human augmentation technology enhances and extends human abilities with technological support and is expected to turn the negative factors associated with aging and disabilities into positive aspects beyond zero. This research proposes a novel human augmentation technology to assist users in performing intelligent tasks that require higher brain functions such as cognition, planning, judgment, and memory. In addition to flexible human processing, the proposed method simultaneously augments human cognitive and motor functions and enables high-speed, accurate, and precise recognition and movements during the intelligent task. The proposed system uses a dissection puzzle as an example of intelligent work. This device supports the user in attempting to solve this puzzle. Using this device, we conducted an experiment to measure the time required to solve a puzzle using the system.

January 24 (Wednesday), 09:00-10:00

GS13-5 Improving Controllability of Manual Control Systems by Altering Visual Information

Kenta Tanaka, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

Human-machine systems, consisting of machines and human operators determining control inputs, are widely used in various fields. Examples of human-machine systems are found in various domains, including car driving, heavy machinery operation. Improving the operability and safety of these human-machine systems sometimes requires the development of information presentation strategies that enable operators to comprehend the state of the system accurately. However, accurately designed information does not necessarily guarantee the prevention of operational errors, which can arise due to factors such as lack of practice, insufficient sensorimotor resolution, or inadequate nerve conduction velocity. Then, we propose a method to display future state of the machine to the human operator, instead of the current state. To validate our idea, we developed the Inverted Pendulum Game, a physics simulation game in which the player attempts to keep the pendulum inverted for as long as possible.

January 24 (Wednesday), 09:00-10:00

Room D

OS7 AROB: Computational intelligence and cognitive science for human biosignals and human well-being I

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

OS7-1 Information matrix method for fitting COVID-19 time series data

Hiroshi Furutani, Tomoyuki Hiroyasu
(Doshisha University, Japan)

This paper describes a mathematical framework to fit COVID-19 time series data of Japanese prefectures. We investigate the spreading of infections in the period from January to March in 2022. The analysis uses the reported daily data of six prefectures, five large population prefectures and one small population prefecture. The adopted model uses the Fisher information matrix presented by Stevens for estimating the daily number of infections. As a statistical model, we employ the Gumbel distribution, which has been used for analyzing COVID-19 spreading patters in various regions. The information matrix method, named as the asymptotic regression by Stevens, can estimate simultaneously three parameters representing the relation between the cumulative number of infections and time. The asymptotic regression method demonstrates that the approach successfully fit the time series data of six prefectures.

OS7-2 Feature Selection for Biosignal Data Modeling: A Multi-objective Optimization Approach using Genetic Algorithms

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

In AI and machine learning, feature selection is essential for efficiency and model accuracy. Our study focused on identifying key features in high-dimensional data, using multi-objective optimization to balance model performance and feature reduction. This method helps select relevant features, which are crucial for model generalization. We compared the multi-objective genetic algorithm (MOGA) with regularization models like the L1-norm SVM. The goal was to minimize metrics like hinge loss and error rate while reducing feature count, thus enhancing model performance. MOGA, known for its effectiveness in complex optimizations, was pitted against the L1-norm SVM, a standard for producing sparse models. Our findings showed MOGA's superiority in generating balanced feature sets, leading to better model performance and reduced computational demands. This result highlights the importance of choosing the proper feature selection method in machine learning, especially for high-dimensional datasets.

January 24 (Wednesday), 09:00-10:10

OS7-3 A Novel Approach to Clustering: Entropy Weighted Fuzzy c-means with Lasso on Motion Sense Data

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

In the dynamic field of data clustering, the Entropy Weighted Fuzzy c-means (EwFCM) algorithm has shown promise but faces initialization sensitivity and scalability challenges. To address these issues, we propose Lasso-enhanced EwFCM, integrating Lasso regularization to improve computational efficiency and feature interpretability. Our method was evaluated on synthetic and MotionSense datasets, yielding promising results. On synthetic data, both traditional and Lasso-enhanced EwFCM achieved 100% accuracy, showcasing the ability to select relevant features. On the MotionSense dataset, Group Lasso-enhanced EwFCM demonstrated superior feature selection and clustering accuracy. This integration presents a promising approach for large-scale data clustering, with the potential for further refinement through parameter tuning and exploring additional regularization techniques.

OS7-4 Comparing Single-Learner and Two-Learner Approaches on Data with Two Types of Interventions

Kensuke Tanioka, Satoru Hiwa, Tomoyuki Hiroyasu
(Doshisha University, Japan)

Recently, precision medicine has been focused on, and it has become to important the estimation of treatment effects to recommend the optimal therapy to each patient. Single-Learner and Two-Learner are approaches to estimate the treatment effect estimation within meta-learner. The advantage of these approaches is that it is easy to implement the algorithm based on existing statistical methods. However, these results depend on these existing statistical methods. Therefore, it should reveal these combinations of meta-learners and these statistical methods under various situations. In this paper, we show the results under the situation such as including outliers through the numerical simulation. We compared eight methods; five methods are Single-learner including the proposed method and three methods are Two-leaner. As a result, we found that lad-lasso is the best performance in this simulation.

January 24 (Wednesday), 09:00-10:15

Room E

GS2 Artificial intelligence I

Chair: Kentarou Kurashige (Muroran Institute of Technology, Japan)

GS2-1 Sitting Posture Recognition Using Wearable Inertial Sensors and Deep Learning

Xinye Liu[1], Mana Tsukamoto[2], Jae Hoon Lee[1]
([1]Graduate School of Science and Engineering, Ehime University, Japan)
([2]Ehime Prefectural Matsuyama Minami High School, Japan)

The prevalence of low back pain among young individuals has witnessed a significant increase in recent years. Such issues can potentially result in ambulatory difficulties and impact the quality of life in the elderly. Unconsciously adopting poor sitting postures often causes and makes worse such low back diseases. Therefore, monitoring sitting posture emerges as an effective solution to prevent them. However, existing monitoring methods predominantly rely on visual sensors or specialized sensors, exhibiting limitations concerning their applicability and scalability. In this study, we employed two Inertial Measurement Unit (IMU) sensors fixed at the neck and lumbar region. The collected data were subjected to classification through a deep learning neural network. The outcomes demonstrated the successful classification of five common sitting postures. This research contributes to advancing our understanding of monitoring effective sitting posture using IMU sensors and deep learning techniques.

January 24 (Wednesday), 09:00-10:15

GS2-2 Lower Body Joint Angle Estimation Using Single Low-Cost IMU Sensor Attached on Waist

Xinye Liu, Tsige Tadesse Alemayoh, Jae Hoon Lee, Shingo Okamoto
(Ehime University, Japan)

In rehabilitation centers, patients often require extended hospital stays for monitoring their motor activity and recovery. This results in prolonged hospitalization, thereby increasing the burden on medical facilities. Therefore, to reduce hospital stays, a personalized rehabilitation system that can easily and simply measure and track patients' motor activities until they regain walking ability is essential. However, existing motion tracking systems are often limited and ineffective due to the high cost and inability to monitor patient's daily movements in real time. To address these issues, this study introduces a novel method for estimating walking motion using a single low-cost inertial sensor fixed to the waist. This method utilizes a deep learning to translate waist inertial data into the joint rotations of the lower limb. The results indicate that the joint angles estimation error of the proposed method is only between 1.2~1.3 degrees, which can be used as a reference for estimating the locomotion parameters and a basis for further human walking motion analysis.

GS2-3 Combination of Contrastive Perturbation and Ensemble Learning on Pseudo-Labeling Using CNN & ViT for COVID-19 X-ray Classification

Thanawit Gerdprasert, Shingo Mabu
(Yamaguchi Univeristy, Japan)

Since 2017, transformer architecture has revolutionized artificial intelligence, particularly in machine translation and image recognition. The Vision Transformer (ViT), a key development for computer vision, interprets images as sequences of patches but faces hurdles in healthcare applications, where traditional convolutional neural networks (CNNs) excel due to their local pattern recognition. To address these challenges, our previous study introduced a hybrid model pseudo-labeling model combining CNNs and ViT. The key innovation is the creation of a pseudo-labeled dataset: when CNN and ViT agree on a classification, that label is applied to unlabeled data. Our current research enhances this by incorporating ensemble learning to further strengthen the framework's reliability and accuracy. We evaluated our method on COVID-19 classification in a semi-supervised setting with limited labeled and extensive unlabeled data. The results showed a performance increase with the proposed Ensemble Learning method, demonstrating our approach's effectiveness in medical image analysis.

GS2-4 Review Usefulness Estimation Models Using Customer Q&A Data in E-commerce Websites

Yasuhiro Oda, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology,
Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

In recent years, the internet’s development has created an environment where information dissemination and acquisition have become highly accessible. Users can post and read their reviews about products and services on EC platforms. These reviews often serve as valuable references for users. However, this feature may lead us to a potential issue, namely a decrease in the visibility of newly posted reviews for users. Consequently, valuable but unrated reviews are not readily available to users. To tackle this issue, it is critical to develop methods to estimate the usefulness score of reviews, including those that have not been rated. In this study, we constructed a machine-learning model to predict the usefulness scores of product reviews on EC sites. To enhance accuracy, we introduced two features derived from customer Q&A. Incorporating these features into the machine learning model significantly improves its accuracy in estimating the usefulness of reviews.

January 24 (Wednesday), 09:00-10:15

GS2-5 Sentimental Analysis on SNS during the COVID-19 Pandemic Using BERTopic to Uncover Insights of the Outbreak

Thanawit Gerdprasert, Aya Hagihara, Katsuya Yamamoto, Sakuya Inanaga, Shingo Mabu
(Yamaguchi University, Japan)

This research explores the sudden spike in COVID-19 cases in Japan during October of 2022, using artificial intelligence to analyze the outbreak's cause. Focusing on social media, particularly Twitter, currently known as X, the study employs sentiment analysis on tweets to gain information or insight regarding the outbreak of COVID-19. The methodology includes data retrieval from official APIs, preprocessing to remove noise, followed by embedding data, and clustering using BERTopic, a natural language processing tool based on the transformer architecture. This objective is to demonstrate the potential of deep learning in analyzing the social network by analyzing the results from the clustering process from BERTopic. The study not only seeks to uncover factors behind the COVID-19 surge but also aims to illustrate how the framework can be used for SNS sentimental analysis.

January 24 (Wednesday), 09:00-10:15

Room F

GS10 Control techniques I

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

GS10-1 Direct Consideration of Passenger States for Ride Comfort Improvement in Autonomous Vehicle's Velocity Planning

Takumi Todaka[1], Kaito Sato[1], Kenji Sawada[1], Junichi Takano[2], Katsuhiko Sando[2], Shohei Imaji[2]
([1]Department of Mechanical and Intelligent Systems Engineering,
The University of Electro-Communications, Japan)
([2]Nissan Motor Co., Ltd., Japan)

Motion planning in autonomous vehicles supports driving safety and enhances path-following performance in comparison to manual driving. However, limiting passenger interventions of auto-driving may exacerbate passenger motion sickness. Therefore, it is significant to research motion planning that does not cause motion sickness using model predictive control (MPC), including the passenger and subjective vertical conflict (SVC) models. In this study, we focus on velocity planning. We compare motion sickness incidence (MSI) in model predictive velocity control when including a linear SVC model in the constraints and when including a linear passenger model in the constraints and evaluate which one improved ride comfort. The numerical experiments demonstrate MSI when the SVC model and the passenger model are included as MPC constraints, respectively. The results are compared to assess the efficacy of the methods in enhancing ride comfort.

GS10-2 A Common Lyapunov Function Approach to Event-Triggered Control with Self-Triggered Sampling for Switched Linear Systems

Shota Nakayama, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

In this paper, a common Lyapunov function approach to event-triggered control with self-triggered sampling for switched linear systems is proposed. A switched system is a system where the dynamics can be switched by a switching signal. In the proposed method, based on the upper bound of the common Lyapunov function, the update time of the control input and the switching signal and the next sampling time of the state are determined. As a control specification, it is guaranteed that the closed-loop system is uniformly ultimately bounded.

January 24 (Wednesday), 09:00-10:15

GS10-4 Preparation of On the Relationship between Opacity and Place-Invariants of Asymmetric Dual Control Systems

Kumi Aizawa, Kenji Sawada
(The University of Electro-Communications, Japan)

This study presents a method for assessing the vulnerability of dual-redundant control systems to cyber attacks. By focusing on Petri Net specific P-Invariants, we assess the extent to which an attacker can infer the structure of the system. We then compare our approach to conventional analysis methods using reachability graphs and consider the basis of current state-opacity analysis.

GS10-5 Opacity Considering Security Levels for Discrete-Time Piecewise Linear Systems

Taiga Matsumae, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

Opacity is one of the security concepts against cyber-attacks, and is frequently for discrete event systems (finite automata). In this paper, for discrete-time piecewise linear (DT-PWA) systems, the notion of opacity and its verification method are proposed. In addition, we consider the security level with respect to the opacity of this system. First, opacity for DT-PWA systems is defined. A necessary and sufficient condition for the DT-PWA system to be opaque is derived. Next, a verification method is proposed. Finally, a numerical example is presented.

GS10-6 Detection Scheme Employing Cyclical Hitting Hammer for Internal Defects in Concrete Structures

Ryutaro Uozumi, Geunho Lee, Chunhe Li, Kaito Hirae
(University of Miyazaki, Japan)

Half a century has passed since Japan's period of rapid economic growth, and Japan's social infrastructure continues to deteriorate. The current situation is that there is a shortage of personnel required for inspections due to the super-aging society. In addition, tunnel inspections require many workers and long hours of labor because they are conducted by humans pounding on the wall surface with hammers. Therefore, there is a strong need to improve the efficiency of inspection methods. In this study, a "defect direction estimation model" focusing on reflected waves from defects was developed to improve inspection efficiency. In order to verify the effectiveness of the model, a cyclic impact machine was developed to enable constant and quantitative impact. The validity of the model was verified through evaluation experiments on test specimens.

January 24 (Wednesday), 12:45-14:15

Room A

OS23 SWARM: Individuality and Collectivity in Living Systems II

Chair: Takashi Ikegami (The University of Tokyo, Japan)
Co-Chair: Norihiro Maruyama (The University of Tokyo, Japan)

OS23-1 Species- and situation-dependent variations of a simple visual response in ants

Yusuke Notomi[1,2], Shigehiro Namiki[2], Ryohei Kanzaki[2], Shigeto Dobata[1], Stephan Shuichi Haupt[2]
([1]Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, Japan)
([2]Research Center for Advanced Science and Technology, The University of Tokyo, Japan)

Many insects, including ants, are spontaneously walking toward conspicuous dark objects, a behavior also known as beacon-aiming, which we investigated here in six ant species. In response to a simple visual beacon, each species displayed characteristic behavioral traits, with one species, Camponotus japonicus, showing no beacon-aiming. However, this species performed beacon-aiming while swimming, but also while wading in shallow water, implying the locomotor pattern is not relevant to induce the orientation response. Swimming in a glycerol/isopropanol mixture demonstrated that beacon-aiming is not triggered by water reception. Another factor that could induce beacon-aiming in Camponotus was heat, of a dry substrate on which the ants were made to walk. These results suggest the potential induction of beacon-aiming in distressing environmental conditions.

OS23-2 Investigating the heterogeneity and its heritability of Tetrahymena thermophila

Akiko Kashiwagi[1], Hiroki Kojima[2], Takashi Ikegami[2]
([1]Hirosaki University, Japan)
([2]University of Tokyo, Japan)

The Tetrahymena thermophila cells are heterogeneous even if they are clonal population. We have characterized this heterogeneity as the variation in the movement by individual tracking analysis and gene expression patterns captured by single cell RNA sequencing (scRNAseq). In this research, we further investigate the characteristics of this heterogeneity by putting emphasis on its heritability. In our tracking experiments, we found that the movement patterns tend to inherit to the descendant. However, this heritability cannot be captured by scRNAseq analysis. Therefore, we applied bulk RNA seq to several populations divided from one individual cell. As a result, we found most of the RNA expression correlated with different population, but some genes did not and these genes expression difference can be regarded as the heritable heterogeneity.

OS23-3 Behavioral Analysis of Ant Colonies: Distinguishing Between Stochastic/Deterministic Modes and Global Behavior

Norihiro Maruyama, Shigeto Dobata, Takashi Ikegami
(The University of Tokyo, Japan)

In this study, we examined the behavior of queen-less and male-less textit{Pristomyrmex punctatus} ant colonies through individual tracking. Fifty individuals from a single colony were placed in a circular arena and their movements were recorded over five hours. Using the U-Net convolutional neural network, we tracked individual ants without markers. Our observations revealed two primary behaviors: clustering and arena exploration, with ants spontaneously joining or leaving clusters. We also noted intermittent, globally synchronous movements within clusters, similar to honeybee bursting dynamics. Additionally, we applied the $epsilon$-transducer method for analyzing ant's movements based on local dynamic states. This revealed deterministic movements during exploration and probabilistic movements during clustering, suggesting the emergence of qualitatively different behaviors in the homogeneous ant population.

January 24 (Wednesday), 12:45-14:15

OS23-4 Multi-scale Information Dynamics in Large-Scale Boids Model.

Atsushi Masumori[1,2], Norihiro Maruyama[1,2], Takashi Ikegami[1,2]
([1]The University of Tokyo, Japan)
([2]Alternative Machine inc., Japan)

Recent research has demonstrated the phenomenon of causal emergence, in which certain macro scales contain more information than their corresponding micro scales. To study this phenomenon, examining information flow between macro and micro scales is a useful approach. In this study, we proposed a method of coarse-graining continuous spaces to define each scale and computed information flow between scales. This can be applied to models where agents move through continuous space, allowing us to analyze hierarchical information flows even with a large number of agents. This paper reports on the results of our preliminary study using this method with large-scale Boids models, suggesting the significant role of surface agents in influencing hierarchical information flows.

OS23-5 Pairwise Generation of Social Memes in Yule-Simon process

Yasuhiro Hashimoto[1], Hiroki Sato[2], Takashi Ikegami[2], Mizuki Oka[3]
([1]The University of Aizu, Japan)
([2]The University of Tokyo, Japan)
([3]University of Tsukuba, Japan)

The evolution of our culture and civilization is closely tied to the development and spread of new customs, technologies, and linguistic expressions, notably ``memes,'' which play a key role in societal evolution. Our research focuses on the evolutionary dynamics of hashtags on social media, examining how their vocabulary and usage frequency change over time, and how they form interconnected semantic structures similar to biological ecosystems. This study explores the evolution of hashtags in the context of collective communication, using a stochastic model based on traditional population dynamics to forecast word occurrences and analyze temporal word correlations, enhancing the accuracy of real-world tagging behaviors. A significant aspect of our approach is the adaptation of the Yule--Simon branching process, tailored to generate word pairs. This modification enables simultaneous analysis of population distribution shifts and network structure evolution, providing insights into the modular transformation of hashtags' semantic space over time.

OS23-6 Swarm Dynamics of Simple Robots with Inherent Inhomogeneity

johnsmith, Norihiro Maruyama, Takashi Ikegami
(The University of Tokyo, Japan)

This study explores the dynamics of swarm robotics through the development of cost-effective, small-scale robots, each equipped with light sensors and vibration motors, and analyzes behavioral changes influenced by external environments and swarm structures in multi-agent systems. These robots serve as active matter. In this study, investigated the dynamics of an inhomogeneous robot swarm in real-world conditions. We found that the observed behavior and adaptive capabilities of the robot swarm differ from simulated models. To quantify the individuality and variability of robot movement, we tracked the motion of a single robot and then expanded the sample size to 5, 10, and 20 robots. Our analysis focuses on understanding how robot behavior changes with the formation of swarm structures and whether a phase transition occurs as the swarm size increases. We report our findings on these emergent swarm modes using information theory.

January 24 (Wednesday), 13:00-13:45

Room B

OS22 ISBC: Quantum leaps after IIAS II

Chair: Takashi Shimada (The University of Tokyo, Japan)
Co-Chair: Ken Noitoh (Waseda University, Japan)

OS22-2 Prognostic medication: predicting medical histories of various species including human beings and dogs done by considering division-speed differences of ES cells

Shun Tomita, Ken Naitoh
(Waseda University, Japan)

A network theory model based on a nonlinear differential equation macroscopically showed a possibility for explaining interaction mechanism of six groups of molecules on information and function in human beings. For the theory, a mathematical study was also conducted, which showed a possibility to predict premonition of an illness, recovery from an illness, and polymorphism. Moreover, we found computation results are consistent with the actual human medical data. However, in cases of human beings, ethical and privacy issues make it difficult to collect much more medical data. Thus, we also collected medical data for dogs to examine effectiveness of the theory. We found that, by considering the total number of cells and the division speed difference of ES cells per year between human beings and dogs, the computational results for dogs are also consistent with dogs' medical history data.

OS22-3 Power-law distributions in an online video sharing system and its long-term dynamics

Kiminori Ito, Takashi Shimada
(The University of Tokyo, Japan)

We study statistical distributions and relaxation process of Niconico, a YouTube-like video sharing platform. Niconico is a dominant platform in Japan with over 90 million registered members. The dataset from Niconico that we analyze in our study includes all data from over 21 million videos, capturing all events on Niconico for five years. From our analysis, the rank-size distribution of video views is found to exhibit a crossover from a power-law with an exponent around −0.5 for the top ≈ 105 movies to another power low with exponent around −1 for the movies in the following ranks. The probability density function of video views for the bottom 90% movies is well fitted by log-normal distribution. This implies that, while videos in the top rank regime follow a different dynamics which yields the power-law, videos in the middle and low rank region seem to be evolving according to a random multiplicative process.

OS22-4 Optimal group structure for group chase and escape

Kohsuke Somemori, Takashi Shimada
(Department of Systems Innovation, The University of Tokyo, Japan)

Chasing multiple escapees by group of chasers is an important problem for many living animal species and for various agent systems. On this group chase problem, it has been reported that having two distinct types of chasers in the group, namely diligent and totally lazy chasers, can improve the efficiency of the group of catching all the targets. In this paper, we search for a better group structure by letting each agent have moderate laziness. We find that there exits an optimal group structure, which performs better than the previously reported group which consists of binary (fully diligent and totally lazy) types.

January 24 (Wednesday), 13:00-14:00

Room C

OS2 AROB: Advanced Information Technology for Education

Chair: Kenneth Mackin (Tokyo University of Information Sciences, Japan)
Co-Chair: Yorinori Kishimoto (Tokyo University of Information Sciences, Japan)

OS2-1 A Consideration of Effect about using Generative AI for Logical thinking Training

Yorinori Kishimoto, Kenneth J. Mackin, Yoshihiro Kawano
(Tokyo University of Information Sciences, Japan)

This paper shows effects of web search and generative AI in logical thinking training in universities. There are few reports on the effects of applying generative AI to education. So, I checked the effects of using generative AI and web search in logical thinking classes at universities. In this example, it was confirmed that students feel that generative AI has a credibility problem. In addition, it was found that it is more efficient to create logic trees using only web searches rather than using the generative AI. And it was effective for simple problems, but less effective for more complex problems of Logical thinking.

OS2-2 Development of a Learning Feedback System of Community Activity for Children with User Types Classification Method in Gamification

Yoshihiro Kawano, Ryota Kadokura, Yoshiha Goto
(Tokyo University of Information Sciences, Japan)

In the elementary school years, career development focuses on enhancing "basic and generic skills," which are career planning skills are particularly vital as they are essential throughout one's life as a functioning member of society. Collaboration between schools and the community through learning activities is crucial to cultivating children's career planning skills. In this study, we have developed a Learning Feedback System (LeaFeS hereafter) with gamification method to support community activities that create opportunities for children to gain work experience. We aim to provide tailored feedback for children using the Gamification User Types Hexad-Scale which categorizes users into six distinct types based on their responses to 24 questions with seven-point scales. LeaFeS offers learning feedback, including career recommendations based on user type classification within gamification. Recommendations for the next job are made based on responses regarding what was enjoyable and what was achieved.

OS2-3 A Proposal of Visualization System for Python Programming Education

Masanori Ohshiro, Yasuo Nagai
(Department of Informatics, Faculty of Informatics, Tokyo University of Information Sciences, Japan)

In recent years, the programming language Python has played a rapidly growing role in information education. In particular, it has become popular as a language widely used in advanced research fields such as data science, artificial intelligence, and image recognition at universities. In Japan, according to the policy set by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), compulsory programming education will be implemented in 2020 for elementary school students, 2021 for junior high school students, and 2022 for high school students, and the programming materials published by the MEXT accordingly adopt Python has been adopted as one of the programming languages to be studied in the programming materials released by the Ministry of Education, Culture, Sports, Science and Technology. Under these circumstances, education of the Python programming language has become important. The authors have been researching and developing a visualization plug-in for the Java language that runs on Eclipse. This visualization system has a static visualization function to visualize the source program and a dynamic visualization function to visualize the process of program execution. We propose a visualization system that applies these visualization functions to the Python programming language. In addition to the basic functions of static and dynamic visualization, we add easy-to-understand visualization of Python-specific elements such as tuple lists. We also propose visualization for programs that are executed sequentially on an interpreter. One of the advantages of an interpreted language is that it is easy to input a partial program, execute it, and check the result to deepen understanding. …

January 24 (Wednesday), 13:00-14:00

OS2-4 Swarm Robotics for Programming Education

Kenneth J. Mackin, Yoshihiro Ohmi, Masanori Ohshiro
(Tokyo University of Information Sciences, Japan)

In this study, we propose a cyber-physical programming education system specialized for swarm robotics, targeting university students. The proposed system is composed of custom designed miniature robots, with wireless connectivity. The robots do not have sensors on their own, but an external web camera connected to the swarm server is used to monitor each individual miniature robot. The swarm robot program is written using the Processing language, with a limited number of methods for robot control to simplify the swarm design and programming. The system also provides a simulator so that each student can design and test the robot swarm without actually connecting to the physical robots. We applied the proposed system to 3rd and 4th year university students to verify the validity of the system.

January 24 (Wednesday), 13:00-14:00

Room D

OS8 AROB: Computational intelligence and cognitive science for human biosignals and human well-being II

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

OS8-1 Detection of Low Muscle Strength from 3-Axis Gait Acceleration Data Using GADF-Encoded CNN toward Physical Frailty Screening

Saki Nakamura[1], Akira Masuo[2], Jun Takeo[3], Takuto Sakuma[1], Shohei Kato[1], Kohei Watanabe[4], Yoshihiro Kawade[5], Toshie Manabe[6], Hiroyasu Akatsu[5]
([1]Graduate School of Engineering, Nagoya Institute of Technology, Japan)
([2]Shubun University Junior College, Japan)
([3]Faculty of Technology, International Professional University of Technology in Nagoya, Japan)
([4]Graduate School of Health and Sport Sciences, Chukyo University, Japan)
([5]Graduate School of Medical Sciences, Nagoya City University, Japan)
([6]School of Data Science, Nagoya City University, Japan)

Currently, the population is rapidly aging in the world. Early detection and prevention of physical frailty is important for extending healthy life expectancy, as aging causes muscle weakness, which affects daily life. In this study, we focused on grip strength and aimed to estimate low muscle strength using acceleration data while walking. Twenty-five females of middle-aged and elderly female aged 51 to 89 participated in this study. Participants were divided into two groups by grip strength of 18 [kgf] as a cut-off, and acceleration data were collected by 3-axis accelerometers during walking training performed in daily life. The acceleration data was aligned to equal length, and arrayed x, y, and z axes in a single row, and then encoded into an image using GADF. The features were extracted by the probabilities as an output of CNN and the gait cycle lengths. We evaluated the discrimination performance of the low muscle strength using SVM with a 5-fold cross-validation method. The proposed model had an accuracy of 84% and a recall of 76%. In the previous method, which evaluated the discrimination performance of low muscle strength after extracting time-domain and frequency-domain features during walking, the accuracy rate was 82%. We suggest that the method of encoding acceleration data during walking into images by GADF could be useful for detecting low muscle strength in middle-aged and elderly people.

January 24 (Wednesday), 13:00-14:00

OS8-2 Optimization of Garbage Collection Routes as Reference Data in Evidence-Based Policy Making

Tomoki Kaho, Shinya Watanabe
(Muroran Institute of Technology, Japan)

This research improves garbage collection in a municipality through Evidence-Based Policy Making (EBPM), which relies on empirical evidence and simulation data for policy development. It explores the trade-off between cost-effectiveness and convenience in Japan, where garbage stations are placed near residences. The study models this issue as a Mixed Integer Linear Programming (MILP) problem, optimizing collection routes to minimize travel distance while considering constraints like station visits and vehicle capacity. It also examines daily garbage volume variations and their effects on route lengths. The study's validity was tested in Muroran City, Hokkaido, using data on garbage station locations and quantities. Comparing the formulated routes with GPS data from collection vehicles showed that the optimized routes were operationally viable and reduced travel distance. This optimization could lead to fuel cost savings and less workload for collection personnel, improving overall efficiency. The results are significant for EBPM-based decision-making in municipal administration.

OS8-3 Personal Identification from Walking Vibration Using CNN with Optimized Combinatorial CWT Images

Tomoyuki Sato, Takuto Sakuma, Shohei Kato
(Graduate School of Engineering, Nagoya Institute of Technology, Japan)

Personal identification based on footsteps using information technology would enable a privacy-conscious personal authentication system. In a previous study, a 96 % accuracy rate was achieved using a series of walking vibrations measured by vibration sensors, but this method is not practical because it requires the measurement of seven consecutive steps taken by multiple vibration sensors. In this study, we propose a model to identify persons based on the walking vibration of one step measured by one sensor. In our proposed model, persons are identified using CNN with input CWT images that have been combinatorially optimized using evolutionary computation. Combinatorial optimization of the input images using evolutionary computation improved the macro-F1 score from 0.706 to 0.723 and achieved an accuracy of 0.751 for the identification of 10 persons.

OS8-4 Estimation of the flocs condition using floc images in dewatering plant by machine learning

Atsuki Fukasawa[1, 2], Shinya Watanabe[2]
([1]Tsukishima JFE Aqua Solution Co., Ltd., Japan)
([2]Muroran Institute of Technology, Japan)

Dewatering is a crucial process in sludge treatment plants, and an appropriate mixing of polymer and sludge is an important factor in achieving efficient dewatering. This study focused on the condition of the flocs produced by mixing sludge and polymer and estimated the flocs condition through visual analysis of flocs images. In this study, the estimation of the flocs condition was assumed to be the classification problem of mixer speed, and validation was conducted to classify the appropriate speed based on the images. The proposed methodology involved the development of a machine learning model characterized by high accuracy and transparency. This model was formulated utilizing two features extracted from the images: the gaps between flocs and the texture. These are the parameters used by humans to estimate the floc condition. The classification accuracy of this model was validated using both interpolated and extrapolated data, resulting in accuracies exceeding 90% in both scenarios. Furthermore, a comparative analysis was undertaken between the proposed transparent-box model and a conventional Convolutional Neural Network (CNN) model. Despite its transparent-box nature, the proposed approach demonstrated a comparable level of accuracy to the CNN model in this comparative study.

January 24 (Wednesday), 13:00-14:00

Room E

GS12 Evolutionary computations (Genetic algorithm)

Chair: Takaya Arita (Nagoya University, Japan)

GS12-1 Automatic Generation of Handbell Music Using Interactive Evolutionary Computation Incorporated Paired Comparisons

Junna Kaigawa, Takuto Sakuma, Shohei Kato
(Graduate School of Engineering, Nagoya Institute of Technology, Japan)

There are not many composers specializing in handbell music in Japan. Therefore, to convey the charm of handbells to as many people as possible, we propose a method for the automatic generation of handbell music that allows anyone to compose handbell music. In this study, we represent a piece of music using a tree structure that incorporates chords, a characteristic of handbell music. We propose an interactive evolutionary computation method for music generation using an individual evaluation method based on pair-wise comparisons. The effectiveness of the proposed method is verified through an experiment in which experienced handbell players evaluate their impressions of the proposed method.

GS12-2 Construction of a fuzzy controller for AUV equipped with a relearning method designed with GA

Takumi Tashima[1], Hiroshi Kinjo[2], Kunihiko Nakazono[2], Naoki Oshiro[2], Eiho Uezato[2]
([1]Graduate school of Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

In this study, we show that the accuracy of the control performance of autonomous underwater vehicles (AUVs) can be improved by relearning the fuzzy controller. In previous studies, fuzzy controllers of AUVs designed by Genetic Algorithm (GA) learning did not provide sufficient control accuracy owing to control by the generalization capability. Therefore, we show that the control accuracy can be improved by relearning the fuzzy controller in real time. Simulation results show that this method is effective even in the presence of disturbances such as waves. In this study, the AUV is relearned by fuzzy control while it is underway. Numerical simulations show that the accuracy of the AUV is numerically improved.

GS12-3 Optimization of Disaster Relief Supplies Distribution Using Evolutionary Methods

Tsuyoshi Ogawa, Mengchun Xie, Mitsuki Nakashima, Yukinori Shimura
(National Institute of Technology (KOSEN), Wakayama College, Japan)

Abstract: Japan is one of the most earthquake-prone countries in the world, and there is concern that a massive Nankai Trough earthquake could cause extensive damage in the near future. In the event of an earthquake, relief supplies need to be transported from disaster prevention centers to evacuation sites, but it is difficult to stably transport relief supplies due to changes in road conditions during a disaster. Therefore, it is important to search for transportation routes that connect disaster prevention centers and evacuation sites. In this study, we treat the search for transportation routes of relief goods from disaster prevention centers to evacuation sites as a multi-depot delivery planning problem (MDVRP) and attempt to optimize the routes using a genetic algorithm, one of evolutionary computation methods, for this MDVRP. As a result of the experiment, we were able to generate routes that take into account road disruptions during disasters, and we confirmed that the number of vehicles and the areas where vehicles are transported change according to the number of vehicles and road closures.

January 24 (Wednesday), 13:00-14:00

GS12-4 Uncovering Web API Performance Anomalies through Response-Time-Guided Fuzz Testing based on Genetic Algorithm

Ying-Tzu Huang, Shin-Jie Lee
(Department of Computer Science and Information Engineering,
National Cheng Kung University, Taiwan)

Fuzz testing is a software testing technique that involves injecting random and unexpected inputs into a program to identify vulnerabilities and flaws. It has been widely applied in diverse domains, frequently in combination with genetic algorithms. While some research endeavors employ a combination of genetic algorithms and fuzzing techniques to identify vulnerabilities in Web application, there is a relative scarcity of studies directly addressing the detection of web API performance anomalies. In this research, we propose a response-time-guided fuzzing approach that utilizes response times and a genetic algorithm to uncover web API performance anomalies. In our experiment with a real-world targeted web API, the proposed approach revealed a sudden and severe response latency, uncovering a performance anomaly that cannot be detected by a pairwise approach. Furthermore, it was confirmed that the detected crash-inducing input almost consistently leads to longer response times.

January 24 (Wednesday), 13:00-14:15

Room F

GS11 Control techniques II

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

GS11-1 A RISC-V Processor with Posit 32bit floating point arithmetic circuit

Aoi Kataoka, Akinori Kanasugi
(Tokyo Denki University, Japan)

Posit arithmetic unit is a floating-point (FP) arithmetic circuit. It represents and operates real numbers using a method different from that conventionally defined in IEEE-754. This paper proposes a processor that can handle up to the IEEE-754 double precision range with 32-bit data as one of the proposals for using Posit arithmetic unit. 32 bits format can handle up to the double precision range, which originally requires 64 bits. As a result, the area and power consumption of the processor itself can be reduced. As a result, the area and power consumption of the processor itself can be reduced, and it is expected to be used in fields such as autonomous robots that require low-power computing devices. This paper employs the Posit format with ES=6 to achieve both a range of numerical values that can be expressed and a certain degree of accuracy.

GS11-2 Model Predictive Control of Spatially Distributed Systems with Temporal Logic Specifications in Finite Time

Ikkei Komizu, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

This paper proposes model predictive control for spatially distributed systems based on temporal logic specifications. In spatially distributed systems, control of temporal patterns is an important issue. We consider a finite horizon optimal control problem whose pattern is specified by a Signal Spatio Temporal Logic (SSTL) formula over finite traces, which is called an SSTL_f formula. We provide the syntax and Boolean semantics of SSTLf formulas, formulate the problem, and devise an evaluation function for solving it by using model predictive control. Furthermore, we demonstrate that the formulated problem can be reduced to a Mixed Integer Linear Programming (MILP) problem.

January 24 (Wednesday), 13:00-14:15

GS11-3 Development of a teleoperation system for mobile robots with object discrimination function using a cascade classifier

Mizuki Hirayama[1], Yoshitaka Matsuda[1], Takenao Sugi[1], Satoru Goto[1], Naruto Egashira[2]
([1]Saga University, Japan)
([2]National Institute of Technology, Kurume College, Japan)

In this research, a teleoperation system for a mobile robot to detect and grasp a target object is developed. The system is constructed by improving an existing system. The system developed in this research has a function of remote operation via keyboard inputs, where the information of keyboard inputs is transmitted through socket communication. The system has also another function of autonomous control using images from USB camera. In the image processing, a cascade classifier is introduced for the detection of the target object. The effectiveness of the system developed in this research was verified through experiments using an actual mobile robot.

GS11-4 Consideration and simulation of appropriate Well-Clear Volume for multi-body multi-copter operations

Ryuma Aoba, Yuichi Yaguchi
(University of Aizu, Japan)

This study proposes a simple formula to express the region of likely collisions, such as the volume of the remaining well clear (RWC) used for collision avoidance of unmanned aerial vehicles (UAVs), taking into account the dynamic characteristics of actual multi-copters and other aircraft, ‘estimating the position after 10 seconds’. The reason for specifying 10 seconds is to assume that observation in the RWC takes from three to five seconds, decision-making takes two seconds, and avoidance action is completed three seconds before the collision, which is 100 m before the collision at a speed of 10 m/s. In this study, we calculate what shape the assumed RWC would take and identify a formula for the RWC that is more in line with the characteristics of actual operation than a conventional RWC that takes on a cylindrical shape.

GS11-5 Pig Sorting System with Three Exits that Incorporates an RGB-D Sensor for Constant Use During Fattening

Kikuhito Kawasue[1], Khin Dagon Win[1], Kumiko Yoshida[2], Geunho Lee[1]
([1]University of Miyazaki, Japan)
([2]KOYO Plant Servies Co., Japan)

In pig production, the number of pigs raised on each farm is increasing, but the population of workers involved in pig production is decreasing, so lighter labor is expected. Weight is a major criterion for pig grading. Too heavy or too light will decrease profits, and pigs need to be shipped at the appropriate weight. However, since each pig weighs more than 100 kg, weighing each pig is very labor intensive. In large farms, more than 50 pigs are kept in a single piggery, and they are shipped together at the same time, after determining the day when they have reached the proper weight for shipment. In this study, a prototype system was developed to automatically measure daily weight distribution. If the weight distribution in the piggery is known, appropriate shipping dates can be determined.

January 24 (Wednesday), 15:35-17:05

Room A

OS10 AROB: Integration of AI and Robotics for Highly Versatile Robots

Chair: Tetsuya Ogata (Waseda University / AIST, Japan)
Co-Chair: Kenichi Ohara (Meijo University, Japan)

Invited Talk 1 Deep Learning for Robotics: Enhancing Adaptive Perception and Action through Predictive Models

Tetsuya Ogata (Waseda University / AIST, Japan)

See page 15

OS10-1 Rotational NewtonianVAE: 3D rotation control method from pixel for automation of suturing

Mai Terashima[1], Ryo Okumura[2], Pedro Uriguen[1], Yuanyuan Jia[1], Tadahiro Taniguchi[1,2]
([1]Ritsumeikan University, Japan)
([2]Digital&AI Technology Center, Technology Division, Panasonic Holdings Corporation, Japan)

This study focuses on 3D rotation and translation control using NewtonianVAE, a type of world models. In many real-world tasks such as suturing in surgical robotics, both translational and rotational control are essential. However, prior research has not explored the learning of 3D rotational motions with NewtonianVAE. Therefore, this study proposes a method to enable 3D rotational control using NewtonianVAE and validates its effectiveness. Experiments were conducted in a simulation environment to assess whether our approach can estimate the pose of a 6DoF object and control it to the target pose in three-dimensional space. The experimental results demonstrated that our approach, trained only on RGB images, can efficiently perform 3D rotation and translation control. This advancement is critical in automated suturing, where precise control of rotation is essential for accurate needle placement.

OS10-2 Enhancing Assistance for Sitting-Up-In-Bed with Humanoid AIREC: A Deep Predictive Learning Approach with Impedance Adjustment

Tamon Miyake, Yushi Wang, Tetsuya Ogata, Shigeki Sugano
(Waseda University, Japan)

The versatile robot coexists with humans, and thus physical human-robot interaction plays an important role in practical use. Especially, robots in nursing that can carry out care tasks safely are required due to the shortage of nurses and the increasing elderly population. This study aims to establish a direct teaching method to teach a robot the impedance and angles of joints during assistance of sitting up in a bed. The humanoid robot Dry-AIREC was used in this study, which has 7-DOF dual arms equipped with torque sensors. We developed a synchronous system of human and robot motions by combining electromyography and wearable motion capture systems. We used a mannequin as a target patient. We confirmed that the proposed direct teaching system enabled the online DNN-based motion generation reaching to the mannequin without application of the contact force and supporting the mannequin to change the state from sleeping to sitting.

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OS10-3 Unsupervised segmentation of time series with multiple dynamical patterns based on error minimization of predictive learning

Ryoichi Nakajo[1,2], Suzuka Harada[2,1], Kei Kase[2,1], Tetsuya Ogata[2,1]
([1]National Institute of Advanced Industrial Science and Technology, Japan)
([2]Waseda University, Japan)

We propose an unsupervised behavior segmentation framework that divides a time series into semantic segments. We follow a knowledge of ethological theories and assume that complex behavior is composed of simple motor patterns with time-varying dynamics. To interpret these multiple dynamics, we perform a predictive learning on a recurrent neural network with parametric bias (RNNPB). During training, the proposed framework shifts the segmentation boundaries to minimize prediction errors. For evaluation, we performed a numerical experiment that simulated a time series of sensory data with multiple dynamics. We trained the RNNPB to clone the time series which randomly transitions six waveform patterns. The results show that the proposed segmentation framework automatically divides data sequences into segments and acquired PBs represent the dynamic information of underlying patterns.

OS10-4 RT System Integration Framework for Robot System Development with AI

Misa Kato, Mayu Suzuki, Kenichi Ohara
(Meijo University, Japan)

Recently, because the required robot systems are becoming more sophisticated and complex, various robot middleware platforms such as RTM and ROS are used to reduce the related time and cost owing to development of software systems. However, interoperability is difficult when assembling modules that operate on different middleware platforms. In addition, it is important that users can easily launch their desired applications without being aware of the differences in middleware platforms, even if multiple middleware platforms is linked. To reduce the burden on the users in the operation of their system, it is necessary to solve new software architecture that absorbs differences in middleware platforms and enables simple system operation. In this paper, we developed RT System Integration Framework, a software framework that operates on different middleware platforms and facilitates the management and operation of robot.

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Room B

GS31 Sensor and multi-sensor data fusion

Chair: Hideki Hashimoto (Chuo University, Japan)

GS31-1 Research on the detection of abnormal piping locations using vibration

Soma Sato, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

Fans, motors, pipes, ducts, etc. used in various facilities generate the same vibration and sound on a steady basis. When these facilities malfunction, new sounds and vibrations may occur that are different from the steady sounds and vibrations that occur during normal operation. The purpose of this research is to detect abnormalities in facilities by detecting such changes. However, since abnormalities in facilities are not supposed to occur, it is very rare for such abnormalities to occur. Therefore, it is not possible to collect sufficient data on abnormalities, and AI cannot discriminate them by recognition and classification, which are its strong points. In such cases, a neural network called an autoencoder is a powerful tool. In this research, we will use Spresense's microphone input for acoustic signal processing and autoencoder for anomaly detection.

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GS31-2 Research on Abnormality Determination Using Microphone and Auto Encoder

Haku Yamamoto, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

Suppose there is an abnormality in the pipes and motors of the equipment we use on a daily basis that should not be there. If we continue to use them without noticing the abnormality, it may affect our business or cause water-related problems. The purpose of this study is to solve such problems.We also believe that this would reduce labor costs and prevent human error. In this study, a development board called Spresense will be used. This board is expected to develop an anomaly detection system with low power consumption and low heat generation. We would like to confirm the effectiveness of this system.

GS31-3 Research on gesture recognition using non-contact sensors

Akari Nakayama, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

Technological advances in our daily lives have raised expectations for gesture recognition, which allows us to remotely and intuitively operate electronic devices. In addition, the problem of the global spread of the new coronavirus has increased the demand for contactless technology. Gesture recognition can identify sign language and replace many consumer electronics such as remote controls, buttons, switches, touch panels, keyboards, and computer mice. Also, it can be used by people with physical disabilities to operate machines with fewer movements and to communicate their intentions. we propose a gesture recognition method using non-contact sensors to improve our lives with advanced technology.

GS31-4 Smart House System for Safety of Elderly Living Alone Based on Camera and PIR Sensor

Yichen Wang[1], Yutian Wu[2], Shuwei Zhang[1], Harutoshi Ogai[1], Katsumi Hirai[3], Shigeyuki Tateno[1]
([1]Waseda University, Japan)
([2]University of Science and Technology Beijing, China)
([3]Hakutsu Technology, Japan)

With the improvement of human life quality, life expectancy generally increases. As a result, more and more elderly people living alone appear. Recently, the safety problems of the elderly living alone have attracted more and more attention from the public. Due to living alone, the elderly cannot be found at the first time when an accident occurs indoors or out, and the rescue time is delayed. This article proposes a way to use the speed up module to realize real-time face detection on the Raspberry Pi and optimize the processing of PIR sensor signals and write a logic system based on the camera and PIR signals to record and analyze the life of the elderly living alone and warning system to their family members

GS31-5 Material classification using heat transfer analysis with infrared camera

Ken Lertdumronglak, Satoshi Makita
(Fukuoka Institute of Technology, Japan)

Material recognition is most applicable in the field of recycling which the input objects are mixed of various materials with different recycling methods. Our study presents a novel approach to material classification using analysis of the object's shape and surface temperature under an induced heat transfer state by a heat source and heat sink provided by the Peltier devices which have stable surface temperature will induce the specimen into a heat transfer state The input parameters are the subject's surface temperature, subject's shape, and Peltier devices' temperature. which are observed by the infrared camera from the start until the subject temperature reached steady state. The output parameters are radiant heat emissivity, thermal conductivity, and heat capacity. The problem with this method is only applicable to homogeneous materials of sufficient size. The system can identify some output parameters of ABS plastic and synthetic rubber which have different heat transfer properties.

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GS31-6 Human Activity Recognition Using Single Smart Insole and Deep Learning

Yuqing Pan, Tsige Tadesse Alemayoh, Jae Hoon Lee, Shingo Okamoto
(Ehime University, Japan)

Technology to recognize various activities in daily life is very important in the fields of healthcare and welfare. In this study, a deep learning approach was employed to recognize static and dynamic activities from data collected with a single original smart insole from eleven participants. The original smart insole developed in this research consists of an insole sensor composed of sixteen Force Sensitive Resistors and a microcomputer with an Inertial Measurement Unit. In the context of human motion, insole pressure sensors quantify pressure variations during the foot's interaction with the ground, while an IMU measures changes in foot acceleration and angular velocity. Three static postures and five dynamic movement patterns are analyzed, namely sitting, standing, squatting, walking, jogging, ascending stairs, descending stairs, and cycling. A Convolutional Neural Network is utilized to extract motion features from pressure, acceleration, and angular velocity changes to classify eight motion patterns. The results of the study are good enough to provide a reference for human motion pattern recognition and provide a basis for further human motion analysis.

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Room C

GS14 Human-machine interaction and collaboration II

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

GS14-1 SEMI-SUPERVISED VARIATIONAL AUTOENCODER BASED OBJECT GRASPING RECOGNITION AND RECONSTRUCTION - A HUMAN ROBOT INTERACTION APPLICATION

Goragod Pongthanisorn, Yifan Lai, Genci Capi
(Hosei University, Japan)

This paper presents a Deep learning-based method to recognize the grasping objects based on the EMG data. In our previous work, a convolution neural network (CNN) was utilized to learn EMG data features. In our model, we used a semi-supervised variational autoencoder (SSVAE) which merges a small number of labels with the vast dataset to have an accurate grasping object classification. We compare the performance of SSVAE and CNN trained by the dataset of multiple subjects. The results show the recognition accuracy of SSVAE is 10~20% higher than CNN and performed well in real-time situations. In addition, we investigate the reconstruction result, with an error of 22%. This method can be used in investigating self-supervised learning, and feature extraction for more intelligent human-robot collaboration HRC systems.

GS14-2 Recognition of Silent Words and Tongue Orientation from EMG

Ryotaro Harada[1], Naoki Hojo[2], Kenji Fujimoto[3], Tadahiro Oyama[3]
([1]Osaka University, Japan)
([2]Kobe University, Japan)
([3]Kobe City College of Technology, Japan)

In recent years, research and development of interface devices for people with difficulty communicating their intentions, such as paraplegics and amyotrophic lateral sclerosis (ALS) patients, have been conducted using their remaining functions. In this study, we aim to develop an interface that can be applied to the operation of various devices by estimating the types of silent speech movements (movements in which only the shape of the mouth is deformed without speech) and tongue orientation based on surface sEMG measured by a small number of electrodes placed on the anterior neck (under the chin) as one such example. In this paper, we conducted evaluation experiments using the proposed method to estimate tongue orientation in four directions and six types of silent speech words. As a result, it was found that the proposed method can estimate the words and tongue orientation with a correct response rate of more than 90 % for three subjects, indicating the possibility of constructing a system that can withstand real-world use.

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GS14-3 Towards a new moral conception for a society of diversity: Embracing animals, intelligent machines, and beyond

Shoji Nagataki[1], Takashi Hashimoto[2], Tatsuya Kashiwabata[3], Takeshi Konno[4], Hideki Ohira[5], Toshihiko Miura[6], Juri Kato[7], Masayoshi Shibata[8]
([1]Chukyo University, Japan)
([2]Japan Advanced Institute of Science and Technology, Japan)
([3]Keio University, Japan)
([4]Kanazawa Institute of Technology, Japan)
([5]Nagoya University, Japan)
([6]University of Tokyo, Japan)
([7]Kanazawa Institute of Technology, Japan)
([8]Kanazawa University, Japan)

The purpose of this presentation is to outline a novel moral theory relevant to a diverse society encompassing animals and conscious machines. In order to attain this objective, we delineate three conditions for being a moral agent by reference to the historical relationship between humans and animals. Furthermore, we argue that the origin of self-consciousness, a prerequisite for moral agency, can be attributed to certain characteristics of the body. We contend that self-consciousness can serve as the basis for mutual recognition of vulnerability that forms the bedrock of the relationship between humans and conscious machines.

GS14-4 Conceptual Blending in Human-Machine Co-creative Interaction: The Relationship between Emergence and Activation of Mismatches

Haote Zhou, Takashi Hashimoto
(Japan Advanced Institute of Science and Technology, Japan)

There is a need to inspire human thinking in human-computer co-creation dialogs. In particular, thinking about concepts makes emergence arise. We argue and discuss the effect of conflict structure in concepts on emergence. This paper proposes a Mismatch Dialogue based on conceptual blending. This dialogue evokes human thinking and establishes a new relationship to harmonize mismatch. We will verify our hypothesis through human-computer dialog experiments. We designed an experiment for this proposal. Our hypothesis is to establish a new relationship to harmonize mismatch, which can evoke human thinking and generate the emergence of concepts. We will analyze the emergence of products generated through concept blending dialogue with the robot and the effect of the dialogue on thinking to verify our hypothesis.

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Room D

GS26 Robot vision and image processing I

Chair: Osamu Fukuda (Saga University, Japan)

GS26-1 A Stand-Alone System for Real-Time Recognition of Wild Boars in a Box Trap Using Deep Learning

Francis Besala[1], Ryunosuke Niimoto[2], Jae Hoon Lee[1], Shingo Okamoto[1]
([1]Graduate School of Science and Engineering, Ehime University, Japan)
([2]Department of Engineering, Faculty of Engineering, Ehime University, Japan)

Nowadays, farmers are facing a wild animal invasion problem. They destroy fields, consume seeds, and keep new trees from growing. Currently, many traps with manual triggers are used to capture boars in general. However, for more effective capture performance, an intelligent system is needed to carry out the capture work. The real-time recognition of wild boar presence in a box trap is essential for automatically capturing them using artificial intelligence. In our previous research, the recognition system could not recognize wild boar in real-time in a single board computer jetson nano and could not have enough computation speed due to the performance of the used algorithm. Therefore, a new recognition system was developed with the YOLOv7 deep learning algorithm and could achieve a frame rate higher than 4 frames per second on a Jetson Nano single-board computer, which is used in the system recognition implemented in this research.

GS26-2 A Study of Approximation Methods for Image-to-Image Multiplication

Kensuke Kimura, Akinori Kanasugi
(Tokyo Denki University, Japan)

In image processing, the circuits are complex and the scale of circuits becomes large due to the large amount of data to be processed. To solve this problem, this paper proposes the approximation method for image processing circuits. It is difficult to visually recognize errors in images due to the limitation of human vision, so approximation is considered to be an effective method in image processing. We approximated the multiplier circuit by using an approximate full adder (AFA) and pruning the circuit, and multiplied two images to compare the image quality with the circuit size. When the PSNR exceeds 30 dB, it is difficult to visually recognize errors in the output image. By using approximation in areas where there is little effect on the output result of the multiplication circuit, the PSNR degradation is minimized and the circuit reduction rate can be further increased.

GS26-3 Optimization of image enhancement process using Genetic Algorithms

Naoki Kubota, Akinori Kanasugi
(Tokyo Denki University, Japan)

In image recognition, environmental factors such as darkness around the subject have posed challenges in the stability of recognition rates. Therefore, this paper proposes a system configuration for optimizing image enhancement processing parameters. The aim is to improve the appearance of low-light images and assist image recognition. The proposed method focuses on Contrast Limited Adaptive Histogram Equalization (CLAHE), which allows for local contrast enhancement. Parameters determining the strength of this processing are optimized using a genetic algorithm. In contrast to traditional methods, multiple parameters are introduced, and pixel entropy change is included in the evaluation function. These additions aim to generate solutions that prevent excessive enhancement in specific areas. Evaluation of the system achieved the generation of higher-contrast images while preventing excessive enhancement. However, a strong correlation with improved image recognition rates was not observed. Future considerations will focus on this aspect.

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GS26-4 Trial analysis system for silhouette puzzles using ArUco Marker

Naoki Matsumoto, Osamu Fukuda, Wen Liang Yeoh, Nobuhiko Yamaguchi, Hiroshi Okumura
(Saga University, Japan)

In recent years, toys such as games and puzzles have been attempted to be used in enjoyable rehabilitation. Our research group focuses on silhouette puzzles with tetrominoes as an example of an intelligent task that requires abilities such as pattern recognition, spatial awareness, logical thinking, memory, and planning and execution of movements. However, studies have not conducted detailed analyses of the operation procedures for solving puzzles. In this paper, we developed a system for recording and analyzing block manipulations to measure and analyze the characteristics of human operations for puzzle trials and to assist in solving this puzzle. We also conducted basic experiments to examine the validity of the system's measurements and analysis. The results of this experiment confirm that it is expected to reveal human trial characteristics.

GS26-5 Analysis of Trial Characteristics in Solving Silhouette Puzzles

Naoki Matsumoto, Osamu Fukuda, Wen Liang Yeoh, Nobuhiko Yamaguchi, Hiroshi Okumura
(Saga University, Japan)

Our research group focus on technologies that support or extend the ability to smoothly perform and address intelligent tasks. Therefore, we investigate and develop a human-augmented hand system for solving silhouette puzzles. However, the type of assistance that is the most effective for users must be clarified. Therefore, trials were conducted under three conditions—``operate while thinking,'' ``operate after thinking,'' and ``operate while checking answer''—to validate the proposed system. Young and elderly participants participated in the experiment. From the results, we have experimentally clarified human trial characteristics and proven the effectiveness of visual assistance when solving silhouette puzzles.

GS26-6 Internal States Estimation Based on Facial Images by Separating Individual Features

Ayaka Asaeda, Noriko Takemura
(Kyushu Institute of Technology, Japan)

Facial expressions are said to reflect a person's internal state well and are commonly used in research on state estimation. However, individual facial features and expression differences can reduce state estimation accuracy. In particular, the estimation of ambiguous internal states such as concentration and drowsiness, which are complex to be expressed by facial expressions, are strongly affected by individual differences. Therefore, we aim to improve the estimation accuracy of ambiguous internal states by considering individual differences in facial images based on the Deviation Learning Network (DLN). In evaluation experiments, we estimate three levels of learners' arousal (Awake/Drowsy/Asleep) using facial image data during e-learning. Furthermore, we used mixup to deal with the model's ambiguity of class discrimination.

January 24 (Wednesday), 15:35-16:50

Room E

GS3 Artificial intelligence II

Chair: Reiji Suzuki (Nagoya University, Japan)

GS3-1 Concentration estimation based on skeletal information and skin conductance response

Yuta Nagakura, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

In this study, we introduced a methodology to assess human concentration and distraction levels using posture data derived from video captured by network cameras positioned in front, side, and rear orientations. The video data were processed with MediaPipe to track skeletal coordinates of body parts at one-second intervals. Additionally, we employed Electrodermal Activity (EDA) analysis, which is known to effectively detect skin conductance response (SCR) fluctuations, a key indicator of concentration levels. By classifying each second of video data as 'concentrated' or 'not concentrated' based on the EDA analysis, and merging this classification with the skeletal data, we created a comprehensive dataset. We then utilized machine learning algorithms, specifically XGBoost and LightGBM, to compare their accuracy and precision in determining concentration levels, revealing the most important features for this assessment.

GS3-2 Adversarial Graph Contrastive Learning for Molecular Property Prediction with 2D and 3D Information

Shota Kizawa, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

Molecular property prediction is crucial in various research fields, including drug discovery and material design. Graph neural networks (GNNs), particularly pretraining-finetuning pipelines with GNNs, have achieved considerable success in molecular property prediction. However, these pretraining methods have the following issues: (1) they do not utilize 3D molecular structures, restricting reasoning capabilities about interatomic forces that depend on the relative spatial positions of the atoms; (2) they are impractical because they collect costly 3D information in all downstream tasks, even when solving (1); and (3) they may capture information irrelevant to downstream tasks, decreasing transfer performance. To address these issues, we propose an unsupervised pretraining method that aims to reduce redundant information, grounded in the information bottleneck, and to utilize 2D and 3D information during pretraining and to avoid using 3D information during fine-tuning. Subsequently, we demonstrate the efficiency of this method through a theoretical analysis and empirical experiments.

GS3-3 Generation of dimensionality-reduced facial thermal image space for stress coping responses

Shiori Oyama, Kent Nagumo, Akio Nozawa
(Aoyama Gakuin University, Japan)

When people are exposed to external auditory or visual stimuli, i.e. stress, they show physiological and psychological responses. These responses are called stress coping responses and can be identified by differences in the fluctuation patterns of haemodynamic parameters. Facial thermal imaging is also an easily measurable physiological and psychological indicator. We have therefore attempted to discriminate stress coping responses using spatial features of facial thermal images. However, facial thermal images are thought to have delays and a continuum of variability with haemodynamic parameters, which have not been taken into account so far. Therefore, in this study, the dimensionality reduction method t-SNE was applied to facial thermal images in order to visualise and quantitatively evaluate the continuity of facial thermal images in stress coping responses.

January 24 (Wednesday), 15:35-16:50

GS3-5 Vibration-based fault diagnosis of rotating machinery using Transformer

Takumi Negi[1], Michifumi Yoshioka[1], Katsufumi Inoue[1], Keishi Omori[2], Masayoshi Todorokihara[2]
([1]Graduate School of Informatics, Osaka Metropolitan University, Japan)
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Fault diagnosis of rotating machinery using vibration data is a critical task with broad applications. Accurate diagnosis using vibration data requires the acquisition of accurate vibration data, including phase information, via a three-axis sensor with high synchronization performance, and conducting an appropriate analysis of the data. Although Long Short-Term Memory is an appropriate analysis method, its computational efficiency is comparatively low. In this paper, we propose a feature extraction method utilizing the Transformer model. Employing the Transformer model can be expected to improve learning speed while maintaining or exceeding the identification accuracy of existing methods, owing to its higher computational efficiency. We further incorporate the orthogonalization loss, previously proposed in other methods, during the training of the Transformer to consolidate the information stored in the internal state. Experiments conducted on data acquired by the three-axis vibration sensor have demonstrated significant improvements in diagnostic performance and computational speed over conventional methods.

GS3-6 Attention on Attention as a part of decoder for the vehicle license plate recognition

Yerdaulet Zhumabay
(Kazakh-British Technical University, Kazakhstan)

The attention mechanism is getting widely used in modern research papers to solve computer vision problems by showing great results, even optical character recognition tasks have multiple attention-based solutions. In this research paper, I would like to know how is actually attention-based architectures are actually applicable to the vehicle license plate recognition problem, and compare them with the recurrent neural networks-based approach. I implement two different decoder blocks to decode extracted features from CNN layers, the first decoder is based on the bidirectional gated recurrent unit (BiGRU), and the second decoder is based on the attention-on-attention (AoA) technique. Connectionist temporal classification (CTC) is applied for sequence labeling. The proposed methods were trained on the RodoSol-ALPR dataset for 1000 iterations. Experiments show that the architecture with the AoA technique is less accurate and challenging to train than the BiGRU method.

January 24 (Wednesday), 15:35-17:20

Room F

GS15 Machine learning I

Chair: Ryo Ariizumi (Tokyo University of Agriculture and Technology, Japan)

GS15-1 Robust probabilistic target-oriented exploration with reliability approximation

Moto Shinriki, Yu Kono, Tatsuji Takahashi
(Tokyo Denki University, Japan)

Deep reinforcement learning is capable of learning from complex input signals due to generalization by neural networks. On the other hand, there is a drawback from the perspective of learning efficiency: it quickly deteriorates as the scale of the environment becomes larger. This problem arises from the need for a vast numbers of sampling iterations for data collection for function approximation and exploration iterations for reinforcement learning. To address this challenge, Minami and colleagues have proposed Regional Linear Risk-sensitive Satisficing (RegLinRS), which is capable of reducing both the number of explorations and sampling (Minami 2022). However, RegLinRS is a deterministic and off-policy algorithm that, when extended to deep reinforcement learning, can introduce biases in estimating expectations. In this study, we proposed Regional Linear Stochastic Risk-sensitive Satisficing (RegLinSRS). This method is a probabilistic generalization of RegLinRS and enables importance sampling when extended to deep reinforcement learning.

January 24 (Wednesday), 15:35-17:20

GS15-2 Investigation of SHAP-based channel selection for emotion estimation using EEG signals

Shuya Hizume, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

In recent years, there has been a growing interest in the field of brain-computer interfaces (BCIs), a development paralleling the rapid digital transformation (DX) unfolding globally. Furthermore, emotions are closely linked to human thought and behavior, forming an essential aspect of human nature. The aim of this study is to establish an optimal and versatile method for selecting channels in electroencephalography (EEG) for emotion classification that is adaptable to various classifiers. The proposed method in this study consists of three steps. The first step involves classifying emotions into three categories using EEG signals from all channels. In the second step, we select channels to be used based on SHAP values. The final step involves classifying the three types of emotions using only the channels selected based on SHAP values and then comparing this classification accuracy with that achieved using all channels.

GS15-3 Matrix factorization using text, image and social network by nonlinear approach with neural networks

Takuya Tamada, Ryosuke Saga
(Osaka Metropolitan University, Japan)

Recommender systems are widely used in e-commerce and content distribution services, and are an important technology for recommending the most appropriate items and content to individual users by analyzing user preferences and behavior patterns. In this paper, we discuss a recommender system using probabilistic matrix factorization (PMF) with supportive information.Recently, there are many PMF based methods using supportive information such as text, image, social network. We propose a model where we leverage neural networks to extract features non linearly from these elements and incorporate them into Probabilistic Matrix Factorization (PMF). In this paper, we conduct experiments on three real world datasets and verify their effectiveness.

GS15-4 Market Prediction Aids Using Machine Learning based on Large Language Model Features

Satoshi Sekioka, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

This study aims to investigate the potential of Large Language Models (LLMs) in predicting the prices of financial instruments, focusing particularly on cryptocurrencies. The outline of this study is as follows: Firstly, we collect trading data for BTC/USDT from the cryptocurrency exchange Binance. This data is then to be converted into OHLCV format based on a fixed time frame. From this OHLCV data, we calculate various technical indicators to be used as features. Next, we convert the OHLCV data into string format and input it into ChatGPT. The linguistic output generated serve as a new feature. Preliminary results suggest that there are instances where models employing features derived from LLMs exhibit superior performance compared to models that use only common financial features. These observations strongly indicate the potential value of information that LLMs provide in predicting price movements within financial markets.

January 24 (Wednesday), 15:35-17:20

GS15-5 Person Re-identification System by Selecting Appropriate Trained Model

Yuma Iwanaga, Yosuke Kawano, Shudai Ishikawa, Kazuhiro Shimada
(National Institute of Technology, Oita College, Japan)

This study addresses the challenge of Person Re-identification (ReID) in sparsely distributed camera environments, where varying angles of view and shooting conditions hinder accurate identification using specific features. Existing ReID approaches assume overlapping fields of view, limiting their applicability. In response, we propose a novel system that enhances ReID accuracy by selecting an optimal trained model for feature extraction based on the diverse shooting environments of multiple sparsely distributed cameras. By selecting the model to the specific conditions of each image, we aim to overcome the limitations of using a single feature for ReID in such scenarios. This adaptive approach holds the potential to significantly improve accuracy compared to traditional methods, paving the way for more effective person re-identification in diverse and non-overlapping camera setups.

GS15-6 Analysis and comparison of vector text representation methods: towards robust representation

Nikolay Kotlyarov, Aldiyar Toleutay
(Kazakh-British Technical University, Kazakhstan)

Vector text representation methods play a crucial role in text search and similarity representation. This study shows the use of large language models (LLMs) for generating vector representations of text. We investigate the challenges of similarity search in a dataset related to chemistry. They compare classical approaches with modified ones, considering various LLMs such as ALBERT, ROBERTA, BERT-large, LLAMA-2-7b, and WIZARDLM-7b. To assess similarity, traditional measures like cosine similarity is compared with stochastic measures, including Kolmogorov-Smirnov test and Kullback–Leibler divergence.

GS15-7 Path Model Textualization of SEM Results based on Deep Learning

Songyi Liu, Ryosuke Saga
(Osaka Metropolitan University, Japan)

Structural Equation Modeling (SEM) is widely used for causal analysis, but path diagrams generated by Structural Equation Modeling are difficult to understand for those who do not have knowledge about Structural Equation Modeling. Therefore, by describing path diagrams generated by Structural Equation Modeling in writing, the people who does not have relevant knowledge can obtain useful information from path diagrams. We propose a deep learning method for converting Structural Equation Modeling (SEM) path diagrams into descriptive text. By utilizing the Faster R-CNN model, it accurately identifies visual elements, and appling OCR for the recognition of text and numbers.

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

Room A

OS24 SWARM: Lunar bases construction and lunar exploration by modular and swarm AI-robots I

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)
Co-Chair: Jun Morimoto (Kyoto University, Japan)

Invited Talk 2 Challenge to Modular and Heterogeneous AI Robot System for Lunar Exploration and Outpost Construction

Kazuya Yoshida (Tohoku University, Japan)

See page 16

OS24-1 An Empirical Evaluation of A Hierarchical Reinforcement Learning Method towards Modular Robot Control

Sho Takeda[1], Satoshi Yamamori[2], Satoshi Yagi[1], Jun Morimoto[1,2]
([1]Kyoto University, Japan)
([2]Advanced Telecommunications Research Institute International, Japan)

Expectations are growing that deep reinforcement learning will enable robots with multiple degrees of freedom to acquire behaviors suitable for real-world applications. However, a robotic system with a variety of components requires many learning trials for each different combination of robot modules. We propose a hierarchical approach to segment tasks according to different robot components. The tasks of the robot, which is composed of multiple modules, are accomplished by skill sets trained on a component-by-component basis. We validated our proposed method by applying it to a valve rotation task using a combination of a robot arm and a robot gripper. An evaluation based on physical simulations demonstrated that hierarchical policy construction facilitates the use of shared, low-level policies to accomplish multiple tasks and to acquire skills from a smaller sample of data.

OS24-2 Toward Autonomous Assembly of Modular Robots and Structures using Real-time Object Detection and Imitation Learning for Lunar Missions

Gustavo Diaz, Tharit Sinsunthorn, Shreya Santra, Kentaro Uno, Kazuya Yoshida
(Tohoku University, Japan)

We focus on autonomous robotic manipulation as part of the Moonshot project to develop Self-evolving AI Robot Systems and human outposts in the moon. We aim to autonomously assemble modular robots using a 7DoF robot arm. We integrated a vision system with different control methods and machine learning algorithms. Several challenges remain in manipulation tasks in dynamic environments, requiring sophisticated control strategies and models. In this sense, two current challenges are the adaptability of robots to different environments and how can they learn from human demonstrations. We present a semi-autonomous Finite State Machine (FSM) implementation and compare with Reinforcement Learning (RL) and Imitation Learning (IL) implementations for the assembly task. We use Nvidia Isaac Gym for RL training and Isaac orbit for IL.

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

OS24-3 Improvement of Fault Tolerance of Quadruped Robots by Detecting Correlation Anomalies in Sensor Signals

Eisuke Matsubara[1], Satoshi Yagi[1], Yuta Goto[1], Satoshi Yamamori[2], Jun Morimoto[1,2]
([1]Kyoto University, Japan)
([2]Advanced Telecommunications Research Institute International, Japan)

We present a sensor anomaly detection method that monitors changes in sensor data correlations. Our method eliminates the need for pre-defined programming to determine abnormal states for every individual sensor. Moreover, real-time anomaly detection is feasible through sparse structure learning. In the experiment, we evaluated the anomaly detection method for a quadruped robot in a simulated environment to maintain its ability to walk during sensor malfunctions by adding large or small noise in a sensor reading. When the robot detects an abnormality, the robot estimates the true value of the noised joint based on a multiple regression model. As a result, improvements were observed in 14 of 24 conditions (12 joints x 2 noises). In the 14 joints where an improvement in the success rate was observed, the success rate increased by 75.4% on average.

OS24-4 Development and Verification of Connection Mechanisms for Modular Robots to Accomplish Practical Various Tasks on the Moon

Ryohei Michikawa[1], Xixun Wang[2], Tomohiro Hayakawa[3], Ryusuke Fujisawa[4], Fumitoshi Matsuno[2]
([1]Kyoto University, Japan)
([2]Osaka Institute of Technology, Japan)
([3]University of Toyama, Japan)
([4]The University of Kitakyushu, Japan)

Modular robots capable of various configurations are expected to be a solution for base construction tasks in a complex and dynamic environment such as the surface on the moon. For modular robots to effectively perform these tasks, it is essential to have a connector mechanism that is compact yet has robust connecting force. In this study, we developed a new connector with a small diameter of 13 cm, but with rigidity that can withstand a load of 35 Nm. The new connector can be detached even if one side is stucked or loses power, minimizing the negative effects of a single module failure. In addition, the genderless connector design allows for unrestricted connection orientation and flexibility in building robots with a variety of modular configurations. We mounted the new connector on an actual modular robots and verified its performance and effectiveness in detail.

OS24-5 Development and Evaluation of a Connecter Module for Wired Communication of Modular Robots

Kiona Hosotani[1], Ryohei Michikawa[1], Tomohiro Hayakawa[2], Fumitoshi Matsuno[3]
([1]Kyoto University, Japan)
([2]Toyama University, Japan)
([3]Osaka Institute of Technology, Japan)

It is preferable for robots rather than astronauts to conduct resource mining and base construction on the lunar surface, considering safety aspects and the feasibility of resources transportable by rockets. Furthermore, the modular robot system is chosen to adapt to various terrains on the lunar surface and perform various tasks. In a modular robot system, communication between the combined modules is required. In this study, we developed an electrical connector that enables 1000BASE-T Ethernet communication between control PC on modules, RS485 communication between control PC on modules and modules equipped only with motors, and power supply from the control PC-equipped module to the modules only with motors. We conducted measurements of throughput and packet loss of Ethernet communication between PCs using the developed electrical connector and confirmed that the communication performance of the developed connector is equivalent to using a normal LAN cable.

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

Room B

OS14 AROB: Robotics Evolution and Intelligence

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

OS14-1 Development of Electrostatic Rotary-Type Actuator for MEMS Microrobot

Shuxin Lyu[1], Yuya Tamaki[1], Daichi Kiya[1], Katsuyuki Morishita[1], Ken Saito[2]
([1]Department of Precision Machinery Engineering, Graduate School of Science and Technology, Nihon University, Japan)
([2]Department of Precision Machinery Engineering, College of Science and Technology, Nihon University, Japan)

Recently, many researchers have expected millimeter-sized microrobots to work in narrow spaces. However, it is challenging to integrate the actuators, controllers, sensors, and energy sources into millimeter-sized microrobots. Previously, the authors proposed a microrobot that can reproduce ants' tripod walking locomotion and demonstrated that it is activated using a shape memory alloy (SMA) actuator. The SMA provided large deformation and force. However, the SMA actuator consumes a lot of power; therefore, we supplied the power externally. To realize a millimeter-sized microrobots, an actuator that is small and has low power consumption is required. In this paper, the authors propose an electrostatic rotary-type actuator. Also, we discuss the design and driving experiment of the electrostatic rotary-type actuator. As a result, our proposed actuator could rotate by 20 rpm where the driving pulse waveform is 50 V pulse amplitude, 5 ms pulse width, and 10 ms pulse period.

OS14-2 Development of Hardware Spiking Neural Networks for Robots Mimicking the Musculoskeletal System of Rat

Futo Igei[1], Shuxin Lyu[1], Katsuyuki Morishita[1], Ken Saito[2]
([1]Department of Precision Machinery Engineering, Graduate School of Science and Technology, Nihon University, Japan)
([2]Department of Precision Machinery Engineering, College of Science and Technology, Nihon University, Japan)

The authors are studying hardware spiking neuron models that mimic the biological neuron with analog electronic circuits. Previously, we developed quadruped robots that can generate the gait using the spiking neuron models. However, the authors used servo motors to actuate the quadruped robots. Servo motors require the driving waveform generated by microcontrollers. Also, we used microcontrollers to create the leg motion. This paper proposes hardware spiking neural networks that can actuate the leg of the rat-type quadruped robot without using microcontrollers. The authors mimic the musculoskeletal system of rats to construct the robot. Also, we used four pieces of artificial muscle wires to actuate the robot, representing the flexor and extensor muscles of the upper and lower limbs. As a result, we show the proposed hardware spiking neural networks can drive alternating flexor and extensor muscles of the upper and lower limbs to move the leg like a rat.

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

OS14-3 Automatic Generation of Teaching Points Considering Misalignment between Robot and Work Coordinate Systems and Sequence Control for Small-Sized Industrial Robots MG400s without Using a PLC

Ryoma Abe[1], Fusaomi Nagata[1], Shingo Sakata[2], Takeshi Ikeda[1], Keigo Watanabe[3], Maki K. Habib[4]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)
([4]The American University in Cairo, Egypt)

When a peg-in-hole task with small clearances is tried to be automated by an industrial robot, there is a problem due to the misalignment between robot and work coordinate systems. Such a misalignment, for example, sometimes occurs by over and under fastening of screws and bolts used to fix jigs on a working table, and tends to cause serious troubles such as breakage of workpieces. In order to cope with the problem, the authors have developed a correction function that automatically generates teaching points for picking and placing only by giving the four corner positions of a working table. The effectiveness and validity of the proposed method were demonstrated through a cooperative peg-in-hole task using two small-sized industrial robots MG400s.

OS14-4 Design of CNN Models for Defect Detection of an Industrial Material Using Image Augmentation Based on Stable Diffusion

Zhelin Zheng[1], Fusaomi Nagata[1], Souma Kanoutani[1], Keigo Watanabe[2], Maki K. Habib[3]
([1]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)
([3]The American University in Cairo, Egypt)

In the case that the occurrence rate of defective products is low, it is not easy to collect a sufficient amount of images including target defects for training a CNN model. As the result, it is also not easy to build a desirable CNN model for defect detection with a high generalization ability. For example, it is reported that GAN (Generative Adversarial Network) is applied to increasing the limited number of training images, however, it seems to be not supported that only designated limited area in an image can be augmented. In this paper, to cope with the need, Stable Diffusion is applied to increasing the limited number of original images while augmenting only the target defect regions in the images. The effectiveness of the proposed method is evaluated through classification experiments of test images with and without defects.

OS14-5 Harmonizing Industry 4.0 and 5.0 to Foster Global Sustainability

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

The Fourth Industrial Revolution, Industry 4.0, ushered in an era of digitalization and automation, transforming industries and economies worldwide. However, as society moves toward Industry 5.0, characterized by human-robot collaboration and sustainability, new dimensions of opportunity and challenges emerge. This paper explores the crucial role of aligning Industry 4.0 and 5.0 for global sustainability, which demands attention in research & development and practical implementation. This paper introduces the fundamental principles of Industry 4.0, highlighting the intelligent utilization of data, automation, and connectivity for industrial process optimization. It further explores Industry 5.0, emphasizing human-centric design and a solid commitment to sustainability. The global significance of this integration is profound, offering solutions to critical issues like climate change, resource depletion, and social inequalities. Interdisciplinary collaboration among researchers, policymakers, and industry leaders is essential for realizing the vision of global sustainability through the amalgamation of Industry 4.0 and 5.0. The paper also examines how this convergence creates unprecedented opportunities to address environmental, economic, and social sustainability. To conclude, we underscore the urgency of addressing global sustainability concerns through the synergistic fusion of Industry 4.0 and 5.0.

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

Room C

OS19 ISBC: Bio-Complexity and Nonlinear system

Chair: Ken Naitoh (Waseda University, Japan)
Co-Chair: Yoshio Ishii (Soka University, Japan)

OS19-1 Molecular Dynamics Simulation Study of Protocell Membrane

Ryuta Kawanami, Susumu Fujiwara
(Kyoto Institute of Technology, Japan)

Since the 1920s, when A. Oparin published his coacervate theory, a number of research on the prebiotic synthesis of RNA[1], cell division[2], etc. have been conducted from the view point of the origin of cell as the building block of life. This study focuses on instability of a protocell membrane. Fatty acid vesicles are known to be sensitive to stimuli such as extreme pH, high temperatures, and external components [3]. The most important problem is that fatty acid vesicles are known to leak their components due to divalent cations such as Mg2+, which are thought to be abundant in the early ocean. Membrane permeability is an important property related to the uptake of molecules from the environment, although too much high permeability inhibits the retention of internally synthesized functional polymers. Various chemical species were dissolved in the early ocean, and it is thought that various organic compounds including nucleotides and amphiphiles were synthesized by thermal and electrical stimuli.

OS19-2 Analysis of orientation factors of gapped DNA labeled with fluorescent probes by molecular dynamics simulation

Takumi Hashi[1,2], Susumu Fujiwara[1], Tomoko Mizuguchi[1], Yoshiteru Yonetani[2], Naoya Shikazono[2],
Ken Akamatu[2], Hiroaki Nakamura[3,4]
([1]Kyoto Institute of Technology, Japan)
([2]QST, Japan)
([3]NIFS, Japan)
([4]Nagoya University, Japan)

DNA can be damaged by various factors. DNA damage can be broadly classified into four types: double-strand breaks, single-strand breaks, apurinic/apyrimidinic sites and base lesions. We focused on damage called gaps, which are formed when some nucleotides are removed entirely in single-strand breaks. Although fluorescent probes are a powerful tool for investigating the structural changes in DNA caused by damage, it is difficult to determine the exact structure of DNA by experiment alone. By labelling gapped DNA with fluorescent probes and performing molecular dynamics simulations, the orientation factor and behaviour of the probes and the distance between the fluorescent dyes are investigated. Undamaged DNA is also examined and compared.

OS19-3 Molecular dynamics simulation of fluorescent dye-labeled DNA with apurinic/apyrimidinic sites

Kotaro Masumoto[1], Susumu Fujiwara[1], Tomoko Mizuguchi[1], Yoshiteru Yonetani[2], Naoya Shikazono[2],
Ken Akamatu[2], Hiroaki Nakamura[3,4]
([1]Kyoto Institute of Technology, Japan)
([2]QST, Japan)
([3]Nagoya University, Japan)
([4]NIFS, Japan)

In fluorescence resonance energy transfer (FRET) experiments, molecular dynamics (MD) simulations are a useful tool for determining orientation factors. In FRET experiments, the distance between fluorescent molecules is calculated by measuring the FRET efficiency. However, the orientation factor used to determine the Förster distance is given, based on the assumption that the dyes are free to move. It is difficult to understand the dynamic structure of DNA by only from experimental measurements. It is expected that combining the data from the experiments with the results of MD simulations enables more accurate estimates of the dynamic structure of DNA. In this study, MD simulations were conducted on DNA labeled with fluorescent probes in order to explore the dynamic structure of the damaged DNA with apurinic/apyrimidinic sites.

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

OS19-4 Molecular dynamics study of tacticity effect of polymer brushes on alanine dipeptide adsorption

Haolun Li, Tomoko Mizuguchi, Susumu Fujiwara
(Kyoto Institute of Technology, Japan)

The protein antifouling effect of polymer brushes is expected to be used for medical treatment. However, the functions of polymer brushes are affected by many factors such as the steric hindrance and the tacticity of polymer brushes. Therefore, it is important to clarify the effect of polymer structures on the protein adsorption on polymer brushes. In this research, the interactions between polymer brushes with different tacticity and an alanine dipeptide were studied by molecular dynamics simulations. We prepared two different tacticity, isotactic and syndiotactic, using 2-methacryloyloxyethyl phosphorylcholine polymer. The number density analysis and structure visualization revealed that isotactic polymer brushes have more and larger holes than syndiotactic ones. The free energy profile of alanine dipeptide binding into polymer brushes shows that the peptide is more easily bound to isotactic polymer brushes. These results indicate that polymer structures affect the protein antifouling effect, even when the same polymer molecules are used.

OS19-5 Analysis of coupling complexity in echo state networks via ordinal persistent homology

Taichi Haruna
(Tokyo Woman's Christian University, Japan)

We study coupling complexity in multivariate time series generated by echo state networks subject to i.i.d. input signals using the ordinal persistent index proposed by the author recently. Given a time segment of a multivariate time series, its ordinal persistent index is defined by taking the persistent homology of a filtered simplicial complex reflecting similarity among the ordinal patterns of individual time series. As the strength of input signals increases, the dynamics of echo state networks shift from asynchronous ones to more synchronized ones. It is shown that the coupling complexity measure takes relatively high values between the two extremes, namely when the strength of input signals to the echo state networks is within a certain range of intermediate values.

OS19-6 Consideration on the time evolution of the vortex layer using hyperfunctions

Yuya Taki[1], Yoshio Ishii[2]
([1]Graduate School of Science and Engineering, SOKA University, Japan)
([2]Faculty of Science and Engineering, SOKA University, Japan)

Complex fluids are nonlinear systems that are closely related to our daily lives. In particular, the time evolution of a vortex layer is a typical example of a nonlinear phenomenon in fluid Dynamics. The vortex layer has singularities where the vortex rolls up, and these can be described mathematically by distribution functions. The distribution function is an unusual function that does not follow the definition of an ordinary function that corresponds between finite values, but that allows it to correspond to the same calculation rules as ordinary functions. Nowadays, this function can describe many fluid phenomena mathematically, such as vortices, double vortices, and vortex sequences. However, the vortex layer has not yet been clearly described by distribution functions. In this study, to examine the effectiveness of Sato's hyperfunction in describing the vortex layer, we have compared it with the Birkhoff-Rott equation under the same analytical conditions.

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

OS19-7 Consideration of wavelet analysis using distribution function and Sato's hyperfunction

Hiroshi Murayama[1], Yuya Taki[1], Yoshio Ishii[2]
([1]Graduate School of Science and Engineering SOKA University, Japan)
([2]Science and Engineering SOKA University, Japan)

The research discusses of nonlinearity in systems, especially in information technology. As examples of nonlinear systems, in the fields of prediction, optimization, stability, and control, there are challenges in understanding these and creating mathematical models. Wavelet analysis, which is an extension of Fourier analysis, can be applied to various fields such as signal processing, image processing, and data compression, and enables simultaneous analysis of time and frequency, allowing for understanding the local characteristics of a signal. In this study, we have investigated Sato's hyperfunctions in the processing of discrete points in digital signal processing. Sato's hyperfunction defines as the difference between the boundary values of the two analytic functions in the upper and the lower half complex plane. The Sato's hyperfunction has been considered for application to wavelet transform and has potential applications in high-frequency noise removal, image compression.

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

Room D

OS12 Psychophysiological measurements and analysis toward multimodal experimental study and its application

Chair: Shusaku Nomura (Nagaoka University of Technology, Japan)
Co-Chair: Yuta Nishiyama (Nagaoka University of Technology, Japan)

OS12-1 A Machine Learning-Based Classification Approach for Assessing the Resilience to Acute Stress Using Physiological Data Following the Use of Mouthwashes

Chayani Dilrukshi[1,2], Kosuke Oiwa[1], Mami Ishikawa[3], Shusaku Nomura[1]
([1]Nagaoka University of Technology, Japan)
([2]Wayamba University of Sri Lanka, Sri Lanka)
([3]Sunstar Inc., Japan)

The investigation of acute stress is important in psychophysiological research due to its significant impact on human health. Given the inevitability of stressful situations, the study focuses on resilience to acute stress (RAS). The aim is to propose a machine learning–based method for classifying RAS post-mouthwash use, leveraging physiological changes, including electrocardiography and skin conductance level. Utilizing data from a within-participant experiment with 20 individuals exposed to a 20-minute stressor, the study evaluates three mouthwash types with varying alcohol concentrations (Alc. 0%, Alc. 3%, and Alc. 9%) alongside a no-rinse control. Employing a 3-second sliding window for data preprocessing, a modified convolutional neural network is introduced for RAS classification. The proposed model achieves an accuracy of 66.6%, demonstrating potential in advancing acute stress resilience assessments with machine learning-based methodologies. This study underscores the capacity of such approaches to deliver more precise and robust results for RAS evaluation.

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

OS12-2 A preliminary study to assess the brain waves during walking: artifact elimination using Soft Dynamic Time Warping

Teng Limin[1], Chayani Dilrukshi[1,2], Shuntaro Hatori[1], Xing Yi[1], Kota Chiba[1], Yoritaka Akimoto[1], Takashi Yamaguchi[1], Shusaku Nomura[1]
([1]Nagaoka University of Technology, Japan)
([2]Wayamba University of Sri Lanka, Sri Lanka)

Existing studies in electroencephalography (EEG) often involve participants in stationary positions, posing challenges in obtaining accurate data during physical activity due to motion-induced noise. This study aimed to assess brain activity during walking and capture auditory event-related potentials (ERPs) using noise/signal separation techniques. Two experiments were conducted: (1) an evaluation of alpha wave activity during walking, and (2) an assessment of auditory ERPs during walking. Soft Dynamic Time Warping (Soft-DTW) was used for noise/signal separation. The first experiment showed significant differences in alpha-wave levels between walking with closed eyes and with open eyes in the occipital, parietal, and central areas. Despite no significant difference obtained by a conventional averaging method to eliminate artifacts, the second experiment demonstrated significant differences in ERP-like responses after applying Soft-DTW. In ERP measurements, using active electrodes and Soft-DTW may effectively eliminate EEG artifacts with body movement.

OS12-3 Non-stereoscopic self-images fail to induce an illusion of limb-disownership arising from visuo-proprioceptive incongruence

Sachini Nawarathna, Wataru HASEGAWA, Chihiro YAMASHITA, Shusaku NOMURA, Yuta NISHIYAMA
(Nagaoka University of Technology, Japan)

Bodily self-perception involves opposing feelings: ownership and disownership. While many studies investigated body ownership in healthy individuals, few investigate disownership. A previous study reported that visual-proprioceptive incongruence induces a limb-disownership illusion using stereo camera. In this study, we aimed to verify if non-stereoscopic images, captured with a monocular 360˚ camera, could elicit the equivalent illusion. Participants, wearing a head-mounted display, observed real-time right-side images of their bodies from a third-person perspective while posing—hiding or showing their left elbow. Also, they performed additional conditions, assuming the same postures with no observation. According to the results of subjective reports and pain threshold measurements, the present setup failed to reproduce the illusion. Nevertheless, we found physiological alterations, suggesting that viewing one's own images assuming a specific posture in this setup influenced autonomic activity in the body. This study highlights the complex relationship between visual perception, body ownership, and physiological responses.

OS12-4 Exploring the Impact of Visually Losing One's Own Body and Continuous Motion Images on Locomotion in a VR Environment While Voluntarily Walking

Asiri Weerasinghe[1], Hajime Kobayashi[2], Shusaku Nomura[1], Moto Kamiura[2,3], Tatsuji Takahashi[2], Yuta Nishiyama[1]
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([2]Tokyo Denki University, Japan)
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Studies have demonstrated that a multimodal virtual reality (VR) system can enhance the realism of virtual walking. However, few studies explore the presence of the user's virtual body and optic flow during locomotion in VR. This study investigated the impact of invisible body and no optic flow on experience of users voluntarily walking in a photo-realistic VR environment. Participants wearing a head-mounted display performed six-step walking at their own timing. Three experimental conditions providing visible body and optic flow as a baseline, invisible body and optic flow, and invisible body and no flow, were conducted on three different days. We found that losing visual body per se decreased the feeling of being-there-now. However, providing the optic flow as well as invisible body maintained the feeling of self-motion, subjective time duration, and fluctuated path, which are equivalent to baseline. We discussed these results in terms of body awareness.

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

OS12-5 A preliminary study on the effect of heart-rate interactive virtual reality on cardiac activity

Xing Yi, Rei Sekigawa, Naoki Iiyama, Shusaku Nomura
(Nagaoka University of Technology, Japan)

We developed a bio-signal interactive virtual reality (VR) system to conduct a preliminary investigation into the effect of heart rate (HR) responsive VR on cardiac activity. In this study, bonfire VR scenes were given to the participants of 20 healthy university students: a living room with a fireplace, wherein the flames flickered in real-time synchronization with the viewer's HR. The experiment was conducted by within-subject design: each participant experienced three input signals (bio-signal, sinewave, and random) in a counter-balanced order. The subjective outcomes were assessed using the visual analogue scale. As a result of the experiment, bio-signal interactive VRs can be observed as most comfortable and natural for subjects compared with the sinewave and random conditions. Compared to the random condition, the heart HR showed a significant positive correlation with the subjective score of ' comfortable.' The alteration in cardiac activity may be ascribed to the psycho-physiological impact.

OS12-6 Tactile Spatial Acuities of Thigh and Pelvis Skin Areas of Individuals

Faisal Mehmood, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Vibrotactile feedback is an important mode of delivering useful information to human operators in a variety of applications such as driving and navigation. The effectiveness of such vibrotactile feedback is coupled with the humans' perception of vibrotactile sensation which is subject to change concerning several factors such as body location, sensory load, and contact integrity. In this study, we conduct a 2-point discrimination experiment in which we explore the effect of direct (on-skin) and indirect (off-skin) contact with vibrotactile sources on the tactile spatial acuity of individuals. Left and right thighs and pelvis areas of the body are examined due to a lack of existing research. The results of the experiment reveal that the tactile spatial acuities for left thigh (Mean=2.04 inches), right thigh (Med=2.21 inches), and pelvis (Med=1.67 inches) areas improve significantly when vibrotactile sources are directly in contact with the skin of individuals compared to the tactile spatial acuities for left thigh (Mean=2.33), right thigh (Med=2.59 inches) and pelvis (Med=2.16 inches) areas when vibrotactile sources are not directly in contact with the skin of individuals. In direct contact condition, the tactile spatial acuity for the pelvis area is relatively better than the tactile spatial acuities for the left and right thighs.

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

Room E

GS6 Bio-inspired robotics I

Chair: Kazunori Hosotani (National Institute of Technology, Tsuyama College, Japan)

GS6-1 Sound Source Proximity Detection System for Deaf and Hard-of-Hearing People Using Smartglasses Equipped with Microphone

Akemi Matsuo, Taku Itami, Jun Yoneyama
(Aoyama Gakuin University, Japan)

Because it is difficult for deaf and hard-of-hearing (DHH) people to obtain information from their hearing, they are unable to notice the approach of life-threatening warning sounds such as ambulance sirens or car horns, and it takes them longer to avoid danger. In this study, we propose a system that detects changes in the distance of a sound source to a device. The effectiveness of this system is demonstrated by the real-time detection of the movement of sound sources toward the wearer based on the increase or decrease in sound pressure received by the microphone installed in the smart glasses, and the results are displayed on the lens every second. We discuss the proposed method and validation results for determining the change in distance from the sound source.

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

GS6-2 An Experimental Study of Flow Structure Around the Oral Arms of a 2D Pneumatic-driven Jellyfish-like Model for the development of an underwater debris-collecting robot

Poon Manakijsirisuthi, Kazunori Hosotani, Ryoji Oya
(National Institute of Technology, Tsuyama College, Japan)

In this study, to serve as a basis for the development of the jellyfish-inspired underwater debris-collecting robot, flow patterns of 2D pneumatic-driven jellyfish-like robots, focusing on flow structures around the rectifying plates modeled after the jellyfish's oral arms, were investigated experimentally. The results of flow fields and the flow rate that passes through the plates obtained by 2D Particle Image Velocimetry (PIV) indicated that by increasing the elasticity of the bell along with incrementing the plates' installment angle up to 20 degrees, the reverse flow in the bell-opening motion, which is disadvantageous for debris collection, can be substantially suppressed. Moreover, of all the four combinations of bell materials and plate angles, the robot configuration with an elastic bell and 0 deg. plate angle is considered more suitable for collecting underwater debris than the others.

GS6-3 Single Actuator Based Four-bar Linkage Flapping Wing Mechanism

Ryoichi Aizawa, Takayuki Hamahata, Geunho Lee
(University of Miyazaki, Japan)

In recent years, many disaster rescue robots have been developed for operation at disaster sites. Among disaster rescue robots, various mobility mechanisms have been devised for robots that dive into rubble to search for buried human lives, but it is difficult for a single mobility mechanism to cope with the narrow and complex terrain of the rubble. Therefore, we conduct research on flight with a robot that can both fly and run in a rubble environment in mind. There are three main types of flight methods used for flying robots: fixed-wing flight, rotary-wing flight, and flapping-wing flight. There are three main types of flight methods used for flying robots: fixed-wing flight, rotary-wing flight, and flapping-wing flight, each of which has different advantages and disadvantages. Fixed-wing flight enables stable long-distance flight but requires a runway for takeoff and landing due to the structure of the aircraft, which obtains lift and other forces by moving itself. Also, hovering flight, in which the aircraft stays in the same position in the air, is basically impossible. Although rotary-wing flight is capable of vertical takeoff and landing and hovering flight for long periods of time, it is susceptible to changes in wind and weather conditions, and its flight stability is inferior to that of fixed-wing flight. Flapping-wing flight is highly maneuverable and enables complex flight maneuvers such as sharp turns and descents. However, because there are many aspects of the flight mechanism that are yet to be clarified, it has not yet been possible to completely reproduce biological-like flapping-wing flight in a robot. Considering the characteristics of each of these flight methods, if the robot can adapt to the environment in …

GS6-4 Shrimp's Swimming Motion Imitated Propulsion Mechanism and Its Application to Underwater Robots

Teppei Inoue, Geunho Lee, Kazuki Takeshita
(University of Miyazaki, Japan)

A variety of underwater exploration robots are currently used for underwater exploration and research. Their main propulsion device is a screw propeller. While this mechanism is highly efficient and versatile, it has various problems, such as attracting marine organisms and malfunctioning due to the rotation of its wings. For this reason, underwater robots that mimic marine organisms have been widely studied. These underwater robots pose less danger to living creatures and are more environmentally suitable than screw propellers. This study describes a novel propulsion mechanism for underwater robots used for exploration of rivers and oceans. Unlike these underwater robot propulsion mechanisms, this study provides a novel propulsion mechanism inspired by shrimp swimming. Focusing on the shrimp's swimming technique of paddling its limbs, we developed a paddle-type propulsion mechanism that applies the movement of the shrimp's abdomen during swimming. To evaluate the effectiveness of the propulsion mechanism, experimental results of propulsive motion using the developed prototype were presented and analyzed. As a result, it was confirmed that this propulsion mechanism has a certain motion performance that can be used as a propulsion device for underwater robots. The establishment of a control method for phase differences in this study will also contribute to the generation of motion for underwater robots that move their fins in a certain pattern, such as rays and squids, which will be the subject of future research.

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

GS6-5 Development of a propulsion mechanism combining elastic fins and plate spring

Togo Yanai, Kenta Tabata, Renato Miyagusuku, Koichi Ozaki
(Utsunomiya University, Japan)

To advance the development of underwater robots, biomimetic approaches have drawn inspiration from manta rays. In our previous works, we have proposed bioinspired pectoral fin designs featuring rigid fins with flexible tips. However, these designs fell short of achieving optimal propulsion efficiency, primarily because the trailing edge of the pectoral fins lacked flexibility. To address this issue, in this paper, we incorporate manta ray's natural fin flexibility into our fin design. We propose the use of flexible materials across the entire fin and equip the pectoral fins with leaf springs. To verify swimming performance, we conducted tests with two flapping motions. This approach is expected to significantly improve propulsion efficiency.

GS6-6 Video recordings and mathematical modeling on the synchronized leg movements of train millipedes

Momiji Yoshikawa, Ikkyu Aihara
(University of Tsukuba, Japan)

We studied the walking mechanism of train millipedes (Parafontaria laminata armigera) both experimentally and mathematically. First, we recorded the leg movement of a waling millipede by a video camera. The phase dynamics of respective legs was quantified by automatic tracking due to DeepLabCut, demonstrating nearly in-phase synchronization in adjacent legs. Second, we proposed a mathematical model based on the framework of coupled oscillator systems. Specifically, we introduced a phase shift parameter to Kuramoto model and searched a suitable parameter value to reproduce empirical data. Finally, we demonstrated that the proposed model can quantitatively reproduce the phase difference of adjacent legs estimated from empirical data. Important future directions include the analysis on the movement of the entire legs and the application of the behavioral mechanism of walking millipedes to the development of bio-inspired robots.

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

Room F

GS9 Cognitive science

Chair: Timothée Levi (IMS laboratory, University of Bordeaux, France)

GS9-1 AlphaZero-based reinforcement learning for selecting procedural rules in ACT-R

Shogo Eguchi, Hideaki Itoh, Hisao Fukumoto, Hiroshi Wakuya
(Saga University, Japan)

Cognitive architectures have been studied for many years to develop intelligent agents, and ACT-R is one of the most extensively studied cognitive architectures. Although ACT-R is useful for simulating various kinds of cognitive processes, learning of selecting the optimal production rule has not been well studied yet. Therefore, in this study, we use the AlphaZero algorithm for the learning in ACT-R. AlphaZero is a deep reinforcement learning algorithm that utilizes Monte Carlo Tree Search (MCTS) and has an excellent look-ahead capability. Through numerical simulations, we study the performances of our proposed ACT-R learning mechanism in some sequential decision problems and show that the AlphaZero-type reinforcement learning method is a viable option in ACT-R.

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

GS9-2 Sonifying the sentiment dynamics of SNS through sentence-based analysis and sound clip mapping

Hiroshi Tanaka, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

The purpose of this study is to propose a method for sonifying the dynamics of fine-grained emotional characteristics in sentences over a large flow of textual information on SNS. We developed a method for extracting the emotional polarities of posted texts on X using a large language model, specifically BERT, and for superimposing multiple sound clips that reflect the distribution of emotional polarities of the collected texts over time. Furthermore, we used MusicGen and ChatGPT to create a set of music clips that reflect different sentiment polarity values. The distribution of sentiment scores was also used to adjust to replay parameters such as volume and BPM. We generated a musical piece based on posts regarding a Japanese baseball game and analyzed the effects of the proposed sentence-based sentiment analysis on the resultant music, compared to traditional word-level sentiment analysis. The results showed that sentence-level analysis provided a more balanced emotional representation, which better reflected collective mood during the game, whereas word-level analysis tended favor positive sentiment.

GS9-3 Experimental analysis of the effects of sound propagation range on co-creative communication in proximity voice chat

Naohiro Nishiyama, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

Proximity voice chat allows users to spontaneously form conversation groups by using avatars to move freely within the virtual space and converse with other users nearby. Although co-creative communication in such virtual spaces is increasing attention, the relationships between local interaction and co-creativity brought about by the acoustic environment in virtual spaces have not been clarified. In this study, we investigate the effects of acoustic characteristics in proximity voice chat, especially sound propagation range, on co-creative communication by designing and conducting a "topic discovery task" in which participants interact and share their interests in a proximity voice chat. Experimental results suggest that differences in the sound propagation range can affect co-creativity by causing differences in the dynamics of interactions. When the sound propagation range was narrow, localized interactions promoted participants' active movement and active acquisition of information. When the range was wider, more global but stable and deep interactions were found to be promoted.

GS9-4 Investigating the structure of emotions by analyzing similarity and association of emotion words

Fumitaka Iwaki, Tatsuji Takahashi
(Tokyo Denki University, Japan)

In the fileld of natural language processing, some studies have attempted sentiment analysis through handling emotions as an explanatory variable or a response variable (Acheampong et al., 2020). One of the most popular emotion models is Plutchik's wheel (Plutchik, 2001). This modelschematizes human emotions in a circular structure, and represents it in two dimensions. But, the validity of Plutchik's wheel of emotion has not been sufficiently examined. In this study, we empirically constructed semantic networks of emotion words and analyzed them to examine the validity of the wheel of emotion structure. Through our experiments, we collected the data of similarity and association of ordered pairs of emotion words, and the networks were constructed.We then analyzed the structure of the networks by a community detection method, and compared it with that of the wheel of emotion. The results showed that each network's structure was, for the most part, similar to that of the wheel of emotion, but locally different.

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

GS9-5 Assisting interpretation of depression diagnosis model utilizing SHAP

Haruka Maehara, Ryo Hatano, Hiroyuki Nishiyama
([1]Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

Recently, there has been a growing trend in the number of patients with depression. With this trend, there is an increasing demand for quantitative diagnosis of depression, and one of the methods is the utilization of AI. However, the introduction of AI into healthcare faces challenges, given the black-box nature of AI. Therefore, this study aimed to construct a model for diagnosing depression using clinical interview data and propose interpretation methods. The proposed methodology comprises of three stages. First, we extracted compressed features using a Gated Recurrent Unit (GRU) Autoencoder applied to the sequence features obtained from the clinical interview data. Second, we train multiple machine learning models and compare their performances by them incorporating data augmentation and feature selection for the compressed features. Finally, we interpreted the depression diagnosis model. Here, we used SHapley Additive exPlanations (SHAP) and the weight matrix of the GRU to achieve the interpretation.

GS9-6 Evolution of metacognitive behavior with a neuromodulated recurrent neural network

Yusuke Takai, Reiji Suzuki, Takaya Arita
(Graduated School of Informatics, Nagoya University, Japan)

Metacognition is the ability to recognize one's own cognitive activity. In a previous study, a circuit equivalent to metamemory with reference to internal states was identified from the results of an evolutionary experiment using a neuromodulated neural network. In this study, we extended the target from memory to cognition and devised a model in which both cognition and metacognition can evolve. The experiments successfully show the evolution of metacognitive behavior whose magnitude changes depending on the amount of noise introduced to degrade the agent's cognitive abilities. The analysis revealed that a modulatory neuron sends modulatory signals in response to instantaneous noise to the substructure underlying the behavioral decision. We conclude that this higher-order functioning neuron is metacognition based on reference that recognizes the degradation in cognitive state and controls the state. Analysis of evolutionary scenarios suggested that concise structures evolved may also contribute to the evolution of higher-order cognitive functions.

GS9-7 Moral Hazard Problems in High-frequency Pitch-by-pitch Data

Wen-Jhan Jane
(Shih Hsin University, Taiwan)

This paper examines whether the pitching decisions under the leading (/lagging) condition moderate (/stimulate) moral hazard behavior. Using the task of pitching data in baseball competitions involving Major League Baseball (MLB) regular season and playoff games, I find strong evidence of a significantly difference between National League (NL) and American League (AL) in moral hazard (MH) behavior. The micro analysis results of these massive data sets indicates that a DH is less likely to be hit by a pitch, but a DH in the AL is more likely to be hit by a pitch compared with a DH in the NL. Moreover, when batter characteristics and interim performance information (IPI) variables are included in the model, the DH effect may actually be larger than the estimated values in previous studies, ranging between 14% and 39%.

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

Room A

OS25 SWARM: Lunar bases construction and lunar exploration by modular and swarm AI-robots II

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)
Co-Chair: Jun Morimoto (Kyoto University, Japan)

OS25-1 Development of a Remote Operation Platform for Plug-and-Play Module Based Robotic Systems

Xixun Wang, Akio Noda, Guang Yang, Fumitoshi Matsuno
(Osaka Institute of Technology, Japan)

Modular robots are the perfect option for applications such as unmanned space exploration because modular robots are reconfigurable for different applications and damaged modules can be quickly replaced. However, it is known that the remote operation of robots with multiple joints is a challenging task, not to mention remote control re-configurable modular robots constructed by heterogeneous modules. This research introduces a remote operation platform that not only controls but also self-assembles multiple heterogeneous modular robots by multiple users from anywhere and anytime. The user interface (UI) visualizes and remotely controls modules over the internet through a Cloud Service (plug-and-play (PnP) server). The PnP server manages the connection of the modules so that multiple modules can be controlled as several independent robots. We applied a prototypic remote operation platform to real-world modular robots. The platform successfully illustrated the robot configuration when the modular robots are plugged-and-played in a remote environment.

OS25-2 Simultaneous Optimization of Morphology and Controller of Legged Robots Considering Rough Terrain

Tomohiro Shimomura[1], Xixun Wang[1], Ryo Ariizumi[2], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]Tokyo University of Agriculture and Technology, Japan)

In this research, the purpose is to design a robot capable of exploration beyond Earth, specifically adapted for rough terrains. Legged robots are chosen because of their high terrain traversing capabilities. To design a legged robot capable of moving in rough terrains, both the configuration, such as leg length corresponding to the uneven ground, and control, such as high moving speed need to be considered. Therefore, we simultaneously optimize both the configuration and control. Terrain resembling a sandy desert and rocky are replicated using Perlin noise and random height generation. And both terrain are included into the reinforce learning to achieve walking tasks. We applied both Monotonic Decrease Method (MDM) and Isomorphic Classification Method (ICM) which is proposed in prior researches to optimize the configuration. The results showed that MDM could not update configuration well, while ICM proved effective in updating. Furthermore, for robots trained using , the reward significantly decreased when walking on rocky terrains compared to walking on Surface configuration of the sand desert terrains. Robots trained on random terrains showed less difference in reward between both terrains, demonstrating the ability to adapt to various rough terrains.

OS25-3 Development of Limb modules for reconfigurable robot on the moon

Yuya Shimizu, Rai Nagao, Keita Okita, Yuina Kadowaki, Yumeto Mori, Tetsushi Kamegawa
(Okayama University, Japan)

On the moonshot project in Japan, we work on research and development for the theme following Lunar bases construction and lunar exploration by modular and swarm AI-robots. We developed Limb modules that can be a part of a modular robot working on the moon. The modular robot consists of various modules and the assembly and disassembly are facilitated through specialized connectors. Limb modules consist of serial links which have three degrees of freedom with pitch, roll and pitch joints. Limb modules can be legs for a robot by connecting to a body module. Limb modules can also have various functions using other modules. Furthermore, our Limb modules have the mobility and the capability to explore the moon. We pay attention to a spool tractor movement using roll joints. In this paper, we show the result of the experiment of the spool tractor movement.

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

OS25-4 Vision-based self-assembly algorithm for a single-legged modular robot

Tomohiro Hayakawa, Shuya Ono, Toshiyuki Yasuda
(University of Toyama, Japan)

Legged modular robots are equipped with a leg component in addition to the inter-module connecting mechanism. When the modules can achieve self-assembly, then the cluster obtains a multi-legged robot shape and functions. In this study, we construct a self-assembly algorithm for the single-legged modular robot to move to the target position via its own vision-sensor. The proposed algorithm is composed of three steps. First, the module searches the opposite module and measures its relative position and orientation. Second, the module moves to a waypoint that is a certain distance away from the target position. In this way, the two modules prevent physical collisions. Third, the module moves to the target position. Through dynamic simulation, we verified that the module is able to move to the target position with an error of less than 60mm at a high probability.

OS25-5 How to Generate Large Amounts of Artificial Lunar Sand for Regolith Handing Studies

Masashi Yoneda, Akio Noda
(Osaka Institute of Technology, Japan)

The Moon's surface is covered with unique sand, and its utilization could be a stepping stone for mankind's full-scale expansion to other celestial bodies. International competition has intensified, especially since the first to discover moist sand is considered the winner. Sand is difficult to model analytically because the nonlinear behavior of sand changes constantly with density due to inter-particle forces acting on a rigid body, and a considerable amount of sand is required to develop and implement theories of behavior and grasping on sand. Therefore, in this study, we attempt to realize the particle size distribution of lunar sand, which was brought back as the first step in the research of grasping theory, by mixing sand that can be obtained inexpensively on the earth. In this report, we present a recipe for the optimum mixing ratio and the results of handling experiments using the sand.

OS25-6 Automatic Design of Legged Robots for Transportation on Rough Terrain

Joji Asai, Ryo Ariizumi
(Tokyo University of Agriculture and Technology, Japan)

This paper presents a design of a legged robot for transportation on a rough terrain. Legged robots have high mobility on rough terrain but have low speed and energy efficiency. Furthermore, the bumpy nature of its locomotion will make it challenging for them to be used as transportation robots. Therefore, it is important to have a framework to optimize the design of legged robots to have higher speed, higher energy efficiency, and higher stability of the loading platform. By employing a recently proposed automatic robot design framework, we obtain a design of a legged robot whose performance is shown by simulations.

OS25-7 Multi-modal locomotion of quadruped robot with restricted joint configuration

Takashi Takuma[1], Masahiro Ikeda[2]
([1]Osaka Institute of Technology, Japan)
([2]Kindai University, Japan)

To launch a robot and explore the moon, it is necessary to design a general robot limb that can switch between arms and legs according to the environment or task. However, this means that the configuration of the limb such as the number of joints and the link length is limited both for the arm and leg. Kamegawa et al. developed a three-joint limb mechanism. The limb is expected to be applied not only as a leg, but also as an arm. Therefore, the joint configuration is not specialized for locomotion. This study proposes multi-modal locomotion using four-limb mechanisms. Two types of the locomotion are proposed, and the velocity and behavior by changing some parameters are reported.

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

Room B

OS1 AROB: Adaptable AI-enabled Robots to Create a Vibrant Society

Chair: Kazushi Ikeda (Nara Institute of Science and Technology, Japan)
Co-Chair: Tetsunari Inamura (Tamagawa University, Japan)

Invited Talk 3 Adaptable AI-enabled Robots to Create a Vibrant Society

Yasuhisa Hirata (Tohoku University, Japan)

See page 17

OS1-1 Synergizing Multi-Robot Assistive Care: An IoT-Driven Framework for Elderly Support in a Simulated Smart Living Lab

Ankit A. Ravankar, Jose Salazar, Yasuhisa Hirata
(Tohoku University, Japan)

As developed nations such as Japan face demographic changes that burden their healthcare systems, the role of Robotics and Artificial Intelligence (AI) in providing long-term support to the elderly becomes increasingly vital. Despite technological advancements in assistive robotics, many remain confined to research settings and have not yet been fully integrated into home care environments where they can offer real-time, coordinated support. This paper introduces an innovative framework for multi-robot assistive care, designed to enable intelligent task distribution among a network of care robots, optimizing efficiency and minimizing the need for user interaction. Our framework leverages a diverse array of sensors within an Internet of Things (IoT) ecosystem, allowing for the ambient operation of devices and enabling users to request services via verbal commands or touch interfaces, such as voice assistants and mobile applications. The system then allocates the most appropriate robot for the task, considering the user's physical condition. Safety and user autonomy are paramount in our design, with the system collecting longitudinal data to enhance user independence. We tested our robots in a state-of-the-art living lab at Tohoku University, simulating a smart nursing care home with integrated sensor technology. Compatibility with the Robot Operating System (ROS) ensures our framework's adaptability, facilitating the addition of new robots and sensors and permitting remote monitoring and control. Our findings, based on various user interaction scenarios, confirms the framework's effectiveness and adaptability in a daily living context. In this research we present the development of robotic systems, empowered by an IoT infrastructure, to improve the performance of activities of daily living (ADL) tasks within a simulated smart living environment. This project is part of the Japan Science and Technology Moonshot R&D program which aims to create a vibrant society by 2050 by utilizing robotics and AI technology.

OS1-2 Can the ease of giving up be detected? The impact of personality and movement tendencies on behavior continuation using unachievable VR Kendama

Haruka Murakami, Tetsunari Inamura
(Tamagawa University, Japan)

Rehabilitation for the elderly focuses on prolonging patient mobility. However, it is difficult to keep them motivated during the life phase. Once the patient gives up, the decline in physical functions causes a vicious cycle of further loss of motivation, therefore it is necessary to take some measures, such as lowering the difficulty level, before patient abandonment. However, there is no known way to find out when a person is likely to give up or whether he or she is likely to give up. Therefore, in this study, we tested whether it is possible to estimate whether and when a person will likely give up on a certain task using an unachievable VR kendama, the Y-G personality test, and pre- and post-experimental questionnaires. In conclusion, we found a strong correlation $r = 0.791$ ($p<0.01$) between the answer "How soon do you think other subjects gave up?" and the subjects' playing time.

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

OS1-3 A System Design of the Nursing Scene Analyzer to Track Items of Interest with a Function of the Human's Correction

Haruka Morotomi[1], Yurina Wada[2], Masayuki Fujiwara[1], Takahiro Koga[1], Ryunosuke Matsuo[1], Mana Ariyoshi[1], Nozomi Uchie[3], Mitsuyo Taniguchi[4], Yumiko Namizaki[3], Masayo Shima[3], Kaisei Wada[3], Junko Yotsuya[3], Kazushi Ikeda[2], Hiroaki Wagatsuma[1]
([1]Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan)
([2]Department of Information Science, Nara Institute of Science and Technology, Japan)
([3]Division of Nursing, Faculty of Medical Science, University of Fukui, Japan)
([4]Faculty of Medicine, University of Miyazaki, Japan)

In the problem for extracting expert tacit knowledge and good skills in a quantitative way. We proposed an interactive curation system that corrects tracking points from an automated object recognition system. The system visualizes a region of interest (ROI) for the target, allowing a human curator to modify its position. The speed of scene video screening from the eye-tracker is controlled by the amount of difference among moving scenes to adjust target movements, aiding accurate curation and saving time. For the clarification of the basement performance of the proposed system, we designed a simple experiment of the eye-tracker with targets in the environment with an apparent ground-truth with colored panels. Initial accuracy was evaluated based on the performance of the object recognition algorithm without human curation. The performance of the human post-curation was evaluated by a smoothness of correcting procedure with respect to the algorithm's results.

OS1-4 An Eye-Tracker Analysis of Viewpoint Differences between Experts and Novices in the Birthing Assistance

Nozomi Uchie[1], Mitsuyo Taniguchi[2], Yumiko Namizaki[1], Masayo Shima[1], Kaisei Wada[1], Yurina Wada[3], Haruka Morotomi[4], Takahiro Koga[4], Mana Ariyoshi[4], Kazushi Ikeda[3], Hiroaki Wagatsuma[4], Junko Yotsuya[1]
([1]Department of Nursing, Faculty of Medical Science, University of Fukui, Japan)
([2]Department of Medicine, University of Miyazaki, Japan)
([3]Department of Science and Technology, Nara Institute of Science and Technology, Japan)
([4]Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan)

Skilled midwives have techniques to help parturient women deliver their babies safely and in better health. Although the techniques have been analyzed so far, the results are not enough reflected in nursing training courses since they are rather qualitative. To analyze the experts' skills quantitatively and improve the training courses, we carried out the gaze analysis of midwifery experts and trainees in a childbirth simulation using a wearable eye-tracker system, computer vision techniques, and statistical methods, since gaze positions/durations are considered to reflect expertise. As a result, we found that the trainees tried to glimpse necessary items during the childbirth process as instructed in the midwifery training course, while the experts certainly kept looking at necessary items confidently. These findings are consistent with the empirical knowledge of experts, that is, novice midwifery nurses tend to have frequent attentional shifts. This implies that eye-tracker analysis of viewpoint differences can clarify what points trainees should take care of and that it may contribute to making a better training course.

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

OS1-5 Semantic Scene Understanding and Region Classification for Navigation of Service Robots in Care Scenarios

Ankit A. Ravankar[1], Akash Chikhalikar[1], Jose Salazar[1], Abhijeet Ravankar[2], Yasuhisa Hirata[1]
([1]Tohoku University, Japan)
([2]Kitami Institute of Technology, Japan)

In recent years, there has been a remarkable surge in deploying mobile robots in residential and public domains, particularly for service, delivery, and human-robot interaction (HRI) applications. However, indoor environments, especially those centered around human activities, presents many challenges for robots owing to the dynamic and complex nature of such settings. For service robots to execute tasks proficiently, they must perceive and navigate through these environments, recognizing not merely obstacles but also discerning objects and their semantic relevance. A nuanced understanding of the relationship between objects and spatial regions can significantly enhance a robot's ability to navigate seamlessly while continuously learning for long-term planning and task execution in human-centric indoor environments. In this paper, we introduce a comprehensive framework for semantic scene understanding and region classification aimed at augmenting the navigation capabilities of service robots in indoor settings. We lay particular emphasis on care scenarios within a living lab facility that mimics a care home environment, consisting of various rooms and regions with numerous objects that can be found in everyday houses. Our framework contains a robust room classification, semantic object recognition, and mapping algorithm integrated with sensor fusion techniques. Our methods allow the robot to perform high-level navigation tasks and enhance human-robot interactions. Our results demonstrate a notable improvement in the robot's navigation and service task performance and interpretation of the indoor environment's semantic structure.

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

Room C

OS20 ISBC: Information and Visualization

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

OS20-1 Impact of High Refresh Rate Displays on eSports

Hideo Miyachi, Teruki Sawa
(Tokyo City University, Japan)

Computer monitors works on 60 Hz generally, but higher refresh rates of 240 Hz and 360 Hz are used for e-Sports. Furthermore, 500Hz displays will be on the market in 2023, which are advertised to provide a comfortable gaming experience. As a preliminary investigation with 360Hz monitor, we conducted a simple reaction test, it showed that most people were able to respond to high refresh rates regardless of their game skill. In this study, we also examined the high frequency monitor contribution on more complex e-Sports game. The game used was Apex Legends in which two players shot at each other one-on-one. Two players played against each other while switching monitors in the range of 240 Hz to 20 Hz. The win rate normalized by the win ratio when the players played on the same 240Hz monitor, suggested that the high-frequency monitor gives us significant advantage.

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

OS20-2 Comparison of VR and non-VR training effects

Kodai Tsushima[1,2], Seiji Miura[1], Takeshi Wakiyama[1], Hideo Miyachi[2]
([1]EBARA Corporation, Japan)
([2]Tokyo City University, Japan)

While IT tools utilizing XR technology, which is the generic term for AR technology, VR technology, etc., are easy to evaluate qualitatively, quantitative evaluation for actual business efficiency improvement is difficult to conduct,tools that have been created in existing research to date. The author and his colleagues have also conducted a study of XR technology in the industrial sector. The authors are aware of the same issue of the need for quantitative as well as qualitative evaluation in promoting industrial application of XR technology. Therefore, in the present study, the authors have developed a method for training workers in the start-up procedures of semiconductor fabrication equipment. The purpose of this study is to determine whether the use of VR technology improves the understanding of operators in the training of start-up procedures for semiconductor manufacturing equipment. We conducted an experiment to compare two types of training for the same procedure: training using VR and training using a Web browser without VR. While the results did not show statistical significance, there was a trend suggesting that participants who underwent VR training tended to have reduced procedural confirmation during actual equipment operation. However, it was observed that the operation time was not shortened.

OS20-3 Asynchronous Physarum Cellular Automata and Interaction with ECA

iori Tani
(Kobe University, Japan)

The plasmodium of true slime mold Physarum polycephalum is a unicellular and multinucleated ameboid organism crawling on the wet plane. It is reported that protoplasmic oscillation due to protoplasmic flow can be observed when true slime mold is enclosed in multiple chambers connected by narrow paths. We suggest an asynchronous cellular automata-like system composed of the model of slime mold that interacts with Elementary Cellular Automata (ECA). In this system, each chamber corresponds to a cell of 1-dimensional cellular automata, the phase of protoplasmic oscillations of each chamber is converted to the state of each cell of the cellular automata, and feedback is provided by either attractive or repellent stimuli to bring the state of the slime mold closer to the results of applying the ECA transition rule to the converted state. The suggested system can generate complex spatiotemporal evolution patterns like class IV for many ECA rules.

OS20-4 Application of Bayesian and Inverse Bayesian inference in Multi-Resource Minority Game

Tatsuki Okano, Kazuto Sasai
(Graduate School of Science and Engineering, Ibaraki University, Japan)

One study on resource allocation issues utilizes the Minority Game (MG), an exceedingly simple model that, despite its simplicity, produces complex outcomes through agent interactions. However, these studies primarily aim for elucidating mechanisms, with limited focus on realizing human-like agents. Therefore, we aimed to develop a multi-agent model striving to achieve human-like diversity by applying Bayesian and Inverse Bayesian inference to an extended model known as the Multi-Resource Minority Game (MRMG) which builds upon the MG. Resultantly, by applying extended Bayesian inference to the MRMG, we observed dynamic group dynamics and successfully confirmed the realization of diversity in the model.

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

OS20-5 Asynchronous Interaction Between Cooperative Agents for Networked Graph Coloring Game

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

Graph coloring game is a network version of a cooperative game to solve a graph coloring problem by a human group assigned to individual nodes. Previous studies showed some externally mixed noisy bots can accelerate the problem solution. However, the parameter and mixing position are sensitive for applying actual groups. To solve the sensitivity, we propose the representation of perturbation from different perspectives, such as asynchronous interaction models of probabilistic action and observation models. As a result, the asynchronous interaction model based on the biased observation of the neighborhoods shows a robust improvement in the performance of the multiagent simulation model.

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

Room D

OS16 AROB: System Sensing and Its Applications 1

Chair: Kosuke Oiwa (Nagaoka University of Technology, Japan)
Co-Chair: Kent Nagumo (Aoyama Gakuin University, Japan)

OS16-1 Overload Countermeasure for Wiggle Joints of Fish-type Balloon Robot by Using Optimization Method

Yuta Isoai, Masafumi Uchida
(Department of Graduate School of Informatics and Engineering,
The University of Electro-Communications, Japan)

This paper describes research aimed at optimizing bending motion in the control of a fish-type balloon robot, overloading countermeasure for wiggle joints. The fish-type balloon robot has a simple joint that connects the balloons in order to balance the buoyancy generated by the balloon and the equipment mounted on the body. As a result, there is a problem in that the joints are subject to stress and are easily damaged. The purpose of this research is to predict the loads applied to joints and optimize the control parameters for bending motion taking these into account. We then evaluated the generated bending motion.

OS16-2 Study of the Effect of Haptic and Visual Feedback on Smartwatch Character Input

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

Touch input is used as a character input method for smartwatches. However, the small screen size of smartwatches has caused operability problems, such as erroneous input and screen occupancy. Therefore, we focus on vibration in smartwatches and investigate the influence of haptic feedback on touch input. Using a combination of touch input and vibration, we will investigate how the combination affects the accuracy and speed of character input.

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

OS16-3 Real-time Drowsiness Evaluation System Using Marker-less Facial Motion Capture

Yudai Koshi, Hisaya Tanaka
(Kogakuin University, Japan)

This study aims to develop a drowsiness expression rating system that can rate drowsiness in real time using only video information. Drowsiness in drivers is caused by various factors, including driving on monotonous roads (e.g., highways), and can lead in problems, such as traffic accidents. The assessment of a driver's drowsiness status is necessary in solving these problems. We have so far developed an offline drowsiness evaluation system using only video image information. It has the drawback of failing to evaluate drowsiness while car driving. Therefore, we develop herein a real-time drowsiness rating system that can operate on multiple platforms and requires only one smartphone or personal computer. We apply the system to car driving on a monotonous course using a driving simulator. The results show the binary, ternary, and quintile classifications of 6.0, 0.8, and 4.3% higher, respectively, when compared to previous studies, suggesting that our system has a high accuracy rate.

OS16-4 Stimulation Frequency Optimization of High-Frequency SSVEP-BCI

Sodai Kondo, Hisaya Tanaka
(Kogakuin University, Japan)

Steady-state visual evoked potential (SSVEP)-based brain-computer interface (BCI) using high-frequency stimulation reduces the visual stress of patients but has uneven quality. In this study, we performed two types of the SSVEP frequency response measurement tasks and presented subjects with a stimulus frequency band that could achieve an accuracy of 90% or more in four-input SSVEP-BCI. Among the two tasks, SSVEP frequency response with a single stimulus had a low correlation with the accuracy of each stimulus frequency in the four-input SSVEP-BCI and was impractical. Meanwhile in SSVEP frequency response measured using an interface having the same structure as the BCI being evaluated, the SSVEP component increased with BCI accuracy. Thus, it is evident that when personalizing SSVEP-BCI from the SSVEP frequency response, it is necessary to measure SSVEP using visual stimuli with a structure similar to that of BCI.

OS16-5 Study of Screen Design Considering Blinking Shapes for Spatial Multiple Choice in BCI using Transient VEP

Shingo Tanaka, Tota Mizuno, Kazuyuki Mito, Naoaki Itakura
(The University of Electro-Communications, Japan)

This study investigates spatial multiple choice in the BCI using transient VEP, taking into account the blinking shape. BCI using VEP is researched for people with physical disabilities, because it can operate only by looking at blinking. Because VEP changes by the pattern of blinking, multiple blinking can be used multiple BCI options. However, the display of a large number of blinking on the screen causes discomfort. To reduce discomfort, this study examined the possibility of spatial-multiple choice with doughnut-shaped blinking. As a result, reproducible waveforms were obtained looking at the blinking. looking at the non-blinking area, the amplitude was smaller. These differences suggest that spatial multichoice is possible even with doughnut-shaped blinking. If all choices could be identified without looking directly at the blinking, it would be useful as a screen design with less discomfort.

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

Room E

GS7 Bio-inspired robotics II

Chair: Keigo Watanabe (Okayama University, Japan)

GS7-1 Data-driven Posture Control for Tensegrity Manipulator based on Accelerometer Measurements

Kazuki Wada, Yuhei Yoshimitsu, Shuhei Ikemoto
(Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan)

Robots with class 1 tensegrity have been studied for advantages such as lightweight, high strength, and impact resistance. However, having no conventional mechanical joint structures makes it difficult to use an encoder and express the robot's posture based on angles. To deal with this problem, this paper proposes a data-driven posture control for a tensegrity manipulator which equips Inertial Measurement Units (IMUs) on each rigid body. For the validation, we used a class-1 tensegrity manipulator with 20 struts and bends by 40 pneumatic actuators whose internal pressures are independently controlled. We generated random desired pressure values to obtain the dataset and measured the equilibrium posture with the IMUs. Based on the dataset, we constituted a mapping from 20 IMUs' signals to 40 pneumatic cylinders' desired pressure as the posture controller. As a result of the experiment, the tensegrity manipulator could reach a desired posture recorded by kinesthetic teaching manner.

GS7-2 Gait and Cost of Transport Analysis for Camel-Type Quadruped Robot

Jumpei Yamasaki[1], Akihisa Ishida[1], Shuxin Lyu[1], Katsuyuki Morishita[1], Ken Saito[2]
([1]Department of Precision Machinery Engineering, Graduate School of Science and Technology, Nihon University, Japan)
([2]Department of Precision Machinery Engineering, College of Science and Technology, Nihon University, Japan)

The authors are studying neuromorphic circuits that mimic biological neurons with analog electronic circuits. Previously, we have developed horse-type and camel-type quadruped robots. The authors implemented neuromorphic circuits in both robots for gait generations. The horse-type quadruped robot performed walk and trot gait depending on its walking speed, whereas the camel-type quadruped robot performed pace and trot gait. The pace gait is a typical gait of the camel that is not typical of the horse. Therefore, the authors observed that different body structures could generate different gait. This paper analyzed the energy efficiency of the gait generated by the camel-type quadruped robot using the cost of transport (COT). COT quantifies the energy efficiency of transporting animals or vehicles. As a result of the analysis, we confirmed that the lowest COT gait for the camel quadruped robot was in the order of trot, pace, and no gait.

GS7-3 DEQ-MCL: Discrete-Event Queue-based Monte-Carlo Localization

Akira Taniguchi[1], Ayako Fukawa[2], Hiroshi Yamakawa[2,3]
([1]Ritsumeikan University, Japan)
([2]The Whole Brain Architecture Initiative, Japan)
([3] The University of Tokyo, Japan)

Spatial cognition in hippocampal formation is posited to play a crucial role in the development of self-localization techniques for robots. In this paper, we propose a self-localization approach, DEQ-MCL, based on the discrete event queue hypothesis associated with phase precession within the hippocampal formation. Our method effectively estimates the posterior distribution of states, encompassing both past, present, and future states that are organized as a queue. This approach enables the smoothing of the posterior distribution of past states using current observations and the weighting of the joint distribution by considering the feasibility of future states. Our findings indicate that the proposed method holds promise for augmenting self-localization performance in indoor environments.

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

GS7-4 Biomimetic snake locomotion using Central Pattern Generators network and bio-hybrid robot perspective

Jérémy Cheslet[1,2], Romain Beaubois[1,2], Farad Khoyratee[1,2], Takashi Kohno[2,3], Yoshiho Ikeuchi[2,3], Timothée Lévi[1,2]
([1]IMS Laboratory, UMR5218, University of Bordeaux, France)
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([3]Institute of Industrial Science, The University of Tokyo, Japan)

Neurological disorders affect millions globally and necessitate advanced treatments, especially with an aging population. Brain Machine Interfaces (BMIs) and neuroprostheses show promise in addressing disabilities by mimicking biological dynamics through biomimetic Spiking Neural Networks (SNNs). Central Pattern Generators (CPGs) are small neural network that, emulated through biomimetic networks, can replicate specific locomotion patterns. Our proposal involves real-time implementation of a biomimetic SNN on FPGA, utilizing biomimetic models for neurons, synaptic receptors and synaptic plasticity. The system, integrated into a snake-like mobile robot where the neuronal activity is responsible for its locomotion, offers a versatile platform to study spinal cord injuries. Lastly, we present a preliminary closed-loop experiment involving bidirectional interaction between the artificial neural network and biological neuronal cells, paving the way for bio-hybrid robots and insights into neural population functioning.

GS7-5 Gait Generation for Quadruped Robot Using Neuromorphic Circuit with Receptor Cell Model

Wataru Nakayama[1], Kosei Sekiyama[1], Akihisa Ishida[1], Shuxin Lyu[1], Katsuyuki Morishita[1], Ken Saito[2]
([1]Department of Precision Machinery Engineering, Graduate School of Science and Technology, Nihon University, Japan)
([2]Department of Precision Machinery Engineering, College of Science and Technology, Nihon University, Japan)

The authors have been studying the implementation of neuromorphic circuits using analog circuits that mimic the nervous systems of living organisms into robotic systems. Previously, we developed a quadruped robot that generates animal gait by changing the output frequency of a neuromorphic circuit based on pressure changes in the sole. However, a microcontroller was required to measure the pressure sensors on the sole. Therefore, we modeled receptor cells that convert external stimuli into electrical signals and combined them with the neuromorphic circuit. In this paper, the authors conducted walking experiments using a quadruped robot implemented with a neuromorphic circuit with a receptor cell model. The pressure sensor-related program was omitted as a change from the conventional quadruped walking robot. The results of the walking experiments confirmed that the quadruped robot equipped with a neuromorphic circuit using a receptor cell model spontaneously generates a gait like "Walk".

GS7-6 Slope change detection of a transverse ledge climbing robot based on momentum observer

Reno Pangestu, Chi-Ying Lin
(Department of Mechanical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan)

A transverse climbing robot refers to a customized climbing robot which travels over the horizontal ledges on the vertical walls. The structure and motion of this robot are inspired by wall-climbing athletes. The robot is especially suited for monitoring and inspection operations in high-rise buildings. The ledges used for robot grabbing could consist of many complicated combinations of features. As a navigation strategy, visual sensors are mounted on the robot, and algorithms are designed to identify grasped objects as the robot moves. However, visual sensors suffer from occlusion difficulties that limit their ability to provide information regarding environmental features. As an effective approach, this study presents a motion planning system based on contact force feedback control. A collision detection method is developed based on momentum observer, time-varying thresholds, and admittance control techniques. This strategy is efficient for the robot to identify the proper grasp position and handle the change of slope in the environment. Simulation results on a four-link transverse climbing robot indicate the effectiveness of this algorithm. In the future, the searching algorithm will be improved so the robot can identify a feasible moving path in more challenging situations.

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

GS7-7 Applying particle swarm optimization algorithm to a multi-retailer supply chain inventory problem

Chi-Jie Lu[1], Dong-Ying Jiang[1], Chih-Te Yang[2]
([1]Fu Jen Catholic University, Taiwan)
([2]Tamkang University, Taiwan)

With the growing emphasis on environmental, social, and governance (ESG), the concept of green supply chain inventory management has become crucial for sustainable business operations. Taking into account environmental impact and resource efficiency for the purpose of reducing carbon emissions, the integration of green policies into inventory and production decisions has evolved into a significant issue within current supply chain management. Especially different supply chain members are subjected to varying carbon reduction policies for multinational supply chains. Therefore, this study aims to examine the multi-stage production inventory problem within a multinational supply chain involving a single manufacturer and multiple retailers from different countries under a combination of carbon reduction policies. First, the total profits and carbon emissions functions for both the manufacturer and retailers are separately established in three stages: material supply, finished product production and delivery, and order and sales. Subsequently, the optimal material supply, finished product production, delivery, and replenishment strategies for each supply chain member are determined to maximize the integrated total profit of the supply chain system. Next, the corresponding problem has been formulated as a nonlinear mixed integer optimization problem and solved by a particle swarm optimization algorithm. Sensitivity analysis to variation of the solver and parameter/parameter combination is further illustrated using several numerical example analyses. This study's contributions are poised to provide valuable guidance to enterprises or supply chain decision-makers, especially those operating within a multinational framework. It aims to effectively balance carbon reduction and profitability within the context of global trends in carbon emission reduction. We anticipate that the findings will guide the enterprise or the supply chain toward sustainable development amidst the global trend of reducing carbon emissions.

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

Room F

GS16 Machine learning II

Chair: Min Cheol Lee (Pusan National University, Korea)

GS16-1 Stable Walking Method of Biped Robots in Gusty Environments with Deep Reinforcement Learning

Yilin ZHANG, Xiaohan DU, Huimin SUN, Shanshan WANG, Kenji HASHIMOTO
(Waseda University, Japan)

This study explores the methods of adaptive enhancement for bipedal robots when facing wind disturbances. With the rapid development of technology, the application of bipedal robots in various environments has become widespread, but maintaining balance and stability in variable wind conditions is a complex challenge. The research adopts an optimization strategy of reward function in Deep Reinforcement Learning (DRL) and tests theories and optimization algorithms through simulating real-world wind scenarios. The study specifically designed a reward system that encourages the robot to maintain a stable posture in strong winds and penalizes unstable behavior, thereby enhancing its stability and walking ability under wind disturbances. Additionally, the study found that the Ornstein-Uhlenbeck (OU) noise in simulations more closely matches real wind patterns compared to standard Gaussian noise, better simulating natural wind. This work indicates a possible development path, showing that bipedal robots are promising in effectively working in outdoor complex environments.

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

GS16-2 Autonomous driving of mobile robots based on Sim-to-Real reinforcement learning: Goal-decomposition based multifunctional reward shaping

Minjae Park, Byeongjun Kim, Wonyeol Yoon, Gunam Kwon, Nam Kyu Kwon
(Department of electronic engineering, Yeungnam University, Korea)

This paper proposes a method for implementing autonomous driving of mobile robot based on sim-to-real reinforcement learning. The cost and safety issues, which are limitations of reinforcement learning, have been improved by applying Sim-to-Real technology. Specifically, a method is used that directly employs the model trained in the simulation. By employing a goal-decomposition based multifunctional reward shaping for reinforcement learning, the mobile robot achieves the objective of planning the path to destination without collision. The proposed method involves designing reward functions for multiple sub-goals. This process helps achieve the main goal by addressing individual sub-goals. We verified the proposed method with gazebo and turtlebot3 in simulation and real environment.

GS16-3 The Task Decomposition and Dedicated Reward-System-Based Reinforcement Learning Algorithm for Block Stacking

Gunam Kwon, Byeongjun Kim, Wonyeol Yoon, Minjae Park, Nam Kyu Kwon
(Department of Electronic Engineering, Yeungnam University, Korea)

This paper presents research on task decomposition skills and reinforcement learning algorithms featuring a specialized reward system for high-level tasks, with a specific focus on block stacking. The proposed approach involves breaking down the block stacking task into four sequential subtasks: first reaching, grasping, second reaching, and putting. Both reaching tasks are trained using the Soft Actor-Critic reinforcement learning algorithm. The grasping and putting tasks are implemented by the simple joint and gripper actions. To validate the feasibility of the proposed method, we carried out testing within the Robosuite framework, specifically designed for the development and evaluation of robot control algorithms. According to four rounds of simulation testing, the average success rate of the first reaching agent is 98.98%, and the average success rate of the second reaching agent is 95.15%.

GS16-4 Early Prediction of Delirium in ICU Using Multitask Learning

Yodai Tanaka, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology,
Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

In this study, we propose a multi-task learning-based model that is more accurate than that of relevant studies for predicting the onset of delirium in intensive care unit patients. This study was conducted in two stages. In the first stage, we selected auxiliary tasks for multi-task learning. In the second stage, we predicted the onset of delirium using multi-task learning based on selected auxiliary tasks using large public ICU dataset. We compared the performance of the proposed method with that of several other methods, and the results showed that the proposed method performed better in terms of sensitivity and AUC.

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

GS16-5 Generating Competitive Behavior in Adversarial Environment Using Reinforcement Learning

Ziyao Han, Fan Yi, Kazuhiro Ohkura
(Hiroshima University, Japan)

A Multi-Agent System consists of multiple autonomous agents interacting with their environment and each other to achieve shared objectives. While various behaviors can be pre-designed for agents within MAS, developing appropriate behaviors in advance can become exceedingly challenging when operating in complex environments. Reinforcement Learning (RL) presents a promising approach to designing controllers for MAS through interactions with the environment. This study achieves a Multi-Agent System in beach volleyball by increasing input information through IR sensors and adding teammate and opponent data. However, determining optimal input sizes is challenging due to the problem of redundancy. This study addresses this problem by integrating an attention mechanism with Reinforcement Learning (RL), resulting in improved performance with a higher Elo score compared to traditional RL methods.

GS16-6 Estimation of genes affecting late recurrence of breast cancer using machine learning and XAI techniques

Ryo Ugajin, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Graduate School of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

In Japan, 90,000 new cases of breast cancer are diagnosed annually, and approximately 10% of these cases are hereditary breast cancers with a significant genetic component. Most breast cancer recurrences occur within five years of surgery; however, some recurrences occur after five years. This study aimed to detect candidate genes that influence late recurrence using machine learning and XAI. In this study, the research subjects were breast cancer patients with high-dimensional gene expression data. The existing framework of previous studies was extended using optimal dimensionality reduction methods and various XAI. The results showed that our machine learning models performed well for all the subtypes, with the Normal subtype displaying the best performance. we visualized the importance of the features contributing to the Normal subtype using XAI, the genes with high importance were identified and subsequently validated using Kaplan-Meier curves, which revealed that one out of two genes was significant.

GS16-7 Predicting Patient Queue Length of Blood Collection Center During Peak Hours using Machine Learning-based Multi-step-ahead Forecasting Frameworks

Tzu-Chi Liu[1], Yi-Chen Lee[1,2], Chih-Te Yang[3], Chien-Chih Wang[4], Chi-Jie Lu[1]
([1]Fu Jen Catholic University, Taiwan)
([2]Far Eastern Memorial Hospital, Taiwan)
([3]Tamkang University, Taiwan)
([4]Ming Chi University of Technology, Taiwan)

In blood collection centers, challenges with patient flow and overcrowding significantly impact service quality. Phlebotomists, experts in blood sample collection, encounter capacity limitations, necessitating effective management through predictive measures. This study employs a multi-step-ahead framework and six machine learning techniques to predict the patient queue length at a blood collection center. Analysis of patient queue data from a Taiwanese medical center's blood collection center revealed that Random Forest outperformed competing methods in forecasting one to three steps ahead. This research offers valuable insights for addressing peak-hour overcrowding and enhancing overall service efficiency.

January 25 (Thursday), 16:05-17:35

Room A

OS6 AROB: Collaborative AI robots for adaption of diverse environments and innovation of infrastructure construction (Moonshot program Goal-3)

Chair: Keiji Nagatani (The University of Tokyo, Japan)
Co-Chair: Kenji Nagaoka (Kyushu Institute of Technology, Japan)

Invited Talk 4 Innovations in Earthworks: A 3-Year Progress Report on Collaborative AI Robots for Adapting to Diverse Environments and Innovating Infrastructure Construction

Keiji Nagatani (The University of Tokyo, Japan)

See page 18

OS6-1 Collaborative Robot Systems for Lunar Landing Pad Construction

Kenji Nagaoka[1], Genya Ishigami[2], Munetaka Ueno[3], Keiji Nagatani[4]
([1]Kyushu Institute of Technology, Japan)
([2]Keio University, Japan)
([3]Japan Aerospace Exploration Agency, Japan)
([4]The University of Tokyo, Japan)

This paper presents collaborative small robot systems for the construction of a lunar landing pad and introduces their mission scenario and key technologies. This project scenario aims at the early stages of future lunar base construction. It involves geotechnical in-situ investigation, construction design and planning, and earthwork for the landing pad construction. These mission tasks are planned to be performed by collaborative robots that are semi-autonomously teleoperated. In this Project, we have designed and developed a small platform of four-wheeled robot systems with active suspension mechanisms. It weighs 50-60 kg and has 12 actuators for mobility. The wheel driving, steering, and suspension mechanisms are driven independently. The robots can perform multiple locomotion modes and also perform multiple construction tasks (e.g., in-situ investigating, bulldozing, and compacting) using various working tools retrofitted to the cargo space in the middle of the vehicle body. In addition, as distinctive subsystems, this paper shows the mission-resilience technology and a new concept of inflatable bags using aerogels as a function of sandbags.

OS6-2 Proposal and Experimental Validation of a Wheeled Centipede-inspired Navigation Robot in 3D Unknown Environments: Harnessing Environmental Interactions by Modulating Body Rigidity

Runze Xiao, Yusuke Tsunoda, Koichi Osuka
(Department of Mechanical Engineering, Osaka University, Japan)

In navigating robots through rugged, three-dimensional (3D) unknown terrains, robots often require complex control and sensing systems to avoid and counteract what are often seen as "obstacles". Contrasting these conventional approaches, our study posits a novel perspective, viewing the environment as an "assistant". This method involves a centipede-like robot that dynamically adjusts its rigidity, using environmental interactions beneficially for navigation without needing obstacle detection or path planning. Specifically, the robot softens to yield and bypass insurmountable obstacles and stiffens to prevent sliding when climbing slopes, effectively navigating complex 3D environments by leveraging environmental elements. Experiments in environments with walls and mountains demonstrate this method's effectiveness.

January 25 (Thursday), 16:05-17:35

OS6-3 ROS2-TMS for Construction: CPS platform for earthwork sites

Ryuichi Maeda[1], Kohei Matsumoto[1], Tomoya Kouno[1], Tomoya Itsuka[1], Kazuto Nakashima[1], Yusuke Tamaishi[1,2], Ryo Kurazume[1]
([1]Kyushu University, Japan)
([2]Tamaishi Juki Co., Ltd., Japan)

In this study, we propose ROS2-TMS for Construction which is a Cyber-Physical System aiming to improve both efficiency and safety of earthwork operations. The system collects on-site environmental information, stores it in a database, and visualizes it in VR. In this paper, we introduce the developed system of ROS2-TMS for Construction and experiments conducted to verify the performance of the proposed system. The proposed system successfully collected environmental information and allowed us to confirm it in VR during the earthwork operation and we confirmed having both the CG and camera scene enabled a more comprehensive understanding of the on-site conditions.

OS6-4 Estimating Soil Moisture Content Considering Environmental Changes Using Thermal Camera

Ryuki Yoshida, Takuya Funatomi, Yasuhiro Mukaigawa
(Nara Institute of Science and Technology, Japan)

We propose a method of estimating soil moisture content using a thermal camera. We focus on heat conduction as a non-contact observable quantity that reflects moisture content in soils. Soil with high moisture content has a greater specific heat, resulting in less temperature change compared to dry soil. By utilizing a reference object which is the same soil as the target with 0% moisture content, we estimate relative moisture content based on temperature change of the reference object. We calculate the covariance with the reference object to evaluate the similarity of the temperature changes. This covariance can be affected by the absolute temperature difference in long-time measurements. To remove this effect, we also calculate the covariance of the derivative of the temperature. In the experiment using soils with different moisture contents, high precision estimation was confirmed. In the outdoor experiment on real ground, the visual moisture map was obtained.

January 25 (Thursday), 16:05-17:50

Room B

OS11 AROB: Intuitive Human-System Interaction

Chair: Masao Yokota (Fukuoka Institute of Technology, Japan)
Co-Chair: Naoto Iwahashi (Okayama Prefectural University, Japan)

OS11-1 World-Grounded vs. Wearable: A Comparative Analysis of Kinesthetic Haptic Feedback Devices for Fine Telemanipulation Task in Virtual Reality

Kumar M. Swami[1], Kiona Hosotani[2], Farhad Shabani[1], Sajid Nisar[1]
([1]Kyoto University of Advanced Science, Japan)
([2]Kyoto University, Japan)

This research compares the performance of the wearable haptic device with the gold standard, which is a world-grounded haptic device (sigma.7). For this purpose, we have designed a fine telemanipulation task (stacking of three identical cubes) using a wearable device (Dexmo, Dexta Robotic Inc.) in Unity 3D and for the world-grounded master haptic device (sigma.7, Force Dimension Inc.) with CHAI3D VR framework. The task accuracy, measured in terms of the x-y alignment of cubes, as well as completion time, was recorded. Additionally, subjective ratings were gathered through a post-study questionnaire. The findings indicate that the world-grounded device yields highly accurate performance, with a minimal positioning error of approximately 0.61 mm. Conversely, the wearable device demonstrates slightly lower accuracy, around 1.4 mm; nevertheless, this falls within an acceptable range for executing fine telemanipulation tasks. Furthermore, we deduced that the wearable device exhibits enhanced performance when users utilize a head-mounted display for interaction within the virtual reality environment and the positioning error was 0.75 mm. This pilot experiment is based on the results of only five subjects. In the future step, we plan to conduct a full-scale user study to obtain generalizable results.

OS11-2 Abnormal Detections by MQTT-Drain Method Considering Scalability of IoT Sensors for Early Landslide Warning System

Noriki Uchida[1], Tomoyuki Ishida[1], Hiroaki Yuze[2], Yoshitaka Shibata[3]
([1]Fukuoka Institute of Techonology, Japan)
([2]Shizuoka Prefectural University, Japan)
([3]Iwate Prefectural University, Japan)

Recent disasters, such as landslides and floods caused by heavy rain, have raised significant concern around the world, prompting the need for quick and efficient response methods. However, a number of IoT sensors would be needed to observe mountains or rivers for early emergency warnings, and so the processes of abnormal detection should be quick and applicable to various types of sensor logs. Therefore, this paper proposed abnormal detections by MQTT-Drain Method. In detail, the generated IoT data logs are parsed by the MQTT-Drain method, and the data within each tree is prioritized according to variance values derived using the cloud-based real-time AI modules such as AWS CloudWatch or GCP Dialogflow. This paper finally reports the implementations of the prototype system, and the experimental results demonstrate that the logs are appropriately categorized into the respective trees, suggesting that the proposed methods effectively worked.

January 25 (Thursday), 16:05-17:50

OS11-3 Development of a Virtual 3D Scanner for Data Augmentation in Point Cloud Shape Recognition

Hiroki Takahashi[1], Toru Kato[1], Meguru Yamashita[1], Akio Doi[1], Takashi Imabuchi[2]
([1]Iwate Prefectural University, Japan)
([2]Japan Atomic Energy Agency, Japan)

When performing shape recognition using machine learning from point cloud data, data expansion can be expected to improve accuracy. In this research, we developed a virtual 3D scanner, VCC (Virtual Cloud Creator), that automatically generates data with a distribution close to actual measurement from large-scale point clouds. VCC can generate labeled point cloud data with an appropriate point cloud density from any viewpoint using 3D measured point cloud data and CAD data created from the point cloud data. It was confirmed that shape recognition accuracy was improved by using the augmented data generated by VCC for learning.

OS11-4 Development of time-series point cloud data changes and automatic structure recognition system using Unreal Engine

Toru Kato[1], Hiroki Takahashi[1], Meguru Yamashita[1], Akio Doi[1], Takashi Imabuchi[2]
([1]Iwate Prefectural University, Japan)
([2]Japan Atomic Energy Agency, Japan)

We have researched and developed a point cloud processing system on the Unreal Engine that recognizes changes between large time-series point cloud data measured by a laser scanner and performs structured data extraction. When associating time-series point cloud data with structural information (pipes, tanks, etc.) of each point cloud, CAD data (structural data) is currently created interactively by humans. Unreal Engine is a game engine that excels in visualization of 3D information and is suitable for checking updated data and automating procedures. We developed a user interface that automatically performs a series of update procedures at the touch of a button, and evaluated the effectiveness of the interface.

OS11-5 Development of a semi-automatic alignment system for fractured bone shapes

Wang Mengze, Hiroki Takahashi, Toru Kato, Dai Ying, Akio Doi
(Iwate Prefectural University, Japan)

This study aims to assist in preoperative planning for fracture treatment and treatment with fracture plates. Isosurface generation is used to extract bones from CT images, but the user had to interactively provide the bone constant C. This constant C was calculated using regression with deep learning, and its accuracy was compared with conventional methods. Next, the fractured bone surface was polygonized using this threshold C, and the polygon model of the fractured bone was automatically restored to its original normal state. Specifically, point cloud data was generated from the vertex information of the isosurface, and only the point cloud data of the fractured bone cross-section was extracted. This was then aligned using the Iterative Closest Point (ICP) method. Furthermore, this method was applied to a case of clavicle fracture to evaluate its effectiveness.

January 25 (Thursday), 16:05-17:50

OS11-6 A study on analysis and visualization of emotional changes of posters on SNS for supporting female cancer

Yasuo Ebara[1], Mizuki Nagano[1], Masahiko Sakaguchi[1], Nobuko Ueda[2], Kayoko Katayama[3]
([1]Osaka Electro-Communication University, Japan)
([2]Peer Ring Association, Japan)
([3]Gunma University, Japan)

Recently, many cancer patients feel pain and hesitation in making their own choices, and peer support is one of the solutions to this problem. Peer support is a support system in which cancer survivors share various know-how with each other and support each other by sharing their distress and way of life with others who have the same problems. In recent years, in addition to peer support by face-to-face, SNS services that enable online communication using the Internet have become widespread. As a way to reduce the anxiety and worries of cancer patients, it is important to spread the peer support through online communication using SNS. In this paper, we conducted an analysis using visualization on the emotional changes of posters in the post articles on Peer Ring, SNS for supporting female cancer. From these analyses, it can be seen that the majority of the posts were related to the emotions of yorokobi (joyful) and iya (mislike). In addition, posters could be classified into seven groups, with the same posters having the same number of representative emotions in the top 1 to 3.

OS11-7 Performance Evaluation of Video Scene Segmentation Approach to Visualize Learner Behaviors

Kaoru Sugita
(Fukuoka Institute of Technology, Japan)

Recently, many companies and universities have introduced teleworking and distance learning using video conference systems. Also, these systems are introduced to education and learning. However, during operation of these systems, the participants or learner may not watch the video because they have also other tasks. For this reason, we have developed some prototype systems for monitoring learner behavior at watching learning content. Our systems could recognize viewing of learning content and measure the viewing time, but it could not distinguish between learning activities (e.g. taking notes or inputting answers for quiz) and side tasks. In our previous work, we have proposed a scene segmentation recorded a learner during viewing a learning content. In this scene segmentation, we used a correlation matrix among all frames, but this process required more processing time than was realistically available. In this paper, we evaluate a processing time for calculating a video correlation matrix controlling frame rate and frame size.

January 25 (Thursday), 16:05-17:35

Room C

OS17 AROB: System Sensing and Its Applications 2

Chair: Tota Mizuno (The University of Electro-Communications, Japan)
Co-Chair: Hirotoshi Asano (Kogakuin University, Japan)

OS17-1 Physiological and Psychological Evaluation during Exposure to Blue Light with Different Bandwidths

Shun Kamiko, Hirotoshi Asano
(Kogakuin University, Japan)

This presentation delves into experiments exploring the impact of blue light-emitting diodes (LEDs) on sleep quality, with a focus on wavelength bandwidth. The study exposed subjects to blue LED light in a dark room, monitoring physiological parameters. Comparison of broadband and narrowband blue LED lights revealed that narrow-band light had fewer adverse effects on sleep, indicating wavelength influence on human physiology. The results highlighted the significant impact of blue LEDs on circadian rhythms, with narrow-band light potentially mitigating these effects. However, the study acknowledges challenges in addressing narrow-band blue light in combination with other wavelengths. In conclusion, the experiment emphasizes the importance of considering wavelength bandwidth in LED blue light for its profound effects on sleep and human physiology.

OS17-2 An exploratory study of regression methods for blood glucose estimation based on near-infrared facial images with wavelengths ranging from 760nm to 1650nm.

Mayuko Nakagawa[1], Kosuke Oiwa[2], Yasushi Nanai[3], Kent Nagumo[1], Akio Nozawa[1]
([1]Aoyama Gakuin University, Japan)
([2]Nagaoka University of Technology, Japan)
([3]National Defense Academy of Japan, Japan)

We have attempted to construct individual and general models for blood glucose estimation by linear regression using the weights of spatial features of facial images measured in the near-infrared wavelength range of 760-1650 nm, which is highly biopermeable, to establish a remote minimally invasive blood glucose measurement method. As a result, the accuracy of blood glucose estimation in the generalization performance evaluation was 32.23 mg/dL RMSE for the individual model and 43.02 mg/dL RMSE for the general model. Since biological information is nonlinear, it is necessary to explore suitable modeling methods for blood glucose estimation, including not only linear regression but also nonlinear regression. The purpose of this study is to explore suitable regression methods among linear and nonlinear regression methods to construct a blood glucose estimation model based on facial images with wavelengths from 760 nm to 1650 nm.

OS17-3 Regression Modeling Using Spatial Features in Facial Thermal Images for Chronic Stress Estimation

Miyu Kimura, Masahito Takano, Kent Nagumo, Akio Nozawa
(Aoyama Gakuin University, Japan)

Mental stress is one of the most common causes of poor physical health. Daily measurement of mental stress is necessary to understand the health status of individuals and to provide appropriate counseling. However, the conventional method of measuring cortisol has the problem that the measurement is time-consuming. Facial skin temperature, on the other hand, can be measured quickly and easily using an infrared thermography camera. In a non-windy, non-sweat-inducing thermal environment, skin blood flow is the primary factor in skin temperature formation. Skin blood flow fluctuates depending on autonomic nervous system activity and other factors, and psychological stress affects autonomic nervous system activity. Therefore, the objective of this study was to evaluate the relationship between mental stress and facial skin temperature distribution. First, facial thermal images and four psychological questionnaires were measured. Next, multiple regression analysis was used to evaluate the relationship between facial skin temperature distribution and psychological stress.

January 25 (Thursday), 16:05-17:35

OS17-4 A Statistical Method for Estimating Autonomic Nervous Activity Using Real Face Images with High Robustness

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

In this study, we investigate a method to quantitatively and robustly remove the effects of light intensity, such as reflections and shadows, in capturing changes in blood flow from real images. We have developed a method to obtain autonomic nerve activity and surface skin blood flow dynamics using real images. In our previous study, we were concerned about the accuracy of the method because it included pixels affected by light intensity, such as blown out highlights and blocked up shadows. Therefore, we have studied several methods to remove the effects of light intensity, but we have not been able to devise a method that is both quantitative and reasonable based on the nature of light intensity. In this study, we propose a weighting method for the data to be used as a new analysis method focusing on the nature of the effect of light intensity, based on the results of the previous studies. Analysis using the proposed method was able to reduce the effect of changes in light intensity caused by large facial movements. However, it was also clear that the degree of reduction depended on the pixel distribution trends. By improving the issues raised based on the results obtained, we will attempt to improve the method to reduce the effect of light intensity regardless of the quality of the data.

OS17-5 12-lead ECG synthesizer based on MQTT standards

Masanori Shiro[1], Yu Sekiguchi[1], Rina Kagawa[2], Hiroshi Sato[1]
([1]AIST, Japan)
([2]Tsukuba University, Japan)

Since electrocardiogram (ECG) is essential data for the diagnosis of cardiac diseases such as myocardial infarction and arrhythmia, residents and students need to view many ECGs during their education as physicians and nurses. However, medical data are sensitive human information and cannot be easily shared. In this study, we proposed a mathematical model to synthesize 12-lead ECG waveforms, which had not been achieved in previous studies, by introducing new parameters to the model proposed in previous studies. Furthermore, we implemented a system for on-time communication of 12-lead ECG waveforms synthesized by our proposed model over the Internet, and succeeded in communicating 12-lead ECG waveforms. In the future, it is necessary to optimize the parameters of the proposed model to enable the synthesis of various 12-lead ECG waveforms affected by disease and exercise.

OS17-6 Analysis of Feather Muscle Using Multichannel Surface Electromyography with Electrodes Capable of Measuring in Multiple Directions

Kohei Okura, Tota Mizuno, Kazuyuki Mito, Naoaki Itakura
(The University of Electro-Communications, Japan)

We have developed the m-ch method to derive the conduction speed of action potentials of muscle fibers and the amount of muscle activity using surface electromyography and have elucidated the detailed muscle contraction mechanism of the biceps brachii muscle, which is a parallel muscle, using ladder-type electrodes. However, the triceps muscle is difficult to measure EMG using conventional ladder-type electrodes because its muscle fibers are not parallel to each other. In this study, we proposed an electrode that can measure multiple directions and attempted to elucidate the muscle contraction mechanism of the pinnatus muscle. Comparison was made in terms of the number of conducting waves extracted at the medial head of the gastrocnemius muscle. The experimental results suggest that the use of two patterns of angular fixation frames allows for more detailed estimation of muscle fiber direction.

January 25 (Thursday), 16:05-17:20

Room D

OS15 AROB: Robotics with Intelligence and/or Informatics

Chair: Mamoru Minami (Okayama University, Japan)
Co-Chair: Tetsuya Kinugasa (Okayama University of Science, Japan)

OS15-1 Experiments of approach posture to divided virtual grid space in work space on automatic harvesting robot

Mizuki Goto[1], Takeshi Ikeda[1], Masanori Sato[2], Seiji Furuno[3], Fusaomi Nagata[1]
([1]Sanyo-Onoda City University, Japan)
([2]Nagasaki Institute of Applied Science, Japan)
([3]National Institute of Technology, Kitakyushu College, Japan)

We proposed a harvesting method that without strict positioning, uses a grid space to perform harvesting behavior based on rough positioning. This method uses a wrapping and grasping hand and multi-linked arm robot arm. Since one of grid space means that the arm's workspace is divided into some grid spaces, the variations of hand positions included in each grid space are different. And numerical analysis has been used to evaluate the variations in approach angles of the robot hand and the utility value of grid space. In this study, we show some experiment results that confirmed the approach to the grid space variable posture.

OS15-2 Categorizing the work area for an autonomous robot harvesting the tomato

Kazuki Morita[1], Takeshi Ikeda[1], Masanori Sato[2], Seiji Furuno[3], Fusaomi Nagata[1]
([1]Sanyo-Onoda City University, Japan)
([2]Nagasaki Institute of Applied Science, Japan)
([3]National Institute of Technology, Kitakyushu College, Japan)

The decline and aging of the workforce have not been halted, and labor shortages have become a serious problem. To solve this problem, smart agriculture is expected to utilize advanced technologies such as robots, AI, and IoT in agriculture. Then, tomato recognition is performed by capturing images from an RGB-D sensor, detecting red from the color information in the images, and detecting circles in the red area. To automate tomato harvesting, the robot must perform the harvesting task as thoughtfully as a human would. To achieve this, image processing is required so that the automatic harvesting robot can preferentially harvest tomatoes that are easy to harvest, instead of mainly harvesting tomatoes that are easy to recognize by the camera. In this paper, we proposed the image processing strategy which divided the tomato trellis into equal sections and evaluated and ranked each section of the trellis.

OS15-3 Visual Feedback Systems for Camera Assistant Robots with AI

Motoki Akazawa[1], Kosuke Arai[1], Rina Karasawa[2], Yusuke Kobayashi[2], Masatoshi Hatano[2]
([1]Graduate School, Nihon University, Japan)
([2]Nihon University, Japan)

The purpose of this study is to construct a visual feedback system for accurate recognitions of target objects with AI (artificial intelligence) object detection algorithm for surgical assistant robots. In the currently, minimally invasive endoscopic surgery required three doctors. However, there is a problem of a decrease in the number of surgeons and medical personnel. Surgical robots have been released as a solution to this problem but they are expensive. Then, we focused on works of assistant doctors to hold the camera who performs to track the target objects and to secure the whole surgical field. Thus, in this report, it is shown that the pseudo gallbladder as the target object was detected with the YOLACT and the camera assistant robot could be controlled with the visual servo system.

January 25 (Thursday), 16:05-17:20

OS15-4 Optimal Posture for Improving Hand Generating Forces Using Genetic Algorithm

Kosuke Arai[1], Shimon Matsuzaki[2], Yuya Motohashi[2], Masatoshi Hatano[2]
([1]Graduate School, Nihon University, Japan)
([2]Nihon University, Japan)

This study is to propose a method to determine an optimal posture of a robot consisting with a mobile robot and a mounted manipulator for improving hand generating forces using GA (Genetic Algorithm). There are several types of machines that combine mobile robots and manipulators, such as rescue robots that remove rubbles lying on victims or open doors in damaged buildings while performing exploratory activities, logistics robots that perform tasks such as delivery, unloading and picking while moving around factories, surgery robots in hospitals and so on. Such robots are limited in size for the convenience of operating in a variety of environments. There are cases that it is difficult to generate sufficient forces with only manipulators because of limited size, then we considered to utilize torques from sub-clawers to improve forces generated by the hand. Experiments were performed to clarify relationships between simulations and experiments.

OS15-5 Can Dinosaurs' Hindlimbs Maintain their Stance Posture Using the Passive Interlocking Mechanism Confirmed in Crocodilian Hindlimbs?

Kazuki Ito[1], Tetsuya Kinugasa[2], Tsukasa Okoshi[2], Kaito Kimura[1], Kentaro Chiba[2], Ryuji Takasaki[3], Damdinsuren Idersaikhan[4], Ryota Hayashi[2], Koji Yoshida[2], Koichi Osuka[1]
([1]Osaka University, Japan)
([2]Okayama University of Science, Japan)
([3]University of Toronto, Canada)
([4]Mongolian Academy of Sciences, Mongolia)

This report addressed the stance mechanism in a non-avian dinosaur Protoceratops andrewsi hindlimbs using a robotic approach. Our previous studies demonstrate the passive interlocking mechanism in crocodilian hindlimbs is crucial to achieving their standing motion. We verified the importance of the passive mechanism by implementing artificial musculotendinous systems, following the inference derived from crocodilians, onto a 3D printed physical model of the Protocereatops skeleton. The experiments validated the feasibility of achieving the stance posture of Protoceratops through the interaction between the artificial musculoskeletal tendinous system and ground reaction forces in a similar manner to crocodilians. This report highlights constructing a physical model with artificial musculotendinous systems is a valuable platform for exploring locomotion in extinct animals.

January 25 (Thursday), 16:05-17:35

Room E

GS8 Bio-inspired robotics III

Chair: Shuhei Ikemoto (Kyushu Institute of Technology, Japan)

GS8-1 Soft Cylindrical Robot : NEJIRIⅡ- New locomotion pattern to overcome steps and bumps-

Kota Sakakibara, Kazuyuki Ito
(Hosei University, Japan)

Soft robots with structural flexibility have increasingly been gaining attention. Previously, we developed a planar-moving soft cylindrical robot—NEJIRI—that utilizes the changes in the center of gravity due to the twisting of its body composed of a soft flexible bellows hose. This robot realizes forward and backward movements, lateral movements, turning, and locomotion within pipes. In this study, we developed an improved robot, NEJIRI II, which employs a new locomotion pattern. In the proposed locomotion pattern, the soft cylindrical robot curves its body to move its center of gravity and overcome steps and bumps. We demonstrated the effectiveness of the proposed mechanism and the new locomotion strategy through experiments wherein the robot overcame steps and a rough terrain. The robot equipped with the proposed locomotion pattern succeeded not only in conventional planar movement using a twisting motion but also in overcoming steps and a rough terrain.

GS8-2 Plant-Symbiotic Robot Skin That Increases in Rigidity as The Plant Grows

Kodai Ochi, Mitsuharu Matsumoto
(The University of Electro-Communications, Japan)

Robot skin is an important factor that determines the appearance and rigidity of robots and is being actively researched. Although a variety of robot skins have been developed, they basically have the best performance when new, and even if the skin is self-healing, the strength after restoration will not exceed the new one. In contrast, organisms and plants can greatly improve their performance as they grow from birth. In this study, we aim to overcome the limitations of conventional robots by incorporating plants into robots and propose a plant-symbiotic robot skin that increases compressive stress, taking advantage of the rapid growth of plant shoots. To check the potential of our concept, we have grown several plants hydroponically on soft materials for about one month. As the results of compressing tests after growing, we were able to confirm that growing peas on soft materials predominantly increased compressive stress.

GS8-3 Dynamics Analysis of a Harnessless Microrobot with Battery Drive

Misaki Takaku, Yifan Yang, Koki Takasumi, Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

The purpose of this study is to compare the effects of different battery loading methods on microrobots, and the walking behavior of several models is compared by simulation. The three microrobot models used in the simulations are one with an external power supply, one with the battery equipped on the top plate, and one with the battery mounted on a dolly and traction on the main body. The shape and components of the main robot body are identical in all models. The simulation results confirmed that the battery equipped model walked with under 0.98g battery weight. The model with the battery in traction walked stably from a battery weight under 4.9 g. When the legs of the microrobot touched the ground with the battery weight of 0.98g, the force applied from the ground to the leg tips of the traction model was about half that of the equipped model.

January 25 (Thursday), 16:05-17:35

GS8-4 Design and Kinematic Evaluation of a 5-DoF Robotic Surgical Instrument

Cameron Crane[1], Nicholas Johannessen[1], Joshua Kleiman[1], Calvin Page[1], Adam Powell[1], Yihao Zheng[1], Sharon Johnson[1], Sajid Nisar[2]
([1]Worcester Polytechnic Institute, United States)
([2]Kyoto University of Advanced Science, Japan)

This research presents the design refinement and prototype development of a 5-Degrees-of-Freedom (DoF) robotic surgical instrument for Robot-Assisted Minimally Invasive Surgery (MIS). Instruments with many degrees of freedom and distinct kinematic layouts can operate inside obstructed areas and overcome the limitations of existing solutions. The mechanical and kinematic design of the system is described with considerations for surgical use and prototyped using biocompatible polymer-based rapid prototyping materials. Five DC-motor actuators drive the surgical instrument mounted on pulleys at the distal end, capable of actuating each joint independently through cable-driven transmissions. This work presents the design and validation of mechanisms responsible for achieving actuation in each degree of freedom. Additionally, we implement a teleoperated control system and describe the results and observations of system motion tests. Future work involves improving the design to overcome current limitations and integrating the instrument as an end-effector on a surgical manipulator for future tests.

GS8-5 Dynamics Studies of Actuator Characteristics for Walking of Musculoskeletal Humanoid Robot Controlled by Artificial Neural Network

Kentaro Yamazaki, Takumi Ishihama, Tatsumi Goto, Rina Okamoto, Yugo Kokubun, Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

Conventional biped robots use CPUs and software to control motors. The complex numerical calculations required for this process require high-performance CPUs with high power consumption. Humans use a Central Pattern Generator (CPG) localized in the spinal cord to generate basic motor patterns, and muscle synergy that coordinates multiple muscles to generate complex and efficient movements. In order for a robot to mimic human musculoskeletal structures and reproduce walking movements, muscle parameters are required. In this paper, inverse dynamics analysis is used to obtain the muscle displacements and forces required for the musculoskeletal humanoid model to walk, and forward dynamics analysis is used to examine the values.

GS8-6 Actuator for Endoscope-Connected Microrobot Driven by Compressed Carbon Dioxide Gas

Takamichi Funakoshi, Yuuya Niki, Kouki Takasumi, Chise Takeshita, Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

The number of cancer patients is increasing worldwide and it is a leading cause of death. Colorectal cancer, which is particularly common, can be cured with early treatment, and endoscopic treatment is used to reduce the physical and mental burden on doctors and patients. We have previously developed millimeter-scale quadrupedal and hexapedal MEMS microrobots using MEMS (Micro Electro Mechanical Systems) processes. However, there were some difficulties, such as the need to supply power to the robot's drive source in order to insert it into the large intestine. This paper presents the development of a micro-rotary actuator that uses compressed air instead of electric power. The size of the actuator was 5.17 mm × 5.13 mm × 1.96 mm, and the maximum torque was 0.0039 Nmm. Also shown is a self-propelled robot with Reuleaux triangular wheels attached to the actuator. The size of the robot was 7.59mm x 6.49mm x 7.59mm, and the maximum speed was 73 mm/s.

January 25 (Thursday), 16:05-17:50

Room F

GS17 Machine learning III

Chair: Hideo Miyachi (Tokyo City University, Japan)

GS17-1 Leg Fault Detection for a Hexapod Robot using Machine Learning

Takahiro Yamasaki[1], Eiho Uezato[2]
([1]Graduate school of Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

This study aimed to detect leg failures during the walking of a hexapod robot. A one-dimensional Convolutional Neural Network (1D-CNN) with supervised learning was applied to identify leg failures from motion sensor data. Time-series data were collected using an Inertial Measurement Unit (IMU) attached to the torso of the hexapod robot. The collected time-series data consisted of time, 3-axis acceleration, and 3-axis angular velocity during walking. The training data were created such that there was an overlap in some parts of the data. The training model was built using the TensorFlow software. Finally, the robot was traversed by an actual hexapod robot to verify on flat ground whether the learned model could discriminate a broken leg.

GS17-2 How much emotional information the distributed representations of tweets in SNS preserve

Osamu Maruyama, Asato Yoshinaga, Ken-ichi Sawai
(Kyushu University, Japan)

In our communication, emotional information is an important factor. We have considered three different schemes to generate embedding vectors of tweets in social media. The embedding generators are based on word2vec, pre-trained BERT model, and fine-tuned BERT model. We found that these embedding vectors preserve the emotional information in different degrees.

GS17-3 Transforming Neural Ordinary Differential Equations into Interpretable Sparse Expressions via Identification of Nonlinear Dynamics under General Dynamical Constraints

Yuya Note, Toshiaki Omori
(Kobe University, Japan)

Current deep learning models, while powerful, lack interpretability due to their black-box nature. This hinders their deployment in real-world applications. Neural ordinary differential equations (neural ODEs) have shown great potential in modeling dynamic systems, but their black-box nature poses challenges for understanding their internal dynamics. This work addresses this by proposing an enhanced model that leverages sparse modeling with a nonlinear dynamical system to extract and interpret the latent dynamics within pretrained neural ODEs. Our approach utilizes generalized dynamic constraints to achieve accurate estimation of the nonlinear dynamics and state behavior inherent in the neural ODE outputs. Compared to conventional methods, our model offers improved identification of basis functions and coefficient estimates, leading to a clearer understanding of the learned dynamics. This paves the way for optimizing and interpreting neural ODEs while maintaining high accuracy, opening up new possibilities for their application in real-world scenarios.

January 25 (Thursday), 16:05-17:50

GS17-4 Data-driven Estimation of Neuronal Network Structure with Biologically Plausible Connectivity Prior

Tsubasa Shoji, Toshiaki Omori
(Kobe University, Japan)

Revealing the network structure in brain is one of the important subjects for understanding brain functions. In this study, we propose a data-driven method for estimating neural network structure with biologically plausible connectivity prior. Our approach combines latent variable estimation through a sequential Monte Carlo method and network estimation based on physiological knowledge. The experimental results showed that the proposed method outperforms conventional methods in accurately estimating network structures. Additionally, the network structure estimated by the proposed method was accurately predicted, while the network obtained using the conventional method failed to reproduce correct network responses.

GS17-5 Estimating of Spatial Input Currents in Morphological Neuron Models by Data-driven Approach

Hirozo Nakano, Toshiaki Omori
(Kobe University, Japan)

It is important to estimate spatial structure of input currents for neurons in order to clarify spatiotemporal information processing in single neurons. One of the neuron models, the multi-compartment model has spatial electrical properties and accurately reproduce spatiotemporal electrical dynamics. In this study, we propose a data-driven method for estimating spatiotemporal input currents in the multi-compartment model from noisy membrane potentials. The propose method is based on sequential Monte Carlo method using simultaneous graphical auto-regressive models. Simultaneous graphical auto-regressive models assume that latent variables at each different position have strong spatial correlation as the geographical distance between two variables decreases. Finally, we verify the effectiveness of the proposed method by using simulation data under the situation where noisy membrane potentials are observable.

GS17-6 Estimation of Golf Ball Initial State Using Linear Basis Expansion with Line Scan Camera - Verification of Estimation Accuracy in Relation to Convergence-Divergence of Ball Trajectory via Basis Functions in Feature Space

Kazuma Yahata, Yuri Hamada, Yosuke Kurihara
(Aoyama Gakuin University, Japan)

In machine learning, handling nonlinear data involves using basis expansion on training data to create a nonlinear feature space model of the explanatory variables. The condition for a feature-space model obtained by basis expansion is that the distribution of features after basis expansion must be convergent. The authors estimated the initial state of a golf ball in screen golf using a linear basis expansion method. However, the estimation accuracy was compared using the amplitude and phase by Fourier transform and Gaussian, sigmoid, sine, and cosine functions as basis functions, the feature distribution in the model obtained from basis expansion can vary based on the chosen basis functions, leading to reduced estimation accuracy. This study concentrates on the feature space model post-basis expansion, comparing the convergence of feature distributions using different basis functions.

January 25 (Thursday), 16:05-17:50

GS17-7 The Effect of Face Orientation on Facial Standardization Using FaceMesh Feature Landmarks in Facial Thermal Images

Atsushi Yoshida, Masahito Takano, Kent Nagumo, Akio Nozawa
(Aoyama Gakuin University, Japan)

In recent years, the needs for remote and quick drowsiness estimation have been increasing and this technology using facial skin temperature distribution, FSTD have been attempted. In these studies, facial thermal images were converted into same face using 68 facial feature landmarks, FFLs to standardize vascular structures. However, this preprocessing requires subjects photographed from the front because the range of the side of the face included in the image changes when the face orientation changes. For estimation models based on FSTD, standardization errors have a significant impact on model accuracy, so a technology for generating high-definition standard face images is needed. By using FaceMesh, a model that extracts 478 3D FFLs from a 2D face image, it is expected that the effect of changes in the orientation of the face can be reduced. In this study, the effect of face orientation on standard face generation using FaceMesh has been evaluated.

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

Room A

GS21 Motion planning and navigation

Chair: Masatoshi Hatano (Nihon University, Japan)

GS21-1 Robots Reading Recipes: Large Language Models as Translators Between Humans and Machines

Oliver Wang[1,3], Grant Cheng[2,3], Luc Caspar[3,4], Akira Yokota[3,4], Mahdi Khosravy[3,4], Olaf Witkowski[3,4]
([1]University of California, Los Angeles, United States)
([2]University of California, San Diego, United States)
([3]Cross Labs, Japan)
([4]Cross Compass, Japan)

Large Language Models (LLMs) are a type of machine learning model trained on vast amounts of natural language that have demonstrated novel capabilities in tasks such as text prediction and generation. These tasks allow LLMs to be remarkably suited for understanding the semantics of natural language, which in turn enables applications such as writing code for computers and translating between human languages. Their capabilities for translating natural language instructions into code to control robots is only starting to be explored. We show that it is feasible for LLMs to perform these translations on a small number of custom modules for manipulation of cocktail ingredients. We use natural language parsers and an ensemble-voting strategy to provide a measurable benefit to the accuracy of this task without fine-tuning. These findings could provide directions for implementing LLMs more effectively and broadening the accessibility of robotic control to users without an extensive software background.

GS21-2 Self localization system for automatic berthing using UWB

Kaito Nakamura, Etsuro Shimizu
(Tokyo University of Marine Science and Technology, Japan)

In Japan's maritime industry, autonomous vessel technology is being developed to improve safety, address crew shortages, and ease urban traffic congestion. In particularly, because the waterways are notably narrow in urban areas, small vessels are utilized. Therefore, autonomous, and remote-control technologies are expected to be used for vessels other than large vessels too. An essential technology for vessel automation is precise self localization; GNSS is the primary method for achieving this, but in urban areas, obstacles prevent positioning. Therefore, we turned our attention to UWB as another positioning method, which is said to be capable of ranging with centimeter-level accuracy. We developed an iPhone application and investigated whether UWB could be used for takeoff and landing operations, which require particularly precise maneuvering of vessels.

GS21-3 Neural-Network-Driven Method for Optimal Path Planning via High-Accuracy Region Prediction

Yuan Huang, Cheng-Tien Tsao, Tianyu Shen, Hee-Hyol Lee
(Graduate School of Information, Production and Systems, Waseda University, Japan)

Sampling-based path planning algorithms suffer from heavy reliance on uniform sampling, which accounts for unreliable and time-consuming performance, especially in complex environments. Recently, neural-network-driven methods predict regions as sampling domains to realize a non-uniform sampling and reduce calculation time. However, the accuracy of region prediction hinders further improvement. We propose a sampling-based algorithm, abbreviated to Region Prediction Neural Network RRT* (RPNN-RRT*), to rapidly obtain the optimal path based on a high-accuracy region prediction. First, we implement a region prediction neural network (RPNN), to predict accurate regions for the RPNN-RRT*. A full-layer channel-wise attention module is employed to enhance the feature fusion in the concatenation between the encoder and decoder. Moreover, a three-level hierarchy loss is designed to learn the pixel-wise, map-wise, and patch-wise features. A dataset, named Complex Environment Motion Planning, is established to test the performance in complex environments. Ablation studies and test results show that a high accuracy of 89.13% is achieved by the RPNN for region prediction, compared with other region prediction models. In addition, the RPNN-RRT* performs in different complex scenarios, demonstrating significant and reliable superiority in terms of the calculation time, sampling efficiency, and success rate for optimal path planning.

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

GS21-5 Assessing the Impact of Dynamic Image Quantization based on Error Diffusion on Visual SLAM

Siyuan Tao, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

Visual simultaneous localization and mapping (SLAM) has already enabled robots to perform high-precision navigation with visual and inertial sensors. However, improvement in SLAM accuracy comes at the cost of increased memory footprint, which leads to the limitation of long-term operation on devices with restrictive hardware resources. One way to solve the problem is to apply a quantization method, which discretizes each pixel value to a lower quantization level, to the input image. In the paper, we introduced a class of dynamic quantization methods called error diffusion, which is capable of preserving environmental information using quantization error. Compared to the existing quantization methods, error diffusion led to lower localization degradation while preserving the memory footprint for feature-based visual SLAM. We showed that the average memory footprint can be reduced up to 25.19% with almost no localization degradation compared to full-precision input images.

GS21-6 Detection of Obstacles Using Multiple Distance Sensors for Collision-Free Flight

Teklay Asmelash Gerencheal, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

The research is focused on creating a reliable object detection and obstacle avoidance system for indoor drone teleoperation to ensure comprehensive safety in all directions during flight. Drones need advanced collision avoidance systems for secure navigation in indoor environments, and this study employs multiple VL53L5CX Time-of-Flight (ToF) distance sensors placed strategically around the drone to achieve 360-degree coverage. These sensors are cost-effective, compact, and have low power consumption, making them ideal for integration into the drone. The main goal is to enhance drone safety and autonomy by enabling them to autonomously detect and evade obstacles. The VL53L5CX sensors continuously measure distances to objects in all directions, providing real-time data to the drone's flight controller. When an obstacle is detected, the system immediately adjusts the drone's path to avoid collisions, ensuring the safety of the drone and its surroundings. This dynamic obstacle avoidance capability is particularly valuable for indoor inspection applications. The research has implemented and tested this system on various platforms, demonstrating its real-world effectiveness. It showcases the potential of integrating VL53L5CX distance sensors into drone technology, making drones safer and more capable of navigating complex environments. This advancement contributes to the broader adoption and innovation in the drone industry, making autonomous, obstacle-aware drone teleoperation a viable and safe option.

January 26 (Friday), 09:00-10:00

Room B

OS3 AROB: Bio-inspired Theory and Applications

Chair: Kunihito Yamamori (University of Miyazaki, Japan)
Co-Chair: Masaru Fukushi (Yamaguchi University, Japan)

OS3-1 Twin-Encoder Approach for Automatic Video Captioning

Koya Kimura[1], Ryo Saito[2], Kunihito Yamamori[3]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, Japan)
([3]Faculty of Engineering, University of Miyazaki, Japan)

This study enhances video captioning using Transformer models, employing RGB features and Optical Flow from pre-trained I3D. The research evaluates whether sentences generated by cross-attention provide more detailed descriptions of video object movements. Video captioning, reliant on neural networks, faces limitations tied to dataset-dependent accuracy. The proposed model integrates Optical Flow into the Encoder, combining the resulting matrix and RGB features through Cross Attention before feeding into the Decoder for caption generation. Evaluation involves MSVD and MSR-VTT datasets, utilizing BLEU and METEOR metrics, alongside a sensitivity analysis comparing model-generated sentences with correct answers. The study aims to determine if the proposed model outperforms existing approaches, offering more detailed descriptions of video objects within a concise framework.

OS3-2 Fault-Tolerant Routing Method for 2D-Torus Network-on-Chips Based on the Passage of Faulty Nodes

Mizuki Nagao[1], Yota Kurokawa[1], Yasuyuki Miura[2], Masaru Fukushi[1]
([1]Yamaguchi University, Japan)
([2]Shonan Institute of Technology, Japan)

Fault-tolerant packet routing is a key technology for realizing dependable and high-performance Network-on-Chips (NoCs) with hundreds of processing nodes. This paper proposes a novel fault-tolerant routing method for NoCs of a two-dimensional torus topology. Conventional fault-tolerant routing methods have two critical problems; communication latency is significantly increased in detouring clusters of faulty nodes and hardware cost is high due to the use of a lot of virtual channels to prevent deadlocks. To solve those problems, the proposed method allows minimal fully adaptive routing which not only detours faulty nodes but also passes through them. This makes it possible to take minimal paths for any pairs of source and destination nodes in any distributions of faulty nodes. The performance of the proposed method is evaluated by the computer simulations of packet routing and compared with a well-known conventional method. The results indicate that the proposed method reduces average latency by about 96.9% and increases average throughput by about 30.0% with 50% less virtual channels in 2D torus NoCs with 10% faulty nodes.

OS3-3 Investigation of malware classification based on image representation

Hyoga Kawagoe[1], Shotaro Usuzaki[1], Kentaro Aburada[1], Hisaaki Yamaba[1], Tetsuro Katayama[1], Mirang Park[2], Naonobu Okazaki[1]
([1]University of Miyazaki, Japan)
([2]Kanagawa Institute of Technology, Japan)

Malware attacks pose a serious threat not only to individuals, but also to corporations and governments. The ease with which variants of malware can be generated by reusing original code and the scale of these operations place a significant burden on analysts. To simplify the classification of malware, we convert malware binary files into grayscale images and then classify these using a Convolutional Neural Network (CNN). We also apply data augmentation using a Generative Adversarial Network (GAN). Experimental results demonstrate an improvement in classification accuracy after training with the augmented dataset from approximately 66% to about 85%, that is, an improvement of approximately 19 points. Data augmentation is an effective technique in classifying grayscale images of malware using a CNN.

January 26 (Friday), 09:00-10:00

OS3-5 On an improvement of hand gesture recognition for realizing an s-EMG based user authentication using finger spelling

Hisaaki Yamaba, Naoki Sawagashira, Kentaro Aburada, Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)

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, we adopted fingerspelling as candidates of such gestures. We introduced manual kana of the Japanese Sign Language syllabary and selected candidate gestures based on them. And also, an attempt to improve the accuracy of gesture recognition is reported. Three electrode sensors are newly introduced to measure s-EMG signals at four points on the surface of subject's forearm. A series of experiments was carried out to evaluate the performance of the method.

January 26 (Friday), 09:00-10:00

Room D

GS4 Artificial life I

Chair: Federico Sangati (Okinawa Institute of Science and Technology, Japan)

GS4-1 Investigating the Baldwin Effect based on Morphological Plasticity derived from Material Softness

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

We focus on phenotypic plasticity, which is the plasticity of morphology as an immediate physical response to the environment due to the softness of the material, and we would like to investigate its influence on the evolutionary process and present possible evolutionary scenarios. This will extend the concept of the Baldwin effect and establish a methodology for designing soft robots. We used a soft robot design model based on the co-evolution of morphology, materials, and control and observed the Baldwin effect on its plasticity. We showed that the plasticity of morphology generated by the interaction with the environment in a certain trial showed evolutionary behavior based on the Baldwin effect. We also established a measure of the amount of deformation caused by interaction with the environment for each trial and compared the results across generations to examine the relationship between fitness and plasticity.

GS4-2 Inhibition of Convergence of Preys' Mimicry Rings due to Low Learning Abilities of Predators

Takashi Sato[1], Haruto Takaesu[2]
([1]Department of Media Information Engineering,
National Institute of Technology, Okinawa College, Japan)
([2]FIXER Inc., Japan)

Since Müllerian mimicry is more effective the greater the number of species involved, multiple mimicry rings tend to gradually converge into one large mimicry ring, but in nature, mimicry rings often do not converge into a single ring. In this study, we conducted evolutionary simulations based on the hypothesis that “predators with low learning ability cannot learn the patterns of poisonous predators and continue to prey on species that exhibit Müllerian mimicry.” We use two types of agent models: PREY and PREDATOR. Each PREDATOR encounters a PREY randomly at each step, uses its own feed-forward neural network (FFNN) to learn the relationship between the PREY’s pattern and the presence or absence of venom. The PREY decodes its own genes to generate patterns using a modified L-system. Evolutionary simulations showed that the convergence of the mimicry ring is inhibited when the learning ability of the PREDATOR is low.

January 26 (Friday), 09:00-10:00

GS4-3 Seeking open-ended evolution based on CVT-MAP-Elites with dynamic switching between feature spaces

Koki Usui, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

This research investigated a hypothesis that the repeated diversification of various traits of individuals as a result of escaping selection pressure produces more adaptive individuals, which plays a significant role in open-ended evolution (OEE) that leads to innovations. For this purpose, We created a Quality Diversity for Open-ended evolution (QDO) that extended CVT-MAP-Elites. The QDO dynamically repeats the process of switching and exploring feature spaces, which are dynamically generated to promote the diversification of individuals. We chose an evolutionary model of 3D virtual creatures that extended EvoCreature as the target of OEE. They evolve in both morphology and behavior, and they can perceive sounds. We conducted an experiment using the QDO, in which a virtual creature aimed at a sound source by climbing over steps, and also conducted a control experiment using a genetic algorithm. The results indicated that the evolutionary algorithm produced a more adaptive individual while diversifying behavioral characteristics, supporting the hypothesis.

GS4-4 Technological Characteristics and Consumer Responses in Augmented Reality Trials

Shiu-Wan Hung, Jyun-Hao Jian, Jing-Ya Huang
(National Central University, Taiwan)

The integration of Augmented Reality (AR) into everyday life has witnessed substantial growth, with retailers keen to enhance the consumer experience and boost purchasing intent through interactive applications. Particularly noteworthy is the virtual makeup trial service offered by major beauty brands, enabling consumers to immerse themselves in a digital beauty experience. This study primarily investigates the impact of beauty product online AR virtual makeup trials on purchase intentions. Employing the SOR model, AR features serve as precursors, and affective and cognitive responses as intermediary variables to examine their influence on purchase intent. The study employed a questionnaire survey to validate hypotheses through a structural equation model. The findings revealed that, in AR online virtual makeup trials, concerns regarding cognitive responses exert a more significant impact on behavioral intentions than affective responses. This highlights the transformative potential of AR technology in the beauty industry and underscores the importance of creating compelling and rational digital experiences. The study provides practical recommendations for businesses in this context.

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

Room E

GS18 Medical informatics

Chair: Maki K. Habib (The American University in Cairo, Egypt)

GS18-1 Estimation of localized slow wave distribution using bipolar EEG cross-spectrum

Yuto Kitamura[1], Takenao Sugi[1], Yoshitaka Matsuda[2], Satoru Goto[1], Shigeto Nishida[3],
Masao Matsuhashi[4], Akio Ikeda[4], Takashi Nagamine[5]
([1]Graduate School of Advanced Health Sciences, Saga University, Japan)
([2]Institute of Ocean Energy, Saga University, Japan)
([3]Faculty of Information Engineering, Fukuoka Institute of Technology, Japan)
([4]Kyoto University Graduate School of Medicine, Japan)
([5]Sapporo Medical University School of Medicine, Japan)

We have been developing an automatic EEG interpretation system that extracts the characteristics of background activity and paroxysmal abnormality of waking EEG records, like the EEGer's visual inspection. The current system uses earlobe referential EEGs to calculate the slow wave characteristics. Therefore, the system encountered difficulties in its topographical interpretation under earlobe activation by slow waves. This study aims to develop a method to automatically determine the distribution of localized slow waves with earlobe activation using bipolar EEGs. The developed method employed the cross-spectrum of two bipolar EEGs, and then the distribution of slow waves was determined. The accuracy of the developed method was evaluated by comparing the results with those of EEGers. The proposed method judged the EEG data with earlobe activation and obtained the proper result for slow wave distribution. An improvement in accuracy was achieved by comparing it with the conventional automatic EEG interpretation system.

GS18-2 Automatic judgment of EEG continuity using wearable EEG device

Masaki Kinoshita[1], Takenao Sugi[2], Yoshitaka Matsuda[3], Satoru Goto[2], Haruhiko Nohira[4],
Yoshiaki Nakao[4], Michihiro Hyoudo[4], Yuichi Kubota[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]Nihon Kohden Corporation, Japan)
([5]Tokyo Women’s Medical University, Adachi Medical Center, Japan)

Electroencephalographic (EEG) records are essential for assessing brain function but require specialized techniques for electrode placement. However, wearable electroencephalographs can be worn without specialized skills, making EEG records possible in emergency care. We are developing a system that automatically analyzes the characteristics of data recorded by wearable electroencephalographs. The system automatically detects artifacts in the EEG and makes judgments on several essential EEG interpretation items. As a result, we captured rough features from the EEG recorded by the wearable electroencephalograph. However, this system does not consider several essential EEG interpretation items. Therefore, in this study, we developed a method for automatically judging EEG interpretation items that have not been considered. As a result, the judgments were sufficiently accurate in three EEG cases recorded in the ICU.

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

GS18-3 Measurement and Evaluation of Facial Electromyogram for Cough Recognition

Takehito Kikuchi[1], Azumi Okubo[2]
([1]Faculty of Science and Technology, Oita University, Japan)
([2]Graduate School of Engineering, Oita University, Japan)

In this paper, we conducted a basic experiment to verify whether it is possible to estimate the preliminary coughing action from the Electromyogram of facial muscles. Myopotential data were classified using a convolutional neural network (CNN). The preliminary coughing behavior includes facial tension and rapid inhalation, and we considered using electromyography (EMG) to measure the movements of facial muscles that cause these movements and to predict coughing in advance by processing the signals. Five facial muscles were selected. First, facial EMGs are measured. Next, a spectrogram is created from the wavelet transform, and a CNN is used to identify the preliminary action before coughing. Five healthy male subjects in their 20s were recruited. EMG signals were extracted for 1 second before and after the timing of coughing, and spectrogram images were generated by Wavelet. For machine learning, we employed the CNN. The loss function and the percentage of correct responses were evaluated. The experimental results showed that the highest percentage of correct responses was obtained using the oculomotor muscle potentials, with a 95% correct rate.

GS18-4 Disease Estimation Based on Gait Images by Separating Individual Features Using Variational Autoencoder

Shiori Furukawa, Noriko Takemura
(Kyushu Institute of Technology, Japan)

With the ageing of society, the number of patients with gait disturbance is increasing. Lumbar canal stenosis (LCS) and cervical spondylotic myelopathy (CSM) are representative diseases that cause gait disturbance. This study proposes a method to recognize LCS and CSM using the patient's gait video. However, the gait images of a patient contain not only disease features but also individual features such as body shape and hairstyle. Such individual features may reduce the accuracy of disease estimation. Therefore, we aim to achieve highly accurate disease estimation by separating and removing individual features from disease features using a variational autoencoder (VAE). In addition, we performed personal authentication on the latent variables extracted by the proposed method and verified whether it performs the classification of individual features.

GS18-5 A mathematical model demonstrating the dynamic homeostasis of red blood and white blood cells

Koki Ishida[1], Hiroshi Yoshida[1,2]
([1]Faculty of Systems Life Sciences, Kyushu University, Japan)
([2]Faculty of Mathematics, Kyushu University, Japan)

The concept of dynamic homeostasis, maintaining balance at the macro-level , producing and eliminating elements at the micro-level, was explored through a mathematical model using a Lindenmayer system. This system simulated blood cells' behavior, including hematopoietic stem cells, red and white blood cells, and precursor cells. The model's rules dictated transformations of these cells and their proliferation and elimination. It successfully demonstrated dynamic homeostasis by showing a balance in cell production and elimination, closely mirroring actual blood cell ratios. The model also simulated regeneration, showing recovery of cell numbers after disturbances, highlighting its potential to mimic biological functions. Future plans include extending this modeling approach to three-dimensional organs or limbs to replicate regenerative processes. This study suggests that dynamic homeostasis in biological systems, often regulated by signaling molecules, can be effectively modeled through mathematical systems with set elimination parameters.

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

GS18-6 Co-delivery of Multi-anticancer Pharmaceuticals to the Cerebral Cavity Using Resorbable Nanofibers

Yuan-Yun Tseng[1], Shih-Jung Liu[2]
([1]New Taipei Municipal Tu-Cheng Hospital, Taiwan)
([2]Chang Gung University, Taiwan)

In this investigation, we utilized the electrospinning method to fabricate nanofibrous membranes from biodegradable poly[(d,l)-lactide-co-glycolide]. These membranes were designed to enable the prolonged release of carmustine (BCNU), irinotecan, and cisplatin. The release behaviors of these pharmaceuticals from the nanofibrous membranes were characterized using an elution method and high-performance liquid chromatography assay in both in vitro and in vivo settings. The results of the experiments demonstrated that the biodegradable nanofibrous membranes maintained elevated concentrations of BCNU, irinotecan, and cisplatin for over 8 weeks within the cerebral cavity of rats. Histological examination revealed a progressive atrophy of brain tissues without inflammatory reactions. This suggests that these biodegradable drug-eluting nanofibrous membranes have the potential to achieve sustained delivery of multiple chemotherapeutic agents concurrently in the cerebral cavity. Such an approach could enhance the effectiveness of glioblastoma multiforme (GBM) treatment while minimizing the toxic effects associated with the systemic administration of chemotherapy.

GS18-7 A digital hardware system for real-time biorealistic stimulation on *in vitro* cardiomyocytes

Pierre-Marie Faure[1,2], Agnès Tixier-Mita[2], Timothée Lévi[1,2]
([1]IMS Lab., Université de Bordeaux, France)
([2]Institute of Industrial Science, The University of Tokyo, Japan)

Every year, cardiovascular disease causes millions of deaths worldwide. These diseases involve complex mechanisms that are difficult to study. To remedy this problem, we propose to develop a heart-brain platform capable of reproducing the mechanisms involved in generating the heartbeat. The platform will be designed to operate in real-time, with the most economical and integrated design possible. To achieve this, we are implementing highly biologically coherent cellular models on FPGA, which we interconnect with in vitro cell cultures. In our case, we are using the Maltsev-Lakatta cell model, which describes the behavior of the pacemaker cells responsible for the heart rhythm, to stimulate a cardiomyocyte culture.

January 26 (Friday), 09:00-10:00

Room F

GS32 Swarm intelligence

Chair: Akimasa Otsuka (Sanyo-Onoda City University, Japan)

GS32-1 Towards robust swarms: Comparison of flocking models with varying complexity

Lauritz Keysberg[1], Naoki Wakamiya[2]
([1]Bielefeld University, Germany)
([2]Osaka University, Japan)

In this paper we conducted a comparison on ten different flocking models to investigate their robustness and susceptibility towards noise effects. The selected models are all used for flocking simulation, but have varying complexity. We established a toolset of three metrics to compare our models. We consider performance as the swarm quality of an undisturbed flock, while robustness is determined as the swarm quality under noise effects. Lastly, we measure the model complexity by introducing a naive arithmetic complexity for an individual agent's computational costs. Among the compared models, we observe a mild trend for a divergence of robustness and performance, as well as a higher robustness for medium-high complexity models.

January 26 (Friday), 09:00-10:00

GS32-2 Dependence of Péclet number on agent-based chemotactic predator-prey system

Chikoo Oosawa
(Kyushu Inst. of Tech., Japan)

Here we concentrate on the world that only chemicals are allowed to use as cues from agents, the chemicals secreted from all agents, diffuse and decay under fluid conditions, give rise to change of motility to agents, that is called chemotaxis. At first, motility of single agent is confirmed, and then we show a simple mechanism of predator(chaser)-prey(target) system consist of such chemotactic agents only. Finally, we explicitly consider fluid conditions in the system. The model system has parameter $alpha$, corresponding diffusion coefficient of the chemicals, inversely relates to Peclet numbers. The smaller Peclet numbers give rise to more obscure chemical traces, but leading to higher survivability-efficient to predator(chaser) as well as prey(target), indicating that they can use complex traces to change their moving directions without using any waves such as electromagnetic and/or sound. These results can be regarded as an emergence phenomena of diffusion- and chemotaxis-driven swarm intelligence.

GS32-4 Evolutionary performance of neutral network controller optimized by adaptive cuckoo search for rotary crane

Rui Kinjo[1], Kunihiko Nakazono[2], Naoki Oshiro[2], Hiroshi Kinjo[2]
([1]Graduate School of Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

In this study, we develop a neural network controller (NC) optimized using the cuckoo search (CS) method. This was inspired by the mendicant behavior of cuckoos. CS is an evolutionary computation algorithm that optimizes a controller by mimicking the ecological behavior of an organism. Previous studies have demonstrated a favorable evolutionary process of NC when the value of the scaling exponent varies stepwise during the scheduling period. However, because adjustment is difficult, we propose an adaptive CS that adjusts the scaling exponent with respect to the evaluation function. Computer simulations show that NCs optimized using the scheduled CS method with respect to the evaluation function have better control performance than those optimized using the scheduled CS method. The best results were obtained for the NCs that applied adaptive CS, and not for the ones that were applied with a staircase schedule.

GS32-6 Optimization of decision-making process in project management framework using hybrid method of particle swarm optimization and game theory

Nuriman Altybayeva
(Kazakh-British Technical University, Kazakhstan)

This paper considers a model of decision making process for project management problems. In project management of business processes the making effective decision on regular basis by using methodology, considering social aspects of involved participants and creating strategies, is critical. In game theory field, this dynamic process with can be considered as a game, in which the “victory” is to complete project with maximum benefits and minimum cost. To make beneficial decision with considering many factors as weighing risks, allocating resources efficiently, team members interaction, the PSO was considered to be the one of most efficient multithreaded optimization algorithm. This study proposes a hybrid approach based on particle swarm optimization (PSO) algorithm and game theory to produce optimal and effective decisions to have a beneficial effect on a project’s outcome. The results such optimization model lead to the most profitable project outcome during critical moments in managing project.

January 26 (Friday), 11:00-11:45

Room A

OS26 SWARM: Swarm and Bio-inspired Systems

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Tokyo Institute of Technology, Japan)

OS26-1 Scalable and Adaptive Flock of Robots based on Artificial Innate Immune System

Muneeb Ahmad, Ali Raza
(Department of Mechatronics and Control Engineering, University of Engineering and Technology Lahore, Pakistan)

Navigating a flock of swarm of robots (SR) through obstacles while maintaining cooperation is still an open challenge. This paper presents a biologically inspired computational method called Artificial Innate immune system (AIIS). By taking advantage of AIIS shared characteristics - robustness, fault tolerance, scalability, and adaptability - with swarm intelligence. The innate part of the AIIS offers a variety of reactive and probabilistic cell functions alongside its self-regulation mechanism translated to enable swarming behaviors. The research is specially focused on flocking behavior in various simulated environments using e-puck robots in a physics-based simulator (Vrep formerly known as CoppeliaSim); however, AIIS can also exhibit other swarm behaviors like aggregation and foraging. The effectiveness of the immuno-inspired approach is established using extensive experimentation. The AIIS-based approach is evaluated and a scalable and adaptive solution for the emulation of the flocking behavior of SR is developed.

OS26-2 Investigating the influence of individual robot perception capability on swarm behavior in an evolutionary swarm robotic system

Asad Razzaq[1], Tomohiro Hayakawa[2], Toshiyuki Yasuda[2]
([1]Graduate School of Science and Engineering, University of Toyama, Toyama, Japan, Japan)
([2]Faculty of Engineering, University of Toyama, Japan)

The Swarm Robotics System (SRS) is a type of system using multiple robots inspired by self-organizing abilities of social organisms such as ants and bees. One of the methods for constructing SRS control systems is the evolutionary robotics (ER) approach, which automatically designs controller parameters. The ER approach is a method for automatically designing the parameters of the artificial neural network (ANN) controller that often deals with homogeneous SRS. This study aims to investigate heterogeneity via perceptual variations between robots, primarily enabled by input acquisition sensors, which play an important role in the acquisition of swarm behavior. Heterogeneous robots with different perceptional capabilities outperform homogeneous ones.

OS26-4 Further exploration of dynamic scalable patterns generated by extended retrograde model

Mari Nakamura
(National Institute of Advanced Industrial Science and Technology (AIST), Japan)

I have studied a heterogeneous boid, which is a multi-agent system composed of types of agents communicating locally. It generates diverse patterns of agent groups, with varying interaction between the types of agents. When interaction is properly adjusted, it generates stable patterns of a unified cluster with symmetric structures, which remain stable regardless of the number of agents (this is, scalability). In a previous paper, the interaction of heterogeneous boid was modified, as two types of agents move in opposition to each other, while the third type connects the existing two types into a cluster. This model was named the extended retrograde model. It generates dynamic patterns, including scalable ones. In this paper, I explored patterns generated by this model further, focusing on the cluster shape. I found a new scalable pattern, and identified it as an irregular-oscillating pattern. I construct rough phase diagrams of these patterns.

January 26 (Friday), 11:00-12:00

Room B

GS29 Robotic mechanism I

Chair: Kazuyuki Ito (Hosei University, Japan)

GS29-1 Automatic Inspection of Solar Panels Using Both Quad Drone Equipped with RTK-GNSS and YOLOv4-tiny

Kentaro Nomura, Shingo Okamoto, Jae Hoon Lee
(Graduate School of Science and Engineering, Ehime University, Japan)

This research focuses on the multi-rotor drone and the deep learning. Then the autonomous flying multi-rotor drone that can automatically inspect anomalies of solar panels in power plants was developed. For more stable flight, four contra-rotating propellers were equipped on the developed drone. The RTK (Real-Time Kinematic)-GNSS that can accurately estimate its own position was also equipped on the drone for autonomous flight. The RTK base station was made by the authors. The YOLOv4-tiny, which is an object detection algorithm, was used for anomaly detection using deep learning. Finally, the system that can receive the videos of anomaly detection that the developed drone captures in real time was developed.

GS29-2 Attitude control of underwater robot using UVG arm

Masayoshi Ozawa, Ryohei Onishi, Toshihiko Shimizu
(Kobe City College of Technology, Japan)

This research addresses the challenge of unstable underwater robot postures caused by unpredictable water currents. A robot arm with a Universal Vacuum Gripper (UVG) is developed to achieve posture fixation and flexibility. The UVG arm, with five degrees of freedom, demonstrates effective position control at depths up to 300m. In experiments using a Remotely Operated Vehicle (ROV) in turbulent water flow, the UVG arm significantly reduces image blurring compared to scenarios without its use. Minor vibrations are observed due to arm rigidity, but these can be mitigated by adjusting arm posture. The findings underscore the advantages of posture fixation for enhancing the stability of underwater robots.

GS29-3 Mobile robot based ball-collection mechanism and its maneuverability for disabled players

Yusuke Hayakawa, Geunho Lee, Yota Ishikawa
(University of Miyazaki, Japan)

In recent years, sports for the disabled have become popular. This paper focuses on ball games. The development of a ball retrieval robot is one way to assist in ball games in para-sports. There are two major problems with existing research: first, the balls used in sports for the disabled vary widely in size and surface material, etc. Second, the interface is user-selective. Therefore, this research aims to develop a ball retrieval mechanism that can respond to changes in ball properties and an interface that can be operated by anyone. In the evaluation experiment, we evaluated the retrieval mechanism using six types of balls and a robot with the interface.

January 26 (Friday), 11:00-12:00

GS29-4 A Conceptual Examination of an additive manufactured high-ratio coaxial gearbox

Philipp Eisele[1], Sajid Nisar[2], Franz Haas[1]
([1]Graz University of Technology, Austria)
([2]Kyoto University of Advanced Science, Japan)

This research introduces the novel "Kraken-Gear" mechanism, emphasizing the advantages of additive polymer 3D printing in high-ratio gearbox systems for lightweight robotic applications, such as surgical instruments. The innovative kinematic solution provides high torsional system stiffness, substantial gear ratios, and backlash-free transmission. Leveraging the "Hot Lithography" additive manufacturing method ensures precise and warp-free gearbox components. Targeting medical technology, the gearbox meets stringent requirements: backlash-free, minimal vibration, high precision, and torque, with minimized weight for ergonomic comfort and fatigue mitigation. Computational simulations, assess forces and stresses, highlighting the potential of additive manufacturing for cost-effective and functionally efficient gearbox fabrication. Nevertheless, careful material selection remains imperative for optimal functionality, especially in demanding medical applications. In summary, this research underscores a promising approach to gearbox fabrication, emphasizing the critical role of material selection and simulation-based assessments for optimal performance.

January 26 (Friday), 11:00-12:00

Room C

GS19 Mobile robots I

Chair: Kiyotaka Izumi (Saga University, Japan)

GS19-1 Path Planning with 3D Point Cloud for Indoor Inspection Drone

Yudai Mizuta, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

Our research focuses on development of drone systems to play an active role in the inspection of power plants and other infrastructures. An autonomous drone system of quadcopter structure was manufactured, and a flight path generation algorithm was developed to perform inspection tasks. The developed drone system uses a visual Simultaneous Localization and Mapping (SLAM) algorithm for position estimate and create a map of the surrounding environment as 3d point cloud data. An original algorithm for creating a flight path was developed for autonomous inspection based on the 3D point cloud map. The path generation algorithm was tested on 3d point cloud maps acquired in multiple environments. Also, flight experiments were conducted, and the results showed that the developed system can fly according to a generated path.

GS19-2 Development of a Practical Articulated Wheeled In-pipe Robot for Both 3-4 in Force Main Inspection of Sewer Pipes

Kenya Murata, Atsushi Kakogawa
(Department of Robotics, Ritsumeikan University, Japan)

This paper reports a practical articulated wheeled in-pipe inspection robot “AIRo-7.1” which is waterproof and dustproof, and can adapt to 3 to 4 in inner diameters. The joint torque can be adjusted by a PWM open-loop control while the other two joints are bent by torsional springs. Thanks to this simple and high-density design, not only downsizing of the robot but also wide range of the adaptive inner diameter were achieved. However, the reducer used in AIRo-7.1 was designed by ourselves. Therefore, preliminary experiments were conducted to clarify the relationship between the actual middle joint torque value and the PWM duty ratio. To examine the adaptive movement, experiments in both 3 in and 4 in pipes with vertical, bend, and diameter change sections. Finally, field experiment was also conducted. From the results, high adaptability to different inner diameters of pipes and slippery environments were confirmed.

January 26 (Friday), 11:00-12:00

GS19-3 Probabilistic Model for High-Level Intention Estimation and Trajectory Prediction in Urban Environments

Yunsoo Bok[1], Naoki Suganuma[2], Keisuke Yoneda[2]
([1]Graduate School of Natural Science and Technology, Kanazawa University, Japan)
([2]Advanced Mobility Research Institute, Kanazawa University, Japan)

To enable successful automated driving, the prediction of road users' motion is indispensable in urban traffic scenarios. Furthermore, recognizing that a vehicle's motion is influenced by other vehicles, it becomes crucial to estimate their intentions. However, the elevated complexity and uncertainty resulting from interdependencies among traffic participants present additional challenges. Despite extensive research on inferring intentions, many studies have concentrated on estimating intentions from interactions, resulting in a lack of robustness against undetected vehicles. Moreover, these approaches tend to be computationally expensive due to the intricacies of urban traffic environments. In this paper, we introduce a stochastic model for intention estimation and trajectory prediction based on the vehicle's kinematic states. By assuming that driver maneuvers consider interactions, there is potential to eliminate the necessity for investigating interactions. The evaluated results demonstrate that the proposed model surpasses physics-based and map-based models in terms of accuracy while maintaining computational efficiency.

GS19-4 Cooperative Merging of Automated Vehicles using Active Speed Bump on Highway On-Ramps

Ryosuke Mizoguchi, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

Cooperative driving is an approach that aims to improve the safety and efficiency of vehicle merging. Cooperative driving means organizing the movements of neighboring vehicles and driving in coordination with each other, and various approaches exist. On the other hand, speed bumps and rumble strips have been introduced in traffic infrastructure. The authors have focused on the interaction between these speed bumps and automated vehicles, and have constructed speed control systems using speed bumps, including active speed bumps (ASB). In this paper, we considered a system that uses ASB for speed control during cooperative driving at on-ramps. We formulated the design problem of an ASB-based cooperative driving system for on-ramps and proposed a method that allows vehicles to merge without collision. The usefulness of the proposed method was verified by simulation using Unity.

January 26 (Friday), 11:00-12:00

Room D

GS5 Artificial life II

Chair: Shih-Jung Liu (Chang Gung University, Taiwan)

GS5-1 The Collaborative Abilities of ChatGPT Agents in a Number Guessing Game

Ekaterina Sangati[1], Federico Sangati[1], Marc Slors[2], Kenji Doya[1]
([1]Okinawa Institute of Science and Technology, Japan)
([2]Radboud University Nijmegen, Netherlands)

We present a new behavioral evaluation of ChatGPT-3.5 and 4 Large Language Models. Groups of 3 ChatGPT agents were asked to play a collaborative number-guessing game in which each agent had to submit a number, and the sum of the team's numbers needed to match the target number. ChatGPT-4 model showed better performance than ChatGPT-3.5. However, both models did worse than previously reported human participant results in this game. A deeper analysis of model errors shows that the two models failed for different reasons, and neither model adopted human-like strategies of social coordination.

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GS5-2 Introduction of Mass Conservation to Asymptotic Lenia

Yuki Shirosaki, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

In the past few years, various extensions of Lenia have been proposed. One of them, Asymptotic Lenia, has been found to exhibit interesting behavior not seen in previous models. We introduced the law of mass conservation in Asymptotic Lenia to bring it closer to real-world conditions. We conducted a random search to see what kind of morphology and behavior were observed in the extended model and found several organisms with characteristic behavior. They were found to share the same feature as Asymptotic Lenia, namely that cell states tend to be intermediate values and constitute complex morphologies. The fact that a variety of behaviors can be observed in a small number of trials for a very wide parameter space indicates the possibility of the existence of organisms with more interesting behavior.

GS5-3 Adaptive Evolution Based on Lineage Differentiation in Lenia

Shion Morishita, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

The artificial life model called Lenia is an extended version of the classical Conway's two-dimensional cellular automaton, the Game of Life (GoL). Although not a few models based on constructive approaches have been proposed to extend Lenia from various perspectives, achieving Open-Ended Evolution (OEE) in Lenia is still a very challenging topic. In this study, as a step towards achieving OEE in the Lenia-type model, we propose an extended model of adaptive evolution based on an explicit mechanism of lineage differentiation. The experimental results show that a variety of species can emerge in the model. We also show that evolutionary scenarios can be classified into two types: one is the case in which almost all of the species reach an explosive state, and the other is the case in which a group of closely related species continue to survive and reach a steady state.

GS5-4 Observation of turn behavior in pill bugs using a multiple T-maze device with long distance between choice points

Ayaka Fujimoto, Yuta Miyama, Toru Moriyama
(Shinshu University, Japan)

When the experimenter gives a pill bug two T-mazes in succession, it turns alternately left and right with a probability as high as about 80%. It is thought that they are equipped with inverter for turning. In a recent study, when they were given T-maze trials with the distance of 12cm between maze intersections, it was observed that they regulated the number of alternating turns in a continuous manner. This animal is thought to have a neural circuit that regulates the inverter for turning. To explore new properties of this neural circuit, we conducted experiments at distance 40 cm between choice points and investigated whether pill bug adjusts the inverter or not when memory of prior turns stored in the inverter is lost.

January 26 (Friday), 11:00-12:00

Room E

GS22 Multi-agent systems I

Chair: Yasushi Kambayashi (Sanyo-Onoda City University, Japan)

GS22-1 Generative Image AI based Robotic Display for Animations

Yanchun Li[1], Yuki Minami[1], Shinsaku Izumi[2], Masato Ishikawa[1]
([1]Osaka University, Japan)
([2]Kochi University of Technology, Japan)

With the advance of text-to-image models (e.g., Stable Diffusion), has led to widespread use of image-generative AI in art and architectural design. Moreover, the robotics domain has seen progress, exemplified by DALL-E-Bot, furthering the application of this technology. In this report, we proposed a novel approach that combines image-generative AI with a distributed coverage control algorithm to enable a robot swarm to portray animations based on user-inputted text. This innovative fusion extends the scope of robotics, utilizing artificial intelligence capabilities to create dynamic and interactive visual displays.

GS22-2 Design of a simulator for multi-agent systems with multiple behavioral algorithms and three-dimensional environment

Naoki Hirata, Naoki Wakamiya
(Graduate School of Information Science and Technology, Osaka University, Japan)

A multi-agent system (MAS) comprises autonomous agents interacting with each other to achieve global objectives. Since a MAS is a complex system, simulation is crucial to understand and analyze behavior of agents and emergence of global and coordinated pattern. Existing MAS simulators, though available, do not fully satisfy demands of researchers, such as incorporation of multiple algorithms written in different programming languages and reflection of real-world phenomena in a real-time manner. In this paper, we discuss the design of a MAS simulator to answer those demands. We built a MAS simulator and verified its implementation.

GS22-3 Interchange Flow Control with Dynamic Obstacles Optimized Using Genetic Algorithms - A Concept of Virtual Walls -

Jyunya Hoshino[1], Yuuki Itoh[1], Ryuma Saotome[2], Tomohiro Harada[3], Kenji Matsuda[1], Tenta Suzuki[1], Mao Tobisawa[1], Kaito Kumagae[1], Johei Matsuoka[1], Toshinori Kagawa[4], Kiyohiko Hattori[1]
([1]School of Computer Science, Tokyo University of Technology, Japan)
([2]Yahoo Japan Corporation, Japan)
([3]Faculty of System Design, Tokyo Metropolitan University, Japan)
([4]Central Research Institute of Electric Power Industry, Japan)

In the near future, all automated vehicles will be able to share information with other vehicles via communications to enable appropriate approaches to traffic control. A new approach to traffic control by fully automated driving is the realization of flat interchange. Unlike conventional approaches, this research focuses on passing through roads and interchanges that do not assume lanes. Specifically, we propose an interchange flow control approach to traffic control using a virtual wall (VW), which acquires and shares the initial position, destination, and speed of all vehicles entering an interchange in a two-dimensional space where vehicles can move freely, and then realizes appropriate control based on this information. Each vehicle calculates the shortest path to avoid the VW individually, thereby realizing safe and rational route selection. In this study, a genetic algorithm is used to determine the location of the Virtual Wall. The effectiveness of the proposed method was evaluated using simulations, and the results showed that compared to the case of manual deployment in the roundabout form, the proposed method using VWs was shown to reduce the total route length as well as the number of collisions to zero. In addition, when comparing the case where VWs were deployed in common for all vehicles and the case where VWs were deployed individually for each vehicle, it was shown that the total route length was shorter when the individual VWs were deployed.

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GS22-4 Animating Book Information to Enact Encounters Between Reader and Books

Satoko Yoshida, Ivan Tanev, Katsunori Shimohara
(Doshisha University, Japan)

Based on the concept that reading is communication between people and books, we postulate not that reading is a one-directional act to interpret and understand the contents of a book but that reading is a bi-directional interaction between them to enable an individual reader to grow. For that purpose, we propose to animate information of books and readers' reading notes as interactive agents and to create an ecological environment consisting of interactive agents where people could experience imaginative and stimulative interactions with such agents as proxies of books and readers' reading notes. Furthermore, in this paper, we conducted simulation experiments focusing on the random movement of book information agents to verify the effectiveness of the proposal. As a result, we found that the impact of agents' random movement on the number of encountered books varied depending on the exploratory curiosity of a human agent toward book information.

January 26 (Friday), 11:00-12:00

Room F

OS18 AROB: Vehicle control

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

OS18-1 Design of a Model-Based Impedance Controller for the Manipulator Mounted on an Autonomous Surface Vehicle

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

In this paper, we develop a motion and force control scheme for the manipulator mounted on an autonomous surface vehicle, under the condition that the vehicle is independently controlled by a motion controller with poor performance. Its features are (1) to achieve a good control performance regardless of the control result of the vehicle, because it includes the dynamics of the vehicle, (2) to be designed on the basis of model-based impedance control, which is applicable to an ocean operation that requires a contact between the manipulator's tip and a soft or fragile surface as well as a rigid one, and (3) to adjust the mechanical impedance of the manipulator to a desired one, in the presence of water waves by changing the value of a design parameter concerning impedance. In the paper, we provide the detailed theoretical results.

OS18-2 Development of Adaptive Braking Controller for Autonomous Vehicles to Achieve Any Ride Comfort Performance Without Using Wheel Velocity

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

Several autonomous driving control methodologies have been developed to mitigate traffic accidents. However, there is a limited number of controllers that specifically address passengers' ride comfort. To tackle this issue, we propose an adaptive controller designed to make the vehicle follow an ideal vehicle model. Moreover, by not using the measuring instrument of the wheel velocity, we aim to reduce both overall costs and maintenance expenses. We confirmed the effectiveness of this controller through numerical simulations.

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OS18-3 Resolved acceleration control of 3-link dual-arm underwater robot with model error compensator

Reo Nishio[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

We have proposed a resolved acceleration control (RAC) method for underwater vehicle-manipulator systems (UVMS) which is a position control method. The model of UVMS used in the control system has modeling errors in the fluid forces acting on the robot. Therefore, we have proposed a method of RAC with disturbance observer (DOB) in a previous study and confirmed its effectiveness. Here, a model error compensator (MEC) that is simpler in structure than DOB and specializes in modeling error and disturbance suppression had been proposed. In this paper, we propose a control method of RAC with MEC and show the effectiveness of the control system by experiment using a 3-link dual-arm underwater robot.

OS18-4 Manipulation of a floating object by two underwater robots with arms

Kyoka Takeda[1], Reo Nishio[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

In future underwater development, it is considered that many tasks will be achieved by cooperative motions of several underwater robots. We have proposed a cooperative method to control each robot individually. The effectiveness of the method has been confirmed by simulation using two 3-link floating underwater robots with a passive universal joint. In this simulation, the passive universal joint is used to the hand operating an object. In this paper, experimental system is explained to confirm the effectiveness of the developing method. In these experiments, a passive spherical joint is used to the hand for increase the degree of freedom instead of the universal joint.

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Room A

OS9 AROB: Human-Centered Robotics

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Zonghe Chua (Case Western Reserve University, United States)

Invited Talk 5 Human-Centered Haptic Devices for Social Communication

Cara M. Nunez (Cornell University, USA)

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OS9-1 Exploring User's Line of Sight And Word Gesture Text Entry Techniques in Virtual Reality

Haato Watanabe, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering, Faculty of Science and Technology,
Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan)

This study proposes a text input method in Virtual Reality space that combines eye gaze and gesture typing. From our prototype system, we revealed that the problems with gesture typing using eye gaze are estimation error of eye gaze and the difficulty of fine adjustment of the eye gaze. Therefore, we constructed a system that supports the acquired gaze deviation and the inability to make fine adjustments. Next, we conducted a user study to compare gesture typing using eye gaze with gesture typing using the VR 6Dof controller and the ordinary method that inputs each character using the VR 6Dof controller. We found that users can conduct gesture typing using eye gaze and that gestures can be written more stably than with gesture typing using the 6Dof controller. Based on these results, we discuss the idea of improvements to the system and examples of how future research can be developed.

OS9-2 Application of Electrical Muscle Stimulation on the Palmar Side of the Hand for Tactile Feedback: A Direct Approach

Karan K C, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

The current methods of providing haptic feedback to the hand for touch sensation use mechanical mechanisms and actuators. This approach makes wearable devices bulkier in size which reduces the user experience. This research aims to replace the mechanical mechanisms and actuators, and achieve the same function using Electrical Muscle Stimulation (EMS). Existing research has applied EMS to the lower arm, upper arm, or dorsal side of the hand for tactile haptic feedback purposes. This research evaluates the use of EMS on the palmar side of the user hand for providing haptic feedback for touch sensation. We proposed a method to stimulate the median and ulnar nerves present in the palmar region of the human hand through EMS signals and conveyed tactile haptic feedback. The median and ulnar nerves branch out into individual fingers in the palmar region, so we targeted each branch by strategically positioning and orienting electrodes. The tactile sensation was evoked in each finger individually without interfering with others, with an overall average voltage of 39.0065V and a current of 0.0755mA. Touch sensation for different finger combinations was also achieved at the same time, for example, combinations of the thumb, index, and middle fingers. Our research demonstrated that using an EMS signal directly on the palmar side provides accurate tactile sensation in each finger without the use of mechanical mechanisms, resulting in a more compact device.

OS9-3 Development of smart chair with controllable seat angle

Tsubasa Esumi, Shoya Fujimura, Noriko Takemura
(Kyushu Institute of Technology, Japan)

We have developed a smart chair with a controllable seat angle. This smart chair operates by sending commands from the control unit consisting of a PC and drivers to the chair part, where two electric actuators change the angle of the seat. To investigate how the smart chair changes the posture of the seated person, we conducted a data acquisition experiment with 30 participants. We used various sensors (webcam, motion capture, seat pressure) to create a dataset during this experiment. We then analyzed the effect of seat angle changes by calculating the average and variance of body movements, thereby assessing the posture changes induced by our smart chair.

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OS9-4 Grasp Anything: A Versatile Soft Robotic Grasping System with Zero-Shot Training

Rene Suarez, Natee Chirachongcharoen, Farhad Shabani, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

This research presents an AI-powered soft robotic grasping approach that is capable of grasping, carrying out sorting, and pick-and-place tasks for objects of varying size, shape, and stiffness with zero-shot training, unlike most of the pick and place systems with either implement soft gripper or AI zero-shot training. We combine the strength of a soft gripper previously developed by the authors and the Grounded Segment-Anything Model (Grounded-SAM), an open-source AI pipeline. The proposed system is capable of identifying and segmenting any objects using Grounded-SAM and estimating their placement with the help of a depth camera (Intel® RealSense™ D435i), and perform grasping, sorting, etc., using prompt-based input from a user. We perform a variety of real-world single- and multi-object experiments and measure the success rate, reaction time of the system after the order, and the capacity of the system to develop sorting tasks. The results show that the proposed system was able to perform the desired tasks with a high success rate of nearly 100% and highly accurate, the initial response time was lower than 4 sec and the system was able to move an object at a distance of 35 cm in less than 20 sec. The proposed system could be helpful in a variety of human-centered robotic grasping and sorting tasks, such as in homes and supermarkets.

OS9-5 Design of an Anthropomorphic Robot Hand to Replicate Human Hand Movements in Real-Time

Pasut Suriyasomboon, Rene Suarez, Hiroshi Kawakami, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

In this study, we present an anthropomorphic robot hand designed to overcome existing limitations in robotic manipulation. Our prototype replicates the intricate movements of the human hand in real-time, addressing challenges such as limited finger joint control and restricted wrist movement. Utilizing a tendon-driven transmission system and Computer-Aided Design techniques, each robotic finger is designed to boast human-like degrees of freedom, closely mimicking the size and structure of human hands. Employing a torsion spring as a muscle analog, the robot hand exhibits natural finger behavior. Experiments validate the versatility of the robotic hand, showcasing its ability to perform tasks such as grasping objects of sizes up to 90 mm x 90 mm and weighing up to 300 g, accurate positioning in 3D space, and swift response comparable to human reflexes. The proposed design holds promise for application in prosthetic devices, manufacturing, agriculture, and hazardous environments.

January 26 (Friday), 13:00-14:30

Room B

OS4 AROB: Biomimetic Machines and Robots I

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

OS4-1 Verification of a random generation method for virtual machined surface models using DTCWT

Shogo Miyazaki, Yuma Hino, Akimasa Otsuka, Fusaomi Nagata
(Sanyo-Onoda City University, Japan)

In the field of product development, shortening of processes is required, so simulation using CAE is essential. However, the product shape modeled by CAE is an ideal shape without irregularities and is different from actual products. Therefore, the generating method of surface models with irregularities (skin models) has been developed. Skin model shapes that represent skin models as point clouds, polygons, and functions are called skin model shapes, and are being used for tolerance analysis. In this study, we validated the method by comparing the shape model generated by DTCWT (Dual-Tree Complex Wavelet Transform) with the actual surface of the processed material. And we compared the generated surface model with the actual surface.

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OS4-2 Defect Detection System for an Automatic Picking Robot Using an ONNX Runtime Model

Shingo Sakata[1], Fusaomi Nagata[2], Ryoma Abe[2], Keigo Watanbe[3]
([1]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([2]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)

The authors have been developing a MATLAB application to efficiently design, train and test prediction models such as CNN, SVM, CAE, FCN and YOLO for various kinds of defect detection problems. In this paper, a VGG19-based transfer learning CNN model built on MATLAB is exported to an ONNX (Open Neural Network eXchange) model in order to use it for the defect detection of a picking robot running on Python. Two user interfaces are developed on MATLAB and Python respectively in order that pixel-level compatibility and interoperability can be satisfied on both frameworks. The effectiveness and validity are shown through classification experiments by an ONNX model and a peg-in-hole task by a small-sized industrial robot incorporated with the ONNX model.

OS4-3 Classification and Evaluation of Workpieces Using 3D CNN Built Based on Voxel Data

Masakazu Hirono[1], Fusaomi Nagata[1], Takumi Kaneoki[2], Yuichiro Shiba[2], Akimasa Otsuka[1], Keigo Watanabe[3]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)

A 3D camera such as RealSence can measure the distance to an object by irradiating infrared rays and obtain point cloud data (PCD), so that it is effective to measure an object shape without being affected by lighting conditions. In this paper, voxel data are converted from PCD measured by a 3D camera. Then, a compact 3D CNN model, which can classify workpieces based on voxel data, is designed using the authors' developed MATLAB application and trained using the voxel data. The applicability of the 3D CNN model to a shape classification problem of eight kinds of 3D-printed objects and its generalization ability is evaluated through classification experiments.

OS4-4 Comparison of Image Data Interpolation Methods in Building a Transfer Learning-Based CNN for Defect Detection

Kanji Matsui[1], Fusaomi Nagata[1], Kazushi Matsuura[2], Hirohisa Kato[2], Akimasa Otsuka[1], Keigo Watanabe[3], Maki K. Habib[4]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)
([4]The American University in Cairo, Egypt)

The authors have been developing a design and building tool for CNN models to enhance the functionality of a pick and place robot. For example, the CNN model obtained by transfer learning technique allowed the robot to predict the orientation of each object for smart picking using a gripper-type end effector. In designing and building transfer learning-based CNN models, resolutions of original image data for training, validation and test have to be downsized, e.g., to 224*224*3, to be fitted that of the input layer of technically opened powerful CNN model selected for the base of transfer learning. When downsizing original sized images into the resolution of input layer of the CNN model used for transfer learning, one of interpolation methods such as Nearest-neighbor, Bilinear and Bicubic has to be selected. If Nearest-neighbor interpolation is applied to downsizing, the output pixel is assigned the value of one of pixels that the point falls within. No other pixels are considered. If Bilinear interpolation is applied, the output pixel value is a weighted average of pixels in the nearest 2-by-2 neighborhood. Also, if Bicubic interpolation is selected, the output pixel value is a weighted average of pixels in the nearest 4-by-4 neighborhood. However, it seems that it has not been sufficiently considered yet which of these methods is effective and more reliable to build a defect detection system based on transfer learning-based CNN. In this study, three types of CNN models, in each of which one of interpolation methods is applied, are built and their generalization abilities are compared through defect detection experiments of an industrial product.

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OS4-5 Application Experiments of FCN Model and YOLO Model for Crack-Type Defect Detection of Industrial Materials

Fumiya Yagi[1], Fusaomi Nagata[1], Ayumu Yoshimura[2], Hirohisa Kato[2], Akimasa Otsuka[1],
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([2]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)
([4]The American University in Cairo, Egypt)

Automation using AI techniques such as CNN (Convolutional Neural Network) and SVM (Support Vector Machine) has progressed in some parts of the inspection processes of various kinds of industrial products. In addition to the essential need such that defective products should be identified based on the presence or absence of a defect, there is another important need from manufactures to want to classify defects based on quantitative criteria such as area and length. In this paper, to cope with such a need, a U-Net which is one of typical FCN (Fully Convolutional Network) models, and a YOLOv3 which is one of YOLO (You Only Look Once) models, are designed, trained and applied to the detection of crack-type defects in an industrial material. Each defect detection performance, i.e., generalization ability, is evaluated and compared using test images. In addition, easiness of making gTruth dataset, designability of model, training time, forward calculation time, and ability of quantitative evaluation are compared.

OS4-6 Rotation Control Experiments Using a PI Observer-Based Backstepping Method in Suspended-Load Rotation-Control Systems

Ryo Eto[1], Shinsuke Kanda[2], Isaku Nagai[1], Keigo Watanabe[1]
([1]Okayama University, Japan)
([2]TADANO LTD., Japan)

For the transportation of suspended loads involving swinging and rotation, machine body control is typically limited to managing load swinging. Research has been conducted on the direct control of the wire rope end using a horizontally movable multirotor. However, a significant challenge arises from the inability to observe the state of the load during transportation. To address this limitation, the suspended load is modeled as a bifilar suspension pendulum. A Proportional-Integral (PI) observer is employed to estimate the attitude of the load, as well as disturbances affecting both the load and the multirotor. The estimated disturbances play a crucial role in implementing the backstepping method, aimed at suppressing the adverse effects of disturbances. Several experiments have been conducted to demonstrate the effectiveness of the PI observer in estimating disturbances related to rotation and load attitude.

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Room C

OS13 AROB: Robot control and Path planning

Chair: Nobuya Takahashi (University of Miyazaki, Japan)
Co-Chair: Masahiro Yokomichi (University of Miyazaki, Japan)

OS13-1 HMC-PSO : Hamiltonian Monte Carlo-embedded Particle Swarm Optimization

Masahiro Yokomichi, Nobuya Takahashi
(University of Miyazaki, Japan)

This paper proposes an extension of particle swarm optimization (PSO) with Hamiltonian Monte Carlo(HMC). PSO is a population-based stochastic approach for optimization problems and is a kind of swarm intelligence techniques. However, many existing variants suffer from the local minima when initial particles are located far from the global minimum in the case of multi modal objective function. This paper aims to develop a new type of PSO in order to overcome this difficulty by embedding HMC in PSO. To attain the global minimum, Quantum-inspired HMC, a modification of normal HMC by changing the mass of particle randomly, is used.The effetiveness of the proposed approach is examined with several benchmark functions.

OS13-2 UAV flight path planning based on deep reinforcement learning

Masami Hisayama, Nobuya Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)

Research has been underway to control robots using deep reinforcement learning. Go AI and video game AI, which are representative results of it, require a high computational load because they use images for neural network training. This paper uses a method called Dueling Network and a fully connected neural network that uses the UAV's position, velocity, and Euclidean distance to the goal as features. The position and velocity of the UAV is controlled to generate the shortest path in three-dimensional space. To solve the problem that learning difficulty in neural networks increases as control approaches the real world, we perform curriculum learning and propose a shortest path generation method for UAVs based on GIS information with a minimum amount of calculation.

OS13-3 Fundamental study focusing on structural similarity of street based on geographic information using graph neural network

Hiroya Hoshihara, Nobuya Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)

In these days, traffic accidents and other hazards lurk in our living environment, necessitating efforts to prevent accidents from occurring. Current research mainly uses machine learning methods to analyze traffic problems. However, in many cases, the analysis is based only on quantified information, and there is little research on risk prediction that takes into account the geometric properties of the traffic network structure. Therefore, in this study, a deep learning model that considers both traffic accidents and geometric properties is employed and analysis is attempted. In the numerical experiments, two datasets are prepared and the classification models are evaluated using AUCs which are derived by ROC curves. The validity of the proposed method was confirmed.

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OS13-4 Development of a Monitoring System for Monorail Railroad Switches

Naoto Matsuda, Yasunobu Hitaka
(National Institute of Technology, Kitakyushu College, Japan)

The Kitakyushu Monorail conducts periodic manual inspections of the railroad switches that determine the course of the trains on the track. Currently, it is required to find the optimal inspection cycle from the perspective of reducing the cost required for the inspection works. The purpose of this study is to develop a system that monitors the current values flowing through the railroad switches to estimate the degree of deterioration, and optimize the inspection cycle. To achieve the purpose, a system that measures and collects the current values flowing through the railroad swich, and accumulates the measured data on a data server is constructed using current sensors and a microcontroller. Analysis of the measurement data obtained experimentally from a railroad switch confirmed that the trend of the current values could be divided into two patterns depending on the direction of its conversion.

OS13-5 Development of a collaborative robotic inspection system for monorail tracks

Rintaro Nonaka, Yasunobu Hitaka
(National Institute of Technology, Kitakyushu College, Japan)

Kitakyushu Monorail Company regularly performs track maintenance and inspection work on a machine tool. With the recent increase in the number of natural disasters, this work has presented challenges such as ensuring worker safety, inspection accuracy, and increasing inspection efficiency. Therefore, we propose an inspection method in which the robot above the track moves according to the distance traveled by the worker who is inspecting under the track. The purpose of this theme is to realize a cooperative inspection system in which the robot moves according to the distance traveled by the worker. For this purpose, we propose a method using acceleration sensors. If the system developed in this theme is used in actual inspections, it is expected to improve the safety and efficiency of current inspections by eliminating the need for workers to go up on the track each time an inspection is performed.

January 26 (Friday), 13:00-14:15

Room D

GS27 Robot vision and image processing II

Chair: Tomohiro Hayakawa (University of Toyama, Japan)

GS27-1 Proposal of String Shape Recognition and Manipulation Using YOLOv5 and RGBD Camera

Junxiang Wang, Yuichiro Toda, Takayuki Matsuno
(Okayama University, Japan)

Manipulation of tying-untying a string has many applications in surgery, manufacturing, and households because there are many deformable objects such as electric cables, and string around our living space. However, many processes, such as the wiring process of flexible cables, are not yet automated. This is because the operation of deformable objects has problems with shape recognition and manipulation. Therefore, our research group has been focusing on constructing a system that can freely operate string with an industrial manipulator. To manipulate deformable objects, some research involves robots applying specific forces and feedback control using force sensors to manipulate objects into a target shape, for example, to tighten a loose knot. However, if the material and dimensions of the deformable object are different, the mechanical properties will also be different. It means to manipulate a new deformable object into a target shape, it is necessary to reset a specific force. Therefore, this paper proposes a method based on a combination of a deep neural network called YOLOv5 (You Only Look Once version 5) and a depth camera to recognize the state of the string when manipulating the knot from a loose state to a tight state. In this paper, the training process of YOLOv5 model and the training data set will first be reported. Then, the method of calculating the area of the target recognized by YOLOv5 model and how to determine whether the knot has changed from loose to tight state will be introduced. Finally, the recognition results of the knot state when the knot is operated from a loose state to a tight state, combined with YOLOv5 and RGBD camera will be reported.

January 26 (Friday), 13:00-14:15

GS27-2 Manipulator Grasp Detection Based on a Novel CAG Block and Multi-Scale Inception

Huimin Sun, Yuan Huang, Yilin Zhang, Chi Li, Kenji Hashimoto
(Waseda University, Japan)

This paper proposes an end-to-end grasp detection method for robotic manipulators based on deep learning. The model's relatively low complexity ensures real-time performance, making it applicable to closed-loop systems. In other words, even when visual feedback is introduced, the system can still react effectively within a reasonable timeframe, enhancing its adaptability to dynamic environments. The utilization of the Channel Attention (CA) block introduces dual-dimensional channel attention, and the incorporation of multi-scale inception allows for a broader range of receptive fields with minimal sacrifice to model complexity. Subsequently, we conduct ablation experiments to validate the algorithm's grasp success rate and accuracy, elucidating the roles of the multi-scale inception block, CA block, and short connections. The accuracy and grasping success rate of our algorithm have been verified on the Cornell dataset, which is 98.8% and 97.8%, superior to the previous methods. Compared with excessive research, it has been improved to a certain extent, and it can also generate correct grasp rectangle for the previously unseen objects which means do not appear in the training dataset.

GS27-3 Improvement in the Versatility of Object Recognition for the Safety Inspection of Building Exteriors Through Image Processing

Masaya Ishikawa, Nobuhiro Okada, Takuya Ikeda
(The University of Kitakyushu, Japan)

Today, there is a growing trend towards the integration of AI in various tasks. However, in the inspection of building safety, human workers still conduct manual labor. There are possibilities of oversight in safety inspection when workers rely solely on visual assessments. By these reasons, we have been working on the development of wall-climbing unmanned cleaning robots. As part of this endeavor, we have focused on creating a system that can autonomously determine whether the target surface being cleaned has any defects. In this research, we conducted image processing and machine learning using a small computer to accurately determine whether the paint on the pillars has peeled off. In this experiment, we examined whether the accuracy improved for multiple objects. For image processing, we utilized the open-source library OpenCV, which consolidates capabilities of Python, for handling images and videos. For machine learning, we employed a supervised autoencoder.

GS27-4 Development of window area detection sensor system based on semantic segmentation for window cleaning robots

Tatsuya Ishii, Nobuhiro Okada
(The University of Kitakyushu, Japan)

In recent years, there has been a growing demand for creation of automatic window cleaning robots because of the many hazards involved in window cleaning work in high-rise buildings by human hands. For cleaning robot to perform automatic cleaning, the robot must estimate its own self-position. In this study, we developed the window cleaning areas detection system using semantic segmentation in order to estimate the window cleaning robot's self-position. First, we trained the window cleaning areas with PSPNet that can yield even larger features than those around pixels. Then, we used the trained model to perform segmentation inference. The results showed that if the inferred image resembled the training data (e.g., visual color and shape), window cleaning areas segmentation was possible.

January 26 (Friday), 13:00-14:15

GS27-6 Vessel Detection Using Thermal Cameras with Ensemble of YOLOv7 and Swin Transformer

Kana Takahashi[1], Kenshiro Okamura[1], Hironori Kitakaze[1], Ryo Matsumura[2]
([1]National Institute of Technology, Oshima College, Japan)
([2]Shunan University, Japan)

This paper proposes an ensemble learning method for vessel detection using thermal camera images. The proposed learning method is an ensemble learning method using YOLOv7 and swin transformer. Our objective is to improve the performance of vessel detection using thermal cameras to realize a lookout support system for vessel navigation. We used a dataset of thermal camera images of vessels and performed ensemble learning with YOLOv7 and swin transformer, and compared the detection mean Average Precision (mAP) of these models. The experimental results showed that the mAP of the YOLOv7 is 0.898, the mAP of the swin transformer is 0.894, and the mAP of the ensemble of YOLOv7 and swin transformer is 0.911. These results demonstrate the effectiveness of our proposed method in improving the performance of vessel detection using thermal camera images.

January 26 (Friday), 13:00-13:45

Room E

GS23 Multi-agent systems II

Chair: Naoki Wakamiya (Osaka University, Japan)

GS23-1 Enhancing Agent Operational Efficiency in Automated Warehouses Through Wider Aisles

Mayo Suzuka[1], Takeshi Nishida[1], Masaaki Nagahara[2]
([1]The University of Kitakyushu, Japan)
([2]Hiroshima University, Japan)

Our specific focus lies on the domain of automated warehouses characterized by numerous narrow aisles. These tight spaces often force agents to pause and wait for each other to prevent collisions, which, in turn, results in suboptimal MAPF plans. To address this issue, we introduce an innovative approach designed to identify these narrow aisles and subsequently widen them, all while striving to maximize both the storage density and the operational efficiency of the warehouse. Our method undergoes evaluation across various scenarios, revealing substantial enhancements in the quality of MAPF plans.

GS23-2 Persistent Surveillance by Heterogeneous Multi-agents using Mutual Information based on Observation Capability

Shohei Kobayashi[1], Kazuho Kobayashi[1], Takehiro Higuchi[2]
([1]Graduate School of Engineering Science, Yokohama National University, Japan)
([2]Faculty of Environment and Information Sciences, Yokohama National University, Japan)

To persistently observe an extensive environment, using many agents with different characteristics is more effective than using a single agent. This study focuses on the heterogeneity of agent's observation capabilities, such as sensor resolution, by representing those differences by probabilistic observation. This representation allows agents to compute mutual information in surveillance area selections and to move where they obtain the most information from their observations, according to the mutual information. Furthermore, we introduce confidence decay for three or more states, a strategy to prompt agents to revisit locations that have not been observed for an extended period of time. Simulations in a changing environment demonstrated that the proposed method enables heterogeneous multi-agents to perform persistent surveillance according to their observation capabilities and outperforms the existing partition and sweep method in a quantitative comparison of observation accuracy.

January 26 (Friday), 13:00-13:45

GS23-4 A Study on Neural Network-Based Controller for Swarm Robots - Analysis of a Pheromone Effects on the Emergence of Swarm Cooperation -

Masashi Suzuki, Iwadate Kenji, Ikuo Suzuki
(Kitami Institute of Technology, Japan)

Social insects tackle complex tasks. Inspired by this behavior, there is a field of robotics research known as swarm robotics. This field explores how swarms of simple robots can collectively address complex tasks. Recently, advancements in neural network technology have increasingly been applied to research in swarm robotics. However, the approaches proposed by this research has not fully explained the emergence of cooperative behavior through communication. To address this, we propose an interpretable neural network-based controller for swarm robots. This controller is made up of two parts; one process communication between robots and another one that process other information. By this design, it enables analysis on communication, allowing investigation into how communication influences cooperative behavior. Additionally, we have conducted a simulation experiment to validate the utility of our proposed controller. In this experiment, we deploy swarm robots equipped with this controller and pheromone communication ability, simulating their collaborative foraging behavior.

January 26 (Friday), 13:00-14:45

Room F

GS24 Neural networks I

Chair: Jae Hoon Lee (Ehime University, Japan)

GS24-1 Learning Caterpillar-Like Movements in Soft Robots with Spiking Neural Networks

SeanKein Yoshioka, Takahiro Iwata, Yuki Maruyama, Daisuke Miki
(Department of Computer Science, Chiba Institute of Technology, Japan)

Soft robots, known for their flexibility and adaptability in interacting with the environment, have garnered much attention. Previous research has primarily focused on controlling soft robots using periodic signals. However, such signals have limitations in generating adaptable movements, i.e., they are restricted to fixed patterns. This study utilized the twin delayed deep deterministic policy gradients (TD3) reinforcement learning algorithm combined with spiking neural networks (SNNs) to control soft robots. A crucial challenge when utilizing SNNs lies in the necessity for the network input and output to exhibit spike sequences characterized by binary values (zeros and ones). Addressing this challenge, we employ population coding techniques for encoding and decoding continuous values into spike sequences. The primary objective is to evaluate the capacity of the caterpillar-like soft robot designed in this study to learn and execute tasks with precision.

GS24-2 A TDA-based Performance Analysis for Quantized Neural Networks

Yugo Ogio, Naoki Tsubone, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

Advances in Neural Network (NN) models and learning methods are causing breakthroughs in various fields. The larger the NN model becomes, the more difficult it is to install the NN model into a computer with limited computing resources. One way to compress NN models is the quantization of the weights. Noise-shaping quantization has been proposed as a quantization method that preserves the performance of NN. This quantization method discretizes the weights, spreads the quantization errors over other weights, and keeps the performance of the NN. However, fewer methods can intuitively assess the effect of quantization of the NN. Therefore, this study proposes a method to visually evaluate the performance of NN by using Topological Data Analysis (TDA). TDA is a method of analyzing data based on topology, which examines the number and size of holes in the data. We apply a TDA-based performance evaluation method to the NN.

GS24-3 Crane control using a neural network optimized by an improved bat algorithm

Hiroyuki Fujii[1], Kunihiko Nakazono[2], Naoki Oshiro[2], Hiroshi Kinjo[2]
([1]Graduate school of Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

In this paper, we propose a three-layered neural network controller (NC) optimized by an improved bat algorithm (BA) for a rotary crane system. In our previous study, the simulation results showed that the NC optimized by the original BA exhibited good control and evolutionary performance. However, the execution time was long in simulation. Therefore, we propose an improved BA that reduces the execution evolutionary simulation time. The simulation demonstrated that the NC optimized by the improved BA had the same control performance as that of the NC optimized by the conventional method and that the time for evolutionary calculations could be reduced.

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GS24-4 Improvement of evolutionary performance using neural network controller optimized using scheduled firefly algorithm

Taishi Tanaka[1], Kunihiko Nakazono[2], Oshiro Naoki[2], Hiroshi Kinjo[2]
([1]Graduate School Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

In our previous study, we designed a three-layered neural network controller (NC) optimized using the firefly algorithm (FA) to suppress the swing of a suspended load on a rotary crane and showed that it demonstrates a good control performance. In this paper, we propose a scheduled FA in which attractiveness, a design parameter of the FA, is varied stepwise for each iteration according to a predefined schedule. The simulation results showed that the NC optimized using the proposed scheduled FA has good control performance and evolutionary performance compared to the original FA. In this study, we focus on the randomness parameter, which is a design parameter of the FA, and propose a scheduling method for this parameter. The simulation results showed that the proposed method demonstrates a better evolution process than the original FA. Keywords: firefly algorithm, neural network, evolutionary computation algorithm.

GS24-5 Improved harmony search algorithm for neural network optimization in rotary crane systems

Ryoma Araki[1], Kunihiko Nakazono[2], Naoki Oshiro[2], Hiroshi Kinjo[2]
([1]Graduate school Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

Rotary cranes are cost-effective nonholonomic systems; however, vibration suppression of suspended loads is a difficult control problem to solve. In this study, we propose the application of harmony search (HS), which is an evolutionary computation algorithm based on musicians' improvisation, to optimize a hierarchical neural network controller (NC) for vibration control of suspended loads in rotary cranes. In our previous study, we proposed an NC optimized by the original HS algorithm for a rotary crane system. However, the algorithm had a long convergence time. Therefore, we propose an improved HS method for changing multiple connection weights instead of one connection weight at a time. The simulation results showed that the NC optimized using the improved HS method exhibits better evolutionary and control performances than when using the conventional method.

GS24-6 Experimental Evaluations on First Passage Time in Brownian Neural Networks

Akihiro Inada[1], Teijiro Isokawa[1], Sho Nakade[2], Ferdinand Peper[2], Yasuhiro Utsumi[3], Naotake Kamiura[1]
([1]University of Hyogo, Japan)
([2]National Institute of Information and Communications Technology, Japan)
([3]Mie University, Japan)

A Brownian Neural Network (BNN) is a type of neural network model built by Brownian circuits. The time density of tokens on the signal lines between neurons in a BNN represents the transfer of information between neurons. Since the token density plays the role of information, it is necessary to clarify the temporal characteristics of the token density within a circuit. In this paper, we evaluate the properties of tokens flowing in a Brownian circuit by numerical experiments with asynchronous cellular automata. We have measured the first passage time of tokens in signal lines of various length. The first passage time is calculated by the travel time of a token's departure to its destination on first arrival. The simulation results show that the distribution of first passage times follows an inverse-gaussian distribution. Also we have measured first transit times in a threshold circuit with a two-token threshold. We found that the distribution of the difference between the first pass times of the two tokens arriving at the output terminal is different from the distribution at the input terminal. This suggests that the threshold function can control the time density of tokens.

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GS24-7 Development of a hardware CPG model for controlling both legs of a musculoskeletal humanoid robot with gait and gait cycle change by higher center and sensory information

Tatsumi Goto, Rina Okamoto, Takumi Ishihama, Kentaro Yamazaki, Yugo Kokubun, Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

Most conventional biped robots process leg movements and information from each sensor by numerical calculation using a CPU. However, to cope with diverse environments, the numerical calculations are enormous, so they must be processed at high speed using a high-performance CPU and high power consumption. On the other hand, focusing on human motor control, it is believed that basic motor patterns such as walking and running are generated by a neural network called the central pattern generator (CPG), which is localized in the spinal cord and is independent of calculation. We have imitated human CPGs with artificial neural networks composed of analog electronic circuits. This study aims to develop a hardware CPG model for controlling both legs of a musculoskeletal humanoid robot whose gait changes according to the higher center and sensory information. We report on the circuit simulation to confirm that walking and running patterns are generated.

January 26 (Friday), 15:00-16:00

Room A

GS30 Robotic mechanism II

Chair: Takehito Kikuchi (Oita University, Japan)

GS30-1 Design of Effective Suction Force Sensible Vacuum Gripper by a 6-Axis Force Sensor

Sou Izumi, Shuhei Ikemoto
(Kyushu Institute of Technology, Japan)

This study proposes a vacuum gripper that can measure the effective suction force applied to an object using a 6-axis force sensor. The object falling in a vacuum gripper occurs when a gap between the object and the pad no longer allows the negative pressure in the chamber. This is rephrased as the absence of a compression force between the object and the pad. Therefore, the force distribution that the attached object pushes the pad during suction reflects the external force, i.e. the effective suction force, required to remove the object. To confirm the validity of the developed vacuum gripper, we conducted an experiment where the developed vacuum gripper sucks a flat plate. As a result, we confirmed that the 6-axis force sensor's signals mean the effective suction force by applying an external force to remove the place.

GS30-2 Dynamic Analysis on Walking Motion of a Hexapod MEMS Microrobot

Yifan Yang, Koki Takasumi, Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

With the advancement of microtechnology, there is growing anticipation for the development of microrobots capable of performing in minimally invasive medicine or maintenance within the precision machinery. In our previous study, we have developed a walking MEMS microrobot with independent legs using a compound 4-bar linkage mechanism. In this paper, we generated the walking of the microrobot by using a dynamic simulator and analyzed the walking motion in order to achieve stable walking. We analyzed the forces acting on the microrobot during walking and measured the forces required to fully actuate the legs. And simulated situations where the actuator malfunctioned to measure the micro-robot's stability during walking. Furthermore, to confirm the walking characteristics of the microrobot, we enlarged the microrobot's volume and compared the walking of the enlarged model with that of the microrobot.

January 26 (Friday), 15:00-16:00

GS30-3 S-curve Based Velocity Profile Design for Reducing Unwanted Vibrations in High-Speed Motion of SCARA Robot

Kyu Tae Park, Jung Ho Kim, Min Cheol Lee
(Department of Mechanical Engineering, Pusan National University, Korea)

Industrial robots are utilized in various environments. For example, industrial robots are used in manufacturing that require repeatable precision, such as product assembly and positioning. One type of industrial robot, SCARA (Selective Compliance Assembly Robot Arm), is known for its fast and precise operation. This robot is characterized by its horizontal arm movement and joint axes perpendicular to the ground and is often referred to as a 'horizontal articulated robot.' However, all robots can experience decreased accuracy due to vibrations during high-speed rotation. Also, this issue can lead to a shorter mechanical lifespan of the robot. We can solve this problem with a new design, changing the robot parts, or other methods. To address this issue without a robot redesign, it is suggested that the use of motor acceleration and deceleration through control algorithms to avoid cost constraints.

GS30-4 Investigation on the Complex Thermo-Mechanical Performance of Ceramic-Coated Aluminum Alloy Pistons

Shah Nawaz Khan, Tauseef-ur Rehman, Cheol Woo Park
(School of Mechanical Engineering, Kyungpook National University, South Korea)

The pursuit of increased engine power-to-volume density has driven the widespread adoption of turbochargers, aiming to enhance volumetric efficiency. While effective in this regard, turbochargers also elevate cylinder temperature and pressure, leading to consequential thermal distortions and a reduction in tribo-contact clearances. These phenomena present potential threats to the engine's longevity, forming a complex challenge in modern automotive engineering. In response to this challenge, thermal barrier coatings (TBCs) have emerged as a promising solution, exhibiting potential in mitigating heat losses, reducing hazardous emissions, and redirecting thermal energy away from the piston skirt within internal combustion engines. This study initiates a comprehensive investigation, subjecting a diesel engine piston to meticulous thermo-mechanical analysis following the application of an innovative yttrium barium zirconate (Y-BZ) coating. The research encompasses comparative assessments with alternative TBCs of varying thicknesses. The findings of this investigation are substantial, revealing a noteworthy reduction in the surface temperature of the piston substrate across diverse TBC applications. Notably, the Y-BZ coating demonstrates exceptional performance, presenting a significant 21% reduction in temperature. These results underscore the transformative potential of the Y-BZ coating in bolstering piston durability under demanding thermal conditions. The superior performance of the Y-BZ coating is attributed to its consistent thermal and elastic properties, in conjunction with a lower thermal conductivity compared to alternative TBC materials. As a result, the Y-BZ coating emerges as a groundbreaking solution, promising not only to enhance engine efficiency but also to significantly prolong engine life. This extensive study stands at the forefront of innovation in the field of engine technology, providing unprecedented insights into the utilization of advanced coatings to elevate engine performance. The research establishes a new standard for the potential applications of thermal barrier coatings, unlocking doors to unparalleled advancements in modern automotive engineering. The development of highly efficient thermal barrier coatings, like Y-BZ, holds promise for minimizing carbon emissions and enhancing fuel economy, fostering a sustainable future for the automotive sector. Moreover, the innovative use of ceramic coatings in internal combustion engines has far-reaching implications for other engineering applications, including power generation and aerospace. In conclusion, this study represents a significant leap forward in the quest for improved engine performance and longevity, with an emphasis on thermal barrier coatings. The promising results achieved through the application of the Y-BZ coating open new horizons for innovation in the automotive industry and offer valuable insights into addressing multifaceted challenges in modern engineering.

January 26 (Friday), 15:00-16:00

Room B

OS5 AROB: Biomimetic Machines and Robots II

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

OS5-1 Evaluation Functions for Switching Methods in Gait Transitions of Quadruped Robots

Kenta Naramura, Shogo Nonaka
(National Institute of Technology, Tsuyama College, Japan)

We aim to explicitly control the gait of quadruped robots in the future. In previous studies, we have investigated gait transitions using central pattern generators (CPG). In this study, we investigated how to construct a simple network that can obtain robust responses for the gait transitions of a quadruped robot, and how to switch between the transitions. However, few indices for evaluating these gait transitions have been presented and comparisons have not been made. In this study, we investigated the evaluation of robot motion for these gait transition methods. The kinetic energy of the robot, the displacement from the target trajectory and the ground contact time of the leg tips were used as indices for kinematic evaluation. These were compared on a dynamics simulation and the evaluation functions of the kinematic characteristics of the gait network and the switching between transitions were investigated.

OS5-2 Simulation on 3D AUKF-SLAM based on multiple RTK-GNSS

Takahiro Shimizu, Hayato Miyoshi, Shoichi Maeyama
(Kagawa University, Japan)

In a previous study, 2D SLAM based on AUKF (Augmented Unscented Kalman Filter), called AUKF-SLAM, was proposed, and it demonstrated that simultaneous estimation of kinematic parameters improves the accuracy on SLAM. We currently aim to develop the 3D AUKF-SLAM, and this paper presents the 6DOF localization system based on AUKF with multiple RTK-GNSS as a preliminary step. We adopted quaternion for attitude representation. However, it is not the best way to estimate each element of the four-dimensional vector of quaternion as state variables because they don’t vary independently. As a solution to this problem, it is reported that simultaneous estimation of the attitude error represented as GRPs (Generalized Rodrigues Parameters) and quantities which isn’t represented as error is effective for the estimation of the attitude and the motion of space crafts. Therefore, we applied this method to wheeled robots to realize 6DOF localization and demonstrated it in a simulation environment.

OS5-3 Identifying PET Bottle Caps with the Hough Transform Technique

Kiyotaka Izumi, Shigeru Inada, Takeshi Tsujimura
(Saga University, Japan)

We are currently investigating the manipulation of PET (Poly Ethylene Terephthalate) bottles using a tabletop manipulator. This paper focuses on developing a system capable of detecting PET bottles in images captured directly above the work area. Ideally, the top-down view of a PET bottle comprises both the bottle's circular body and its cap. To identify these circular elements, we utilize the Hough transform for circle detection. However, the relative positioning of these circles varies depending on the PET bottle's location in relation to the image center. Leveraging this geometric arrangement information, we propose a method to accurately pinpoint the position of the bottle cap by eliminating misdetected circles. The efficacy of our proposed method is demonstrated through some experiments.

January 26 (Friday), 15:00-16:00

OS5-5 Application of SimCLR to Defect Detection and Study of Cropping Method

Hirohisa Kato[1], Fusaomi Nagata[1], Mochimitsu Komori[2]
([1]Sanyo-Onoda City University, Japan)
([2]Kyushu Institute of Technology, Japan)

This paper focuses on cropping as image augmentation for applying SimCLR to defect detection. Most areas of defect images of industrial products have the same characteristics as non-defect images, and defects exist only in some areas. Therefore, in image augmentation using cropping in SimCLR , the non-defect image is cropped from the defect image, which makes SimCLR's contrastive learning no longer work. To solve this problem, our study examines three methods that uses uniformly distributed noise images and masking of non-defect areas. The experimental results show that all methods improved the classification accuracy of defect images. In particular, the best results are obtained with the method of masking the non-defect areas of the defect image.

January 26 (Friday), 15:00-16:00

Room C

GS20 Mobile robots II

Chair: Yuichiro Taira (Sojo University, Japan)

GS20-1 Estimation of Approaching Vehicle Position and Speed using Traffic Mirror Images at Intersection

Hiroto Kawahata, Yuki Minami, Shura Suzuki, Masato Ishikawa
(Osaka University, Japan)

Automated vehicles often use visual information to assess safety. Therefore, it is difficult to assess the safety in the environment with many blind spots, such as T-junctions with poor visibility. Previous studies have explored the use of traffic mirrors for detecting approaching objects. Accurate estimation of the position and velocity of approaching vehicles is expected to enable safer merging decisions. In this study, we propose an estimation method of the position and velocity of an approaching vehicle based on the camera image reflected in a traffic mirror. The camera on the control vehicle recognizes the approaching vehicle reflected in the traffic mirror. We derived the geometric transformation equation that can estimate the position of the approaching vehicle by using the recognition information and the road information. Experiments with actual robots confirmed the effectiveness of the proposed method.

GS20-2 Automated Control of Magnetic Adhesion for Inspection Drones

Takumi Watanabe, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

The use of drones for inspection work at industrial sites, which is currently carried out visually, is attracting attention. In order to overcome the disadvantages of drones, such as rapid battery consumption and the inability to fly stably near ceilings, a drone that can magnetically adhere to the ceiling was proposed in this paper. A special magnetic wheel mechanism that can turn the magnetic force on or off was embedded on top of the drone. In addition, a control algorithm of automatic magnetic adhesion and release operations was developed. The automatic control method of the developed drone system for magnetically adhering to an iron ceiling from flight and transition from adhesion state to flight was verified through experiments.

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GS20-3 A Semiautonomous Drone System for Inspecting Structures

Yuta Sato[1], Masaru Kamada[2], Munehiro Takimoto[3], Yasushi Kambayashi[4]
([1]Major in Computer and Information Sciences, Graduate School of Science and Engineering, Ibaraki University, Japan)
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([3]Department of Information Sciences, Tokyo University of Science, Japan)
([4]Department of Informatics and Data Science, Sanyo-Onoda City University, Japan)

Taking pictures of the structure surface by a camera mounted on a drone is an efficient way for structure inspections. To achieve this means, we developed a semiautonomous drone system that autonomously keeps stable flying posture that is facing straight to the structure's surface with right angle and at a constant distance from the surface while the operator gives rough commands such as move up and down, and move left and right. To demonstrate the effectiveness of our system, we made the drone system fly in a large room and keep facing straight to the flat wall at the distance of 200 cm while we commanded its rough movements. The results showed that the drone system kept stable flying posture. We successfully observed that the stability was statistically significant. In this paper we report the implementation details that states how to make an off-the-shelf drone autonomously keep its flying posture stably and accurately.

GS20-4 Enhanced Dynamic Window Approach with Elliptical Obstacle Avoidance

Kensuke Higashimura, Satoshi Ueki, Takahiro Ikeda, Hironao Yamada
(Gifu University, Japan)

The paper discusses the need for robotics in changing factory layouts and the development of Autonomous Mobile Robots(AMRs) that can work safely with humans in complex environments. One key challenge is obstacle avoidance, especially dynamic obstacles. The Dynamic Window Approach(DWA) is a common obstacle avoidance algorithm but faces issues with circular trajectories. The paper introduces an enhanced version of DWA aiming for avoidance of people for mobile robots. It adds an evaluation factor that considers a pedestrian's future position predicted with a Kalman filter, enabling proactive avoidance. It also introduces an elliptical path planning strategy, defining elliptical trajectories around pedestrians. This approach aligns the ellipse with the person's movement direction, providing a more natural and efficient way to avoid dynamic obstacles compared to circular paths. The paper demonstrates the effectiveness of this enhanced DWA through simulation, showing that it can navigate alongside humans and interact with dynamic obstacles effectively.

January 26 (Friday), 15:00-16:30

Room D

GS28 Robot vision and image processing III

Chair: Kenji Hashimoto (Waseda University, Japan)

GS28-1 Light-weight Color Image Conversion like Pencil Drawing for High-level Synthesized Hardware

Honoka Tani, Akira Yamawaki
(Kyushu Institute of Technology, Japan)

We are developing pencil drawing-style image conversion software suitable for high-level synthesis, HLS, technology that automatically converts software into hardware. The pencil drawing-style image conversion consists of the former and latter processes. The former generates the images expressing edge strengths and their directions. The latter process convolves the line segment corresponding to the edge strength with its direction. As hardware-oriented software description, the medium data across the former and latter processes are optimized. However, the obtained image is still a gray-scaled image. To make it support the color image, this paper inserts a process compositing the original color image with the grayed pencil drawing-style image to not intervene in the pipelined data path behavior. The experimental results show that the colorization hardware had no significant performance degradation issues for circuit size, run time, or power efficiency compared to the pencil drawing hardware with grayscale.

GS28-2 Integration of multiple partial point clouds based on estimated parameters in photogrammetry with QR codes

Keita Baba[1], Yutaka Watanobe[1], Keita Nakamura[2], Taku Matsumoto[3], Toshihide Hanari[3], Kuniaki Kawabata[3]
([1]The University of Aizu, Japan)
([2]Sapporo University, Japan)
([3]Japan Atomic Energy Agency, Japan)

This study proposes a method for integrating reconstructed models by partial-to-partial registration using photogrammetry reconstructed models and QR codes. It has been considered difficult to integrate photogrammetry reconstructed models because the scale of each reconstructed model is different each time. In this study, we solve this problem by placing QR codes of known size in the environment for reconstruction and scaling each reconstructed model based on the size of the QR code. To verify this method, we compared the accuracy of the integrated model with that of the reconstructed model from all images. The comparison results show that a tolerance of 20 mm is highly accurate. We consider that this approach will be effective in reducing the time required for mapping using robotic and photogrammetric methods.

GS28-3 Flotsam Detection using Anomaly Detection Based on Semantic Segmentation

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In this paper, we propose a method for flotsam detection using anomaly detection based on semantic segmentation to prevent maritime accidents involving small vessels. Our proposed method uses semantic segmentation to detect areas on the sea surface, structures on the sea, and vessels. Then, flotsam detection is realized by assuming that the unlearned objects in the sea surface area that have not been detected, i.e., those that have not been labeled, are flotsam. Due to the various types of flotsam, collecting these data and conducting training is challenging. Therefore, our proposed method can solve this problem. In the proposed method, we adopt PSPNet and HRNet as semantic segmentation models. These are used for training and conducting flotsam detection experiments, followed by performance evaluation. The experimental results using the proposed method confirm that it can detect real flotsam. Furthermore, we confirmed that PSPNet is an effective method for flotsam detection.

January 26 (Friday), 15:00-16:30

GS28-4 Investigation of the Effect of Distance Between Object and Camera on Performance in Nighttime Object Detection Using Infrared Night-Vision Camera

Ryoma Ishizu[1], Hironori Kitakaze[1], Ryo Matsumura[2]
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([2]Shunan University, Japan)

This paper investigates the effect of the distance between the object and the camera on detection performance in nighttime object detection using the infrared night-vision camera. Our goal is to improve the performance of nighttime object detection using infrared night-vision cameras. We proposed a novel data augmentation method with pseudo-infrared night-vision image conversion for nighttime object detection in our previous work. The above-mentioned investigate is conducted by the model trained using the proposed method. We compared the detection performance using each test dataset consisting of images captured at object-to-camera distances of 5, 10, and 15 m. Experimental results confirmed that detection performance reduces as the distance from the object to the camera increases, whether indoors or outdoors, and that the detection limit distance is 10 m.

GS28-5 Verification of GAN-Based Style Transfer for CG-Based Generative Training Data in Training a Wood Ear Mushroom Detection Model

Hajime Taguchi[1], Ryo Matsumura[2], Hironori Kitakaze[1]
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([2]Shunan University, Japan)

To address labor shortages, we developed a wood-ear mushroom detection model for automatic harvesting. However, detecting crops such as wood ear mushrooms requires a significant amount of training data. In our previous work, high accuracy was achieved with a small number of real-world images by combining the use of CGI in the training data, and mitigating the reality gap between the CGI and real-world image was expected to further improve the detection accuracy. In this study, we verified whether CGI for real-domain transfer using a GAN-based method can improve the accuracy of wood ear mushroom detection. The accuracy was improved by approximately 6% in the F2-score between the CGI and GAN-generated datasets. However, there was no significant difference in detection accuracy when training a combination of real-world and generated image data. We believe the resolution and amount of training data must be optimized.

GS28-6 Image Segmentation Method Based on a Two-Stage Approach for Harvest Order Decision of Densely Growing Crops

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([2]Shunan University, Japan)

This study proposes a method for determining the appropriate harvesting order for wood ear mushrooms by recognizing their growth stages and harvesting priorities from depth images. We aim to minimize crop damage and improve the quality of harvested crops during the harvesting of densely growing crops using a robot arm. The proposed model was trained using a simulated CGI of wood ear mushroom growth, and the appropriate priority order was determined using depth images obtained from a stereo camera. The experimental results show that the correct harvesting order can be outputted in 57.5% of the cases for the 40 sets of test data. The results show that it is possible to determine the harvesting order of dense wood ear mushrooms based solely on depth images. However, there is still room for improvement in operations in actual environments.

January 26 (Friday), 15:00-16:00

Room F

GS25 Neural networks II

Chair: Fumio Uchikoba (Nihon University, Japan)

GS25-1 Landslide Area Segmentation of Synthetic Aperture Radar Images Using U-net with Convolutional Autoencoder Trained by Pre-training and Fine-tuning

Shingo Mabu, Yutaro Shibata, Thanawit Gerdprasert
(Yamaguchi University, Japan)

This study explores the use of synthetic Aperture Radar (SAR) images for finding landslide areas. Although SAR can observe the surface of the earth at night and in bad weather condition, it is difficult for human eyes to interpret SAR images. To address this problem, this study proposes a disaster area segmentation model using deep learning, specifically an enhanced segmentation model based on UnCAE (U-net with convolutional autoencoder). Given the difficulty of obtaining labeled disaster area images, the model is trained not only on a labeled dataset (fine-tuning) but also on an unlabeled dataset obtained from a wide range of SAR images (pre-training). Evaluation on a SAR image of the northern Kyushu area, Japan reveals improved segmentation performance compared to conventional methods, with statistically significant differences.

GS25-2 Text-Based 3D Human Motion Retrieval with Motion-Text Negative Filtering

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([4]Center for Human Nature, Artificial Intelligence, and Neuroscience, Hokkaido University, Japan)

In text-based motion retrieval methods, the diverse expressions in the text should be associated with motion sequences, enabling flexible retrieval of motion data from extensive 3D human motion datasets. However, associating the spatial-temporal structure of 3D human motion data with complex text representations is a difficult task. In addressing this problem, some studies employ contrastive learning to learn shared embedding spaces for motion and text. The contrastive learning method effectively understands the correspondence between long-term motion sequences and complex textual representations. To enhance the effectiveness of contrastive learning, those studies incorporated negative filtering to detect and exclude false negative samples, which can disturb contrastive learning. Although negative filtering for contrastive learning can be effective, negative filtering based only on the similarity of the annotation text is not considered sufficient for multimodal learning. In this paper, we propose motion-text negative filtering, which is different from previous studies; it detects false negative samples based on the similarity between motion and text. We showed that our model outperforms the previous studies on some metrics in the motion retrieval and action recognition tasks.

GS25-3 Neural Network Controller Optimized with Artificial Bee Colony Algorithm for Rotary Crane Control

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Rotary cranes play a crucial role at construction sites and factories to transport, load, and unload loads. However, unlike ordinary cranes, these cranes are nonholonomic systems because they perform only rotating movements, making it difficult to control the suppression of the suspended load. Therefore, safety issues and a shortage of skilled operators exist, and an automatic control system that can be handled by unskilled operators is required. This paper proposes a method for designing a neural network controller optimized using an artificial colony bee algorithm for rotary cranes. The simulation results show that the proposed method improves the control performance.

January 26 (Friday), 15:00-16:00

GS25-4 Neural network controller optimized by a scheduled cuckoo search for a jib crane installed on an unstable system

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([1]Graduate school of Engineering and Science, University of the Ryukyus, Japan)
([2]Faculty of Engineering, University of the Ryukyus, Japan)

In recent years, shortage of operators in the construction and manufacturing industries has become a serious problem owing to falling birthrates, aging population, and labor shortages owing to COVID-19. Therefore, automatic machine control devices that do not require operators are being actively developed. One such automatic control device is a crane system. This study aimed to develop a jib crane system that can control the swing of a load equal to or greater than that of a skilled jib crane operator. A neural network controller (NC) to control the load was proposed for a jib crane installed on an unstable base, such as ships floating at sea, and the NC was optimized using the cuckoo search algorithm.