ABSTRACTS

Plenary Speech 1 (Room G)

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

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

From rigid to soft to biological robots.

Josh Bongard

The University of Vermont, USA

Organisms and robots must find ways to return to a viable state when confronted with unexpected internal surprise such as injury, or external surprise, such as a new environment. Rigid robots can only confront such challenges by adapting behaviorally. Soft robots have the added option of morphological adaptation: changing shape, material properties, topology, plurality, and/or mass. Finally, biological robots -- machines built completely from biological tissues -- inherit the protean nature of their donor organisms, providing them with forms of morphological and behavioral adaptation beyond even today's most morphologically plastic soft robots. In this talk I will review our recent efforts to create biological robots, and how their protean natures have led us to rethink how we approach soft robotics, embodied cognition, and intelligence in general.

Biography:

Josh Bongard is the Veinott Professor of Computer Science at the University of Vermont and director of the Morphology, Evolution & Cognition Laboratory. His work involves automated design and manufacture of soft-, evolved-, and crowdsourced robots, as well as computer-designed organisms. A PECASE, TR35, and Cozzarelli Prize recipient, he has received funding from NSF, NASA, DARPA, ARO and the Sloan Foundation. He is the co-author of the book How The Body Shapes the Way We Think, the instructor of a reddit-based evolutionary robotics MOOC, and director of the robotics outreach program Twitch Plays Robotics.

Plenary Speech 2 (Room G)

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

Chair: Toru Namerikawa (Keio University, Japan)

Analysis and Synthesis of Heterogeneous Multi-agent System via Blended Dynamics Approach

Hyungbo Shim

Seoul National University, Republic of Korea

This talk emphasizes that a group of heterogeneous multi-agent dynamics exhibits an emergence of new behavior when some parts of the dynamics are enforced to synchronize, and the new behavior can be represented by the so-called blended dynamics. This fact is utilized for analysis of the behavior of coupled oscillators and for explaining how a large number of agents in a group can enhance the robustness of the group. The fact, when viewed in a different angle, can also be used for synthesis of a heterogeneous multi-agent system intended for distributed computation. We demonstrate a few applications of the designs in this talk.

Biography:

Hyungbo Shim received the B.S., M.S., and Ph.D. degrees from Seoul National University, Korea, and held the post-doc position at the University of California, Santa Barbara. Since 2003, he has been with Seoul National University, now the director of Automation and Systems Research Institute. He has served as an associate editor for Automatica and IEEE Trans. on Automatic Control. He is the IPC chair of IFAC World Congress 2026. His research interests include stability analysis of nonlinear systems, observer design, disturbance observer technique, secure control systems, and synchronization for multi-agent systems.

Plenary Speech 3 (Room G)

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

Chair: Reiji Suzuki (Nagoya University, Japan)

Human-Agent Interaction as Augmentation of Social Intelligence

Hirotaka Osawa

Keio University, Japan

Human-agent interaction is a broad discipline that deals with the interaction between humans and social agents. Agents in human-agent interaction exist in many implementations, including social robots, on-screen agents, and game characters, but they all have one thing in common: they are social entities that are perceived by humans as having intentions. Just as artificial intelligence technologies augment human intelligence, these agent technologies can be considered augmenting human society in future. This talk will look at some of the agent research in the field of human-agent interaction, including anthropomorphic technology, board game research, and science fiction research, and examine how human-agent interaction can augment human society in the future.

Biography:

Dr. Hirotaka Osawa is an associate professor in Keio University and visiting associate professor in University of Tsukuba. His research field is in human-agent interaction, including development of anthropomorphic devices, simulation for social agent using social games, and humanity studies using science fictions including sci-fi prototyping. He believes that social intelligence tasks, such as recursively reading each other's intentions, are an important factor in the evolution of artificial intelligence, and he carries out these studies from this perspective. He is senior editor of Japanese Society of Artificial Intelligence. He is also a board member of Science Fiction and Fantasy Writers of Japan.

Invited Talk 1 (Room B)

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

OS8 AROB: Recent Natural Language Processing Models and Applications

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

Low-resource languages and recent deep learning technologies

Kiyota Hashimoto

Prince of Songkla University, Thailand

Recent deep learning technologies have achieved superior results for many natural language processing tasks in English and other major languages. There are, however, many languages, low-resource languages, for which enough amount of learning data, basic preprocessing tools, and foundational linguistic knowledge are not well available. Among them, some low-resource languages including Indonesian, for example, have been successfully coped with at least partially with seq-to-seq approaches while other languages including Thai and Burmese have been waiting for more advancement. In this presentation, some difficulties of low-resource languages are explained, and several ways to overcome such difficulties are introduced. Based on them, some recent achievements particularly in Thai, Burmese, and Indonesian are discussed.

Biography:

Professor at Prince of Songkla University, Thailand. D.Eng (Nara Institute of Science and Technology). He has worked for natural language processing research more than 20 years, and one of his recent research interests is handling low-resource natural languages such as Thai, Indonesian, Burmese, which lack well-designed corpora for machine learning. Until 2015, he worked at several universities in Japan, including Osaka Prefecture University. Currently he is also Collaborative Professor at Kanazawa University, and serves as associate editor of some journals.

Invited Talk 2 (Room A)

January 27 (Friday), 9:00-9:30

OS5 AROB: Human-Centered Robotics

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Irfan Hussain (Khalifa University, United Arab Emirates)

Telesurgical Skill Enhancement Through Visuohaptics and Error Amplification

Zonghe Chua

Assistant Professor, Department of Electrical, Computer, and Systems Engineering Case Western Reserve University - USA

Surgeon skill is strongly linked to improved postoperative patient outcomes. However, in minimally-invasive telesurgery, there is a long learning curve with surgical trainees needing to adapt to diminished depth perception, limited haptic feedback, and the unique dynamics of the surgeon-side manipulanda with few opportunities to undergo time-intensive expert coaching. These factors motivate a need for automated training methods to accelerate the development of key components of telesurgical skill in trainees. Robotic telesurgical platforms, like the da Vinci Surgical System are uniquely suited to deliver such training experiences as they can measure the kinematics of their operator and provide high-fidelity visual and haptic feedback to facilitate skill learning. In this talk, I will discuss training approaches to improve (a) movement dexterity and (b) force control of operators using haptic feedback from a telesurgical robot, as well as new vision-based deep learning methods to provide such haptic feedback.

Biography:

Zonghe Chua is an assistant professor at Case Western Reserve University in the Department of Electrical, Computer, and Systems Engineering. He currently directs the Enhanced Robotic Interfaces and Experiences Lab which develops new approaches to integrating multimodal user and environmental sensing with smart algorithms to provide multisensory feedback to the user that can enhance skill acquisition and real-time performance during teleoperation. He received his BS from the University of Illinois at Urbana-Champaign in 2015, and his MS and PhD from Stanford University in 2020 and 2022 respectively, in mechanical engineering. While at Stanford he worked at the Collaborative Haptics and Robotics in Medicine Lab and was a Stanford Bio-X Luber Stryer Interdisciplinary Fellow, an Intuitive Surgical Student Fellow, and a young National University of Singapore Fellow. His work on neural network-based visual force estimation and haptic feedback was a best overall paper nominee at IROS 2022.

Invited Talk 3 (Room A)

January 27 (Friday), 9:30-10:00

OS5 AROB: Human-Centered Robotics

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Irfan Hussain (Khalifa University, United Arab Emirates)

The Rise of Reconfigurable Maintenance Robots

Mohan Rajesh Elara

Associate Professor, Engineering Product Development,
Singapore University of Technology and Design (SUTD) - Singapore

Reconfigurable robots are intelligent machines capable of autonomously changing their kinematic morphologies to overcome complexities in the traversing environment or task being handled. Their promise of a high degree of versatility, robustness, and modularity is set to open up a wide range of new applications for robots. However, developing these robots is highly challenging. While some progress has been achieved, there are still many open issues. In this talk, I will share our ongoing efforts at the Singapore University of Technology and Design towards the design, development and deployment of reconfigurable robots using a well-defined set of deployment use cases in the maintenance domain. I will also provide an insight into our concerted efforts being a catalyst to inspire an ecosystem of Singapore based robotic startups in the maintenance domain.

Biography:

Dr. Mohan is currently a Provost Chair Professor with the Engineering Product Development Pillar at Singapore University of Technology and Design. He received his Ph.D. and M.Sc degrees from the Nanyang Technological University. His research interests are in robotics with an emphasis on reconfigurable platforms as well as research problems related to robot ergonomics and autonomous systems. He has published more than 150 papers in leading journals, books, and conferences. Dr. Mohan is currently serving as an Associate Editor of the IEEE Robotics & Automation Letters and IEEE Nanotechnology Magazine. He is the recipient of the SG Mark Design, ASEE Best of Design in Engineering Award, Tan Kah Kee Young Inventors' Award and A' Design award. He is the co-founder of Lionsbot and Oceania Robotics, robotics companies that develop a wide range of autonomous robots for specialized niche industries. Dr. Mohan has served in various positions of organizing and technical committees of several international competitions and conferences.

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

Room A

OS22 SWARM: Motion Analysis and Control of Advanced Robotic Systems

Chair: Fumihiko Asano (Japan Advanced Institute of Science and Technology, Japan)
Co-Chair: Yuta Hanazawa (Kyushu Institute of Technology, Japan)

OS22-1 3D Walking of Telescopic Legged Rimless Wheel Robot on Floor with Steps

Yuta Hanazawa, Yuhi Uchino, Shinichi Sagara
(Kyushu Institute of Technology, Japan)

In this paper, we show a rimless wheel robot with elastic telescopic legs has the ability to overcome high steps through 3D numerical simulation. Previous studies showed that a rimless wheel robot with elastic telescopic legs has high adaptability to steps in numerical simulations. However, as far as we can ascertain, no actual rimless wheel robots have been developed for walking environments with high steps. To develop the rimless wheel robot with the ability to overcome high steps, we first create 3D walking simulator of the robot on Unity. We then confirm the optimal elasticity of the elastic telescopic legs through numerical simulation.

OS22-2 Modeling and Motion Analysis of Planar X-shaped Passive Bipedal Robot with Springs and Hip-joint Friction

Fumihiko Asano, Bowen Tang
(Japan Advanced Institute of Science and Technology, Japan)

This paper proposes planar X-shaped passive bipedal robot models with linear springs and hip-joint friction, and numerically analyzes the fundamental gait properties. First, we outline the model assumptions and the equations of motion, holonomic constraint conditions and collision for stance-leg exchange. Second, we conduct numerical simulations of passive dynamic walking and show that adding springs below the hip joint makes stable gait generation achievable even on steep slopes. Furthermore, we also show that adding viscous friction torque to the hip joint and increasing the elastic coefficient can make stable gait generation even on steeper slopes.

OS22-3 Appropriate Attachment of Viscoelastic Elements for Smooth Rear Foot Take-off in Passive Dynamic Walking of Flexible Rimless Wheel

Fumihiko Asano, Yuxuan Xiang, Runyu Liu, Cong Yan
(Japan Advanced Institute of Science and Technology, Japan)

This paper introduces two different models of passive flexible rimless wheels, Type A and Type B, that consist of three rigid frames and six viscoelastic elements, and numerically analyzes the fundamental gait properties. Type A has viscoelastic elements mounted between a mounting position on the inside of one frame and that on the outside of the counterclockwise adjacent frame, whereas Type B has those mounted between a mounting position on the outside of one frame and that on the inside of its counterclockwise adjacent frame. We conduct numerical simulations while considering several necessary conditions for stable passive-dynamic gait generation, and show that Type A succeeds in many cases but Type B does not succeed at all.

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

OS22-4 Generation of Limit Cycle Gait with Static Standing Posture as Initial and Terminal States

Fumihiko Asano, Mizuki Kawai
(Japan Advanced Institute of Science and Technology, Japan)

This paper proposes a novel method for generating a limit cycle gait by repeating gait initiation from a static standing posture and gait termination to the same posture. The stance-leg motion must be completed in one step even though it is affected by the collision for stance-leg exchange, and the control system is designed by dividing the motion into two phases before and after the collision. First, we introduce a model of an underactuated rimless wheel (URW) that consists of an eight-legged rimless wheel and a reaction wheel, and describe the equations of motion and collision. Second, we discuss the stability condition of the reaction wheel that behaves as zero dynamics, and derive an approximate analytical solution of the target initial angular velocity using the linearized URW model. Furthermore, based on the results obtained, we numerically identify the target initial angular velocity, and verify the effectiveness through numerical simulation.

OS22-5 TAOYAKA Ⅶ: A multi-legged robot capable of climbing columnar objects and walking on rough terrain

Shohei Tomikawa, Kazuyuki Ito
(Hosei University, Japan)

In our previous works, we have developed a six-legged robot that can climb various columnar objects without measuring their shape and size by imitating an octopus-like behavior. In addition, it could walk on a flat horizontal plane. However, its legs were not sufficiently stiff to enable rough terrain such as rubbles and steps. The goal of this research is to improve our previous robot to adapt it to various environments such as steps and rough terrain. Experiments were conducted, and as the results, we confirmed that the robot can climb columnar objects as well as walk on rough terrain and steps.

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

Room B

GS5 Artificial life

Chair: Mizuki Oka (The University of Tsukuba, Japan)

GS5-1 How Large Elite Size Can Facilitate the Evolution of Artificial Creatures with NEAT

Siti Aisyah Binti Jaafar, Reiji Suzuki, Satoru Komori, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

This study proposes a simple method based on a novel use of elitism in NEAT (NeuroEvolution of Augmenting Topologies) to increase the population size and diversity while keeping the evaluation cost small to avoid premature convergence of the population. In the proposed elitism, we assume that the evaluated fitness of best-fit individuals will be succeeded and reused instead of being re-evaluated during subsequent fitness evaluation, which can reduce the evaluation cost if the elite size is large. We evolved the morphology and behavior of artificial creatures in a 3D multi-agent environment with a simple target approach task. We conducted experiments involving four cases with comparable conditions that show the performances of the evolution with the small or large elite and population sizes. We show that the proposed elite method has surprisingly facilitated the evolution of artificial creatures by increasing the population diversity that avoids premature convergence under a small evaluation cost.

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

GS5-2 Emergence of the Spectral and Temporal Separation of Acoustic Niche in Coevolution of Artificial Creatures

Masaya Hiramoto, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

The acoustic niche hypothesis is known as an evolutionary phenomenon that the signaling behavior has evolved to split the acoustic space and minimize overlaps with other callers through the selection of the spectral and temporal characteristics of their signaling behavior. This study aims to investigate the evolution of complex niche separation of acoustic behaviors among species in the spectral and temporal domain by using the artificial creature framework, called EvoCreature, in which 3D-shaped creatures generate sound by physical contact between objects. We conducted experiments with the different strength of interaction among species using the fitness function that focused on the spectral and temporal interferences among species in their acoustic space. We found that there existed the moderate degree of interspecific influence that allowed the population to evolve adaptively through the separation of their acoustic niche.

GS5-3 Factors Affecting the Continuous Adoption of Smart Wearable Devices

Shiu-Wan Hung[1], Juin-Ming Tsai[2], Guan-Ting Lin[1]
([1]National Central University, Taiwan)
([2]National Taipei University of Nursing and Health Sciences, Taiwan)

With the increasing maturity of big data technology and mobile networks, smart wearable devices (SWD) are regarded as a new technology movement after smartphones. Increase in telecommuting and increasing interest in self-health monitoring, especially during the COVID-19 pandemic, is significantly driving the market growth of SWD. This study explored factors influencing continued use of SWD. A cross-level analysis model integrating network externalities, gamification theory, technical characteristics and perceived value theory is constructed. Hierarchical linear models were used to test hypotheses. Empirical results show that at the individual level, gamification enhances users' perception of value. At the group level, the effect of network externalities significantly affects the willingness to continue using the device. Therefore, designers should establish a clear product positioning and enhance interactivity to build customer loyalty.

GS5-4 Evolution of developmental plasticity in virtual multicellular soft robots

Xiangjun Yang, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

Developmental plasticity, defined as the ability of a single genotype to produce more than one phenotype in response to environmental conditions, plays an important role. We apply the concept of multicellular development to evolve both bodies and controllers of soft robots evaluated within simulated physics environment. In the model, an environment is selected randomly at the beginning of each generation and its ID is given as an input to the gene regulatory network used for developmental process. We successfully evolved robots that dynamically acquire phenotype adapted to the environment. We defined several indices to evaluate the phenotype of the robots to quantitatively analyze developmental plasticity, and found that the robots acquire a large body and uprightness when given a difficult environment. The synchrony of the cell's movements is also modified according to the environment. In addition, plasticity was shown to be greatest when the proportion of difficult environments was greater.

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

GS5-5 An Eco-Evo-Devo Platform for the Evolution of Acoustic Signaling Generated by Movement of Virtual Creatures

Satoru Komori, Reiji Suzuki, Takaya Arita
(Graduate School of Infomatics, Nagoya University, Japan)

Acoustic communication is found in many species, but its origin remains unclear. Our interest lies in the origin of acoustic communication based on the hypothesis that noises associated with animal behaviors became valuable as information through the evolutionary process, and then noises started to be used by the receivers and then by the senders. To investigate this, we previously constructed a virtual creature model focusing on the emergence of acoustic communication. In this study, we aim to enhance its biological relevance and applicability as practical robots. We constructed a new virtual creature model in which its morphology and behavior can vary intermittently through its lifetime, by introducing the process of ontogenetic development. As an initial experiment, we explored whether their adaptive behavior to sound evolved. The experimental results showed that the creatures evolved to approach or aggregate a sound source by making use of sounds while enhancing their mobility through developmental process.

GS5-6 Design of image processing circuits using approximate multipliers

Hiroyuki Saito, Akinori Kanasugi
(Department of Electronics, Tokyo Denki University, Japan)

Image processing tolerates levels of arithmetic error beyond human perception. Also, it is not necessary to maintain a certain level of image quality, depending on the application. Therefore, it is possible to reduce the circuit scale, by applying approximation. This paper proposes a method to apply approximate multiplier to the circuit for image scaling. These approximate multipliers are composed of several types of approximate adders with different characteristics. This technique reduces the circuit scale and obtains the desired circuit flexibly within tolerance. The proposed circuit was compared with an accurate image processing circuit as a performance evaluation. As a result, it was found that the proposed circuit can obtain images with various image quality depending on the reduction ratio of the circuit scale and the combination and placement of the approximation circuits.

January 25 (Wednesday), 09:00-9:45

Room C

GS9 Bio-mimetics & Brain science

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

GS9-1 Extraction of Mechanical Actuator Parameters by Dynamics Simulation of Left-Right Muscle Pairs for Human Walking and Running and Correspondence with Muscle Synergy Theory

Motokuni Ishibashi[1], Kenji Takeda[1], Lyu Shuxin[1], Takumi Ishihama[1], Tatsumi Goto[2], Kentaro Yamazaki[2], Megumi Aibara[2], Minami Kaneko[2], Fumio Uchikoba[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

Conventional biped robots consume large amounts of power because they use CPU and software programs to compute complex control operations. On the other hand, for basic motor control, such as walking, the central pattern generator (CPG) localized in the spinal cord patterns locomotion, and muscle synergy reduces a burden of motor control by coordinating the muscles necessary for locomotion. To realize this in a biped robot, the displacement of actuators that mimic muscles and the force generated are necessary, and it is necessary to compare them with physiological data. In this paper, we calculated the time series parameters of the actuators during walking and running based on inverse dynamics using an anatomical human musculoskeletal model. Then, they were discussed in correspondence with the electromyograms of walking and running.

January 25 (Wednesday), 09:00-9:45

GS9-3 Developing Light-Weight Simulation Models of Beam-Like Soft Robots: A Case Study using Webots Robotic Simulator

Bahar Haghighat[1], Jeremy Wanner[2], Radhika Nagpal[3]
([1]University of Groningen, Netherlands)
([2]Meta (formerly Facebook), Switzerland)
([3]Princeton University, United States)

Development of hardware and control programs for conventional rigid-link robots is supported by several well-established and powerful robotic simulators. However, due to existing limitations in such simulators, development of soft robots is mainly guided by experimentation rather than simulation, requiring numerous fabrication iterations and extensive time. This work presents a simple modeling and calibration approach using Webots robotic simulator for creating computationally light-weight physics-based simulation models of beam-like soft robotic modules, a well-developed class of soft robots. We develop the models directly within the Webots robotic simulator. First, we show how a beam-like soft body can be modeled based on a mass-spring system in Webots. Second, we present an automated procedure for calibrating the resulting model parameters using data gathered from a real soft beam-like object. Finally, we employ the developed models to demonstrate a variety of simulated beam-like soft robotic modules with different actuation and locomotion modes.

GS9-4 SN-38-incorporated Biodegradable Polymeric Micro/Nanoparticles for Potent Interstitial Chemotherapy for Malignant Glioma in Rats

Yuan-Yun Tseng[1], Ya-Ling Tang[2], Shih-Jung Liu[2]
([1]Department of Neurosurgery, New Taipei Municipal Tu-Cheng Hospital (Built and Operated by Chang Gung Medical Foundation), Taiwan)
([2]Department of Mechanical Engineering, Chang Gung University, Taiwan)

Using electrospraying, the potent chemotherapeutic agent 7-ethyl-10-hydroxycamptothecia (SN-38) was embedded into 50:50 biodegradable poly[(d,l)-lactide-co-glycolide] micro/nanoparticle (SMNs). The SMNs were stereotaxically injected into the brain parenchyma of healthy rats and intratumorally injected into F98 glioma-bearing rats for estimating the pharmacodynamics and therapeutic efficacy. SN-38 was rapidly released after injection and its local (brain tissue) concentration remained much higher than that in the blood for more than 8 weeks. Glioma-bearing rats were divided into three groups: group A (n = 13; no treatment), group B (n = 12; stereotaxically injected Gliadel wafer and oral temozolomide), and group C (n = 13; stereotaxic and intratumoral introduction of SMNs). The SMNs exhibited significant therapeutic efficacy, with prolonged survival, retarded tumor growth, and attenuated malignancy. The experimental results demonstrated that SMNs provide an effective and potential strategy for the treatment of MG.

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

Room D

GS11 Control techniques

Chair: Yuichiro Taira (Sojo University, Japan)

GS11-1 Development of obstacle avoidance system for an object transportation robot by measuring obstacles

Hayato Tokuda[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 paper, a control system for a transportation robot of an object with obstacle avoidance function is developed. First, by manually inputting the location of the target object and goal object, the robot moves straight to the target object. When the target object is captured by the camera, the robot approaches it. Once close enough, the target object is grasped by the manipulator. After that, the robot moves to the goal object in the same manner. When the robot is close enough to it, the robot releases the grasped target object. If an obstacle prevents the movement, obstacle avoidance is performed. In the obstacle avoidance, the robot uses a distance sensor to detect the location of the obstacle. The robot moves according to the control command generated by using the obstacle information. The usefulness of the developed control system is verified by experiments using an actual transportation robot.

GS11-2 Decentralized Event-Triggered Output Feedback Control for Cyber-Physical Systems

Koichi Kitamura, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

Event-triggered control over a sensor network is studied as one of the control methods of cyber-physical systems. Event-triggered control is a method that communication occurs only when the measured value is widely changed. As a control specification, we consider the notion of uniformly ultimate boundedness. Using this notion, it is guaranteed that if the state reaches a certain set containing the origin, the state stays within this set. And, the occurrence of events in the neighborhood of the origin is inhibited. First, the problem is formulated. Next, it is reduced to an LMI optimization problem.

GS11-3 LMI-Based Design of Structured Sparse Output Feedback Controllers

Yuta Kawano, Koichi Kobayashi, Yuh Yamashita
(Hokkaido University, Japan)

In this paper, we consider the design of controllers for discrete-time linear systems by sparse optimization. Sparse optimization minimizes the norm of a matrix and minimizes the number of nonzero elements in a particular column or row of the matrix. This sparse optimization problem is reduced to the LMI optimization problem. By solving an LMI optimization problem, it is possible to design sparse controllers, and it is expected that the number of sensors and actuators in cyber-physical systems will be reduced. The effectiveness of the proposed method is presented by a numerical example.

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

GS11-5 On switched objective function focused on driver's condition for shared control

Yuzuna Horiuchi, Kenji Sawada
(The University of Electro-Communications, Japan)

Shared Control is a driver assistance system in which the driver and controller have seamless driving authority over each other and steer the vehicle. In order to achieve shared control that is comfortable for drivers, it is necessary to manage the driving authority between the driver and the controller. In other words, it is important to switch appropriate supports based on the driver's condition and driving skill. In this study, we focus on the driver state and aim to help reduce the driver's steering load by judging the necessity of support intervention, and then switching the support. The controller is a model predictive controller of a mixed-logic dynamic system that achieves the supervisor function for judging the appropriateness of support intervention and the Shared Control function for switching the objective function. By employing a mixed-logic dynamic system formula, each function is optimized to ensure that the switching conditions are satisfied.

GS11-6 Performance Improvement methods of RISC-V processors by extending instructions and implementing approximate adders

Yuta Kobayashi[1], Akinori Kanasugi[2]
([1]Faculty of Engineering, Tokyo Denki University, Japan)
([2]Department of Electronics, Tokyo Denki University, Japan)

Approximate arithmetic units are the circuits that tolerates a constant errors. Human imperceptible errors are allowed in audio and image processing. This paper proposes a control method by adding instructions to RISC-V processors for using approximate arithmetic units. The approximate arithmetic unit can be used as an accelerator by adding instructions. As a result, approximate arithmetic programs can be executed, and enable efficient operations in using advanced technologies such as AI and robotics. We implemented three approximate arithmetic units and instructions. Also, four instructions implemented to enhance the bit arithmetic. The processors and circuits were designed in Verilog HDL, a hardware description language, logic synthesis, simulation and implementation for FPGA were performed using the EDA tool. In addition, processors and approximate circuits were evaluated by the executed clocks of programs and absolute errors of circuits.

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

Room E

GS16 Identification and Estimation

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

GS16-1 Investigation on the Influence of a Communication Robot who calls User's Name

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

The use of communication robots has been increasing in a field of early childhood education. Several studies reported that social robots are effective in educational support. In this study, we conducted evaluation tests of heart rate measurements to survey user’s emotional changes by cheering messages with and without calling the subjects’ names during a picture-coloring task. The measured R-R intervals were analyzed, and the LF/HF values were calculated. In addition, we used a set of NASA-TLX as a subjective evaluation. The statistical analyses on the items of the NASA-TLX showed that significant differences existed only in the physical demand with the increasing stresses after the tests. However, there are not severely high scores in all items and significant differences in the other items. With regard to the comparison on the LF/HF, statistical analyses showed significant differences before and after the cheering message with calling their names.

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

GS16-2 Development of Progressive Cavity Pump with Piezoelectric Sensing for Slurry Liquid Identification

Daisuke Sato, Jun Ogawa, Yosuke Watanabe, Masaru Kawakami,
MD Nahin Islam Shiblee, Hidemitsu Furukawa
(Yamagata University, Japan)

Commercially available nursing food has poor appearance and texture and is expensive. To address this challenge, we are taking a 3D printing approach. 3D printing for nursing care food has ink material limitations. In this paper, we propose an ink material discriminator for 3D printing of nursing care food using a piezoelectric sensing-based progressive cavity pump (PCP). After sensing, features were increased and logistic regression was applied to classify and estimate five different ink materials for care food. The estimation results correlated to some extent with the viscosity measurement results of the ink materials. Therefore, by using this device as a supply pump for a food 3D printer, it is possible to function as a system to determine whether to supply ink materials to the 3D printer based on the discrimination results.

GS16-3 Investigation on Multi-lag Poincaré Plot Expression in Mental Stress Evaluation with Ultra-short HRV Data

Nan Bu
(National Institute of Technology (KOSEN), Kumamoto College, Japan)

Evaluation of mental stress levels and affective states have attracted increasing attentions in recent years. Short-term physiological data, or ultra-short term data that is less than 60 s, is much desirable from the practical point of view, since it requires less computation and storage hardware resources for data processing. Nonlinear transformation of heart rate variability (HRV), such as Poincare plot, may deliver useful information that benefits (ultra-)short term HRV analysis. This paper aims to investigate multi-lagged expressions of Poincare plot transformation as a novel method to discriminate mental stress conditions according to ultra-short HRV data. The data length of evaluation windows is set between 30-60 s. Mental stress discrimination analysis is carried out with different stress levels on eight subjects. Electrocardiogram (ECG) signals have been measured and R-R intervals (RRI) data is derived from the ECG signals. These RRI data are segmented with three data length settings, and then analyzed with Poincare plots using different lagged expressions. Traditional indices of Poincare plot expression are obtained to investigate the difference between number of lags.

GS16-4 Detection of concrete deterioration based on hammering sound data using data analysis and machine learning

Keisei Takara[1], Naoki Oshiro[2], Jun Tomiyama[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)

The hammering test is often used to detect the deterioration of concrete based on the sound produced by a hammer striking the concrete. We studied machine-learning methods for detecting concrete deterioration and determining its status. The deterioration of concrete and corrosion of its reinforcing bars cause the deterioration of reinforced concrete structures. These structural defects lead to insufficient strength. The non-destructive tests (NDT) are applied to detect concrete deterioration, such as component thickness discrepancies. These discrepancies generate an irregular sound when the concrete is hammered. The judgment of deterioration from sound needs the high skill of an inspector. We tried to make this judgment more easily applicable to the user, and also it works automatically. A support vector machine (SVM) and mel frequency cepstral coefficient (MFCC) can be utilized with the hammering sound to automate this detection method. In the experiment, we used a concrete block with three squared holes which have different thickness. Experimental results showed that the combination of SVM and MFCC had a sufficient judgment with high accuracy. We studied machine-learning methods for detecting concrete deterioration and determining its status.

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

GS16-5 Pig weight prediction system using RGB-D sensor and AR glasses - Analysis method with free camera capture direction -

Kikuhito Kawasue[1], Pwint Phoo Wai[1], Khin Dagon Win[1], Geunho Lee[1], Yusuke Iki[2]
([1]University of Miyazaki, Japan)
([2]Miyazaki Prefecture Livestock Research Institute, Japan)

Pig weights are important indicator for the healthcare and the economic operation of pig farms, and the development of a system to easily estimate these weights is desired. Therefore, a convenient pig weight estimation system using RGB-D sensors has been developed. An RGB-D sensor (Intel Realsense D455) is used as the sensing device for weight estimation. Weight estimation is performed on 3D point cloud data of photographed pig images. When capturing pigs, it is desirable to have a constant camera orientation toward the pigs However, it is not easy to always capture from the same direction because pigs move around quickly in the piggery. A method with a high degree of freedom in the capture direction by exploiting pig symmetry of the pig's body is introduced in this paper. The system is applied for a wearing device using AR (Augmented Reality) glasses.

GS16-6 Fault detection for small-scale solar panel power generation using hand-held infra-red cameras

Kenneth J. Mackin
(Tokyo University of Information Sciences, Japan)

Solar power plants are one of the growing fields of renewable energy sources. Increased number of buildings and houses now install solar panels on rooftops, and some local governments are now requiring new houses and buildings to install solar power generation. Different cameras are used for remote sensing of solar panel faults depending on the cause of the fault. Infra-red cameras are effective for detecting internal damage causing low or no electricity production. There are previous reports on using drones installed with infra-red cameras to detect faults in large-scale solar panel power plants. But in urban areas, there are many restrictions for flying drones. In this paper, we report on the using hand-held infra-red cameras to manually capture images of solar panels, and using these infra-red data detect faults in solar panels for small-scale solar power generation. The results are discussed, and future works are proposed.

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

Room F

GS30 Robotic Mechanism

Chair: Xiongshi Xu (Okayama University, Japan)

GS30-1 Biomimetic locomotion mechanism for propulsion improvement in pipes

Hiroki Yokoyama, Geunho Lee
(University of Miyazaki, Japan)

This study focused on in-pipe problems that occur in everyday life. It focused on in-pipe exploration robots that play a role in maintaining safety in piping. Therefore, it set the task of improving the adaptability of the moving mechanism among many pipes, and worked on the goal of improving adaptability in piping. To answer this challenge, this study set three goals: to be able to progress in a vertical state, to be able to adapt to different diameters, and to be able to progress through branches in any direction. It developed a GI mechanism by analyzing the necessary forces with reference to four characteristics of two organisms. Using an experimental machine equipped with this GI mechanism, the experiment confirmed that the three goals could be achieved. As a result, this paper confirms the effectiveness of the GI mechanism.

GS30-2 Mushroom cultivation and harvesting in media supported by 3D printed anisotropic elastic structures

Kouki Saito, Jun Ogawa, Yosuke Watanabe, MD Nahin Islam Shiblee,
Masaru Kawakami, Hidemitsu Furukawa
(Yamagata University, Japan)

Mushrooms grow so fast during the harvest season that they can double in size in a day. However, the soft and fragile nature of mushrooms makes manual harvesting of domestic brand varieties a necessity. Therefore, an important industrial issue in the efficiency of mushroom cultivation in Japan is how to make mushrooms easy to harvest and grow. The technical elements of mushroom harvesting are 1) non-damaging harvesting methods, 2) control of colony growth, and 3) expansion of growing area. This study proposes a three-dimensional and deformable culture medium to solve the problems 1)-3). The proposed three-dimensional medium has a 3D printed anisotropic elastic well structure embedded inside. The medium keeps the medium in a three-dimensional shape and allows mushrooms to be generated from the sides and bottom. In addition, we show that during the harvesting period, by applying pressure to the medium in a single direction. The soil can be removed from each side of the mushrooms and the mushrooms can be harvested.

GS30-3 Hydraulic Dual-Arm Robot with Two-Step Transmission

Yuki Sawamoto, Hiroaki Seki, Tokuo Tsuji, Tatsuhiro Hiramitsu
(Kanazawa University, Japan)

Due to the population ageing, demand is growing for robots to assist the elderly. However, only a few of the robots currently under research can perform household chores for the elderly. Therefore, the purpose of this study is to develop a robot that can perform household chores in place of the elderly. Such robots must be simultaneously strong and quick, which is difficult to achieve. Hence, we adopted a two-step-transmission hydraulic source comprising stepper motors, slide screws, and hydraulic cylinders, solenoid valves. This hydraulic source is simple, compact, and low noise, and can switch between quick and powerful drive. Here, we propose a dual-arm robot equipped with the hydraulic source. The robot has 3 degrees of freedom in the translation and rotation of the hand. To verify the usefulness, the prototype was made and the operation time was verified.

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

GS30-5 An Autonomous UAV System for Inspecting Structures

Yuta Sato[1], Masaru Kamada[1], Munehiro Takimoto[2], Yasushi Kambayashi[3]
([1]Ibaraki University, Japan)
([2]Tokyo University of Science, Japan)
([3]Nippon Institute of Technology, Japan)

We have developed an inspection system that makes a UAV fly automatically at a constant distance from a structure. The UAV has five LiDAR sensors; two in front of the fuselage, one on each side of the fuselage, and one on the bottom of the fuselage. The two LiDAR sensors in front of the UAV measure the distance between the UAV and the wall. Then, based on the values obtained from each, the UAV determines whether it is squarely facing the structure. One LiDAR sensor on each side of the UAV measures the distance to the structure on either side of the UAV. Based on the environment in which the UAV is flying obtained from the LiDAR sensor described above, a digital potentiometer was incorporated into the controller of the UAV so that operations similar to those controlled by a human pilot using a controller can be realized programmatically.

GS30-6 Actuator Module Development for a 3D Printed Biped Robot Using Low-Cost BLDC Motor

Kazuya MAEGAKI[1], Tsige Tadesse ALEMAYOH[2], Jae Hoon LEE[2], Shingo OKAMOTO[2]
([1]Faculty of Engineering, Ehime University, Japan)
([2]Graduate School of Science and Engineering, Ehime University, Japan)

Biped robot design has been a prominent area in robotics field research in the past decades. As a result, huge progress has been made. The core part of bipedal robotics is the design of actuators. Most existing actuators yield stiffer and less agile dynamics to the robot. On the other side, the typical actuators embedded with proper reduction gear set in the market are expensive. Therefore, the purpose of this research is to develop and control a biped robot at a low cost. Therefore, in this study, some actuators were developed using a low-cost BLDC motor and a 3D-printed body to develop a biped robot. The designed actuator employs intermediate pulleys and timing belts to reduce rotational velocity and transmit torque in two steps. Two actuator types that have the same reduction ratio were developed for the biped robot. After fabricating the actuators, an output torque test was conducted to investigate whether sufficient torque can be achieved. The biped robot equipped with these actuators was assembled and checked for any mechanical design mistakes. Lastly, a test to control multiple motors at the same time was conducted.

January 25 (Wednesday), 13:00-16:10

Room A

OS23 SWARM: Swarm and Bio-inspired Systems

Chair: Masahito Yamamoto (Hokkaido University, Japan)
Co-Chair: Yasumasa Tamura (Tokyo Institute of Technology, Japan)

OS23-1 Hierarchical and Distributed Patrol Strategy for Robotic Swarms with Continuous Connectivity

Kazuho Kobayashi[1], Takehiro Higuchi[2], Seiya Ueno[2]
([1]Graduate School of Engineering and Science, Yokohama National University, Japan)
([2]Faculty of Environment and Information Sciences, Yokohama National University, Japan)

This paper proposes a hierarchical and distributed strategy for patrolling missions by robotic swarms, including a fixed base station. One of the essential requirements for autonomous robotic swarms is predictability from human operators. As a clue to satisfy this requirement in patrolling missions, the strategy employs hierarchized algorithms to maintain continuous connectivity to the base station by (i)global patrol and (ii)local patrol. Each robot selects the location to patrol by one of the two algorithms, according to the robot's role. The paper also introduces a performance metric for the base station's situational awareness, which may indicate the swarm behaviors' predictability. The simulation study tested the proposed strategy and compared it to an existing strategy. The proposed strategy demonstrated successful patrol behavior with continuous connectivity to the base station. Though the existing strategy performed better in some aspects, the proposed strategy effectively covered the whole mission area and provided the base station with higher situational awareness.

OS23-2 Generating Cooperative Behavior in a Robotic Volleyball Team with Curriculum Learning

HaoJie Wang, Yin Xu, Kazuhiro Ohkura
(Graduate School of Advanced Science and Engineering, Hiroshima University, Japan)

Contrary to a single robot, multi-agent systems (MAS) focus on working together rather than on the individual performance of each robot. However, when the number of robots increases, the environment becomes significantly more complex and the variance of policy gradients disappears exponentially, which makes it difficult for the algorithm to learn a stable strategy. This paper demonstrates how to overcome this difficulty through the use of Curriculum Learning (CL) and Behavioral Cloning (BC). The experiments run computer simulations where the six robots need to learn not only how to catch and hit the ball back but also how to cooperate with the other robots. This paper compares the results of the experiments with and without CL and BC showing that CL and BC can help the robots to learn how to play volleyball and cooperate with the other robots.

OS23-4 Developing Multi-agent Adversarial Environment Using Reinforcement Learning and Imitation Learning

Yin Xu, Yupeng Liang, Kazuhiro Ohkura
(Graduate School of Advanced Science and Engineering, Hiroshima University, Japan)

A multi-agent system is a system composed of multiple autonomous agents that interact with each other and the environment. A multi-agent system that develops cooperative strategies by reinforcement learning doesn't perform well, mostly because of the sparse reward problem. The sparse reward problem means that it is difficult for agents to obtain positive rewards during the initial exploration. This study conducts a multi-objective adversarial environment in which robots play the beach volleyball game. This study combines imitation learning (IL) with reinforcement learning (RL) to solve the sparse reward problem. The results show that the proposed approach gets a higher score in the Elo rating system and robots perform better than the conventional RL approach.

January 25 (Wednesday), 13:00-16:10

OS23-5 Evaluation of Anomaly Discovery Techniques of Swarm Using Explainable AI for Knowledge Discovery

Haruta Isobe[1], Tomoyashu Deguchi[2], Masao Kubo[1], Hiroshi Sato[1]
([1]Department of Computer Science, National Defense Academy of Japan, Japan)
([2]Team Lab, Tokyo, Japan)

This paper examines the accuracy of the XAI framework of Choi.et.al.(2021) in detecting anomalies in swarms. Here, different NN (VGG16, MoboleNetV2, ResNet50, and DenseNet121) are used as predictors, and Grad-CAM is used for XAI to discuss the three components of swarm formation by Boid and their anomaly detection accuracy.

OS23-6 Coevolution of morphology and behavior for simple agents with dual sensors in predator-prey pursuit problem

Lars Kahlert, Ivan Tanev, Katsunori Shimohara
(Doshisha University, Kyoto, Japan)

We use a team of simple agents featuring direct mapping from perceptions to movement to solve the predator-prey pursuit problem. We extend on the previous research where it was somewhat unrealistically assumed that a single line-of-sight sensor can see through other agents. To bridge this reality gap, we introduced a dual-sensor morphology and used a strongly typed genetic algorithm to co-evolve the offset of both sensors and the behavior of predator agents. We discovered that the additional complexity does not slow evolution and that evolved capturing behaviors show a better robustness towards noise. We also observed that different (genetically homogeneous) predator agents exhibit different emergent behaviors depending on the stage of the trial and the perceived environmental information.

OS23-7 Proposal of Signal-less Intersection Control with Dynamic Obstacles Optimized by Using Genetic Algorithm --- A Concept of Virtual Walls --

Ryuma Saotome[1], Kiyohiko Hattori[1], Tomohiro Harada[2], Johei Matsuoka[1]
([1]Tokyo University of Technology, Japan)
([2]Tokyo Metropolitan University, Japan)

Significant improvements in autonomous driving technology using AI have spurred research in automated vehicular control, resulting in several innovative proposals. A leading concept is that of signal-less intersections and crossings. Assuming that all self-driving vehicles will be wirelessly controlled in the near future, constant communication with neighboring vehicles will enable optimal traffic control. At signal-less intersections, incoming automated vehicles exchange information relating to position, speed, and intended movement (e.g., straight, right turn, left turn, etc.). Consequently, the interconnected system generates optimal trajectories for the vehicles to safely cross the intersection without traffic signals. To achieve such a result, we propose aggregating and optimizing information from automated vehicles at intersections. To be more precise, a virtual wall is set up at intersections based on the direction and speed of incoming and outgoing vehicles, and each automated vehicle takes a path that avoids the wall to achieve safe and rational route selection. In this study, a genetic algorithm was used to determine the location of the virtual wall. Simulations using the genetic algorithm solution showed that a safer path design with zero path obstruction was obtained, compared to manual placement.

January 25 (Wednesday), 13:00-16:10

OS23-8 Swarm Robots Using Lévy Walk in Targets Exploration -Computer Simulation for Performance of Lévy Walk with Concession

Yoshiaki Katada[1], Kazuhiro Ohkura[2]
([1]Setsunan University, Japan)
([2]Hiroshima University, Japan)

This paper investigated the performance of the Levy walk with concession. Robots concede other robots when they receive the signal that other robots execute longer walks. We conducted a series of computer simulations varying ranges detecting other robots' walk distance signals, the number of robots, the number of targets, and the distribution of targets. The results suggest that the search efficiency of Levy walk was improved by increasing the range detecting other robots' walk distance signal. Furthermore, we confirmed that the search efficiency improvement saturates beyond the threshold of range detecting signal.

OS23-9 Switching stable patterns in heterogeneous boid model

Mari Nakamura
(National Institute of Advanced Industrial Science and Technology (AIST), Japan)

Boid is a model for animal group motion. In my previous papers, I proposed the heterogeneous boid model comprised of some types of boid agents. This model generates stable patterns of the agent group, by tuning the interaction among types of agents properly. When switching the interactions, this model transforms agent group pattern. In this paper, I report the variations of the transformation process and explain their mechanism. In most cases, the scalable and stable patterns are smoothly transformed to each other in a short time after the switch, because these patterns are resilient. In an exceptional case, the agent cluster is broken into fragments after the switch. I propose a minor revision to avoid the fragmentation, which helps the smooth transformation in this case.

OS23-10 Extending Behavior Dimensions with Curriculum Learning for Use in Astronaut Support Robots

Keita Tashiro, Jyouhei Matsuoka, Kiyohiko Hattori
(Tokyo University of Technology, Japan)

In recent years, utlizing machine learning to controll robots in 2D space has become widespread. On the other hand, in 3D space such as in outer space, it is known that learning becomes difficult due to the curse of dimensionality. To address this issue, we propose a dimensional extension method to state and action spaces using curriculum learning, which controls the difficulty level of learning in stages. We will conduct experiments comparing models with and without curriculum learning in a computer simulated environment of the International Space Station. In the training, a task is set to patrol pre-defined checkpoints without bumping into walls. The experimental results confirm that the model with curriculum learning acquires movement control with fewer wall collisions.

OS23-11 Movement control of a single-legged modular robot for self-assembly

Tomohiro Hayakawa, Sora Noguchi, Toshiyuki Yasuda
(University of Toyama, Japan)

Legged modular robots are equipped with a leg component in addition to the inter-module connection mechanism. When the modules connect with each other, then the cluster obtains a multi-legged robot shape and functions. However, the module is not equipped with a wheel; thus, it is not easy for the module to move by itself. Therefore, the inter-module assembly method has not yet been developed. In this study, we develop a new single-legged modular robot hardware, whose DOF configuration of the leg is a sprawling type. Moreover, we construct a moving control method for the module such that it can move to a desired location. Through simulations and robot experiments, it was verified that the module is able to move to the desired location with a small error.

January 25 (Wednesday), 13:00-16:10

OS23-12 Evolving collective behavior of a multi-legged robotic swarm in a rough terrain environment

Haruhi Tsukamoto[1], Daichi Morimoto[1], Motoaki Hiraga[1], Kazuhiro Ohkura[1], Masaharu Munetomo[2]
([1]Hiroshima University, Japan)
([2]Information Initiative Center, Hokkaido University, Japan)

This paper focuses on generating collective behavior of a multi-legged robotic swarm in a rough terrain environment. Many studies in swarm robotics utilize mobile robots driven by wheels because it is easy for designing the basic motions of robots. The multi-legged robotic swarm is expected to operate in rough terrain fields that are hard for wheeled-mobile robots to operate. However, designing a robot controller becomes a challenging problem because a multi-legged robot has a large number of actuators than wheeled-mobile robots. This paper employs neuroevolution that is a technique to train artificial neural networks by using evolutionary computation for designing a robot controller. The performance of the multi-legged robotic swarm is evaluated by a path formation task. The experiments are conducted using computer simulations with Pybullet physics engine. The recurrent neural network with a single hidden layer is employed as the robot controller. The result shows that the neuroevolution approach successfully generates a path formation behavior in flat and rough terrain fields. The result also shows that controllers evolved in rough terrain fields could cope with more difficult terrain settings.

OS23-13 Attention agent for collective behavior of a robotic swarm with deep neuroevolution

Naoya Shiozaki, Yu Watanabe, Daichi Morimoto, Motoaki Hiraga, Kazuhiro Ohkura
(Hiroshima University, Japan)

This paper focuses on generating collective behavior of a robotic swarm by using an attention agent. An attention agent is a novel deep neural network (DNN) architecture using a selective attention mechanism. An attention agent outperforms conventional DNNs on some reinforcement learning benchmarks that use image input. The robotic swarm using an attention agent is expected to generate collective behavior from raw image inputs. This paper applies an attention agent to a controller of a robotic swarm. The performance of the attention agent is compared with the conventional convolutional neural network (CNN). The controllers are evaluated in a round-trip task that requires robots to move two target areas alternately. The result showed that the attention agent shows better performance than the CNN in the round-trip task.

January 25 (Wednesday), 13:00-16:10

Room B

OS3 AROB: Biomimetic Machines and Robots

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

OS3-1 Rotational Control of Both a Suspended Multi-Rotor and a Load by Using Robust Gain Scheduling

Kazuya Miyamoto[1], Shinsuke Kanda[2], Isaku Nagai[1], Keigo Watanabe[1]
([1]Okayama University, Japan)
([2]TADANO LTD., Japan)

For the load swaying and rotation in suspended load transportation, the control by a suspending machine could only handle the swaying control of the load, and additionally there was a problem that requires a dedicated control method for each suspending machine. Therefore, research on the direct control of a wire-rope tip has been studied by using a horizontally movable multirotor, which is applicable to any types of suspending machines or VTOL aircrafts and can also control both swing and rotation. In particular, the latter control when any load is suspended has a problem that several uncertainties are involved in modeling the system. In this research, an observer-based gain-scheduling state-feedback control method is applied to a multirotor system with a load that includes several uncertainties, such as the mass of the load, the wire rope length, etc., and its usefulness is confirmed through a simulation.

January 25 (Wednesday), 13:00-16:10

OS3-2 An Unscented Kalman Filter Based on the Adams-Bashforth Method for Estimating the State of an Osprey-type UAV with Two 2-DOF Tiltable Rotors

Soma Takeda, Isaku Nagai, Keigo Watanabe
(Okayama University, Japan)

In the Unscented Kalman Filter (UKF) in a discrete-time state-space model, the Runge-Kutta method has already been proposed for the time update equation of the sigma-point. While the Runge-Kutta method can realize a highly accurate state estimation, it is not suitable for estimating the state of objects with relatively fast moving, such as autonomous drones, because it uses a high-order numerical approximation, which reduces the computational efficiency. In this study, the Adams-Bashforth method is applied to the UKF algorithm to achieve relatively accurate state estimation while reducing the computational load. The effectiveness of the proposed method is demonstrated by simulating the state estimation of an Osprey-type drone with two 2-DOF tiltable coaxial rotors.

OS3-3 Proposal of Hyper CLS Data for Industrial Robots - HCLS Statements for Sequence Control of Multiple Robots -

Ryoma Abe[1], Fusaomi Nagata[1], Daiki Terasaki[2], Hirohisa Kato[2], Takeshi Ikeda[1], Keigo Watanabe[3]
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([2]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([3]Okayama University, Japan)

In designing and manufacturing processes using CAD/CAM systems, cutter location source (CLS) data are generally used for intermediate data to finally generate numerical control (NC) data for various types of NC machine tools. CLS data mainly include a statement as `GOTO' to designate the position and orientation of a cutting tool. However, it is not supported for industrial robots and mechatronics systems by such standardized CLS data to have special statements for such as handling a customized end-effector and a camera system, executing a visual feedback control or cooperative control, and implementing AI systems like convolutional neural networks (CNNs). This paper aims to propose Hyper CLS data that can support the above functions. The effectiveness of HCLS data is experimentally evaluated by implementing a synchronized work process using two small-sized robots with four-DOFs.

OS3-4 A Proposal of a Defect Detection Model for Few Training Images Using Mutual Information as a Loss Function

Hirohisa Kato[1], Fusaomi Nagata[2], Mochimitsu Komori[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]Faculty of Engineering Department of Electrical Engineering and Electronics, Kyushu Institute of Technology, Japan)

In the field of defect detection, which uses CNN-based image recognition to detect small cracks and chips in industrial products, products with defects are not produced intentionally, so the number of images containing defects that can be used as training images is a few. To solve this problem, this paper proposes a feature extraction model learning method inspired by Invariant Information Clustering (IIC) which is one of the unsupervised learning methods.In the IIC method, original training images and augmented images with added noise and deformation are prepared, and the network is trained by maximizing the mutual information of the network output obtained from these images. The method does not add noise or deformation to the training images as in the IIC method, but rather creates pairs of images within a mini-batch and calculates the mutual information of the paired images.

January 25 (Wednesday), 13:00-16:10

OS3-5 Translational Motion Control of a Tandem-type UAV with Tiltable Rotors to Move on a Wall Surface

Hideaki Komura, Isaku Nagai, Keigo Watanabe
(Okayama University, Japan)

In recent years, various types of drones have been paid attention to and are expected to play an active role in many fields. When flying in all directions, the attitude of the conventional drones changes depending on the situation. Among them, a tandem-type rotor with 2-DOF tiltable coaxial rotors has been already proposed to prevent the drone attitude changes and to apply it to structural inspections. Note however that gimbal lock occurs when moving the wall surface, due to the singularity of the Euler angle. Therefore, this research proposes an attitude angle control method using a quaternion. A controller using a quaternion is designed, and simulation experiments are conducted using Simulink, considering the effects of gyroscopic effects and tilt angle limitations of the rotor. Thus, it is demonstrated that the proposed method is useful for real-world applications.

OS3-6 A Range-finding System Using Multiple Lasers for an AUV and Self-position Estimation

Takashi Utsumi, Isaku Nagai, Keigo Watanabe
(Okayama University, Japan)

AUVs (Autonomous Underwater Vehicles) cannot be equipped with large measurement devices for acquiring the self-position. Therefore, a distance measurement method using multiple lasers has been proposed up to now. In this study, we aim to implement such a method using a small microcontroller and install it in an AUV for self-position estimation. After describing the AUV to be used in this paper and a range-finding system using multiple lasers, distance measurement and angle calculation experiments are presented, and finally future s are given.

OS3-7 Path planning of mobile robot based on 2.5D mapping

Furan SHI, Reiri ABE, Hiroshi MAEDA, Kiyotaka IZUMI, Takeshi TSUJIMURA
(Saga University, Japan)

This study proposes a path planning system using LiDAR mounting on a wheelchair robot. The proposed system is based on a LiDAR, a mobile robot, and a ROS system. The path planning system first creating a 2.5D map based on continuous 3D measurements of the LiDAR on the terrain, plots obstacles in the coordinate system and establishes 2.5-dimensional automatic path planning. Then it analyzes the introducing map to find an end point of the robot, and finally guides the robot to that end point. The proposed 2.5-dimensional map is generated by transforming the 3D data obtained from the LiDAR into 2D plane containing elevational information of obstacles. That is why path planning for terrain robot can be conducted real time. A 2.5D path planning constructed using. Experimental results show that the system can recognize and avoid 3D objects to reach the end point. A comparison of the 2.5D path planning system with the 2D path planning system shows that the 2.5D path planning system is more general than the 2D path planning system.

January 25 (Wednesday), 13:00-16:10

OS3-8 Experimental verification of the wavelet-based surface modeling method considering wear progression process

Akimasa Otsuka, Ryoga Hama, Fusaomi Nagata
(Sanyo-Onoda City University, Japan)

Industrial technology has been significantly developed, and the high performance and precision machines are desired. Friction and wear are the important factors to achieve the development. Mechanical machines consisting of the parts have usually mating surfaces, and friction and wear on the surface affect the product performance and life. Therefore, friction and wear phenomena must be considered at the design stage to design a machine that has long life and high performance. Predicting the surface feature quantitatively and accurately is difficult because the wear phenomena is not cleared yet. There are some methods to predict the worn surfaces, but those method cannot generate the virtual surfaces randomly. In this study, a generation method of the virtual primary profile curves is proposed in consideration of wear applying wavelet transformation, and the simulated profile curves are verified comparing the actual profiles obtained in actual experiments.

OS3-9 Fitness Lookup Table Reduces the Runtime of Evolution of Swimming Gaits of Fish Robot

Marta Alberca Sancho, Ivan Tanev, Katsunori Shimohara
(Doshisha University, Japan)

Long runtime of the evaluation trials is one of the crucial setbacks of the evolution of physical robots. Nevertheless, the substantial reality gap sometimes requires the use of physical robots rather than their software simulations. In this paper we introduce an approach inspired by the empirical evidence that identical genotype s (chromosomes) in genetic algorithms (GA) appear and consequently, require an evaluation multiple times in due course of evolution. The approach is based on the introduction of a fitness lookup table (FLT), which stores the fitness values of the already evaluated genotypes. The retrieval of the fitness of already evaluated genotypes from FLT in their subsequent evaluations is much faster than the duration of the trial on the robot, which, according to the experimental yields a bout a two fold reduction o f the runtime of evolution via GA of the undulatory swimming gaits of a fish robot.

OS3-10 Investigation of Periodic Transition Method Using CPG for Quadruped Robots

Kenta NARAMURA, Shogo Nonaka
(National Institute of Technology, Tsuyama College, Japan)

We have so far aimed at explicitly controlling the gait and walking speed of quadruped robots in the future. Therefore, periodic transitions in gait have been investigated in previous studies using Central Pattern Generator (CPG). There, a transition method was proposed that focuses on parameters representing the degree of the adaptation and the magnitude of a tonic input and treats them uniquely. However, according to Matsuoka, the originator of the Matsuoka oscillator we used in this study, the influence on frequency is mainly related to two parameters related to the time constant. Therefore, in this study, a new method is constructed to transition the period by varying the parameters in time, and a comparison is made between the methods from previous studies and the time-constant method. Comparisons were also made on dynamics simulations, and the characteristics of each method were investigated.

OS3-11 Proposal of a fall discrimination algorithm based on upper body skeletal information

Shogo NONAKA, Yuki ASANO
(NIT, Tsuyama College, Japan)

In recent years, manpower shortages have become more serious in nursing and care facilities. Therefore, we have considered an autonomous mobile monitoring and care system, to detect abnormal conditions and to understand the state of the patient. In this paper, we aim a system building that detects abnormal conditions such as falls by integrating visual and auditory recognition elements. The information used to determine abnormal conditions such as falls is expected to be concentrated in the upper body, including facial expressions, posture, and gestures. Hence, we propose an algorithm for detecting abnormal conditions that can make judgments based solely on skeletal information of the upper body. The proposed algorithm is built on a skeletal recognition system, and its effectiveness is verified by conducting experiments on each discrimination scene to confirm whether recognition is possibility.

January 25 (Wednesday), 13:00-16:10

OS3-12 Control for a fully actuated UAV equipped with two 2-DOF tiltable rotors

Xiongshi Xu, Keigo Watanabe, Naoki Yoshiwaki, Isaku Nagai
(Okayama University, Japan)

This paper presents a method for controlling the position and attitude in a fully actuated UAV equipped with two 2-DOF tiltable rotors. Since most of the control systems in multirotor UAVs with tilted or tiltable mechanisms are overactuated, it is generally impossible to solve the rotation speed and tilt angle of each rotor uniquely at the same time. In previous research, a tandem-rotor UAV using two 2-DOF tiltable coaxial rotors is studied, where the coaxial rotor with 2-DOF tiltable mechanism is simplified to one rotor with two brushless motors and two servo motors. The total number of the motors is eight for the tandem-rotor UAV. Therefore, in this study, it aims to develop an aircraft with 2-DOF tiltable rotors to realize a fully-actuated system that enables independent control in position and attitude, using a small number of motors. Finally, some results are demonstrated in some simulations by MATLAB.

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

Room C

OS15 ISBC: Complex biomolecules and hazards

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

OS15-1 Prognostic medication: whether the macroscopic equation model can also predict dog's medical data of illness

Shun Tomita, Ken Naitoh
(Waseda University, Japan)

A network theory model based on a nonlinear differential equation [1-3] 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 by Konagaya et al. [4], which showed a possibility to predict premonition of an illness, recovery from an illness, life patterns of organisms, and polymorphism. As the results, 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 medical data. Thus, we also collected the medical data for dogs to examine the effectiveness of the theory. We started comparison with computations and actual dog data.

OS15-2 Prognostic medication: macroscopic equation model describing manic-depressive illness

Koichi Shibasaki, Ken Naitoh
(Waseda University, Japan)

Abstract: A network theory model described by a nonlinear differential equation [1][2][3] macroscopically showed a possibility for explaining interaction mechanism of six groups of molecules on information and function in human beings. Then, along with the number theory applied for the differential equation, Konagaya derived critical mathematical conditions, predicting the premonition just before sickness (discrepancy from a healthy condition). [4] Moreover, computational several time-histories of sickness obtained by solving the nonlinear differential equation with various parameters agree well with actual time-dependent patterns of sickness, which is requiring outpatient visit or hospitalization for human beings. [4] This report focuses on periodic up-down of molecules among several computational time histories that may represent manic-depressive illness (bipolar disorder), while examining especially starting age of manic-depressive illness (bipolar disorder) and its cycle. Moreover, relationships between manic-depressive illness and other psychoses (such as depression) or suicides are also discussed through comparison with actual statistical data.

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

OS15-3 Regional trends in the number of COVID-19 cases

Keisuke Chujo[1], Tatsunori Seki[1], Toshiki Murata[1], Yu Kimura[1], Tomoaki Sakurai[1], Satoshi Miyata[1], Hiroyasu Inoue[2,3], Nobuyasu Ito[3]
([1]SoftBank Corp., Japan)
([2]University of Hyogo, Japan)
([3]RIKEN, Japan)

In this study, we analyse the COVID-19 cases data to investigate the regional infection trends in Japan. There had been seven outbreaks by October 2022 in Japan. In every previous outbreak, COVID-19 cases were observed to increase at different rates in different regions. The prefectural infection ratio is defined using COVID-19 cases data and study the characteristic of each pandemic wave. The order of infection progression is estimated in some previous waves of the COVID-19 pandemic. This study has shown that the infection spread from the Kanto region in the fourth pandemic wave and the infection spread simultaneously from four regions in the sixth wave. It is also found that the infection situation trend in Okinawa differs from that in other regions.

OS15-4 Prediction of COVID-19 Using SIR and AR models: Tokyo and nation-wide cases

Tatsunori Seki[1], Keisuke Chujo[1], Toshiki Murata[1], Tomoaki Sakurai[1], Satoshi Miyata[1], Hiroyasu Inoue[2,3], Nobuyasu Ito[3]
([1]SoftBank Corp., Japan)
([2]University of Hyogo, Japan, Japan)
([3]RIKEN, Japan, Japan)

The predicted number of positive cases in Tokyo is calculated using a modified SIR model. The ratio of the number of positive cases nation-wide to the number of positive cases in Tokyo is extrapolated based on the the autoregressive model, and the number of positive cases nation-wide is calculated from the predicted in Tokyo. In the peak prediction for Tokyo, the seventh wave is about 50,000 where the observed is about 30,000, and the eighth wave is at about the same level as observed and predicted in late December. This result suggests that the increase in prediction error by distribution shifts, which is a problem in the application of SIR model, can be suppressed by combining the prediction by the local SIR model with an expanded estimation ratio, and that locally it is sufficient to approximate the distribution shifts with a step function.

OS15-5 Molecular Dynamics Study on Cluster Damaged DNA Containing Apurinic/Apyrimidinic Sites on the Same Strand

Kazushi Terakawa[1,2], Susumu Fujiwara[1], Tomoko Mizuguchi[1], Yoshiteru Yonetani[2], Naoya Shikazono[2], Ken Akamatsu[2], Hiroaki Nakamura[3]
([1]Kyoto Inst. of Tech., Japan)
([2]QST, Japan)
([3]Nagoya Univ., NIFS, Japan)

DNA has susceptibility to alkylation, oxidation, and irradiation, which can lead damage to the molecular structures such as base damage, apurinic/apyrimidinic site (AP site), and strand breaks. These damages are usually repaired by enzymes in the cell. However, when the damages are locally crowded and clustered, the enzymatic repair cannot work adequately, which can lead to cell death and cancer. In this work, we carried out MD simulations of DNA with AP sites; we particularly focused on a situation in which two AP sites are positioned at the same strand. The results found that the presence of AP sites in DNA significantly changes the structure of DNA, which possibly make a significant effect on the enzymatic repair.

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OS15-6 Protein Design based on A Novel Hypothesis of Protein Evolution

Tomoei Takahashi[1], George Chikenji[2], Kei Tokita[1]
([1]Graduate School of Informatics, Nagoya University, Japan)
([2]Graduate School of Engineering, Nagoya University, Japan)

We have proposed a new design approach: a Bayesian learning formulation of the protein design problem that includes hypotheses about new protein evolution and a statistical mechanics approach. Furthermore, we estimated the amino acid sequence by an analytical method called the cavity method, and achieved a high design success rate for a two-dimensional lattice HP model. However, the redesign results for lysozyme, a realistic protein, are still low and there is room for improvement. The necessary conditions for the evolutionary hypothesis and the prior distribution of the amino acid sequence were tested in the HP model and found to be valid for certain special temperatures and chemical potentials.

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

Room D

OS7 AROB: Measurement and control of mobile vehicle

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

OS7-1 Development of Robust Braking Controller for Autonomous Vehicles to Achieve Any Ride Comfort Performance Without Using Wheel Velocity

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

In Japan, the number of accidents still exceeds 300,000 as of 2021. People have paid attention to the autonomous driving technology as one technology to reduce the number of accidents. However, to develop a controller is very difficult since some vehicle parameters have unknown variation and some vehicle states cannot be measured. In this study, to overcome this problem, we develop a robust braking controller that can realize the ride comfort desired by the passenger even through the wheel velocity cannot be measured as well as the actual vehicle parameters are different from the nominal values. To confirm that our controller meets the demand, we performed numerical simulation. As a result, we confirmed that our controller can make the vehicle stop at the target position as well as satisfy the passenger's ride comfort when the vehicle parameters are different from the nominal value.

OS7-2 Design of a Motion and Force Controller with Impedance Error for an Underwater Vehicle-Manipulator System with a Differently-Controlled Vehicle

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

This paper deals with the design of a motion and force control scheme for underwater vehicles, each of which has a manipulator. Its features are (1) to be designed in consideration of the dynamics of the vehicle including the marine thrusters (i.e., its actuators), (2) to ensure the stability properties in the presence of bounded disturbances (e.g., a water current and water waves) by means of an impedance error, and (3) to achieve a desired mechanical impedance which is suitable for a subsea operation that requires a contact between the manipulator tip (e.g., the hand or an object grasped by the manipulator) and an environment whose surface is soft or fragile. This paper presents the detailed theoretical analysis of the motion and force controller developed in this paper.

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OS7-3 Attitude measurement for underwater robot using inclinometer considering dynamic characteristics and gyroscope

Yuka Daiguji[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

Attitude measurement is essential for underwater robots, and the attitude of the robot is measured by an Internal Measurement Unit (IMU) with an angular velocity sensor (gyroscope). Since the attitude measurement by the gyroscope is subject to an error due to drift, it is necessary to correct the error. Here, an inclinometer is a sensor that can directly measure the attitude angle and has high measurement accuracy in a static environment. In this paper, we propose a sensor fusion method using the gyroscope and a dynamic model of the inclinometer. The effectiveness of the proposed method is demonstrated by an angle measurement experiment around a single horizontal axis.

OS7-4 Experimental comparison of UVMS position control methods with and without constraints on one hand of a dual-arm robot

Kenta Yamamoto[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

Most of the control methods for Underwater Vehicle-Manipulator Systems (UVMS) have been proposed based on the configuration consisting of vehicle position and attitude, and manipulator joints displacement. The authors have proposed a Resolved Acceleration Control (RAC) method for UVMS based on the task-space consisting of the position and attitude of both the vehicle and manipulator end-tips. In this paper, we compare the performance of the RAC control method with joint-space control methods namely, Computed Torque and Sliding Mode Control methods through experiments using a 3-link dual-arm underwater robot in floating state (without constraint) and when grasping a fixed object with one hand (with constraint).

OS7-5 Force control of a floating underwater robot equipped with two 3-link manipulators

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

Underwater robots equipped with multiple manipulators, called UVMS (Underwater Vehicle-Manipulator System), are expected to play an important role in various marine development applications, such as offshore structure construction and deep-sea mineral mining. UVMS can be used in place of humans, especially in tasks that require contact with seafloor and underwater structure. However, in underwater work, the robot may interact with the surrounding environment and tools, which may lead to unstable robot control. Thus, the authors have developed a force control system for UVMS and verified its effectiveness through simulations and experiments. This paper compares the results of force control experiments conducted in the floating and fixed object one-handed grasping states.

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

Room E

GS8 Biomedical imaging & Medical informatics

Chair: Hiroshi Tanaka (Tokyo Medical and Dental University, Japan)

GS8-1 Interday variations in the spatial distribution of facial skin temperature and the impact of subjective health conditions on them

Masahito Takano[1], Kosuke Oiwa[1], Bikash Lamsal[2], Akio Nozawa[1]
([1]College of Science and Engineering, Aoyama Gakuin University, Japan)
([2]Kajima Technical Research Institute, Japan)

Thermal skin images are used for evaluating physiological and psychological states. To realize remote daily health monitoring, we have attempted to estimate subjective health conditions based on the thermal face image. In our previous study, we constructed an anomaly detection model to detect poor health conditions and the AUC (Area under the receiver operating characteristic curve) of the anomaly detection model was 0.70. However, it remains unclear how the spatial distribution of facial skin temperature changes in response to subjective health conditions. In this study, we statistically analyzed collected thermal face images to investigate how the spatial distribution of facial skin temperature changes interday and the impact of subjective health conditions on them. As a result of the comparison between health conditions, we confirmed that the average temperatures at some regions of the face in the poor health conditions were higher than those in the good health conditions.

GS8-2 Development of automatic facemask template generator

Takehito Kikuchi[1], Misaki Okamura[2], Hiromitsu Hamakawa[1]
([1]Faculty of Science and Technology, Oita University, Japan)
([2]Graduate School of Engineering, Oita University, Japan)

The goal of this study is to create software that automatically generate facemask templates for individuals from a set of their facial data. Its process has 4 steps; input a photo set, localization of landmarks, generation of a net of a mask, and addition of margin area. To evaluate the fitness and air flow, we conducted two experiments. In the fitness experiments, four masks were produced with the software and positional error for the landmarks were measured. Accordingly, the maximum error included approximately 30 mm due to the differences in the shape of jawbone and the convexity of cheek. The flow analyses were conducted with the particle image velocimetry and a black-colored face mannequin and facemask. The airflow around the proposed mask successfully reduced flow leakages compared with a squared mask. In addition, we are developing the improved landmark acquisition software by using a 3D camera.

GS8-3 Automatic tracking by Semantic Segmentation for measurement of lumbar muscle thickness during grasping a heavy object

Keisuke Otsuka[1], Taku Itami[1], Jun Yoneyama[1], Kimiwa Itami[2], Keiko Seki[2], Mikiko Senda[2]
([1]Aoyama Gakuin University, Japan)
([2]University of Shiga Prefecture, Japan)

Aging society in Japan has created a shortage of nurses and caregivers. One of the reasons for this is occupational low back pain. Accordingly, in order for as many people as possible to engage in the prevention of low back pain, it is important to evaluate the lumbar burden through simpler methods and to self-identify the risk of low back pain. Therefore, the present study focuses on measuring the thickness of the lumbar muscles as a simple method of evaluating the burden on the muscles with little physical impact and aims to track the thickness of it from ultrasonic images. By automatically extracting the lumbar muscle membrane and spine using semantic segmentation, the lumbar muscle thickness is calculated. We demonstrate the effectiveness of this proposed method by calculating the accuracy of lumbar muscle thickness measured from ultrasonic movies when grasping a heavy object.

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

GS8-4 An Attempt to Discriminate Health Condition Deterioration Using Heart Rate Variability by Machine Learning

Daiki Tamashiro[1], Koji Yoshimitsu[2], Satoshi Ono[1]
([1]Information Science and Biomedical Engineering Program, Department of Engineering, Graduate School of Science and Engineering, Kagoshima University, Japan)
([2]Department of Occupational Therapy, School of Health Sciences, Faculty of Medicine, Kagoshima University, Japan)

Many studies have been devoted to identifying the deterioration of health conditions; however, most of them require a variety of vital signs and have yet to be verified using only heart rate variability. Monitoring health status only from heart rate variability, which smartwatches and other wearable devices can obtain, must realize advanced health monitoring using simpler devices. Therefore, this study attempts to discriminate the deterioration of health conditions without limiting disease using heart rate variability by machine learning. Experimental results using several machine learning models, including Supervised Time Series Forest, on a dataset generated from the MIMIC-III database suggest that HRV-based features have a potential to effectively discriminate patients in deteriorating health conditions.

GS8-5 Development of a Health Assist System through Character Recognition of Food Receipts

Abhijeet Ravankar[1], Ankit Ravankar[2], Arpit Rawankar[3]
([1]Kitami Institute of Technology, Japan)
([2]Tohoku University, Japan)
([3]Mumbai Unviersity, Mumbai, India)

This paper proposes a health assist system which recognizes food receipts from a single image and recommends appropriate food items to the user. In the proposed system, the user takes a photo of the cafeteria receipt which includes the menu items of the food purchased in university cafeteria or company cafeteria. Through an optical character recognition, the system then recognizes the different items purchased and builds up a database of the items. In Japan, most of the university cafeteria receipts also includes the amount of salt intake, green intake, apart from price of the items. These critical data are also stored in the database. The system then finds the eating pattern of the user and recommends appropriate food items to the user. The experiments were conducted using actual cafeteria receipts of university over a period of more than 4 months. The system can achieve a recognition accuracy of more than 90 percent.

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

Room F

GS12 Data mining

Chair: Nan Bu (National Institute of Technology, Kumamoto College, Japan)

GS12-1 Linguistic Explanation of Classification Mechanism for Dynamic Problems using Fuzzy Classifiers

Kensuke AJIMOTO, Yoshifumi KUSUNOKI, Tomoharu NAKASHIMA
(Osaka Metropolitan University, Japan)

Fuzzy classifiers can linguistically explain its classification mechanism while achieving high classification accuracy. In this paper, we aim to explain the classification mechanism in dynamic environments where the classification boundary changes over time. For this purpose, we propose an online updating of fuzzy classifiers by means of Confidence-Weighted Learning, which is one of the online learning methods for linear classifiers. We have confirmed that the classification mechanism of the learning model can be explained linguistically by examining how the weights of the classifiers, which are semantized by some fuzzy if-then rules, follow the dynamic changes in the true classification boundary.

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GS12-2 Double-ConvMF:Matrix factorization using user and item description text

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

Recommender system is a useful tool for presenting appropriate items to consumers. The development of e-commerce sites and review sites has made it possible to access a large amount of product descriptions and user reviews, and it is believed that more advanced recommendation models can be proposed by efficiently utilizing this text information. ConvMF is a first model that integrates text and probabilistic matrix factorization(PMF) which is one of the matrix factorization method. In this method, features are extracted from item text such as item descriptions using CNN architecture and integrated into PMF. However they focus only on the item text and not on the user factor. As a result, this method can not reflect user characteristics. Therefore, this paper proposes a new recommender system to extract both item and user features from item and user text using CNN and integrate them into matrix factorization.

GS12-3 A Multiple-Input Deep Learning Model for EC Site Review Usefulness Estimation Based on Product and Review Texts

Ryu Sunaga, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

Relatively few studies have considered the use of supporting information beyond reviews in the development of review recommendation models. In this study, we propose a deep learning model called 2Input-BERT designed to predict the usefulness score of product reviews using two types of textual information as input, including the texts of reviews of products as well as written descriptions of the same products. We compared the performance of our proposed model to that several other methods, and the results show that it exhibited better performance in predicting the usefulness of online reviews and incorporating supporting information.

GS12-4 Effectiveness of Character-level CNN and its Examination of Perturbation for Weights

Kazuteru Miyazaki, Masaaki Ida
(National Institution for Academic Degrees and Quality Enhancement of Higher Education, Japan)

Character-level convolutional neural networks (CLCNNs) are commonly used to classify text data. The authors applied and confirmed the validity of a CLCNN to a matching test to verify whether a university's diploma policy for accreditation and degree conferment appropriately represents the name of the major field of study. In another work, the efficacy of a CLCNN was confirmed in ensuring the consistency between the school s diploma and curriculum policies. In this paper, we experimentally verify the effectiveness of CLCNN using tweet data. In particular, the discussion focuses on the performance change caused by the number of units and perturbation of weights using the NTCIR-13 MedWeb task that is a well-known test collection for multi-label problems. Also we apply CLCNN to a real and public tweet dataset on the reputation of a cell phone. From these experimental results, the efficacy of the CLCNN has been empirically verified.

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GS12-5 Engineering a Data Processing Pipeline for an Ultra-Lightweight Lensless Fluorescence Imaging Device with Neuronal-Cluster Resolution

Zihao Yu[1], Mark Christian Guinto[1], Brian Godwin Lim[1], Renzo Roel Tan[1], Junichiro Yoshimoto[2], Kazushi Ikeda[1], Yasumi Ohta[1], Jun Ohta[1]
([1]Nara Institute of Science and Technology, Japan)
([2]Fujita Health University, Japan)

In working towards the goal of uncovering the inner workings of the brain, various imaging techniques have been the subject of research. Among the prominent technologies are devices that are based on the ability of transgenic animals to signal neuronal activity through fluorescent indicators. This paper investigates the utility of an original ultra-lightweight needle-type device in fluorescence neuroimaging. A generalizable data processing pipeline is proposed to compensate for the reduced image resolution of the lensless device. In particular, a modular solution centered on baseline-induced noise reduction and principal component analysis is designed as a stand-in for physical lenses in the aggregation and quasi-reconstruction of neuronal activity. Data-driven evidence backing the identification of regions of interest is then demonstrated, establishing the relative superiority of the method over neuroscience conventions within comparable contexts.

GS12-6 Pain Score Prediction During General Anesthesia Using Long Short-Term Memory (LSTM) Networks

Jiann-Shing Shieh
(Department of Mechanical Engineering, Yuan Ze University, Taiwan)

In this research, the main objective is to develop a long short-term memory (LSTM) networks model that could predict pain scores depending on surgical stress index (SSI) data. The input variables were SSI, normalized heartbeat interval (HBInorm), and normalized photoplethysmographic waveform amplitude (PPGAnorm). The output variable was assessment by anesthesiologist in terms of pain score between 0 to 100. Ninety patients' data were used where seventy patients for training, ten patients for validation, and ten patients for testing. The three LSTM networks models have been tested. The second model was selected due to its low mean absolute error (MAE) and standard deviation (SD) results. In this research, we concluded that SSI could be useful to predict the pain level and the model accuracy results might be improved as well during surgical operations with further improvements on the data consistency using different approaches.

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Room C

GS2 Artificial intelligence 1

Chair: Tanapun SRICHANTHAMIT (Hokkaido University, Japan)

GS2-1 Investigation of Object Detection Methods with the Goal of Building a Recipe Recommendation System

Yuki Santa, Ryuichi Matoba
(National Institute of Technology, Toyama College, Japan)

Currently, food loss is one of the factors adversely affecting the global environment. Especially in Japan, cases of direct disposal of uncooked food account for 30.3% of total household food loss. The main factors contributing to the direct disposal of food are the lack of management of expiration and consumption dates, and the failure to serve food after purchase. Therefore, we propose a system that uses an object detection model to detect the main food ingredients in images and recommend recipes. It is difficult for the system to detect all the ingredients that exist in the world. We solve this problem by creating an object detection model that can detect major food ingredients, and by creating an auxiliary system to reduce the burden of inputting food ingredients in a food management system that requires manual input.

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GS2-2 A Proposal of Indoor Location Estimation by Neural Network Using Wi-Fi Access Points

Tetsuya Hiromitsu, Ryuichi Matoba, Hiroshi Oguma
(National Institute of Technology, Toyama College, Japan)

This study has been done on location-based network selection methods. Outdoor positioning can be estimated using multi-GNSS and so on. However, the method to achieve positioning accuracy of 2m or less indoors has not been studied yet. In this research, we used Received Signal Strength Indicator (RSSI[dBm]) strength from Wi-Fi access points to estimate the position by learning with a simple perceptron model using neural networks. The results of location estimation using the trained model showed a correct response rate of about 98%. The correctness rate of the location estimation was about 98% for the data of 45 points on three floors. This indicates that it is possible to estimate the position in the vertical direction as well as the horizontal direction.

GS2-3 Generating Floor Plan with Zoning Method and Adjacency Constraint Considering Characteristic of Japanese Layout

Ayaka Sugiura, Takuto Sakuma, Shohei Kato
(Graduate School of Engineering, Nagoya Institute of Technology, Japan)

Architects in design offices and construction companies create comfortable floor plans according to a client's request. However, because the process requires a lot of time and manpower, it is necessary to improve their work efficiency. The purpose of this project is to support the creation of floor plans by automatically generating floor plan candidates. It is formulated as a mixed integer quadratic constraint problem to minimize the excess area of a floor plan. A layered approach is used to realize zoning, one of the architectural methods, to generate a floor plan candidate that takes advantage of the characteristics of Japanese floor plans. While previous methods cannot generate floor plans that consider corridors, the proposed method can generate candidate floor plans that consider corridors connecting to multiple rooms by using constraints that can express adjacency relationships.

GS2-4 Compression method for natural language processing models considering the attention head of pruning target

Akito Tokumasa[1], Michifumi Yoshioka[2], Katsufumi Inoue[2]
([1]Osaka Prefecture University, Graduate School of Engineering, Japan)
([2]Osaka Metropolitan University, graduate school of Engineering, Division of Electrical and Electronic Engineering, Japan)

Model compression, such as pruning, is necessary to improve the computational efficiency of pre-trained transformer-based models like BERT, whose size has been increasing in scale and have become difficult to use. Pruning is divided into unstructured and structured methods. Unstructured pruning allows for greater flexibility than structured pruning in determining which parameters to remove but has difficulty with tensor reconstruction after model compression. Structured pruning, on the other hand, has higher computational efficiency but lower discrimination capability. Improving the accuracy of a model compressed by structured pruning, especially layer-wise pruning, is an important task. Poor man's BERT (PMB) is a method that applies structured pruning to BERT layers. This method determines which layers should be removed manually based on empirical hypotheses, such as "adjacent layers have redundant information." We propose two approaches to improve PMB: introducing the change of the loss of the model as a new evaluation criterion to determine the layers to remove and recovering deleted attention heads that generate a valid attention map to maintain the discrimination capability. We evaluated the performance of the proposed method on the GLUE dataset and improved estimation accuracy in the QNLI task from 87.63% to 88.32% compared to PMB.

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GS2-5 Deep MAnTra: Deep Learning-based Multi-Animal Tracking for Japanese Macaques

Riza Rae Pineda[1], Takatomi Kubo[1], Masaki Shimada[2], Kazushi Ikeda[1]
([1]Mathematical Informatics, Division of Information Science, Nara Institute of Science and Technology, Japan)
([2]Teikyo University of Science, Japan)

Multi-instance object tracking is an active research problem in computer vision, where most novel methods analyze and locate targets on videos taken from static camera set-ups, just as many existing monitoring systems worldwide. These have proved efficient and effective for many established monitoring systems worldwide, such as animal behavior studies and human and road traffic. However, despite the growing success of computer vision in animal monitoring and behavior analysis, such a system has yet to be developed for free-ranging Japanese macaques. With this, our study aims to establish a tracking system for Japanese macaques in their natural habitat. We begin by training a monkey detector using You Only Look Once (YOLOv4) and investigating the effect of different transfer learning techniques, curriculum learning, and dataset heterogeneity to improve the model's accuracy. Using the resulting box detections from our monkey detection model, we use SuperGlue and Murty's algorithm for re-identifying the monkey individuals across the succeeding frames. With a mean AP@50 of 96.59%, a precision score of 93%, a recall of 96%, and a mean IOU(AP@50) of 77.2%, our Japanese macaque detection model trained using a YOLO-v4 architecture with spatial attention module and Mish activation function based on 3-stage training curriculum yielded the best performance. For animal behavior studies, our tracking system can prove effective and reliable with our achieved 91.35% MOTA even on our heterogeneous dataset.

GS2-6 Development of A Real-Time Automatic Water Break Detection in Mare Using Image Recognition

Tom Uchino[1], Riku Koyama[1], Hayato Ohwada[1], Niken Prasasti Martono[1], Takashi Hatazoe[2]
([1]Department of Industrial Administration Faculty of Science and Technology, Tokyo University of Science, Japan)
([2]Department of Veterinary Medicine, Joint Faculty of Veterinary Medicine, Kagoshima University, Kagoshima, Japan)

Economic losses owing to dystocia or neonatal death, as well as animal welfare, require a reliable forecast of parturition. The water breaking is known to occur in stage two of foaling, 20 to 30 minutes before. As a result, if water breaking in mare can be detected automatically, breeders will be able to predict foaling more accurately without constantly monitoring the horse. We proposed a method to monitor calving by detecting the dropped fluid on the floor to predict calving using CNN as deep learning model. Moreover, we performed two rule-based correction methods to reduce false positives in the absence of water loss in the classification model. The results shows that the model and the two correction methods could classify water breakage achieved a 96.20% accuracy and 79.02% F-measure. The visualization of the basis of the model using CAM showed that the model correctly classified the water break.

GS2-7 Binary PSO Introducing Lévy Flight For Optimization of the Storage Layout Assignment Implementing an AGV in Existing Product Placement

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

Order picking is one of the essential processes performed by human workers in many warehouses; however, warehousing is suffering from an acute shortfall of labor, making warehouse work difficult to meet demand. For this problem, many companies have introduced automated guided vehicle (AGV), which transports products picked by pickers to a depot, to automate order picking processes. Nevertheless, frequently ordered products are often stored near the existing drop-off point so simply installing an AGV will not maximize the effectiveness of its use. Therefore, we propose a storage assignment method that enables more efficient operation of an AGV by rearranging an existing product layout. Integrating class-based storage with particle swarm optimization algorithm and optimized the product placement under the AGV operation. The results are verified by simulation experiments and showed that the distance traveled for picking was greatly reduced compared to simply installing an AGV in the existing product layout.

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Room D

GS10 Cognitive Science

Chair: Florentin Wörgötter (University of Goettingen, Germany)

GS10-1 Verification of the Emergence of a Hierarchical Structure of Language through Cultural Inheritance with Consideration of the Mother Tongue

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

The purpose of this study is to conduct an artificial language transfer experiment called the IALL experiment on Japanese speakers. By conducting IALL experiments, artificial languages become compositional. Moreover, by conducting IALL experiments with Japanese speakers, we can expect the emergence of a structural language that includes functional words. Also, due to the recent spread of COVID-19, laboratory experiments may lead to the spread of infection. Therefore, it is necessary to conduct remote experiments online. Therefore, this study developed a tool for conducting IALL experiments remotely and evaluating compositionality and generating initial language. Using these tools, we will conduct IALL experiments on Japanese speakers and evaluate the results.

GS10-2 Tracking Method of Animal Repellent Robot Based on Flashing Visual Stimulus

Shijie Ge, Geunho Lee, Hiroki Yokoyama
(University of Miyazaki, Japan)

Animal husbandry is an important part of the primary industry, and protecting the breeding animals with economic value is one of the important topics. Invasive animals will become the source of infection, causing the occurrence and expansion of epidemic diseases. In order to drive away invasive animals to protect livestock from being infected by epidemic diseases, this study proposed a tracking radiation drive system to drive away invasive animals. The system can lock the invading wild animals through image data, track them according to their positions, and at the same time use the changing driving signals to illuminate, so as to finally achieve effective driving. Through staged experiments, we gradually verified the effectiveness of the system.

GS10-3 Does the mechanical mouth create an illusion of food texture perception due to differences in mastication?

Kosuke Hirose, Jun Ogawa, Yosuke Watanabe, MD Nahin Islam Shiblee, Masaru Kawakami, Hidemitsu Furukawa
(Yamagata University, Japan)

One of the new computational frameworks is physical reservoir computation. Focusing on this framework, we have previously developed a soft-matter artificial mouth "Gel Biter", which is composed of multiple polymeric materials based on the structure of the human oral cavity. This soft machine can discriminate even subtle differences in food texture with high accuracy. In general, chewing speed differs from person to person. Then, we focus on the result that brittle foods tend to be chewed faster/more finely based on sensory evaluation in some cognitive studies. This study has analyzed the accuracy of the Gel Biter by changing the parameters of its robotic arm, and the differences in food texture perceived when the chewing speed is changed. As a result, there is no significant difference in discrimination accuracy for each speed. The cluster analysis shows that the food characteristics are captured and classified. In addition, the estimation results for fast chewing indicates that mechanical mouth also generates the illusion such as human perceive different food textures.

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GS10-4 Facilitating Co-creative Communication in Proximity Voice Chat by Artificial Agents: Preliminary Investigation Based on a Collective Word Guessing Task

Riku Shimamoto, Reiji Suzuki, Takaya Arita
(Graduate School of Infomatics, Nagoya University, Japan)

Proximity voice chat is a communication platform that allows users to navigate freely and have conversations with their neighbors in a virtual space. However, there is a possibility of group agglutination and loss of opportunities for diverse interactions because of a lack of nonverbal cues. This study aims at designing artificial agents that can facilitate co-creative communication in a real proximity voice chat, according to our analyses based on an agent-based model. We first developed a proximity voice chat system in which artificial agents can move and emit sounds. We then conducted experiments with human participants using a co-creative task in which participants guess a target word from their lists of related words through conversation in the system. We discuss whether and how artificial agents moving around participants and emitting noises or related words may positively affect co-creative communication in terms of the utility and diversity of chosen words.

GS10-5 Ropivacaine/dexamethasone-eluting microparticles via electrospraying technique for postoperational pain control

Shih-Jyun Shen, Shih-Chieh Hsu, Chia-Jung Lu
(Chang Gung University, Taiwan)

Microencapsulation plays as an important role in biomedical technology owing to its particular and attractive characteristics. In this work, we developed ropivacaine and dexamethasone loaded poly(D,L-lactide-co-glycolide) (PLGA) microparticles via electrospraying technique and investigated the release behavior of electrosprayed microparticles. The particle morphology of sprayed particles was assessed using scanning electron microscopy (SEM). The in vitro drug release kinetics were evaluated employing an elution method, and the in vivo pharmaceutical release as well as its efficacy on pain relief were tested using an animal activity model. The microscopic observation suggested that sprayed microparticles exhibit a size distribution of 5-6 □m. Fourier-transform infrared spectrometry and differential scanning calorimetry demonstrated the successful incorporation of pharmaceuticals in the PLGA particulates. The drugs-loaded particles discharged sustainably high concentrations of ropivacaine and dexamethasone at the target region in vivo for over two weeks, and the drug levels in the blood remained low. By adopting the electrospraying technique, we were able to prepare drugs-embedded polymeric microparticles with effectiveness and sustainable capability for postoperative pain control.

GS10-6 Core-shell insulin-loaded nanofibrous scaffolds for healing diabetic wounds

Chen-Hung Lee, Yen-Wei Liu
(Chang Gung Memorial Hospital-Linkou, Taiwan)

Patients with diabetes mellitus have up to a 15% lifetime risk of non-healing, which results in high possibility of limb amputation. This work developed core-shell nanofibrous bioactive insulin-loaded poly-D-L-lactide- glycolide (PLGA) scaffolds that release insulin in a preserved manner for repairing wounds in diabetic rats. For the biodegradable core-shell nanofibers, PLGA and insulin solutions were fed into two capillary tubes of different sizes that were coaxially electrospun using two independent pumps. The nanofibers sustainably released insulin for four weeks. The hydrophilicity and water-containing capacity of core-shell nanofibrous insulin/PLGA nanofibers significantly exceeded those of blended nanofibers. The nanofibrous core-shell insulin-loaded scaffold decreased the amount of type I collagen in vitro, increased the transforming growth factor-beta content in vivo, and enhanced diabetic would repair. The core-shell insulin-loaded nanofibrous scaffolds prolong the release of insulin and help diabetic wound healing.

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GS10-7 Analysis of a latent space structure in generative neural net trained by sound data.

Itsuki Doi, Hiroki Kojima, Takashi Ikegami
(University of Tokyo, Japan)

Recent neuroscience research has shown that the cognitive mapping system in the brain encodes and maps various types of information, including spatial, sound, shape, and social relationships. In this study, we used a deep generative neural network (GAN) to model the cognitive map of sound and examined how characteristics of sound, such as frequency, are represented in the latent space of the network. We found that the distribution of these characteristics in the latent space was smooth, similar to the 'tonotopy map' in the auditory cortex of animals. This study builds upon our previous work on using generative neural net (VAE/GAN) to model the cognitive map of spatial navigation and aims to provide insight into the neural representation of sound.

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Room E

GS15 Human-machine interaction and collaboration

Chair: Ryosuke Saga (Osaka Metropolitan University, Japan)

GS15-1 Throwing Support Scheme Based on the Development of a Robot with Gesture-Estimation Functions

Naohisa Togami, Geunho Lee
(University of Miyazaki, Japan)

People with upper limb dysfunction (hereafter referred to as "people with upper limb disability") have extreme difficulty in controlling their hands to hold the ball and release their fingers at the appropriate time. Therefore, although they can gesture to throw the ball as well as able-bodied people, they often give up participating in sports that involve throwing. In this study, we propose a throwing support system that utilizes the " throwing gestures" performed by peoples with upper limb disability. Specifically, the system estimates the intention of a people to throw from the movement of his or her shoulder when the people performs the gesture of throwing, and the robot throws the ball according to the intention. This system is expected to enable throwing assistance using the intuitive motions of people with upper limb disability.

GS15-2 Human augmentation hand to solve dissection puzzle problem

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

Human augmentation technologies can strengthen and compensate a lack of human abilities associated with aging and physical disabilities. These technologies have been trying to be applied in manufacturing and agricultural sites to improve work efficiency, reduce fatigue, and cover differences in worker's skill. This research proposes a novel human augmentation hand to assist users in performing intelligent tasks that require higher brain functions such as cognition, planning, judgment, and memory. The silhouette puzzle is adopted as an example of intelligent task. The human augmentation hand captures the environment image with an attached camera, and the puzzle pieces necessary for solving the silhouette puzzle are derived by a full-search algorithm. Then, the system can provide the user a hint for solving puzzles and can assist his/her to handle the puzzle pieces. The preliminary experiment was conducted to confirm the system operation and to examine its usefulness. The experimental result revealed that the proposed system improved the task efficiency that requires higher brain functions.

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GS15-3 Solution search algorithm for solving support of dissection puzzle

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

Puzzles are often used in the training and rehabilitation of brain functions and motor coordination. However, its enjoyment may decrease as the burden of puzzle solving increases. Therefore, we propose a support system that can support a player to solve silhouette puzzle with Tetromino blocks. The system captures an image of the silhouette puzzle, then solves the problem based on a full-search algorithm. Finally, the system outputs hints to solve the problem. The system allows the player to shorten the playing time, avoid incorrect answers, reduce the mental load, and increase the duration in concentration. The preliminary experiments validated the concept of the proposed system. Based on the solution search algorithm, the system successfully supported the players to concentrate on the task of placing puzzle blocks to the target position.

GS15-4 Development of a humanoid-based presentation system for making a good impression on the audience

Yuya Ogoshi[1], Seiko Taki[2], Tomohiro Hayakawa[3], Toshiyuki Yasuda[3]
([1]Graduate School of Science and Engineering, University of Toyama, Toyama, Japan)
([2]Faculty of Social Systems Science, Chiba Institute of Technology, Chiba, Japan)
([3]Faculty of Engineering, University of Toyama, Toyama, Japan)

Humanoid robots have recently gained attention as means of conveying information and it is generally believed that they should behave like humans. However, since humanoid robots are intrinsically different from humans, it is unclear whether robots can make a good impression on people by imitating human behavior. In this study, we clarify that humanoid robots have specific behaviors that make a good impression on people. First, we analyzed human presentation behaviors. In the analysis, we clarified the eye-gaze ratio, the head and arm movements order, and speech timing in human presentations that audiences prefer. Second, based on the analysis results, we constructed a human-like behavior mode and three modes of other behaviors slightly different from human behavior. We applied the four modes to the humanoid robot, and sensory evaluation was performed. The results show that when humanoid robots behave differently from humans, they make the best impression on the audience.

GS15-5 Pose-based factor analysis for muscle deterioration with LSTM-AE

Ryotaro Ishii[1], Tairyu Saito[2], Kaoru Inoue[2], Eri Sato-Shimokawara[2], Shoji Yamamoto[1]
([1]Tokyo Metropolitan College of Industrial Technology, Japan)
([2]Tokyo Metropolitan University, Japan)

Appropriate physical activity is important for maintaining a healthy lifestyle. Our muscles keep their function through daily loads, by which we can sustain our lives without any inconvenience. However, with the spread of unexpected diseases like covid-19, we experienced the risk of losing that physical activity. Lack of physical activity leads to a loss of muscle capacity, it is liable to impair your health in spite of oneself. Therefore, we developed a novel system to detect the deterioration of physical functions by using compensating pose analysis and foot sole pressure with LSTM-AE.

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GS15-6 Statistical Analysis of Interday Variations in Subjective Health Feelings and Facial Color

Takato Hattori[1], Kosuke Oiwa[1], Bikash Lamsal[2], Akio Nozawa[1]
([1]College of Science and Engineering, Aoyama Gakuin University, Japan)
([2]Kajima Technical Research Institute, Japan)

Facial color is a remotely measurable vital sign that fluctuates with facial cutaneous blood flow, which is governed by autonomic nervous system activity. Therefore, the diurnal variation in "subjective health feelings" and facial color may provide an analogy for the state of the autonomic nervous system. Previous studies have suggested that long-term fluctuations in periorbital color information may be related to physical condition. However, in previous studies, facial regions were segmented, limiting the area of analysis. In addition, despite the variation in physical condition, an integrated analysis was conducted based on subjective health scores. In this study, the facial visible images were spatially standardized without specifying the segmented region of the face, and the color information of the entire face and each index of subjective health feelings were statistically analyzed.

GS15-7 Explore the relationship between the measurement of stiffness presented at the fingertips and the evaluation of perceived value

Tomoe Ozeki[1], Tetsuya Mouri[2]
([1]Department of Informatics, Aichi University of Technology, Japan)
([2]Department of Mechanical Engineering, Gifu University, Japan)

Stiffness has an influence on human feelings and impressions, and can change our decision-making and attitudes. Quantitative methods to measure perception and experiments to assess psychological effects have been developed in many studies. However, there have been few studies that collect and examine both. The purpose of this study was to investigate the relationships and tendencies between the quantitative measurement of stiffness and the subjective impression of the object. This paper presents our experimental design and implementation, including the measurement method and impression evaluation. If we can understand how hardness affects people's decision-making, we will be able to make concrete proposals and establish guidelines for the optimal hardness of controllers and levers.

GS15-8 Real World Clicker Manipulation Method by a Smartphone

Shin-ichiro Sakamoto, Keigo Noguchi, Satoshi Iwaki
(Hiroshima City University, Japan)

The authors have been developing a robot teaching interface using a Real World Clicker (RWC:Real World Clicker), which uses a TOF-type laser distance sensor mounted on a pan-tilt actuator as a laser pointer to measure the 3D position of a manipulated object. Conventionally, a PC mouse has been used as the main RWC control device. However, this method has the problem of requiring a PC environment. Therefore, in this paper, we decided to use a smartphone as a control device because of its superiority in terms of daily use and convenience. The effectiveness of the proposed method was confirmed by the results of evaluation experiments with multiple subjects.

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Room F

GS22 Model estimation

Chair: Renzo Roel Perez Tan (Nara Institute of Science and Technology, Japan)

GS22-1 A Method to Extract Quantity Relationships among Items using Ridge Regression for the Supervision of Construction Cost Estimation

Masaharu Kato, Yoshifumi Kusunoki, Nakashima Tomoharu
(Osaka Metropolitan University, Japan)

In the field of construction, cost estimation is conducted prior to the construction work. In the estimation work, a document that summarizes the required items and their quantities is created, and supervision work is required to validate the document. However, there are no clear standards for the validation of item quantities, and it depends on the supervision workers' own discretion based on past construction trends. In this study, we organize the data from past cost estimation documents and extract the relationships of item quantities. In our proposed method, item quantities' relationships are extracted by linear regression based on a set of independent variables formulated by ridge regression. We performed numerical experiments using pseudo-datasets to determine the performance of our proposed method.

GS22-2 Consideration of a non-linear mass-spring model for dexterous string manipulations

Kenta Tabata, Hiroaki Seki, Tokuo Tsuji, Tatsuhiro Hiramitsu
(Kanazawa University, Japan)

Manipulation for deformable object is difficult in robotics. The deformation of the deformable object is not the same, despite the same manipulation. This is due to the difference in the object characteristics, which depend on knitting, material, etc. This leads to difficulties in the motion planning. We propose a method that estimates the string model by comparing the real string movement and simulated string movement in a certain manipulation repeatedly by trial and error. This method realizes several manipulations using unknown strings. But feasible range was limited to uniform strings. In this paper, we proposed string model for representing various kind of string. This model assumed that mass distribution is not uniform and bending properties is different depending on extraction and contraction. Where this model was applied to several non-uniform string and uniform string, we confirmed that the proposed model can express the actual string movement.

GS22-4 Online Simultaneous Localization and Mapping with Parallelization for Dynamic Line Segments based on Moving Horizon Estimation

Haziq Muhammad, Yasumasa Ishikawa, Kazuma Sekiguchi, Kenichiro Nonaka
(Tokyo City University, Japan)

The development of SLAM in a dynamic environment is important for the application of robots in our daily environment. We introduce a novel SLAM method that explicitly considers the velocity of the environment uniformly where it does not distinguish between stationary and dynamic objects. This method approximates the environment features as dynamic line segments. We apply the moving horizon estimation to optimize the state numerically. To achieve online SLAM, one of the approaches to increase the speed is through the parallelization of the optimization robot and map part. Furthermore, in order to increase the robustness of the estimation, we implement an algorithm that determines spurious estimations and removes those estimations. The result of this approach denotes that the presented algorithm was fast enough to achieve online SLAM.

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GS22-5 Research on Young's modules measurement of Bincho charcoal

Haruto Kubo, Nobuo Iwasaki, Kazuya Okamoto, David Marsh
(National Institute of Technology, Wakayama College, Japan)

In Akizugawa, Tanabe City, Wakayama Prefecture, a percussion instrument called the Tannkin is produced using Bincho charcoal. Tuning of Tannkin is done by hand by craftsmen. So tuning takes a great deal of time. Therefore, we are investigating an efficient method of producing Tannkin. In previous study, a system to adjust pitch by using Young's modulus was considered. However, a large error in tuning occurred. We attributed this to the non-uniformity of the shape of Bincho charcoal. Therefore, in this study, we attempted to accurately measure Young's modulus by uniformly processing Bincho charcoal in advance. As a result, we were able to significantly reduce the variation in Young's modulus in this study, in contrast to previous studies in which the variation in Young's modulus from one piece of Bincho charcoal to another was large. In the future, Tannkin will be tuned using the Young's modulus obtained in this study.

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Room A

GS1 Agent-based modeling

Chair: Niken Prasasti Martono (Tokyo University of Science, Japan)

GS1-1 Agent-based Interaction Model with Exogenous and Endogenous Parameters

Mikihiro Suda, Takumi Saito, Mizuki Oka
(Grad. School of Science and Technology, University of Tsukuba, Japan)

We humans literally interact with each other every day of our lives. Understanding our never-ending chain of open-ended interactions is important not only for artificial life research, but also for many other fields of study. Several models have been proposed to artificially reproduce such interactions, but our previous investigations have revealed that existing models do not accurately capture the emergent tendencies of novelty. In addition, it is known that human social activities are a combination of exogenous and endogenous activities, but the models proposed so far do not clearly reflect this dichotomy. Therefore, we extend the agent-based Polya's urn model to create a model that can adjust the exogenous and endogenous degrees as well as the emergence tendency of novelty much closer to reality than existing models.

GS1-2 MORI-A CPS: Soft modular actuator support with 4D assembly simulation

Shoma Abe, Jun Ogawa, Yosuke Watanabe, MD Nahin Islam Shiblee,
Masaru Kawakami, Hidemitsu Furukawa
(Yamagata University, Japan)

Soft modular robotics combines soft materials and modular mechanisms. We are developing a vacuum-driven actuator module, MORI-A, which combines a 3D printed flexible parallel cross structure with a cube-shaped hollow silicone. The MORI-A module has five deformation modes: no deformation, uniform contraction, uniaxial contraction, flexion, and shear. By combining these modules, soft robots with a variety of deformabilities can be constructed. However, assembling MORI-A requires predicting the deformation from the posture and mode of the modules, making assembly difficult. To overcome this problem, this study aims to construct a system called "MORI-A CPS," which can predict the motion of a soft robot composed of MORI-A modules by simply arranging cubes in a virtual space. This paper evaluates how well the motion of virtual MORI-A modules, defined as a combination of swelling and shrinking voxels, approximates real-world motion. Then, it shows that the deformations of virtual soft robots constructed via MORI-A CPS are similar to those of real robots.

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GS1-4 Learning to mimic programmers gaze behavior for program comprehension improvement

Jeanne Barthélemy[1], Takatomi Kubo[2], Takeshi Itoh[2], Kiyoka Ikeda[2], Kazushi Ikeda[2]
([1]Sorbonne University, France)
([2]Nara Institute of Science and Technology, Japan)

Gaze behavior of human coders could allow to improve programmer-aiding tools relying on program comprehension algorithms, as gaze reveals which subsets of source code programmers focus on in order to understand its function. When real gaze data is unavailable, algorithmic solutions for gaze behavior estimation might be used in order to integrate gaze behavior in a global programmer-aiding tool pipeline. Our goal is the implementation and training of an algorithmic solution in order to generate trajectories describing gaze behavior. We successfully implemented an automatic gaze behavior generation algorithm with visibly better performances than a random policy during a program comprehension task. This implies that automatic program comprehension improvement with gaze trajectories could be possible in real time, without the need for eye gaze tracking devices. Workflows similar to ours could enhance programmer-aiding tools, but also benefit society more broadly by giving new insights toward building AI with attention mechanisms.

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Room B

OS4 AROB: Computational intelligence and cognitive science for human biosignals and human well-being

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

OS4-1 Estimation of a treatment effect based on a modified covariate method with L_0 norm

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

In clinical trials, we assumed the situation that new treatments are not effective compared to the control treatment as result. It is unknown if the new treatment is ineffective for all patients or if it is effective for only a subgroup of patients with certain characteristics. If a subgroup can be detected, the patients in the subgroup can receive effective therapy. To detect subgroups, we need to estimate treatment effects. To achieve this, various treatment effect estimation methods have been proposed based on the sparse regression method. However, these methods are affected by noise. Therefore, we propose new treatment effect estimation approaches based on the modified covariate method, one using lasso regression and the other ridge regression, using the L0 norm. The proposed approaches were evaluated through numerical simulation and real data examples.

OS4-2 Analysis of the sixth wave COVID-19 outbreak in Japan

Hiroshi Furutani, Tomoyuki Hiroyasu
(Doshisha University, Japan)

This paper reports a mathematical study on the modelling and analysis of the daily number of COVID-19 infections in Japan. We investigate the spreading of infections in the period from January to March in 2022, which is usually called as the sixth wave of COVID-19 outbreak. The analysis uses the reported daily data of infections in 9 prefectures, and aims to estimate the position and height of the peak in the time series data. As a statistical method, we employ the Gumbel distribution model, which has been used as the fundamental distribution in the field of Extreme Value Theory. The linear regression approach is adopted for parameter estimation and data fitting. This study can demonstrate that the Gumbel model successfully estimate the height and position of peak.

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OS4-3 Generating corneal panoramic images from contact specular microscope images

Yusuke Nagira[1], Yuzuha Hara[2], Satoru Hiwa[2], Naoki Okumura[3], Noriko Koizumi[3], Tomoyuki Hiroyasu[2]
([1]Graduate school of Life and Medical Sciences, Doshisha University, Japan)
([2]Department of Biomedical Sciences and Informatics, Doshisha University, Japan)
([3]Department of Biomedical Engineering, Faculty of Life and Medical Sciences, Doshisha University, Japan)

This paper proposes a framework to automatically generate a whole cornea image from videos taken by a contact specular microscope. Relatively focused images were extracted from the videos, and panoramic compositing was performed. If a whole image can be generated, it is possible to detect guttae from the image and to investigate the extent to which guttae are present. The system was implemented, and the effectiveness of the proposed framework was examined. The system was implemented using custom-made composite software, and a supervised learning model using U-Net was used for guttae detection. When the constructed system was applied to 94 different mouse model FECD corneal videos, many images were correctly synthesized. The implementation and application of the method to the data in this study confirmed the effectiveness of the method.

OS4-4 Deep-learning models in medical image analysis: Detection of esophagitis from the Kvasir Dataset

Kyoka Yoshioka[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 this study, we implemented an endoscopic imaging system using four different Convolutional neural network architectures and compared their accuracy. Those are GoogLeNet, ResNet-50, MobileNet V2, and MobileNet V3. The models were applied to the Kvasir dataset, an open dataset of endoscopic images released in 2017. The results of the models were compared for their accuracy. As a result, GoogLeNet achieved the best results. A post hoc explanation of the models using SHapley Additive exPlanations and Gradient-Weighted Class Activation Mapping were also applied. Post hoc explanations of the models with Grad-CAM and SHAP allowed us to understand the characteristics of the obtained models.

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Room C

OS6 AROB: Intuitive Human-System Interaction

Chair: Masao Yokota (Fukuoka Institute of Technology, Japan)
Co-Chair: Noriki Uchida (Fukuoka Institute of Technology, Japan)

OS6-1 Drowsy Driving Prevention System by Keeping Arousal State with Smart Speaker

Noriki Uchida[1], Mizuki Ohyama[1], Yoshitaka Shibata[2]
([1]Fukuoka Institute of Techonology, Japan)
([2]Iwate Prefectural University, Japan)

Many traffic accidents caused by drowsy driving happen yearly, so this study proposes the drowsy driving prevention system by keeping the arousal state with the smart speaker. In the proposed methods, two kinds of conversations with the driver are controlled by the cloud-based AI modules. One is the lightweight thinking conversations based on selectable questions like dogs or cats, and another is the heavyweight thinking conversations based on the natural conversation by AI module. In the experiments using the prototype system, the arousal level with the driving simulator is measured by the eye tracker, the brainwave, and the surveys. The results show that the proposed system is effective for keeping the arousal state, but the natural conversations indicate a slightly annoyed state compared with selectable conversations.

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OS6-2 A Study on Virtual Avatar Diving Motion for Standing Type Female Diver Virtual Experience System

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

In systems that display avatars, the unnaturalness of their motion is a major problem. To solve this problem, we further developed a system based on "Amavia-WHC". This system is a standing type virtual reality Ama diving experience system. The arm movements in breaststroke, obtained by Ama motion capture on land, and the symmetrical leg movements in underwater Ama motion capture were assumed to be periodic. Based on the correspondence data between the arm and leg motions, we applied DP matching to a series of arm motions of a learner to estimate and apply natural arm and leg diving motions in real time. It was shown that the application of the proposed method achieved the estimation and application of natural motions for the part of the body where the learner did not provide any motion input, and that the unnaturalness of the avatar's underwater posture was significantly improved.

OS6-3 A study on analysis on poster's emotion on SNS for supporting female cancer in COVID-19 pandemic

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

The pandemic caused by the COVID-19 still has a great impact on the entire society. In an unstable situation, estimating and predicting trends in people’s awareness and behavior will be important until convergence of the COVID-19 pandemic, when an unknown infectious disease is encountered in the future. On the other hand, in order to promote the cancer control, it is important for cancer patients to have scenes where people with similar experiences can provide counseling support and information, and where patients can share their experiences. it is required to enhance the peer support that supports patients and their families by sharing their experiences as peers. In recent years, in addition to peer support by face-to-face, SNS services that enable online communication using the Internet have become widespread. In the paper, we apply the post data of the free membership SNS “Peer Ring”, a peer support community for those who are facing female cancer, to analyze the emotional ups and downs of people with female cancers during the COVID-19 pandemic. Furthermore, we aim to estimate and predict what kind of emotions the COVID-19 effect to people suffering from female cancers.

OS6-4 Towards Robotic Deep Spatiotemporal Language Understanding Based on Mental Image Directed Semantic Theory

Rojanee Khummongkol[1], Masao Yokota[2]
([1]University of Phayao, Thailand)
([2]Fukuoka Institute of Technology, Japan)

Among subsets of natural language, spatial language, more exactly spatiotemporal language here, has been considered most essential for human-like interaction between people and robots expected in near future. Quite distinctively from conventional learning-based approaches to natural language understanding (NLU), mental image directed theory (MIDST) proposes a robotic deep NLU methodology based on a mental image model and a formal system for knowledge representation and reasoning. This paper gives a brief sketch of MIDST and its application to systematic formulation and computation of commonsense knowledge of space and time within the framework of predicate logic.

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Room D

GS6 Bioinformatics

Chair: Ken Naitoh (Waseda University, Japan)

GS6-1 Lower-Limb Joint Angle Estimation of Different Motion Activities from Pelvis Inertial Data

Tsige Tadesse Alemayoh, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

Human pose estimation is among the emerging fields which are being actively researched and attracting interest for various purposes. Applications could range from healthcare to robotics, from automation to virtual reality. Existing methods vary in sensor type, sensor quantity, and utilized algorithms. Optical motion capture systems and multiple inertial sensor systems have been widely utilized. Particularly, optical systems suffer from high setup and maintenance costs, environmental lighting, and space limitations. Hence, most existing studies have been constrained to indoor activities only. Despite drifting error problems of inertial sensors more robust inertial sensors are surfacing in the market recently. Leveraging this advancement, inertial sensors can be good candidates for data collection as they are not bound by space and lighting. In this research, we developed a deep learning-based lower limb joint angle estimator using only one inertial sensor placed on the waist. During the data collection, the subject wears five inertial sensors. A 15-minute data of forward/backward walking, sideways movement, and some complex movement was collected outside in an open space. The ground truth leg joint angle data is calculated from the orientation output of each individual sensor. However, the input to the neural network is only the 3-axis accelerometer and 3-axis gyroscope of the inertial sensor attached to the waist. Convolutional Neural Network (CNN) was trained using the collected data. Resultantly, CNN achieved an average mean absolute error (MAE) of 3.95º for the six joint angles. Finally, the trained model was tested using unseen datasets which showed a promising result that can be used as a foundation for different applications.

GS6-2 Error Compensation of SpO_2 Measurements Using Earlobe-Attached Wearable Pulse Oximeter

Takuma Kitagawa, Masayuki Tanabe, Masahiko Nishimoto, Toshitaka Yamakawa
(Kumamoto University, Japan)

Recently, lifestyle-related diseases have become a common health problem. The prevention of such diseases requires, among other measures, regular exercise. Therefore, we developed a wearable pulse oximeter for acquiring measurements from the earlobe and use in training and activities of daily living. The oximeter acquires physiological signals from the earlobe and provides wireless measurements of percutaneous arterial oxygen saturation (SpO_2) and heart rate. As a prototype oximeter may show errors owing to body motions and perspiration, we conducted the Valsalva test on 21 university students to verify the oximeter accuracy through the Bland–Altman analysis and root-mean-square error. The error of SpO_2 values of 89% or less was larger than that established by the Japanese Industrial Standard (JIS). Thus, we corrected the error for compliance with the JIS, thus mitigating its effects on the measurements.

GS6-3 Estimating Potential Biomarkers of Late Recurrence in Breast Cancer using Machine Learning

Masanari Nojima, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

In this study, we propose a machine learning model designed to estimate potential biomarkers of late recurrence in breast cancer. First, we constructed machine learning models, including those for survival time analysis. We then trained these models using a gene expression dataset of breast cancer patients for each subtype. We evaluated the models by calculating the output concordance index and cumulative/dynamic Area Under the ROC Curve. The proposed approach showed better performance than a random estimation model. We then applied SHapley Additive exPlanations (SHAP) to estimate the input features that contributed to the outputs. Subsequently, we evaluated the inner product, defined as the ordinal score, of the SHAP values and Principal Component Analysis's loadings. This ordinal score enables us to estimate the potential biomarker genes for late breast cancer recurrence more continuously.

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GS6-4 Evaluation of Lower Limb Muscles from a Guided Speed of Resistance Exercise Using a Hip-Joint Exoskeleton

Byungmun Kang[1], YoonMyung Kim[2], Dongwoo Kim[3], Hwang-Jae Lee[3], Dokwan Lee[3], Hyung Gyu Jeon[4], DaeEun Kim
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The performance of resistance exercise can represent muscular strength, such as the muscle contraction or weight-lifted, one-repetition maximum (1RM). The main goal of this study is to estimate the muscular strength through the performance of the resistance exercise with the hip-joint exoskeleton robot. We first measured the muscular strength of the lower limb for ten subjects to obtain the muscular indicators with a fitness machine such as one RM. Then the exercise measurement was taken again over the subjects wearing the hip-joint exoskeleton robot, providing the resistance with joint torque. The subjects are supposed to follow a guided speed of exercises, knee-up and squat. From the data, we develop a performance metric for the muscular strength indicator, using the correlation between muscular strength and resistance-based exercise performance. We propose a new metric to determine muscular strength, which is related to the adaptation level of how well subjects follow the speed level of a guided exercise.

January 25 (Wednesday), 16:45-17:45

Room E

GS14 Evolutionary computations (Genetic algorithm)

Chair: Tomoharu Nakashima (Osaka Metropolitan University, Japan)

GS14-1 Approximation Circuit Design Method for FPGA Using Genetic Algorithm

Koki Mizumura[1], Akinori Kanasugi[2]
([1]Graduate School of Engineering, Tokyo Denki University, Japan)
([2]Tokyo Denki University, Japan)

The demand for higher speed and lower power consumption of digital LSI has increased. In recent years, approximate circuits have attracted attention. It improves circuit scale and delay times, sacrificing computational accuracy to solve above problems. FPGA consist of look-up tables (LUT), which store all input/output relationships in internal memory. Therefore, even if the logic gates are deleted, the circuit size does not change, unless the number of input/output pins changes. The proposed method utilizes technology mapping method. This method enables a circuit configuration that minimizes the number of logic stages. Approximate circuits were synthesized using genetic algorithm and compared with the original circuit. The proposed method shows that some logic circuits can be constructed with a small number of LUTs. The results show an acceptable error rate, and the circuit size can be changed depending on the genetic algorithm conditions.

GS14-2 Automatic Music Composition Using Interactive Evolutionary Computation Considering Handbell Chord Features

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

Handbells are a musical instrument with such a beautiful sound that they have been called the "singing voice of angels", but they are not well known in Japan, and many people do not know the good features of handbells.Moreover, the recognition of handbells is low in Japan. Many people are not aware of the good features of handbells. In order to make many people aware of the charm of handbells, it is important to compose many pieces of music that take advantage the features of handbells. In this paper, we propose a method of music generation using interactive evolutionary computation, based on the characteristics of handbell music, that uses a tree structure to represent music and many simultaneous notes. We examine the effectiveness of the proposed method by generating musics using the proposed system by handbell player and inexperienced handbell player, and by evaluating their impressions of the generated musics.

January 25 (Wednesday), 16:45-17:45

GS14-3 Solving polygon packing problems for arbitrary frames with the Hierarchical GA

Tsukasa Kojo, Ryoto Minami, Shudai Ishikawa
(National Institute of Technology, Oita College, Japan)

The polygon packing problem is a problem of arranging figures of various shapes and sizes on a plane without overlaps and has long been studied in the fields of geometry and combinatorial optimization. The polygon packing problem is an evolution of the padding problem. This study proposes an algorithm to solve the polygon packing problem with free rotation for an arbitrary frame. The genetic algorithm (GA) is based on the evolutionary theory that aims to construct adaptive systems and is known to be effective in finding approximate solutions to NP-hard problems. GA is performed by repeatedly performing genetic manipulations such as selection, crossover, and mutation on a population of individuals to search for a solution. In conventional methods, the pieces to be placed are selected, and the GA is used to place the pieces in a frame. The method uses a Hierarchical Genetic Algorithm (HGA) to merge repeatedly and split pieces, and redefine pieces to compute a single large individual finally. HGA is a hierarchical partitioning of the problem, where the upper and lower layers perform elementary operations so that the general intersection method can be applied. Specifically, (1) two pieces are selected from the set of pieces in the lower layer and integrated or split, (2) the selected pieces are placed in appropriate positions in the upper layer, integrated, redefined as a single piece, and added to the set. In other words, the pieces are combined to approximate the frame's shape. This process allows the pieces to be placed regardless of the size or shape of the structure and is expected to reduce the computational cost significantly. In our experiments, we created a practical data set and performed filling on multiple types of frames

GS14-4 Position control of marine robot using fuzzy controller designed by genetic algorithm

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

Marine robots are used to investigate underwater and seafloor organisms, structures, and resources. In this paper, a control system for a small marine robot is developed and simulation experiments are conducted. The control system is based on fuzzy control. Fuzzy control is similar to human control in that it determines rules, quantifies them in the form of membership functions, and determines the amount of manipulation. The present controller uses a function in the non-fuzzification process to determine the operating quantities. The coefficients of this function were obtained using a genetic algorithm. Using this control system, the marine robot was able to move to the desired position in the simulation.

January 25 (Wednesday), 16:45-17:45

Room F

GS17 Intelligent control

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

GS17-1 Acquiring biped locomotion controllers using reinforcement learning and reference motion

Naoya Itahashi, Hideaki Itoh, Hisao Fukumoto, Hiroshi Wakuya
(Saga University, Japan)

Acquiring biped locomotion controllers for humanoid robots is a challenging problem, and reinforcement learning has attracted much attention as a method for automatically acquiring them. Many previous studies that have realized locomotion controllers by reinforcement learning used some additional information such as stable regions of the Zero Moment Point (ZMP) and motion capture data, but each approach had a difficulty. In this paper, we propose a novel reinforcement learning method that utilizes a reference motion, which can be produced by a low-quality controller, to give the robot some information regarding how the robot should move over time. The robot learns to achieve a given task objective while imitating the reference motion. We show through experiments that (1) the learning becomes faster with the reference motion than without it and (2) that our method can be used to acquire new motions that are better than the reference motion.

GS17-2 Route Finding for Autonomous Vessel Considering Obstacle Avoidance by Deep-Reinforcement Learning

Rinto Kozono[1], Yutaro Tsurumi[1], Yasunori Nihei[2], Ryosuke Saga[2]
([1]Osaka Prefecture University, Japan)
([2]Osaka Metropolitan University, Japan)

This study proposes a method that enables the generation of short-length routes with consideration of obstacle avoidance and significantly reduces the computation time compared with existing research for ocean route optimization. The reduced computation time allows the recalculation of routes for autonomous vessel underway. The proposed method can generate new and superior routes for vessels that need to change their routes due to certain factors by simulating the recalculation of four cases of the vessel underway that may require recalculation.

GS17-3 Self-adjusting PID Control system using Neural Network for Binary Power Plant

Kun-Young Han[1], Gee-Yong Park[1], Myeong-Kyun Lee[1], Dong-Han Yoo[1], Hee-Hyol Lee[2]
([1]Korea Atomic Energy Research Institute, Korea)
([2]Waseda University, Japan)

A PID control system has a wide application on power plants because of its simple structure and easily implement. However, the characteristic value of a binary power plant using low-grade thermal energy changes in the actual power generation environment since hot water, which serves as the heat source contains many impurities with corrosive components, and its temperature changes according to the environmental conditions. The fine-tuning of the PID controller's parameters is an intricate task in operation of the binary power plant, which has uncertain parameters or unmodeled dynamics due to the characteristic value changes, despite the fact that it has simple structure and easily implement. All of these call for the development of new controller for the binary power plant. This paper proposes a self-adjusting PID control system using Neural Network for the binary power plant, and presents a design strategy of the proposed control system. The simulation control results of the proposed control system show it provides a robustness for the binary power plant, which has uncertain parameters or unmodeled dynamics.

January 25 (Wednesday), 16:45-17:45

GS17-4 Interactive Tracking Algorithm of Trolley Robot Employing Proximity Sensors

Shijie Ge, Geunho Lee, Naohisa Togami
(University of Miyazaki, Japan)

In view of the common small amount of multiple handling operations in the manufacturing industry, in order to assist the carrier and achieve the purpose of labor saving, we propose a tracking robot that can assist in handling.The robot reads the user's position information through proximity distance sensor, judges the user's motion state according to the position information, and controls the robot according to the motion state. In order to control the robot better, we designed a PID controller and verified its convergence through simulation experiments. Finally, we verified the effectiveness of the robot through many experiments and questionnaires in the factory.

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

Room A

OS21 SWARM: Individuals and collectives in (artificial) living

Chair: Takashi Ikegami (University of Tokyo, Japan)
Co-Chair: Michael Crosscombe (University of Tokyo, Japan)

OS21-1 Fluctuations of the gene expression in populations of Tetrahymena thermophila

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

We analyzed the heterogeneity of gene expression states of thousands of Tetrahymena thermophila cells using single-cell RNA-seq (scRNAseq). Expression states of cells varied from cell to cell at any point in the cell cycle. In particular, cells in MAC-G1 and MAC-G2 were in various expression states, while cells in MAC-S and MAC-amitosis were somewhat closer in gene expression state. The expression level of genes of surface-immobilized antigens and transmembrane proteins was highly variable. These results indicated that the internal states of T. thermophila are diverse, and the expression of cell surface genes that might relate to communication with an environment including intercellular communication is highly variable.

OS21-2 Emergence of Individuality and the Self-organization of the Collective: The epsilon transducer analysis of an ant colony

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

Swarms of animals are studied in both micro and macro view by those with an interest in understanding how collectives of simple individuals can exhibit intelligent behaviours. Whilst the macro-level behaviours are easy to observe, the processes by which those behaviours emerge from the micro-level remain difficult to ascertain. In addition, large numbers of individuals in swarms make it technically difficult to accurately observe all of their behaviours and interactions. In this paper, we explore the tracking of 64 markerless Pristomyrmex punctatus ants and study the dynamics of the individuals in an attempt to understand the mechanisms which produce the collective behaviours of the colony. Using the epsilon-transducer reconstruction method, we infer finite-state machines which accurately reflect the observed dynamics produced by the hidden states of individual ants, in order to accurately predict changes in the behaviour of the colony.

OS21-3 Novelty Creation and Preferential Attachment in Hashtags' Evolutionary Dynamics

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

We study the evolutionary dynamics of hashtags, widely used in various web services as a social annotation to user-generated content. We consider hashtags as memetic actors in a specific form of cultural evolution, in which the vocabulary or their combination, and their popularity correspond to biological species and populations, respectively. The emergence of new hashtags and their spread within social groups has been modeled by some stochastic processes, showing a nice agreement with the empirical data on average. However, they are based on some unrealistic ideas; the emergence of novel hashtags is given as an external condition, and the structure of the hashtag's semantic space is given a priori and temporally fixed. We conduct the data analysis of a real photo-sharing service and discuss the validity of such assumptions.

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

30-minute open discussion

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

Room B

GS21 Mobile robots

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

GS21-3 Safety Controller Based on Control Barrier Functions using Quasi-Saturation Function

Satoshi Ueki, Takahiro Ikeda, Hironao Yamada
(Gifu University, Japan)

This paper proposes a safety controller based on control barrier function using a quasi-saturation function. The proposed controller can be used together with another trajectory tracking controller. The main purpose of the proposed controller is to enhance safety. However, the control input of the safety controller become to zero, so no input is generated that would interfere with the tracking controller when away from the obstacle. To facilitate the design of control barrier function, we propose the control barrier function using quasi-saturation function. Numerical simulations were performed to verify the effectiveness of the proposed safety control using CBFs with the quasi-saturation function. We demonstrated its effectiveness through numerical simulations on two-wheeled mobile robot.

GS21-4 Comparison Study for Very Low UAV Traffic Management between US, EU, and ISO

Yuichi Yaguchi
(University of Aizu, Japan)

This study aims to find the gap and development objective in constructing the unmanned aircraft traffic management system (UTM). Currently, FAA in the US proposed UTM ConOps v2 in 2020, and they are preparing version 3 to publish in 2022. EU has also already published an integrated air traffic management system named U-Space, and they provide some system function requirements and design regulations for developing UTM. On the other hand, ISO published some relative standards, and such ISO standards were previously published rather than ICAO. Still, the actual civil airspace authorization almost belongs to ICAO and authorities. From this background, this study surveys the functional structure and system requirement of each US and EU UTM concept and compares it with ISO standards. Also, we want to find the gap between each other with human out-of-the-loop (HOOTL) flight, such as autonomous or AI flight systems.

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

GS21-5 Sea urchin habitat density survey test in a coastal area using a μ-ASV

Makoto Morito[1], Junichiro Tahara[1], Shun Fujii[1], Hiroshi Matsunaga[2], Kenichiro Sato[2]
([1]Tokyo University of Marine Science and Technology, Japan)
([2]MARINE WORKS JAPAN LTD., Japan)

Currently, the phenomenon of ocean desertification, known as rocky shore denudation, is occurring all over the world. One of the causes is the feeding damage by sea urchins on seaweed beds called seagrass beds. In order to restore the seaweed beds, it is necessary to exterminate the proliferating sea urchins. We have developed an automated survey system that provides information on sea urchin habitat distribution and seafloor topography to streamline the extermination process. Based on a small surfboard-based ASV developed in our laboratory, an underwater camera and sonar are attached to the ASV, which navigates automatically to collect data. By analyzing the obtained data, we were able to obtain the habitat distribution of sea urchins and a topographic map of the seafloor, which are necessary for sea urchin extermination.

GS21-6 LiDAR-Theta*: Safe Path Planning Algorithm for Mobile Robots in Partially Observable Environments

Shunta Ishizuya, Takuto Sakuma, Shohei Kato
(Nagoya Institute of Technology, Japan)

For robot navigation tasks in partially observable environments, finding safe and short paths with limited information is critical. Because of its simplicity and guaranteed optimality, A* algorithm is adapted in most cases. The problem with A* algorithm is that the shortest path on the graph is most often not equivalent to the realistic shortest path. In addition, A* algorithm does not directly consider the size of the robot, so collisions must be considered differently. To solve these problems, we propose LiDAR-Theta*, which combines Theta* algorithm for finding any-angle paths and LiDAR collision check.We experiments in a simulator and real-world environments and confirmed that the proposed method is effective for robots to search for short realistic paths in partially observable environments.

GS21-7 Practice of Marine Education using Educational Underwater Vehicle “CHVIS”

Masayoshi Ozawa, Ryohei Onishi, Toshihiko Shimizu
(Kobe City College of Technology, Japan)

This is important goal for maritime section to continuously produce excellent human resources since Japan enact the basic low on ocean policy in 2007. By using underwater vehicle for education, it expand the target student to appeal from only maritime section to include robotics section. In this paper, through the utilization of educational underwater vehicle CHVIS, possibility of continuous implementation of education methods: from elementary school to college. CHVIS is utilized as attraction, programming device, training material and PBL subject in each phases. From the questionnaire results, maritime education through underwater vehicle appeals who have interest in programming, or robot.

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

Room C

OS18 ISBC: Quantum leaps after IIAS Complexity workshop

Chair: Nobuyasu Ito (RIKEN, Japan)
Co-Chair: Ken Naitoh (Waseda University, Japan)

OS18-1 Urban scale pedestrian simulation in Kobe City center

Daigo Umemoto[1], Maiko Kikuchi[2], Ayako Terui[2], Koutarou Abe[2], Ryuushi Shimizu[2], Katsuki Hirashige[2], Nobuyasu Ito[1], Itsuki Noda[3]
([1]RIKEN R-CCS, Japan)
([2]NTT DOCOMO co.ltd., Japan)
([3]Hokkaido University, RIKEN R-CCS, Japan)

We attempted to construct a digital twin of Kobe City center, from the aspect of pedestrian traffic simulation. Policy evaluation was conducted using traffic demand based on mobile phone population statistics provided by NTT DOCOMO, INC., CrowdWalk, an agent-based pedestrian simulator, and manually edited map obtained from Open Street Map to implement pedestrian signals. Background pedestrian population was estimated to be 6,509, and 10,000 evacuees are assumed in Shinko area. All of them are assumed to evacuate into Three stations, JR Sannomiya, Hankyu Sannomiya, and Motomachi. The evacuation time was originally simulated to be 25,685 s without any aided policies. As a policy, splitting the evacuation route reduced the evacuation time into 17,780 s which is 69% of the original. In addition, removing signals reduced the time furthermore into 9,550 s, 37% in total. Only removing signal resulted 12475~s, which is a reduction to 52 % of the original.

OS18-2 Engine-verseology: recent progresses for solving 100-year-old mysteries and engendering versatile technologies

Ken Naitoh, Tomotaka Kobayashi
(Waseda University, Japan)

Natural phenomena in the universe are mathematically and physically similar to those in a small mechanical engine: expansion flow during engine combustion and the Big Bang and breakup of flexible particles such as fossil fuel droplets, biological cells, biological molecules, stars, and subatomic ones. This idea of similarity and two mathematical principles on indeterminacy and stability posit new stochastic differential equation systems lying between the Boltzmann, Langevin, and Schroedinger ones for explaining the mysteries of subatomic, biological, mechanical, and cosmic engines and also bringing their solutions. This approach leads to seven interdisciplinary sciences and three technologies of a Big Bang-like engine (Fugine & Fusine), universal medicine against aging (Prognostic medicine), and an artificial ageless genius. In ISAROB 2018, we introduced the concepts and some concrete achievements. In the present report, we will show the recent further progresses on transition to turbulence, particle theory, Fugine, Fusine, prognostic medicine, and artificial genius.

OS18-3 Diverse behaviors from a simple dynamical map with the flooring function

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

We have studied some properties of a recently proposed simple dynamical map. Though it is a simple first-order map with no free parameters, it offers a wide variety of dynamical paths depending on the initial value. Some analytical results as well as numerical investigations are presented.

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

OS18-4 May's dream: the interactions in biological networks were random matrices after all

Kei Tokita
(Department of Complex Systems Science, Graduate School of Science, Nagoya University, Japan)

We present proof that the species interaction matrix calculated using the OTU (operational taxonomic unit) dynamics of the mouse intestinal microbiota corresponds to the random matrix assumed by May in 1972. The evolution of species interactions in complex and diverse ecosystems to follow a probability distribution governed by a limited set of parameters is demonstrated here for the first time. We also display complex OTU dynamics predicted to result in chaos in the murine intestinal microbiota through the replicator-mutator dynamics with estimated interactions.

OS18-5 On the density dependence of ecological and social contact rates

Takashi Shimada
(The University of Tokyo, Japan)

The empirical findings on the human-human contact rate is reviewed and its possible implication is discussed. The observed linear dependence of the contact term on the population, which makes the system invariant against the uniform change of the population (typical population size or density), is natural for the coarse-grained population dynamics model.

OS18-6 Analysis of Japanese Wikipedia using Self-consistent Metrics for Articles' Complexity and Editors' Scatteredness

Fumiko Ogushi, Takashi Shimada
(Osaka University, Japan)
(The University of Tokyo, Japan)

Wikipedia is a multilingual online encyclopedia. While all language versions of Wikipedia are examples of collective knowledge spaces that follow the same basic strategy, there are differences that reflect the nature of each community. Revealing the universal and individual aspects of the different communities is an interesting challenge. We analyzed the Japanese Wikipedia using our self-consistent metrics of the editor's scatteredness and the article's complexity based on the editor-article bipartite network constructed from the edit records. The basic characteristics of the editor-article network are the same as for Japanese and English Wikipedia. In addition, in Japanese Wikipedia, the top-ranking articles in the complexity measure are mainly those related to European history and politics. Such articles require much expertise to update them.

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

Room D

GS3 Artificial intelligence 2

Chair: Shudai Ishikawa (National Institute of Technology, Oita College, Japan)

GS3-1 Study of Waste Ratio Estimation Using Object Detection and Image Processing

Masato Nishii[1], Ryuichi Matoba[1], Shuntaro Mori[2], Keiichiro Yamamoto[1], Masamoto Tafu[1]
([1]National Institute of Technology, Toyama College, Japan)
([2]Toko Metal Co., Ltd., Japan)

Waste treatment facilities must sort, reduce volume, detoxify, and stabilize waste before it can be landfilled or incinerated. Sorting is the process of separating recyclable metals, bottles, cans, PET bottles, plastics, etc. from the waste. Currently, many sorting processes are performed manually to identify foreign materials that may be mixed in during or after sorting. If machines can identify foreign matter with greater accuracy than the human eye, recycling efficiency can be improved, leading to the creation of a recycling-oriented society. This research aims to improve sorting efficiency by using foreign object detection and image processing to estimate the proportion of each waste material from mixed waste images.

GS3-2 Object Detection of Ground Cover Plants Using SSD

Ryuki Hayashi[1], Ryuichi Matoba[1], Tomohiro Morizane[2], Takehide Nakagawa[3],
Masataka Ohde[4], Masamoto Tafu[1]
([1]National Institute of Technology, Toyama College, Japan)
([2]TOYAMA SHOJI CO.,LTD, Japan)
([3]Yatsuo Kogyo Co., Ltd, Japan)
([4]Greenproduce Co., Ltd., Japan)

In Okinawa Prefecture, the problem of red soil runoff from land areas to sea areas due to typhoons has been an ongoing problem since the 1950s. As a countermeasure, planting of ground cover plants (GCPs), which are effective in preventing soil runoff, has traditionally been planned. However, weeds that inhibit the growth of GCPs must be removed at the same time. When the area is large, there are limitations in identifying and removing weeds with the human eye. Therefore, this study examined a method to determine GCP cover using object detection. As a result, we succeeded in detecting weeds in the image with about 70% accuracy by visualizing the boundary between plants and soil in the image, calculating the area of plants and soil through image processing, and using SSD to identify plants and soil.

GS3-3 A Study of an Interview Evaluation System Considering Eye Gaze Information

Takeru Kobayashi[1], Ryuichi Matoba[1], Kaori Fukagawa[1], Akira Tsukada[1], Cooper Todd[2]
([1]National Institute of Technology, Toyama College, Japan)
([2]University of Toyama, Japan)

People communicate with others in social life. There are two types of communication: verbal communication (abbreviated as VC) and non-verbal communication (abbreviated as NVC). NVC refers to the exchange of information other than spoken language, which includes various types of information such as facial expressions, eye contact, posture, and gestures. It has also been reported that more eye contact in dialogue is associated with more persuasiveness and confidence. Based on these backgrounds, we wondered if it would be possible to evaluate not only spoken language but also nonverbal aspects of the interview using information on eye movement during the interview. In this study, we aim to create an interview evaluation system that evaluates eye gaze behavior included in NVC. As an evaluation of our experiment, we compared the calculated percentage of eye gaze with the actual evaluation values obtained by the interviewer's scoring of the subject's interview video.

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

GS3-6 Development of OD Estimation System using Human Tracking

Tsubasa Nishiura[1], Soichiro Yokoyama[1], Tomohisa Yamashita[1], Hidenori Kawamura[1], Yoshimi Sato[2], Rei Hasegawa[2], Miyuki Hirasawa[2]
([1]Hokkaido University, Japan)
([2]C's Lab Co., Ltd., Japan)

In recent years, the balance of payments of bus services in Japan has been worsening, and OD (Origin-Destination) data that aggregates the bus stop sections used by each passenger is needed to establish efficient schedules and routes. In this study, we propose and validate a method for estimating the number of bus passengers with technologies of object detection, tracking, and a matching in order to estimate OD data of bus passengers with high accuracy. As a result of applying our proposed system to real bus passengers' images, we confirm the accuracy of OD data and discuss how to improve our system.

GS3-7 Smart House System for Safety of Elderly Living Alone Based on Camera and PIR Sensor

Yichen Wang[1], Yutian Wu[1], Shuwei Zhang[1], Harutoshi Ogai[1], Katsumi Hirai[2], Shigeyuki Tateno[1]
([1]Waseda University, Japan)
([2]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. According to the above problems, this paper designs a safety system for the elderly living alone based on low-cost sensors and Raspberry Pi, to help document the life of the elderly and reduce the concerns of relatives.

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

Room E

OS12 AROB: System Sensing and Its Applications 1

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

OS12-1 Comparison of Relationship Between Pectoral Fin Movement and Fin Shape Based on Force Index for Fish Type Balloon Robot

Naoki Kagiya, Masafumi Uchida
(The univ. of electro-communications, Japan)

Balloon robots are composed of a balloon body, which is filled with helium to provide buoyancy. Fish type balloon robots (FBR), in particular, incorporate caudal and pectoral fin motion as a propulsion mechanism, which can be combined to realize complex motions. However, the pectoral fin motion has a disadvantage that the propulsive force generated by the pectoral fin motion is small, and it is necessary to improve the propulsive force. Since the weight of an FBR is limited, it is necessary to select a fin that can obtain a larger propulsive force with the same weight. In this report, pectoral fins of different shapes and materials are created and the propulsive force generated by various fin movements is measured. Then, the results are compared and the most suitable fin for FBR is selected.

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

OS12-2 Research of Body Sway Caused by Matrix-Shaped Tactile Stimuli on Dorsum of Foot

Daisuke Kobayashi, Tsubasa Sasaki, Takeshi Hayashida, Masafumi Uchida
(University of Electro-Communications, Japan)

When problems occur in these functions due to acquired causes such as aging or illness, problems arise in the postural control function, leading to accidents and injuries. In this study, a tactile stimulator was developed for the purpose of guiding body movements to assist in postural control, and a method of guiding the body using MSTS patterns presented on the dorsal surface of the feet was investigated. Body sway induced by tactile stimuli was measured by tracking markers on the top of the head. The results suggest that tactile stimulation of the dorsal foot can induce body sway in a specific direction.

OS12-3 Study of Character Input Using Mounted Sensor in Smartwatch

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

Conventional methods for smartwatches include touch and voice input. However, these input methods have several problems; therefore, a more comfortable input method is required. Herein, we propose an input screen design and operation as a new input method and investigate its usefulness as a character input method. Specifically, we propose a circular keyboard as the input screen design and screen touch and gesture inputs as input actions. An experiment was conducted with four subjects to measure the input speed and error rate. The results show that the number of character inputs per minute is 41.5, and the error rate is 2.1% when the input action is touch input only, and 31.7, and the error rate is 2.5% when the input actions are touch input and gesture input. The results reveal that the proposed method is fast, and the rate of erroneous input is low, indicating its usefulness as a novel character input method for smartwatches.

OS12-4 "Ask AnyOne" system - A Q&A bridge to encourage research collaborations within an organization

Masanori Shiro[1], Ayumu Miyakawa[1], Tsukasa Fujita[1], Masanao Ochi[1,2],
Yuichi Iwasaki[1], Tetsuo Yasutaka[1]
([1]AIST, Japan)
([2]Univ. of Tokyo, Japan)

With the goal of resolving concerns and problems in promoting research as efficiently as possible, we proposed and implemented a friendly system named 'AAO' (Ask AneOne), to get researchers acquainted with each other within a large organization. We designed the system with low operational costs, user friendliness, and information security in mind. We actually piloted this system in a small group of less than 100 researchers for about six months. We report on the effectiveness of the system and the problems we found as a result. In particular, we analyzed questions that were easy to answer and questions that were difficult to answer.

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

OS12-5 Comparison of Head-Mounted Display versus Four-sided Screen Displays on Passive Viewing Experience for Panoramic Video

Hirotoshi Asano[1], Junko Ichino[2], Yusuke Tokunaga[3], Masayuki Wada[3]
([1]Kogakuin University, Japan)
([2]Tokyo City University, Japan)
([3]Kagawa University, Japan)

This study investigates how user experience is affected during the viewing of panoramic videos in both virtual reality (VR) environments and non-VR environments. In particular, we investigate the differences between the effects of two viewing environments on the physiological and psychological, memory aspects of the users. We conducted experiments and compared three display-type conditions: a head-mounted display (HMD), four-sided screen display (SCREEN), and SCREEN with a narrow field of view when using goggles (SCREEN-GOGGLE). We found that the SCREEN users remembered the content of the videos more accurately than the HMD users. These results are consistent with the nasal skin temperature results, suggesting that, compared to SCREEN users, HMD users had a lower mental load.

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

Room F

GS20 Manipulator

Chair: Fusaomi Nagata (Sanyo-Onoda City University, Japan)

GS20-1 Development of Universal Gripper with Viscous Variable Fingertip

Takeshi Nishida
(The University of Kitakyushu, Japan)

We developed a universal gripper for industrial robots using reformed magnetorheological (MR) fluid and consisting of two fingers able to grasp small objects. The fingertips are composed of an elastic membrane enclosing the reformed MR fluid. The fingers have a diameter smaller than 25 mm, and a magnetic flux circuit structure for changing the magnetic flux density in less than 0.1s by 0.24 T or more. A rotation mechanism of the permanent magnet allows the control of the solidification of the fingertips. Several experimental results show the effectiveness and performance of the developed universal gripper.

GS20-2 A Study of the Indirect Haptic Feedback Device Using Magnetic Force

Fumiya Sakaguchi, Mengchun Xie, Mitsuki Nakashima, Yukinori Shimura
(Department of mechatronics engineering course, Advanced Engineering Faculty, National Institute of Technology(KOSEN), Wakayama College, Japan)

In recent years, Haptic Feedback Devices (HFD) that can simulate haptic sensations have been used in Extended Reality (XR) technology, allowing users to experience virtual environments. However, conventional Direct HFDs either touch the hand directly or are attached to the human body, which can cause discomfort and interfere with finger movements. In this study, we propose a device that uses magnets to indirectly provide haptic feedback to resolve the sensory discomfort caused by direct feedback devices. For indirect HFD, the mechanical energy required for feedback is obtained from magnetism. To verify the feasibility of this proposal, we created an HFD that reproduces the weight of fried rice that does not exist by combining a Chinese wok and the device, and conducted a questionnaire survey of the participants to evaluate its usefulness.

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

GS20-3 Local 3D measurement with a mobile manipulator in a wide-area space

Hayato Hagiwara[1], Yoshimasa Nakamura[1], Yoshiaki Yamazaki[2]
([1]Tokyo Metropolitan Industrial Technology Research Institute, Japan)
([2]Meisei University, Japan)

In factories and construction sites where 3D information is unknown or scarce, 3D measurement is used to reconstruct or inspect aging equipment. To solve this problem, we proposed autonomous 3D measurement by a mobile manipulator equipped with a 3D sensor for the vicinity on the end-effector. For a mobile manipulator to perform autonomous 3D measurement, it must be able to detect and measure blind spots that are not visible from the front. We developed and tested a mobile manipulator with the ability to detect and measure blind spots. In our experiments, we conducted measurement experiments on a rectangular object. As a result, this mobile manipulator was able to detect and measure blind spots autonomously.

GS20-4 Developing an electroadhesive robot hand for grasping various objects including a sheet of paper

Kanta Hayashida, Hideaki Itoh, Hisao Fukumoto, Hiroshi Wakuya
(Electrical and Electronic Engineering Course, Department of Science and Engineering, Graduate School of Science and Engineering, Saga University, Japan)

Grasping a sheet of paper is an important but difficult task for robots because a sheet of paper is thin, soft, and fragile. In this study, we develop a novel robot hand that can grasp a sheet of paper as well as other objects of various shapes. The developed hand has two fingers with which it can grasp various objects. Furthermore, interdigital electrodes that are embedded at the end of a finger attract a sheet of paper when a high voltage is applied, which enables a safe grasping of a sheet of paper. The gripper was easily created using a 3D printer. Experiments show that our gripper can grasp a sheet of paper as well as an eraser.

GS20-5 The linearized finite screw deviation model of the multi-axis manipulator

Jaehyung Kim, Min Cheol Lee
(Pusan National University, Korea)

This article proposes a novel finite screw linearization method for calculating a non-conventional deviation case in finite screw theory. In previous research, the quasi-differential function of finite screw theory has been conducted for serial manipulator calibration. However, this method requires continuous trajectory for calibration. On the contrary, the proposed method enables the calculation of the deviation from the successive finite screw. This makes the proposed method enables the calibration of the successive manipulator without continuous trajectory by the proposed method. In the simulation calibrating seven degrees of freedom manipulator, the proposed method validated that enable of the successive finite screw deviation, which can be applied to a serial manipulator calibration technique using the proposed method.

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

GS20-6 SMG clinger: development of a heat-dependent softness-switching gripper based on filamentous gels

Hibiki Aoyama, Jun Ogawa, Yosuke Watanabe, Masaru Kawakami,
MD Nahin Islam Shiblee, Hidemitsu Furukawa
(Yamagata University, Japan)

There is a growing demand for soft robotic hands suitable for grasping brittle and fragile objects. Several soft gripper studies have reported the ability to grasp soft and fragile objects without damage. Soft gripper studies are essentially a one-to-one correspondence between the object and the gripper. This study proposes a one-to-many correspondence entangling and grasping mechanism by self-organized morphological adaptation with only a string-like rigid/soft switching gripper without complex grasping strategies. Our soft gripper employs an elongated shape memory gel that can switch between rigid and flexible, adhesive and non-adhesive at different temperatures. Through grasp validation, we achieve one-to-many grasping without using detailed grasping strategies or precise control.

GS20-7 Soft Manipulator inspired by octopi: Object grasping in all anatomical planes using a tendon-driven continuum arm

Klara Bezha, Kazuyuki Ito
(Hosei University, Japan)

In this paper, we focus on the development of a soft continuum arm manipulator inspired by the morphology of octopi and their intelligent behavior. The proposed arm is mainly composed of soft silicone rubber material, offering high levels of arm deformation and flexibility of movement. Tendon-like actuator strings are incorporated inside the arm to generate motion. Using a pulling mechanism of the actuating strings, the arm mimics octopi's behavior by performing 5 different motions in all 3 body planes: Lateral right and lateral left motion in the sagittal plane, ventral and dorsal motion in the coronal plane, and helical torsion motion in the transverse plane. The proposed soft arm can grasp, move, and lift various hard and soft objects, without previous sensing nor the usage of suction cups, making it a powerful low-complexity tool for object manipulation in complex environments.

January 26 (Thursday), 12:35-14:45

Room A

OS20 SWARM: Fusion of biological and engineering approaches for swarm design

Chair: Shun-ichi Azuma (Kyoto University, Japan)
Co-Chair: Toshiyuki Yasuda (University of Toyama, Japan)

OS20-1 Survive as a Collective: A Simple Network Model for Altruistic Social Interactions of Vampire Bats

Takeshi Kano, Shokichi Kawamura, Taishi Mikami, Akio Ishiguro
(Research Institute of Electrical Communication, Tohoku University, Japan)

Vampire bats, which die within three days if food is unavailable, can survive for over 10 years by developing a highly sophisticated social community in which they share food with each other. This food-sharing behavior occurs not only among blood relatives but also among unrelated individuals through self-organizing social relationships based on grooming behavior. Determining the mechanisms for generating food-sharing communities in vampire bats will contribute to the design of new engineering systems with high survivability. In this study, we propose a simple network model to extract the essence of the interrelation between food sharing and grooming behaviors and demonstrate through simulations that high survivability can be achieved under appropriate food sharing and grooming behaviors.

January 26 (Thursday), 12:35-14:45

OS20-2 Biological-like swarm systems designed from a non-biological approach

Yuichiro Sueoka
(Osaka University, Japan)

Swarm robotics is engineering in which a single individual with limited capabilities exhibits behavior similar to that of nature as a swarm through interactions among robots and with the environment. This paper reports on the effectiveness of an AI technology-based approach to swarm system design, rather than an organism-inspired approach to the emergence of functions. In particular, we will discuss the current status and issues of swarm systems beyond the frameworks of biology and engineering, taking cooperative transport by swarm robots as a subject and describing examples of system designs that provide robustness, scalability, and flexibility.

OS20-3 Evolutionary Acquisition of Collective Exploration Behavior in Heterogeneous SRS: Investigation on Neural Controller Configuration

Asad Razzaq[1], Minato Takizawa[1], Tomohiro Hayakawa[2], Toshiyuki Yasuda[2]
([1]Graduate School of Science and Engineering, University of Toyama, Toyama, Japan)
([2]Faculty of Engineering, University of Toyama, Toyama, Japan)

The Swarm Robotics System (SRS) is a type of system using multiple robots inspired by the self-organizing ability 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. This approach often deals with homogeneous SRS, i.e., a swarm in which all robots have the same ANN controller. In this study, we attempt to generate swarm behavior by robots with heterogeneous multiple ANN controllers, aiming to realize a high degree of role sharing by different behaviors in a swarm. The evolutionary process and swarm behavior in a cooperative exploration task is investigated. Results show that the ER approach with heterogeneous controllers performed significantly better than the homogeneous one.

OS20-4 Distributed Object Position Estimation and Localization with Noisy Relative Measurements

Ryo Asai, Kazunori Sakurama
(Kyoto University, Japan)

In this study, we tackle the problem of object position estimation and localization of multi-agent systems. We have two objectives. The first is to obtain a consistent estimate of a target object position. The second is to improve self-localization of robots. We formulate the two objectives as an optimization problem with a cost function derived from the maximum likelihood method. To solve the optimization problem in a distributed manner, we first reformulate it into a consensus constrained optimization problem. Then we employ the method of Lagrange multiplier and propose gradient-based dual ascent algorithm. The proposed method can be implemented without external information from GPS, motion capture systems, and so on.

OS20-5 Control of Multi-robot Systems Using A Future Map

Aki Matsutaka[1], Shun-ichi Azuma[2], Ryo Ariizumi[1], Toru Asai[1]
([1]Graduate School of Engineering, Nagoya University, Japan)
([2]Graduate School of Informatics, Kyoto University, Japan)

In a smart warehouse, efficient control of mobile robots is required. This paper improves the recently proposed method based on a future map in terms of the computational time of generating a route. In this system, each robot is controlled by a receding horizon policy, where a map server saves the scheduled route of each robot and each robot determines its optimal route by reading the information from the server. This paper proposes a new method for generating an optimal route based on a spatio-temporal graph, which contains the future trajectories of robots. The effectiveness is verified by numerical simulations.

January 26 (Thursday), 12:35-14:45

OS20-6 Proposal of efficient shepherding controller with adjusting gains according to the navigation phase

Riku Tada, Yusuke Tsunoda, Teruyo Wada, Koichi Osuka
(Osaka University, Japan)

In recent years, swarm robot systems inspired by organisms' collective behavior have been studied extensively. Among control techniques for swarm robots, we focus on the "shepherding system," in which a small number of agents (shepherds) drive multiple agents (sheep). This system improves the movement efficiency of group robots that perform various tasks. While various controllers of the shepherding system have been proposed in previous studies, this study focuses on the FAT controller proposed by Tsunoda et al. In this research, we conducted a simulation-based analysis of FAT for the case of a shepherd guiding multiple sheep. The results of guidance performance suggested two situations in which the ratio mentioned above should be large or small during guidance. Furthermore, we designed a new shepherding model in which the shepherd adjusts each action's gain (fixed in the conventional FAT) during navigation.

OS20-7 Designing a Swarm Behavior Rule to Create a Functional Structure Keeping a Constant Temperature

Hiroaki Kobayashi[1], Takuma Miyamoto[1], Tomohide Yabuki[2], Shunsuke Shigaki[3], Shigeto Dobata[4], Ryusuke Fujisawa[5]
([1]Department of Creative Informatics, Graduate School of Computer Science and Systems Engineering, Kyushu Institute of Technology, Japan)
([2]Faculty of Engineering Department of Mechanical and Control Engineering, Kyushu Institute of Technology, Japan)
([3]Department of System Innovation, Osaka University, Japan)
([4]Department of General Systems Studies, Graduate School of Arts and Sciences, The University of Tokyo, Japan)
([5]Department of Creative Informatics, Computer Science and Systems Engineering, Kyushu Institute of Technology, Japan)

Swarms of social insects such as termites are known to behave as autonomous decentralized systems with no central control system. In an autonomous decentralized system, each individuals decides their behavior using only local information surrounding them. On the other hand, the swarm can accomplish complex and diverse tasks as a whole. Such properties are expected to be applied to various fields including robotics. In particular, the cooperative behavior of termites during nest construction is an example of a complex task. Mounds produced by termites are known to show a very complex structure and multifunctionality. In this paper, we propose a behavioral rule model in which termites use temperature information. Then, we show its robustness to changes from the outside environment by computer simulations. In addition, we discuss whether temperature information is used as a behavioral rule for termite mound construction.

OS20-8 Cooperative Transportation of an Object with a Nonholonomic Velocity Constraint by Multiple Decentralized Autonomous Robots

Yuto Fukao[1], Takahiro Endo[1], Fumitoshi Matsuno[1], Yoshihiro Morimoto[2], Takumi Koshimoto[2], Daisuke Mizuno[2]
([1]Kyoto University, Japan)
([2]Mitsubishi Electric, Japan)

In this study, we propose a method for the cooperative transportation of an object with two parallel passive wheels by multiple distributed autonomous robots. The object with the wheels to be transported does not slide along the axle direction, so it is a nonholonomic velocity constraint. We design a distributed cooperative transportation controller considering the nonholonomic constraint of the object with the wheels. Each robot moves and pushes the object with the wheels according to the obtained target velocity by the controller and can transport the object to the desired position and orientation. Furthermore, the effectiveness of the proposed method was verified by dynamic simulations.

January 26 (Thursday), 13:00-14:30

Room B

OS8 AROB: Recent Natural Language Processing Models and Applications

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

Invited Talk 1 Low-resource languages and recent deep learning technologies

Kiyota Hashimoto (Prince of Songkla University, Thailand)

See page 14

OS8-1 Coherence analysis of clauses for argument mining from assembly minutes

Yo Amano[1], Wakana Hashimoto[1], Hiroto Yano[1], Kazuhiro Takeuchi[2]
([1]Graduate School of Engineering, Osaka Electro-Communication University, Japan)
([4]Faculty of Information and Communication Engineering, Osaka Electro-Communication University, Japan)

The deliberations and discussions of each member of the Diet or local assemblies are recorded in the meeting minutes. The minutes of publicly available meetings enable us to confirm the background of the budget proposal and how the budget was discussed and approved. However, reading and interpreting the minutes requires a considerable amount of effort. In addition, unlike a text written by a single author, meeting minutes describe the process of concluding discussion and disagreement among several people. In this paper, we examine the analysis of arguments in the meeting minutes using a large-scale language model, aiming to support general users in utilizing the minutes.

OS8-2 An improved method for multi-label classification methods using deep neural language models with ensemble learning

Yuuki Kusumoto, Makoto Okada, Naoki Mori
(Osaka Metropolitan University, Japan)

In this paper, we propose a deep language model to improve the conventional method of classifying Japanese review texts published by travel agencies into multi-label. In today's business world, the need to utilize a large amount of text data is increasing, and automating the assignment of multiple labels to each text and improving the accuracy of the assignment is a major challenge. However, it is not easy to classify texts belonging to multi-label, and therefore, improvement of conventional methods is required. Therefore, we proposed a deep language model that improves the classification of text data with multiple labels by using ensemble learning to create specialized classifiers for each label and integrate them and confirmed the effectiveness of the proposed model.

January 26 (Thursday), 13:00-14:30

OS8-3 Caption Generation with Pre-defined Attention

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

Caption generation is one of the multimodal learning tasks and deep learning contributes to the improvement of precise caption generation. Generally, a human annotator generates multiple captions for an image based on his/her interest but caption generation systems cannot generate multiple captions. The system is constructed as a function with one-to-one correspondence and can make only a caption essentially. We have developed a topic-bound caption generation system and implemented the system that generates multiple captions according to a focal point in an image. However, there is still room for improvement in the previously proposed system. In this paper, we aim to improve the accuracy of predicted captions from the viewpoint of Rouge scores and employ ResNext instead of VGG19. Our proposed caption generation system is constructed with neural network systems; ResNeXt, an object detection system, and Transformer, a neural language model. ResNeXT extracts image features from an image and the image features are employed for caption generation in the neural language model. The neural language model is constructed with Decoder-based Transformer, which accepts background knowledge as a memory. The focal point emphasizes a specific object in the image and controls caption generation based on the specific object. In evaluation experiments, we used MSCOCO dataset and make focal points for MSCOCO dataset. We trained the proposed system and predict untrained data with the trained system. The proposed system is superior to the previously proposed system from the viewpoint of both Rouge scores and topic word inclusion rates.

OS8-4 Topic-bound News Summarization with Neural Language Model

Taiki Yamanaka[1], Hidekazu Yanagimoto[2]
([1]Osaka Prefecture University, Japan)
([2]Osaka Metropolitan University, Japan)

Conventional neural network-based summarization systems could not generate multiple summaries from a single article. However, humans can generate multiple summaries from a single article, depending on the topic of interest. To realize this feature, we developed the system to control the summaries generated by giving topic words to the system. Specifically, we made it possible to vary the summaries generated by applying an attention to the topic word. We then evaluated the summaries generated to see if they were based on the topic words. The results confirmed that the summaries were generated according to the topic words, and we also confirmed that 60% of the summaries contained the topic words. In future work, we will be able to increase the complexity of the model to achieve higher accuracy and to find the optimal parameter settings.

January 26 (Thursday), 13:00-14:00

Room C

OS16 ISBC: Complex information

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

OS16-1 Behavior Comparison in Game of Chicken with Cards Based on Bayesian Inference Models

Takuto Sekine, Kazuto Sasai
(Ibaraki University, Japan)

In recent years, as AI has been widely introduced into society, we have more and more opportunities to use it in our daily lives. In order for people to engage with AI in a co-creative way, it is important to have an interaction that is not only based on logic, but also on creative thinking. In this study, we analysed the results of interactions between humans and robots and between humans and robots using Card Chicken Race (CCR), a card game based on the Chicken Race model. We used random, Bayesian inference and Bayesian inverse Bayes (BIB) inference as strategies for robot actions. The results showed that strategy changes and outcomes typical of person-to-person games were also detected in BIB inference, indicating creativity

January 26 (Thursday), 13:00-14:00

OS16-2 Gaze Trajectory Prediction Based on Inverse Bayesian Inference

Ryuichi Kubota, Kazuto Sasai
(Ibaraki University, Japan)

Friston et al. proposed a predictive coding theory that explains the human cognitive basis through a predictive model, and Bayesian theory is used in this predictive model. However, in human gaze behavior, tiny eye movements and large linear movements coexist, and Bayesian inference, in which information shrinks as learning progresses, cannot explain large linear movements. Therefore, it was confirmed that the learning adaptation process of the emergent prediction model proposed by Gunji et al. and human gaze behavior share a common property called Levy walk. Based on the above, we hypothesized that it would be possible to predict human eye movements by extending the emergent prediction model to a two-dimensional level. Based on this hypothesis, we compared the prediction performance with existing methods.

OS16-3 Pose Estimation by Using Computer Graphics Datasets of Heavy Machine for Dismantling Automobile

Koshiro Murakami, Hideo Miyachi
(Tokyo City University, Japan)

Image processing using deep learning has been applied to many methods, such as pose estimation, object detection and remote sensing. In recent years, a lot of pose estimation methods are studied, but most of them is for human. However, pose estimation can be applied not only human but also other object such as heavy machine. In this study, we propose the pose estimation method for heavy machines for dismantling automobile by using computer graphics datasets. In the automotive disassembly process, improving work efficiency is very important, but there is no method for quantifying work efficiency. By applying pose estimation using deep learning to heavy machines, the tracking of their movements can be used to improve the efficiency of operations. However, deep learning requires a huge amount of data. The creation of a unique dataset is a major issue, as it is required the collection of a sufficient amount of data and the huge amount of data annotation. To improve the issue, we created a dataset by computer graphics images of heavy machines. Computer graphics is parametric data, so it can create a lot of data, and annotate data more easily. At the first step to using a computer graphics dataset, we tried to estimate the pose of miniature heavy machines. As a result, it can estimate the pose of miniature heavy machines correctly.

OS16-4 Examples of VR use as an alternative to social studies tours

Kodai Tsushima[1], Hideo Miyachi[2]
([1]EBARA Corporation/Tokyo City University, Japan)
([2]Tokyo City University, Japan)

The outbreak of Covid-19 has affected school education in various ways. The 2020 school closure is still fresh in our memories as a particularly symbolic event, but various other activities in school education have also been cancelled. Among these, one activity that has been increasingly cancelled is the social studies field trip. This case study introduces a VR tour of the Kinugawa River upper stream dam cooperation facilities using a virtual tour at Kinugawa Elementary School conducted by the authors in November 2021, and also reports on the results of a questionnaire survey of the students. The purpose of this report is to contribute to the consideration of the use of VR in school education with a view to the after-Covid-19 era.

January 26 (Thursday), 13:00-14:45

Room D

GS4 Artificial intelligence 3

Chair: Jiann-Shing Shieh (Yuan Ze University, Taiwan)

GS4-1 Creating the Natural Datasets by the Clothing Extraction Module and it Adopts to Virtual Try-On System

Takumi Ikenaga, Shudai Ishikawa
(National Institute of Technology, Oita College, Japan)

Virtual try-on aims at transferring a target clothing image onto a reference person. Previous studies usually focus on preserving the character of a clothing image when warping it to an arbitrary human pose. However, this study has not considered the user's real environment, and the current virtual try-on cannot support input from webcams, smartphones, and other devices. In this paper, we propose creating the natural datasets by clothing extraction module and it adopts to virtual try-on. The clothing extraction module makes it possible to create datasets simply by taking a person's image. By training a virtual try-on on natural datasets and incorporating person detection and background removal, a virtual try-on that can respond to the user's real environment is expected to be realized. In the experiment, we trained on natural datasets and compared try-on results. As a result, it was found that more data is needed to improve try-on accuracy.

GS4-2 A novel algorithm for Thunderstorms prediction in Thailand using an Artificial neural network and the ARIMA Technique

Krongkhwan Paksonisit[1], Apichit Rittikul[2], Khanabhorn Kawattikul[3],
Preut Thanarat[4], Chatklaw Jareanpon[1]
([1]Polar Lab, Department of Computer Science, Faculty of Informatics Mahasarakham University, Thailand)
([2]Meteorologist, Thai Meteorlogical Department, Thailand)
([3]Department of Information Technology, Faculty of Social Technology, Rajamangala University of Technical Tawan-ok, Thailand)
([4]Department of Media and Information, Faculty of Informatics Mahasarakham University, Thailand)

Nowadays, the global climate is changing due to the occurrence of thunderstorms, which cause serious damage. The K index (KI), which helps predict thunderstorms in Thailand, can evaluate the potential for atmospheric rise caused by convection and heavy rain. KI can only be predicted in advance, 6-8 hours. Therefore, this study will provide a novel algorithm for KI or thunderstorm prediction of the next day. Using time series analysis, the factor affecting thunderstorms is the upper air; Temperature 500, 700 and 850 hPa and Temperature Dewpoint 700 and 850 hPa. From the five factors, the four appropriate prediction factors are coming from ARIMA (Autoregressive Integrated Moving Average), and the last one factor is came from LSTM (Long Short-Term Memory), After that, the KI prediction will calculate from these factors. The output from this research evaluated by RMSE and MAPE shows the appropriated performance that the value is less than 10. It can probably apply for aviation business.

GS4-3 A Study of Robots' Emotional Expressions Using IAPS, an Object Detection Algorithm, and a Caption Generation Algorithm

Yusuke Kimata, Duk Shin, Yuta Ogai
(Tokyo Polytechnic University, Japan)

The IAPS (International Affective Picture System) is widely used in psychological experiments and has accumulated knowledge about people's emotions when they look at photographs. Using this knowledge, we believe that we can make a robot behave as if it has emotions by designing how it reacts to the object detection results from camera input. We used YOLO as an object detection algorithm and CATR as a caption generation algorithm. Since the IAPS labels and the labels of each algorithm differ, we created a table to compare them and examine whether they discriminate. In the future, we plan to use the results of this research to make humanoid robots such as Pepper move based on emotional responses to camera input.

January 26 (Thursday), 13:00-14:45

GS4-4 Self-Generation of Reward by Logarithmic Transformation of Multiple Sensor Evaluations

Yuya Ono[1], Kentarou Kurashige[2], Afiqe Anuar Bin Muhammad Nor Hakim[1], Yuma Sakamoto[1]
([1]Division of Information and Electronic engineering, Muroran Institute of Technology, Japan)
([2]Department of Information and Electronic Engineering, Muroran Institute of Technology, Japan)

Although the design of the reward function in reinforcement learning is important. It is difficult to design a system that can adapt to a variety of environments and tasks. Therefore, we propose a method to autonomously generate rewards from sensor values, enabling task- and environment-independent reward design. Under this approach, environmental hazards are recognized by evaluating sensor values. The evaluation used for learning is obtained by integrating all the sensor evaluations that indicate danger. Although prior studies have employed weighted averages to integrate sensor evaluations, this approach does not reflect the increased danger arising from a higher amount of more sensor evaluations indicating danger. Instead, we propose the integration of sensor evaluation using logarithmic transformation. Through a path learning experiment, the proposed method was evaluated by comparing its rewards to those gained from simple reinforcement learning and prior approaches.

GS4-5 Application of Game Balancing Method Based on Deep Reinforcement Learning to Pokemon and its Evaluation

Ryohei Okamura, Atsuo Ozaki
(Osaka Institute of Technology, Japan)

We propose a method for adjusting the game balance in competitive games such as Pokémon so that many people can enjoy the game more. Conventional methods have a problem that they do not take into account the strategy and depth of competitive games. Therefore, we propose a method for adjusting the game balance that takes into account not only the winning percentage but also game theory. Experimental results show that the proposed method can improve the parameters used in existing competitive games to make them more enjoyable for people. This suggests that game balancing of competitive games, which tends to become increasingly complex, can be automated.

GS4-6 Some Schedules of Reverse Quantum Annealing for Knapsack Problem

Yudai Tanaka, Michiharu Maeda
(Fukuoka Institute of Technology, Japan)

Quantum annealing attracts attention as a new computing technique and is expected to solve combinatorial optimization problem with high accuracy and speed. It has been known that combinatorial optimization problem can be formulated in the Ising model. Quantum annealing utilizes the Ising model and explores the ground state. The final state is considered as a solution derived by quantum annealing. Since quantum annealing is a heuristic approach, we provide an approximate solution for combinatorial optimization problem. For quantum annealing, reverse quantum annealing has been suggested and can be applied to the p-spin model (p = 3) to improve the success probability over forward quantum annealing. Reverse quantum annealing which has a classical state as the initial state increases the magnitude of transverse field and decreases after time tinv, while forward quantum annealing decreases gradually. We examine some schedules of reverse quantum annealing for knapsack problem. As a result, under certain conditions, reverse quantum annealing shows an increase in the probability of success compared to forward quantum annealing.

January 26 (Thursday), 13:00-14:45

GS4-7 Non-contact Estimation of Photoplethysmography Signal based on Facial Videos using Multi-task Learning

Yuki Nakazawa, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

In 2019, 55.4 million people have died worldwide and approximately 44% of them were due to noncommunicable diseases. As we can prevent them in advance, monitoring of person's physical and mental health conditions is strongly desired. In this study, we propose a deep learning model to estimate the photoplethysmography signal from facial videos using only a web camera. We can use the peak-to-peak length of this signal to calculate heart rate and heart rate variability. In addition, non-contact estimation enables the elimination of discomfort caused by contact-type devices. We evaluate whether the estimated signal has an accurate peak position and discuss its validity.

January 26 (Thursday), 13:00-14:00

Room E

OS13 AROB: System Sensing and Its Applications 2

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

OS13-1 Development of SSVEP-BCI with Less Flickering Sensation

Sodai Kondo, Hisaya Tanaka
(Kogakuin University, Japan)

A steady-state visual evoked potential (SSVEP), one of the potentials used in a brain-computer interface (BCI), is mainly evoked through a blink frequency stimulation below 20 Hz. SSVEP-BCI is noise tolerant, but the flickering sensation caused by flashing stimuli puts users at risk for photoepilepsy and stress. In this study, we evaluated the stress of 10 to 70 Hz stimuli to determine the degree to which subjects perceive a flickering sensation. We also proposed the SSVEP-BCI with 26–40 Hz, 56–70 Hz, and eight inputs and compared their performance. SSVEP-BCI of 26–40 Hz had 96.94% accuracy and an information transfer rate (ITR) of 55.32 bits/min, and SSVEP-BCI if 56–70 Hz had 56.94% accuracy and an ITR of 20.56 bits/min. After comparing the SSVEP-BCI performance in this study with the flickering sensation caused by different frequencies, results reveal that a stimulus frequency of 30–38 Hz was recommended.

OS13-2 Performance Improvement of 3D-CNN for Blink Types Classification by Data Augmentation

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

Eye blinking can be classified into conscious (voluntary) and natural (involuntary) blinking. When developing a blink input interface, these blink types must be automatically classified. We previously proposed a method for blink type classification using a 3D convolutional neural network (3D-CNN). This 3D-CNN model takes an input image sequence including the periocular area and outputs a predicted probability that determines three classes: "voluntary blinking," "involuntary blinking," and "not blinking." In our previous study, we found that the bias in the position of the eye region in the input image is a factor that reduces the classification accuracy. To address this problem, we employ data augmentation to improve the accuracy of blink type classification. Augmented data were generated by shifting 5 or 10 pixels in the horizontal and vertical directions. Comparing the new results with those obtained without using data augmentation, it was confirmed that classification accuracy was improved.

January 26 (Thursday), 13:00-14:00

OS13-3 Objective Assessment of Self-Study Attitude among High School Students Using - Relationship between Blink Rate and Learning Contents -

Hiroki Horiuchi, Hisaya Tanaka
(Kogakuin University, Japan)

This study objectively ‘evaluates students’ attitudes toward learning, especially their attitudes toward self-study, using biometric technology. In Japanese secondary education, the evaluation of interest, motivation, and attitude, commonly used in learning evaluation, is based on subjectivity, that is, from the teacher’s perceptions. In many cases, points are given or deducted only for major actions that everyone can agree on, and a uniform evaluation is given to everyone else.. Therefore, we considered that adopting an objective evaluation that is based on number of blinks, head movements, and brain waves, rather than relying solely on the teacher’s memory, would lead to fairer grades and improve teachers’ outputs. Here, we report on the degree of concentration in self-study in relation to number of blinks.

OS13-4 Eye-gaze Detection based on 3D Convolutional Neural Network

Chaofan Zhang, Kiyohiko Abe
(Tokyo Denki University, Japan)

Eye-gaze input device is an extremely useful tool for people who have physical disabilities and experience difficulties in freely moving their bodies due to diseases such as muscular dystrophy, amyotrophic lateral sclerosis (ALS), and spinal muscular atrophy (SMA). Eye-gaze input system is not only used as a communication support for people with severe physical disabilities but also for purposes such as determining the line-of-sight direction when playing a video game. Commercial off-the-shelf (COTS) eye-gaze input devices currently on the market use special sensors, such as infrared cameras and sensors, to achieve the high-precision measurement of eye movements. Most of these devices are very expensive, making it burdensome for many who need them. Therefore, we propose a new method using a video for estimating the directions of people’s eye-gazes, this video can be captured by the built-in camera of a notebook computer. This method uses 3D convolutional neural network (3D-CNN), which is an extension of convolutional neural network (CNN) in the time axis, to classify eye-gaze directions, namely up, down, left, right, front, upper left, and upper right. We prepared a dataset, containing many one-second videos, for training the model. We wanted to run our model in real-time but lacked clarity on what the beginning and ending the action of an eyes. However, when looking at the video captured by the camera, we could clearly determine these points. Accordingly, we only considered the eye actions that both started and ended in the front. We employed OpenCV Haar-like features to track tester’s face and only used the images of the eye cut from the images of the faces for classification. The discrimination condition, robustness, and stability under the present study were superior to those our previous study wherein we used 2D-CNN to classify the eye actions. In the future, we will consider how to improve the performance of the proposed model through possible changes in architecture of 3D-CNN.

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Room F

GS18 Machine learning 1

Chair: Noritaka Shigei (Kagoshima University, Japan)

GS18-1 A soundscape analysis of bird and cicada vocalizations based on azimuth and elevation localization using robot audition and machine learning techniques

Hao Zhao[1], Reiji Suzuki[1], Ryosuke Kojima[2], Takaya Arita[1], Kazuhiro Nakadai[3]
([1]Nagoya University, Japan)
([2]Kyoto University, Japan)
([3]Tokyo Institute of Technology, Japan)

This study aims to apply robot audition and machine learning techniques to investigate the natural soundscape of forest animal vocalizations based on azimuth-elevation estimation of sounds. We focus on the recordings in an experimental forest in Japan, where a 16-channel semi-spherical microphone array had been placed, and birds and cicadas dominated the soundscape. We propose a classification method to extract the sound events of cicadas and birds of the localization results obtained from sound source localization and separation based on HARK, using HARKBird. This method uses latent space representations of sounds based on Wav2Vec2 model. We adopt the classification method for several recordings and then we conducted a preliminary analysis of their vocal activity and the azimuth and elevation information. The result showed the different soundscape patterns of bird and cicada vocalizations. The behavior of cicada vocalizations may have reduced the vocal activity of birds while needs further detailed analyses.

GS18-2 A speaker recognition system with CNN in noisy environments and a speech imaging method

Shunki Tsumagari[1], Kazuya Kishida[2]
([1]Advanced Mechanical and Electronic Control Systems Engineering, National Institute of Technology, Kagoshima College, Japan)
([2]Department of Electronic Control Engineering, National Institute of Technology, Kagoshima College, Japan)

In recent years, as Voice User Interface (VUI) has been attracting attention, some studies have been conducted on voice recognition systems and many systems using Neural Network (NN) have been proposed. One of the challenges in the field of speaker recognition is that it is difficult to achieve a high recognition rate in noisy environment. We believe that Data Augmentation (DA), commonly used in the field of image recognition, is one of solutions for improving recognition rate of speaker recognition systems in noisy environment. In this study, we propose a method that generates an image from a speaker's specific speech and constructs the speaker recognition system with Convolutional Neural Network (CNN) using the generated speech image. To improve the robustness of the speaker recognition system in noisy environment, we propose a method to generate speech images in pseudo-noisy environment using three types of filters of smoothing.

GS18-3 Feature Selection Method with Low Rank Attribution for Predicting Body Temperature Range of ICU Patients in Machine Learning

Ayumi Amaike, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

In this study, we propose a feature selection method based on low rank attribution (LRA) to create a lightweight and high-performance intensive care unit (ICU) patient body temperature range prediction model. We used recursive feature elimination with cross-validation as the feature selection algorithm and analysed the effect of LRA, which accelerates the calculation of feature importance inside the algorithm using principal component analysis transformation, on the model training time. Our proposed method improved the AUC score by up to 1.4 points over the baseline in predicting normal, fever and hypothermia body temperature ranges for ICU patients. The training time of the model using the features selected by the proposed method was only 11% of the baseline value. Even when the number of features to be input into the model was reduced in feature selection using LRA, the model training time was reduced without significantly degrading the model performance.

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GS18-4 Detecting Soccer Events from Social Media Using Natural Language Processing and Machine Learning

Yukiya Sato, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

We propose a machine learning model to detect soccer events from Twitter posts. We performed this work in two stages. In the first stage, we collected live tweets relating to soccer games and their associated timestamps. Next, we preprocessed the tweets and create features such as TF-IDF, part-of-speech tags, the number of repeated characters, and the number of tweets per minute. Then, we used supervised learning algorithms such as k-NN, naive Bayes, and LightGBM to classify the tweets as referring to “non-event,” “goal,” “yellow card,” “red card” or “substitution” class. In the second stage, we detected actual events for each time period from event subsets based on this classification. We then compared the performance of burst detection as a representative event detection method with unsupervised learning algorithms such as k-means clustering, GMM, Ward's method, and HDBSCAN.

GS18-5 Simultaneously Estimating and Controlling Neuronal Nonlinear Dynamics Based on Statistical Machine Learning Approach

Taketo Omi, Toshiaki Omori
(Kobe University, Japan)

Controlling neurons is one of the most crucial subjects for understanding and manipulating brain function. However, to constitute a control law, it is necessary to estimate the latent neuronal state dynamically from partial observations. We propose a data-driven framework for simultaneously estimating and controlling the nonlinear dynamics of individual neurons. We derive an online algorithm for estimating latent variables and model parameters and controlling neuronal dynamics by employing statistic machine learning and model predictive control approach. We verify the effectiveness of the proposed method using simulation environments. The results suggest that with the proposed method we can simultaneously estimate the latent variables and the parameters and control neuronal dynamics toward the desired firing pattern.

GS18-6 Computation Time Reduction and Accuracy Improvement of Secure Multiparty Computation for Back Propagation by Introducing Communication Timeout

Yoshiki Higo[1], Noritaka Shigei[1], Hirofumi Miyajima[2], Hiromi Miyajima[1]
([1]Kagoshima University, Japan)
([2]Nagasaki University, Japan)

In this paper, we consider effective implementation on the transport layer of the network and effective modification of the secure multi-party computation algorithm for back propagation learning of neural networks to improve the increase of computation time and the deterioration of accuracy due to the communication failure with the servers. Specifically, we propose introducing Adam optimizer, a timeout for client reception and proceeding with learning with the remaining servers other than the timeout one. Further, in order to improve the performance when using timeout, we propose an effective scheme, called update suppression, which suppresses updates of learning parameters with a certain probability, even for communicable servers. We implement the proposed methods on the system, in which one client and eight servers are interconnected via a TCP/IP network. The experiments on the system consisting of one client and eight servers interconnected via a TCP/IP network demonstrate the effectiveness of the proposed methods.

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GS18-7 Reconstructing Perceptual Images from Functional MRI Signals Using Framework Based on Flow-based Image Generation Model

Kensuke Inaba, Toshiaki Omori
(Kobe University, Japan)

Reconstruction of perceptual images from fMRI recordings is an important research field in neuroscience and is expected to be a promising technique for reading the brain. However, learning the mapping between fMRI signals and corresponding stimulus images is a challenging problem. The problem lies in the fact that the hierarchical information processing in image reconstruction of the visual cortex is complex and has not been fully clarified. In this study, we focus on the similarity between the hierarchical information processing structures of the visual cortex in the brain and neural networks, and reconstruct perceptual images from fMRI signals using a framework based on a neural network generation model. In particular, by applying a flow-type image generator called a free-form Jacobian of reversible dynamics (FFJORD) as a generator, we aim to decode the sequential acquisition of image shape features in the learning and inference process of image reconstruction, and to deepen our understanding of the visual mechanism of the brain.

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Room A

OS19 SWARM: Behavioral measurement and modeling technology to consider individual cognitive functions of organisms

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

OS19-1 Development of Three-dimensional Cultured Skeletal Muscle Tissue and Its Application

Hirono Ohashi, Ryo Teramae, Shunsuke Shigaki, Masahiro Shimizu, Koh Hosoda
(Department of Systems Innovation, Osaka University, Japan)

Bio-hybrid robots embedded with three-dimensional cultured skeletal muscle tissue as an actuator have been developed. Three-dimensional cultured skeletal muscle tissue is composed of muscle cells and extracellular matrices. Animal skeletal muscle tissue is a set of uniformly oriented fibers formed by myoblast through proliferation and differentiation. For engineering of three-dimensional cultured skeletal muscle tissue, we care about cell orientation. Our previous study showed that our fabrication method (geometric constraints) could induce the orientation of muscle fibers. The quality of a three-dimensional cultured skeletal muscle tissue as an actuator is determined by its contraction force. Thus, in this study, we characterized our three-dimensional muscle tissue by measuring contraction force for robot application. Furthermore, we developed a 1-DOF robotic arm embedded with our three-dimensional muscle tissue. We applied electrical stimulation based on the functional analysis and observed that the robotic arm could be driven by our three-dimensional muscle tissue.

OS19-2 Experimental investigation of the effects of periodic intake on odor source localization behavior of silkmoth

Shunsuke Shigaki, Takumi Matsushita, Koh Hosoda
(Osaka University, Japan)

In this study, we experimentally verified the relationship between periodic odor intaking and localization performance of an adult male silkmoth, which uses female sex pheromone as a cue for localization behavior. The adult male silkmoth is able to localize to a female by walking with strong flapping when it receives sex pheromones with antennae on its head. Although the silkmoth can not fly, it uses flapping to obtain propulsive force and to actively intake odor in its own direction. The flapping frequency is not always constant and is modulated depending on the situation. However, the relationship between frequency modulation and localization behavior is still unclear. We employed an insect-machine hybrid system to generate a periodic odor intaking that is equivalent to the flapping of wings, and measured the relationship between the odor intaking and behavioral changes during the odor source localization. The results suggest that it is important not only to increase the odor intake frequency but also to make a big difference in the airflow between odor interception and intake.

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OS19-5 An Encounter with Nestmates will Boost the Search Efficiency of Ant Foragers

Yuuki Hirano, Tomoko Sakiyama
(Soka university, Japan)

In order to confirm the effect of contact with other ants on the exploratory behavior of the Formica japonicas, ants were placed inside ANTAM and their exploratory behavior was recorded for 5 minutes. In the main (comparison) experiment, an ant was (not) brought into contact with another ant every 30 seconds during this five-minute period, and data were obtained. The results of the two experiments were compared, it was found that contact did not decrease the degree of diffusion, rather it increased the degree of diffusion. It is considered that the exploratory ants on ANTAM maintain their straight motions by contacts with other individuals, and also realize fine local searches in all directions through contacts. Results demonstrate that ants in both experimental conditions exhibit Lévy walks, suggesting that exploratory ants boost the search efficiency by contacting with other ants without loosing Lévy walks.

OS19-6 Observation of turn alternation in pill bugs using an automatic turntable-type multiple T-maze device

Akika Utsumi[1], Shuji Shinohara[2], Toru Moriyama[1]
([1]Shinshu University, Japan)
([2]Tokyo Denki 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 pill bugs are equipped with inverter for turning. The success rate of this alternating turn decreases as the distance between the intersection of the two T-mazes is increased, reaching about 50% at 16 cm. In a recent study, when they were given approximately 2,000 consecutive 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 16 cm between maze intersections and investigated whether pill bug adjusts the inverter or not when memory of prior turns is lost.

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Room B

OS24 SWARM: Snake Robot

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

OS24-1 Local Hump-shape Transformation for an Articulated Mobile Robot by Changing the Approximation Range on an Downward Bending Curve

Ching Wen Chin, Motoyasu Tanaka
(Department of Mechanical Intelligent Systems Engineering, Graduate School of Information Science and Engineering, The University of Electro-Communication, Japan)

This study presents a control method for an articulated mobile robot to change its local body shape in a complex environment. During locomotion in a complex three-dimensional environment, the robot may move in a different path than planned due to the slippage of the wheel or contact with obstacles. A local body shape transformation control which allows the robot to change its local body shape on the original continuous curve is proposed. The local body shape transformation is realized by changing the approximation range of the robot on the continuous curve. This control is named ``local hump-shape transformation'' as it forms a hump-shape when lifting a part of the robot body away from the continuous curve. Simulations are carried out to evaluate the effectiveness of the local hump-shape transformation control on various types of continuous curves.

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OS24-2 Joint States Feedback Adapt Control for Snake Robots That Move on Random Poles Environments

Yongdong Wang, Yuya Shimizu, Tetsushi Kamegawa, Akio Gofuku
(Department of Interdisciplinary Science and Engineering in Health Systems, Okayama University, Japan)

We propose a decentralized adaptation mechanism capable of adapting to obstacles in the environment. This decentralized adaptation mechanism consists of an Extended Curvature Derivatives Control (ECD) term, a combination of a JSFAC term, and an Angular Damping (AD) term. The ECD is an extension of the curvature derivatives control that allows the angle of the snake robot to propagate more smoothly from the head to the tail. We use the joint states, so that the joints can decentrally adjust the command torque when they encounter an obstacle, which we call JSFAC. In addition, we add an AD term to reduce the motors' vibration by increasing the motors' damping. Finally, we conduct experiments on the proposed mechanism in simulation. The results indicate that the proposed combination of decentralized control methods allows better determination of whether an obstacle is beneficial or harmful to propulsion and more effective adaptation to environmental obstacles.

OS24-3 Experiment and Simulation Verification of Damage to a Snake Robot Falling from a Height

Yuya Shimizu, Yuina Kadowaki, Tetsushi Kamegawa, Akio Gofuku
(Okayama University, Japan)

A snake robot is a robot inspired by a biological snake. The snake robot is expected to be applied to searching disaster sites and inspecting pipes in plants. In such environments, robots can be broken by falling from a height. But it is possible to expand the ability of a snake robot as a rescue robot by reducing the risk of being broken. Although measures against collision when a snake robot falls have not been researched much, this research theme is important to apply a snake robot to real fields. To survey the phenomenon of the snake robot falling, we conducted an experiment to make the snake robot fall from a height. In this paper, we report the result of the experiment using the actual robot and evaluate the dynamics simulation based on the experiment. Then we discuss the distribution of the impact by using the result of the simulation.

OS24-4 Study and Experimental Verification of the Landing Posture of a Falling Snake Robot

Yuina Kadowaki, Yuya Shimizu, Tetsushi Kamegawa, Akio Gofuku
(Okayama University, Japan)

In this paper, the discussion centers on an experiment to analyze the change in the impact of a falling snake robot depending on its landing posture. In our previous research, we proposed a landing posture that can reduce the impact when a snake robot falls. Several posture candidates were selected, and the results of their fall simulation suggested that a completely horizontal pose to the ground and a spiral shape would reduce the impact. Therefore, in this study, we dropped the robot from a height of 1.85 m in two different patterns: a horizontal pose and a spiral pose. We also constructed a simulation of the fall impact experiment on a dynamics simulator to simulate the experiment on a real robot. From the simulation results, we discuss the distribution of impact to the robot when it collides with the ground.

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OS24-5 Path Following Control of a Snake Robot with Passive Joints

Ryo Ariizumi[1], Kazunori Sakakibara[1], Toru Asai[1], Shun-ichi Azuma[2]
([1]Nagoya University, Japan)
([2]Kyoto University, Japan)

Snake robots are expected to be robust to actuator failures. However, it is not easy to control a snake robot if some of the joints become passive because of, i.e., problems in power supply lines or some mechanical problems. This paper considers the path following control of a snake robot with passive joints. By extending the authors' previous work for single passive joint cases, a controller for multiple passive joint cases is given. The validity of the method is shown by numerical simulation.

OS24-6 Design and Development of Super-KOHGA: A Multi-Crawler Snake-Like Robot with Enhanced Mobility

Belal A. Elsayed, Ryohei Morita, Kota Yamazaki, Tatsuya Takemori, Fumitoshi Matsuno
(Kyoto University, Japan)

In this paper, we propose the new multi-crawler robot Super-KOHGA. The novel design of this robot includes linear joints that move in the perpendicular direction of the crawlers' longitudinal direction. Thanks to these linear joints, the position of the active yaw joint (which connects two crawler units) can be changed along the sideway directing. Therefore, the joint angle range can be increased while avoiding collision between the crawler units. The design of Super-KOHGA is composed of 4 crawler units with three connecting unit joints. Each connecting unit includes a yaw joint in addition to two linear joints. The robot also has active joints in the pitch direction to allow motion in 3D environments. Thanks to this design, the maximum joint angle between the crawler units are ± 90 degrees in yaw and pitch directions. Therefore, the robot can generate a small turning radius while maintaining small gaps between the crawler units (for enhanced traversal performance). The developed robot showed its effectiveness to achieve motion with a small turning radius by utilizing the linear joint motion.

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Room C

OS11 AROB: Robotics, Bioinspiration, and Intelligence

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

OS11-1 Development of Neuromorphic Circuits with Receptor Cell Model for Animal-Like Gait Generation Using Foot Pressure

Katsuyuki Morishita[1], Hiroki Takayanagi[1], Akihisa Ishida[1], Isuke Okuma[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 to mimic the mechanism of gait generation in animals and implement the mechanism in robots. Previously, the authors developed a quadruped robot that spontaneously generates gait through feedback on foot pressure. A neuromorphic circuit controls each leg of the quadruped robot. However, the quadruped robot requires a microcontroller to convert pressure sensor signals and generate driving waveform for servomotors. This paper describes a newly developed neuromorphic circuit that does not require the processing of a microcontroller to convert pressure sensor signals. The authors add the receptor cell model and the integrating circuit to the conventional neuromorphic circuit. Since the receptor cell model and the integrating circuit convert the pressure sensor signals, the same processing using microcontrollers could perform. As a simulation and measurement result, our proposed neuromorphic circuit can be implemented in our quadruped robot without a microcontroller for converting pressure sensor signals.

OS11-2 A Study on Frequency Response Characteristics to Light Intensity of Receptor Cell Model with Integrated Circuit

Isuke Okuma[1], Katsuyuki Morishita[1], Hiroki Takayanagi[1], Ken Saito[2]
([1]Department of Precision Machinery Engineering, Graduate School of Science & Technology, Nihon University, Japan)
([2]Department of Precision Machinery Engineering, College of Science & Technology, Nihon University, Japan)

The authors study hardware neuron models that mimic the characteristics of biological neurons using analog electronic circuits to implement in a robot system. Previously, we focused on the receptor cells in the sensory receptors of organisms to incorporate the superior ability to understand the environment into robot systems. The authors developed a receptor cell model that mimics the characteristics of receptor cells. In this paper, the authors discuss the frequency response characteristics of the contracted receptor cell model with the integrated circuit. The CdS cell has connected to the receptor cell model to respond to light intensity. The measurement result shows that the output frequency increases as the amount of light irradiated to the CdS cell increases.

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OS11-3 Development of Quadruped Robot System Mounting Integrated Circuits of Pulse-Type Hardware Neuron Models for Gait Generation

Akihisa Ishida[1], Hiroki Takayanagi[1], Isuke Okuma[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 robots equipped with pulse-type hardware neuron models (P-HNMs) that mimic biological neurons. Previously, we developed the quadruped robot equipped P-HNMs and confirmed the generation of animal-like gait that transitions gait in response to the speed of movement. However, the P-HNMs were discrete circuits soldered by hand, resulting in large variations. In this paper, the authors developed an integrated circuit of P-HNMs to reduce the circuit variation. The integrated circuits of P-HNMs are mounted on a quadruped robot. The author confirmed that the quadruped robot equipped with integrated circuits of P-HNMs could generate a gait like "Walk," the gait of quadruped animals.

OS11-4 Improvements of Detection Accuracy and Its Confidence of Defective Areas by YOLOv2 Using an Image Augmentation Method

Koki Arima[1], Fusaomi Nagata[1], Tatsuki Shimizu[1], Akimasa Otsuka[1], Hirohisa Kato[2],
Keigo Watanabe[3], Maki K. Habib[4]
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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)

The authors have been studying a defect detection system for industrial products using CNN (Convolutional Neural Network), CAE (Convolutional Auto Encoder) and SVM (Support Vector Machine). CNN and CAE work for defect detection and its visualization, respectively. They need two types of calculation processes such as defect detection and recognition, so that real-time defect detection in the actual production line is concerned. In this paper, the authors try to apply YOLOv2 to a defect detection and its visualization. Generally, YOLOv2 requires complicated labeling process to prepare a training dataset. Therefore, an image augmentation method is proposed to efficiently generate training data for YOLOv2, by which it is expected that the performance of defect detection and its visualization is improved. The effectiveness is shown through experiments.

OS11-5 Proposal and Evaluation of an Image Classifier for Detecting Defective Wrapped Film Products

Tatsuki Shimizu[1], Fusaomi Nagata[1], Koki Arima[1], Akimasa Otsuka[1], Hirohisa Kato[2],
Keigo Watanabe[3], Maki K. Habib[4]
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([3]Okayama University, Japan)
([4]The American University in Cairo, Egypt)

The authors have evaluated the applicability of convolutional neural networks (CNNs) and support vector machines (SVMs) to the defect detection processes of actual products' images provided by several kinds of manufacturers. Wrap film products have a unique structure of which a thin transparent film, that easily reflects room lights, is wound around a core material. That is the reason why it is not easy for conventional visual inspection systems to detect defects such as unwound or stuck out areas. It seems that commercially available image recognition systems are not sufficient in terms of performance to detect anomaly wrap film products. One of the reasons is that the frequency of occurrence of anomaly product is low, so that it is also not easy to obtain adequate number of images including defects. Our interesting of this study is that it is evaluated whether one class learning-based SVM (OCSVM) can cope with this defect detection problem or not. OCSVM does not require images including a defect, i.e., the training of OCSVM can be done using only images without a defect. A new method, in which the covariance vector included in a latent variable is used as a feature vector, is considered. Actually, the covariance vector and mean vector to calculate the latent variable are outputted from an encoder part of a variational autoencoder (VAE). The covariance vector is used as a feature vector for training OCSVM. The effectiveness is compared with other two kinds of feature vectors generated from fully-connected layers of AlexNet and VGG19.

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OS11-6 Cognitive Robotics and Affordance

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

Cognitive robotics represents an emerging interdisciplinary field that embodies cognition, reasoning, and learning functions together with adaptive software and hardware capabilities. Also, cognitive robotics focuses on the ability to anticipate and trigger intended actions, recognize and understand events of interest, make proper and timely decisions, generate motor actions, understand natural languages, and expect and assess the outcome of actions and the actions performed by other entities sharing the same task operational environment. To properly understand interactions and actions in a natural environment, the affordance concept describes and understands the effect of actions. At the same time, a robot interacts with objects in real time. Accordingly, affordances represent vital attributes that should be perceived by cognitive robotics. Affordance describes the interactive relationship between a robot, an action performed by the robot, an object on which the action is performed, and predicting and understanding the effect. This paper introduces the concept of cognitive robotics, affordance, autonomy, adaptive behaviors, design requirements, and their enabling technologies. Also, it tries to highlight the role of affordance in shaping the intelligence of cognitive robotics, enhancing their real-time performance, and ensuring safe-reliable decisions and motor actions

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Room D

GS23 Motion planning and navigation

Chair: Daisuke Kurabayashi (Tokyo Institute of Technology, Japan)

GS23-1 Travelling Salesman Problem: Novel spiders-inspired approach

Akhmet-Sultan Alatau[1], Ayan Aksha[1], Abzal Myrzash[1], Iskander Akhmetov[2]
([1]School of Information Technology and Engineering, Kazakh-British Technical University, Kazakhstan)
([2]Institute of Information and Computational Technologies, KIMEP University, Kazakhstan)

The problem of optimizing the route with multiple destinations has always been a problem, which is costly and time-consuming. Since the first publication of the article about the Traveling Salesman Problem, we have seen dozens of solutions some are brute-force, some heuristic. As a result of the researchers' works, not only we gained a better understanding of TSP, but also numerous datasets containing the most optimal routes for each problem. One of those datasets is TSPLIB, which contains more than 200 problems with calculated routes from 15 to 15000 points. Some of those problems will be used in this research to evaluate the performance of a novel route-optimizing approach. The following approach is spiderweb inspired, meaning it's based on finding the centroid of a cluster of points, forming a weblike structure around it optimizing constraints of points selections to have less intersections in route.

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GS23-2 Fundamental Research for ship operation considering Underwater noise

Chika Yamada, Toshio Tuchiya, Etsuro Shimizu
(Graduate School of Marine Science and Technology Tokyo University of Marine Science and Technology, Japan)

In recent years, the problem that underwater noise generated by human activities may have impacted marine mammals is concerned worldwide. In particular, the radiated noise from ships is the same frequency band that large baleen whales use in their daily lives, and it is believed that it may have some impact on them. Therefore in UNCLOS and IMO, discussions on underwater noise are becoming more active and new regulations are being made. So, we need to consider how to reduce the radiated noise from ships currently in operation. The simplest approach to reduce the noise from ships in the case of FPP, which are often installed on large merchant ships, is to decrease the propeller speed to suppress the generation of cavitation. However, in this case, the navigation speed is also decreased. On the other hand, for medium and small ships equipped with CPP, there is a possibility to reduce noise generated by cavitation without decreasing the navigation speed, as long as the propeller pitch angle and shaft revolution are appropriately selected. Based on the case study of noise reduction measured by the research vessel equipped with CPP, this study discusses the operation method of a training ship equipped with CPP from the aspect of ship noise reduction.

GS23-3 Visual SLAM scheme for exploration robots in untextured terrains

Rio Kajiura[1], Satoshi Ono[1], Takashi Kubota[2]
([1]Information Science and Biomedical Engineering Program, Department of Engineering, Graduate School of Science and Engineering, Kagoshima University, Japan)
([2]Japan Aerospace Exploration Agency, Japan)

Mars exploration has been conducted to search for the origin of life and to evaluate the habitability of Mars, and rovers have been used as a means to explore the surface in detail. The exploration rover travels over rough terrain in an environment where communication delays occur, so autonomous control is required. Stereo cameras are often used for conventional rovers. However, this study focuses on a method using a monocular camera from the viewpoint of fail-safe operation.In addition, image-based self-position estimation methods are based on the assumption that feature points are acquired, and therefore, they cannot obtain enough feature points for posture estimation in environments where feature points are scarce. For this reason, this study focuses on a monocular camera-based vSLAM method that is robust to environments with few feature points.

GS23-4 Development of Remote Control and Virtual Guide Route Generation System for Inspection Drones Using Depth Camera-Based Environment Recognition

Ryunosuke TAKAGI, Teklay Asmelash GERENCHEAL, Yudai MIZUTA,
Jae Hoon LEE, Shingo OKAMOTO
(Graduate School of Science and Engineering, Ehime University, Japan)

This research article describes drone teleoperation systems using virtual guideline generation for indoor industries inspection and surveying purposes using depth camera-based environment recognition and self-positioning system. The drone flies near the walls and any other target objects inside industries to inspect and survey all possible or targeted objects within the room. It is difficult to conduct physical or personal surveys and inspections in hazardous factories and industries. Thus, this research is mainly implemented in such areas to inspect and survey indoor hazardous industries in which the GPS is not available. A virtual guidance line was introduced and generated for the safety of the drone, quality of image data, and successful surveying and inspecting process. Therefore, an independent standalone system was constructed using the ROS framework, which implements an open-source algorithm called ORB-SLAM to estimate a self-positioning system that relies on feature points obtained from the depth camera information. Thus, by obtaining the distance between the camera and the detected object from the depth camera information, a virtual line is created at a certain distance from the object so that the drone flies alongside. The drone is designed to detect planes, corners, and angles and position itself perpendicular to the scanning point. So that it changes its position and orientation according to the target objects or wall's structure.

January 26 (Thursday), 16:05-17:20

GS23-5 Adaptive Optimal Path Search with a Neural Network using Hebbian Learning

Tomas Kulvicius, Minija Tamosiunaite, Florentin Wörgötter
(University of Goettingen, Germany)

Finding optimal paths in connected graphs requires determining the smallest cost for traveling along the graph's edges. This problem can be solved by several algorithms where costs are predefined and unchanging for all edges. Here we design a neural network representation of path finding problems by transforming cost values into synaptic weights, which allows for online weight adaptation using learning. Starting with an initial activity value of one, network activity propagation leads to solutions, which are identical to those of the Bellman-Ford algorithm. The neural network has the same algorithmic complexity as Bellman-Ford and we can show with two examples that network learning (e.g., Hebbian learning) can adapt the weights in the network augmenting the resulting paths according to some task. Hence, the here-presented novel algorithm may open a different regime of applications where path-augmentation (by learning) is directly coupled with path finding in a natural way.

January 26 (Thursday), 16:05-17:20

Room E

OS14 AROB: System Sensing and Its Applications 3

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

OS14-1 A Method to Remove the Effect of Light on the Evaluation of Autonomic Nervous Activity Using Real Face Images

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

The demand for emotion estimation has increased in recent years, including efforts to improve the workplace environment, which has created a need for an easier and less expensive method of estimation. We previously proposed a method to evaluate stress fluctuations in real-time by analyzing fluctuations in the R-B component values in the nasal area, which are susceptible to autonomic nervous activity. However, this method is limited by the effects of white noise owing to light reflection and black noise owing to shadows, which may decrease the accuracy of the evaluation. In this study, we examine the possibility of establishing a method to eliminate these effects, thereby enabling a more accurate assessment of the autonomic nervous activity. From previous studies, it is clear that R-B component values fluctuate significantly with facial and body movements. This may be because the amount of light entering the skin changes significantly with facial and body movements. Therefore, in this study, we attempt to reduce the effect of light intensity by narrowing the range of the R-B component values used for analysis from the R + G + B value, which are considered synonymous with the amount of light entering the skin. After removing pixels with R-B component values corresponding to white and black, we determine the variation in the R-B component values and successfully reduce the significant variation caused by the movement of the face and body. In addition to reducing the fluctuations caused by facial and body movements, we successfully obtain fluctuations that were thought to be due to autonomic nervous activity. Subsequently, we analyze the videos in a state of rest, which does not include intentional facial and body movements. We observe a reduction in the fluctuations caused by unconscious movements, and the fluctuations caused by autonomic nervous activity that had been offset by the movements become visible. However, the results of experiments in which the effects of autonomic nervous activity are easily obtained, such as the discomfort experiments used in previous studies, it was revealed that the results varied depending on the shooting conditions. Therefore, it is necessary to further study a method that can remove the effect of light intensity from any environment and angle, considering the practical application.

January 26 (Thursday), 16:05-17:20

OS14-2 Introducing Emotional Experiences in the Transformer for Next Place Prediction

Masanao Ochi, Kenji Tanaka, Ichiro Sakata
(The University of Tokyo, Japan)

Consumers are more likely to empathize with what their friends they know regularly communicate than with influencers they have never met, which can evoke strong emotions toward making a purchase. However, whether these emotional experiences impact people's everyday behavior (people flow) has not been clear. In this paper, we propose a method to introduce emotional experience into the next location prediction using the Transformer. We used Twitter posting data and cell phone location data (Agoop) in the experiment to predict the next location around Ebina Station in Kanagawa Prefecture. Our method improved +3.80 points on the F-value of the next location prediction with emotional experiences as location features. Introducing the emotional experience should help plan the design of flow paths and tenant placement in commercial facilities, particularly the possibility of controlling people's flow by increasing the emotional experience given by places.

OS14-3 Effects of Thermal Stimulation to Neck Skin on Sympathetic Nervous Activity and Arousal Level of Drivers

Minobu Takahashi, Hirotoshi Asano
(Kogakuin University, Japan)

Of the motor vehicle traffic accidents reported by police in 2019, 9% of fatal accidents and 15% of injury accidents were reported as accidents affected by distraction. Temporary drowsiness while driving has been cited as a factor in distracted accidents. One factor in these accidents is temporary drowsiness due to boredom and fatigue caused by long hours of driving. The development of safe driving support technology that can properly assess the driver's state of alertness and immediately respond to it is an important issue for building a safe and secure traffic society.We have developed a biofeedback system that provides appropriate temperature stimulation to the thermal receptors based on nasal skin temperature fluctuations, which significantly reflect sympathetic nerve activity. This drowsiness suppression system may intervene in part against sympathetic activity.

OS14-4 Analysis of Spatial Distribution Characteristics of Facial Skin Temperature on Stress Coping

Shiori Oyama, Kosuke Oiwa, Akio Nozawa
(Aoyama Gakuin University, Japan)

When exposed to external stimuli, people show two types of responses. These are called stress-coping responses or active and passive coping responses. These stress coping responses are discriminated by differences in the variability of hemodynamic parameters. However, the existing measurement method for hemodynamic parameters is contact measurement, and a remote measurement method is required for application. Therefore, we focused on Facial thermal image, one of the remotely measurable indicators of the cardiovascular system. Using Facial thermal images, we attempted to analyze the spatial distribution of skin temperature during each stress coping response. Facial thermal images were measured during the experiment to elicit active and passive coping responses. Facial thermal images were compared with standard Facial thermal images taken without stress coping, and the spatial distribution of standard skin temperature during each stress coping response was analyzed.

January 26 (Thursday), 16:05-17:20

OS14-5 Sparse Modeling for Interindividual Mean Features in Facial Skin Temperature Distribution

Atsushi Yoshida, Kosuke Oiwa, Akio Nozawa
(Aoyama Gakuin University, Japan)

In recent years, the need for technologies to detect drowsiness remotely and quickly is increasing. In our recent study, constructing individual drowsiness estimation model was attempted by using sparse modeling based on facial skin temperature distribution which can be captured remotely. However, it was confirmed that sparse modeling powerfully decomposes behavioral indicators which have larger features than that of drowsiness. In a general model using sparse modeling, individual differences among subjects could be prioritized and decomposed. Therefore, we conceived the idea of applying an averaged face to reduce the effects of decomposing individual differences. By partially averaging images across subjects, it is thought that such effects can be removed. In this study, constructing a general model for drowsiness level estimation and investigation of the availability of the averaged face has been attempted.

January 26 (Thursday), 16:00-17:00

Room F

GS19 Machine learning 2

Chair: Shohei Kato (Nagoya Institute of Technology, Japan)

GS19-2 Development of Real Estate Investments of Kazakhstan based on Multivariate Statistics and Machine learning techniques

Aktilek Assylbek
(Computational science and statistics Kazakh National University named Al-Farabi)

Kazakhstan’s insurance sector has been steadily growing since the commence ment of market reforms. Insurance is one of the risk management tools used to safeguard the property interests of legal entities and individuals, as well as to ensure the growth and security of businesses. Our study aims to derive a technique of property valuation in Kazakhstan, utilizing mathematical answers and offering mathematical approaches, by analyzing and relying on the experience of other nations. As a consequence of our effort, we want to arrive at one of the most accurate techniques to assess the property of Kazakhstan residents, withthe potential to be used as a credible tool for both independent appraisers and rhinestone corporations.

GS19-3 Estimation of types and quantity of liquid in a bottle using shaking motion

Daiki Ishimura, Daisuke Iida, Kazuyuki Ito
(Faculty of Science and Engineering, Hosei University, Japan)

In this paper, we focus on estimating types and quantities of unknown liquid in a bottle using a robot. In General, when unknown liquid is contained in a bottle, by shaking it, we can roughly estimate its types and quantities. So, we develop a robot arm, and it imitates human’s behavior to estimate them. The procedure is as follows. To prepare pre-information, the robot arm shakes bottles containing various liquids, and obtains data of the strain gauge and the microphone. Then the robot shakes a bottle containing unknown liquid and estimates its quantity and type using Bayesian inference. As a result, we confirmed that the unknown liquids contained in a bottle could be estimated with a high probability.

January 27 (Friday), 09:00-11:25

Room A

OS5 AROB: Human-Centered Robotics

Chair: Sajid Nisar (Kyoto University of Advanced Science, Japan)
Co-Chair: Irfan Hussain (Khalifa University, United Arab Emirates)

Invited Talk 2 Telesurgical Skill Enhancement Through Visuohaptics and Error Amplification

Zonghe Chua (Case Western Reserve University, USA)

See page 15

Invited Talk 3 The Rise of Reconfigurable Maintenance Robots

Mohan Rajesh Elara (Singapore University of Technology and Design, Singapore)

See page 16

OS5-1 A Neuro-Musculoskeletal Model-based Algorithm to determine the Electrical Muscle-Stimulation Distribution to display Virtual Weight

Ryohei Michikawa[1], Hiroshi Yokoi[2], Fumitoshi Matsuno[1]
([1]Kyoto Univ., Japan)
([2]The Univ. of Electro-Communications, Japan)

Electrical muscle stimulation has attracted attention as a method of presenting virtual weights. The advantages of this method are its light-weight system as only electrodes are attached to the skin and high applicability due to the freedom of the hands. Previous studies have not realized the coordinated electrical stimulation of multiple muscles or quantitative electrical stimulation based on models. In this paper, we propose an algorithm for calculating the distribution of electrical stimulation that combines a neuromusculoskeletal model of human biomechanics and a weight perception model based on the hypothesis of weight/force sensation. Using this algorithm, it is possible to determine the appropriate electrical stimulation of multiple muscles based on the target person's posture and the weight to be presented.

OS5-2 Assisted-Wheelchair Navigation Using Haptic Assistance

Sivadol Phamornsuwana, Sajid Nisar
(Kyoto University of Advance Science, Japan)

The purpose of this research was to design and evaluate a wheelchair equipped with a haptic cushion, with the goal of enhancing mobility and safety of the operator. To this end, a simulation-based approach is employed using the Robot Operating System (ROS) and a haptic cushion to provide haptic cues to the wheelchair bound person. The effectiveness of the proposed approach is then evaluated in a user study where the participants operate a wheelchair in the virtual environment and haptic feedback is provided to guide them navigate the field in minimum time and without making collisions. The performance of participants operating the simulation with and without haptic feedback is assessed. The results suggest that haptic feedback can significantly improve the decision-making abilities and safety of operators.

January 27 (Friday), 09:00-11:25

OS5-3 An Adaptive Fuzzy-Based Algorithm to Recognize Human-Gait Type for Locomotion-Assistance Devices

Natee Chirachongcharoen, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

To correctly detect the gait-type of a human using conventional machine learning algorithms, that often require extensive data collection and are time-consuming, it is important for the recognition algorithms to be adaptable to each individual user. In this research, we propose an algorithm that can adjust the rules for gait-type recognition and personalize them for individuals without requiring their prior data. The proposed algorithm uses the Fuzzy Logic System (FLS) and Welford's (variance computation) method to enhance the adaptability. The fuzzy rules for gait recognition are based on statistical values that are updated over the personalization adaptive training period for the new users using Welford's method. These updated fuzzy functions become the optimal functions for recognizing the gait type of each user. In simulations, our adaptive fuzzy-based algorithm (AFBA) showed a recognition accuracy of 63.0%, an improvement of 33.4% over the non-adaptive fuzzy-based recognition algorithm. Additionally, the AFBA was able to adapt its model and perform recognition within 5.783 gait cycles.

OS5-4 A Soft Pneumatic Gripper with Bidirectional Bending Using Single-Port Actuation

Rene Suarez[1], Belal Elsyed[2], Sajid Nisar[1]
([1]Kyoto University of Advanced Science, Japan)
([2]Kyoto University, Japan)

This research describes the design, fabrication, and performance of a soft robotic finger that can achieve bidirectional bending using a single-port pneumatic actuation. Using the proposed soft finger design, a three-finger gripper is developed. In contrast to the existing designs, the proposed soft finger achieves bidirectional bending through a simple pre-curved body. To evaluate the functionality of the proposed design, a prototype is developed using silicone casting. The tip force and bending angle of the finger are measured by applying pressures ranging from 0 to 100 kPa, yielding bending angles between -34° and 34° and a maximum tip force of 2.72 N at 100 kPa. The gripper is evaluated by grasping objects of different shapes, weights, and sizes. The results show that it could successfully grasp objects twice bigger than its normal grasp area (6 cm).

OS5-5 Design and Kinematic Analysis of a 5-Degrees-of-Freedom Robot-Assisted Surgery Instrument

Charles Manger[1], Sajid Nisar[2], Adam Clayton Powell[1]
([1]Worcester Polytechnic Institute, United States)
([2]Kyoto University of Advanced Science, Japan)

Minimally Invasive Surgery (MIS) offers several advantages over traditional open surgery, including reduced postoperative pain and shorter hospital stays for patients. However, it requires the use of robotic tools to assist surgeons in executing intricate procedures inside the patient's body through small incisions. The aim of this research is to design a robot-assisted surgical instrument that can be affixed to an existing surgical manipulator, enabling the operator to access and operate in regions that are obstructed by other organs, while being able to perform complex surgical tasks such as grasping and suturing. The surgical tool is powered by a hybrid transmission consisting of gear-based and tendon-driven mechanisms. A computer-aided design of the 5-degree-of-freedom surgical tool is created and required tendon forces are calculated through static force analysis. In the future, we intend to fabricate a prototype of the surgical instrument and evaluate its functionality through experimental testing.

January 27 (Friday), 09:00-10:15

Room B

OS1 AROB: Bio-inspired Theory and Applications (1)

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

OS1-1 Performance of Machine Learning base NIDS on Re-organized Kyoto 2016 Dataset

Ryo Saito[1], Masaru Aikawa[2], Kunihito Yamamori[3]
([1]Interdisciplinary Graduate school of Agriculture and Engineering, University of Miyazaki, Japan)
([2]Center of Education and Student Support, University of Miyazaki, Japan)
([3]Faculty of engineering, University of Miyazaki, Japan)

This paper introduces the contradiction between the label and the detection results by three malicious communication detection tools included as features in the sample. We re-organized the samples based on the detection results based on the features from ”Kyoto 2016 Dataset (K2D)”, then remove the data redundancy and ”Same-Feature with Different-Labeled (SFDL)”data. These two datasets, the original K2D and the ”re-organized K2D (K2D-R)” are compared by the classification accuracy of two algorithms, Random Forest (RF) and Gradient Boosting Decision Tree (GBDT). Experiments showed that the K2D-R led to low classification accuracy, so anyone should carefully use K2D as a NIDS dataset.

OS1-2 Robustness comparison of machine learning algorithms for NIDS under the same environment

Masaki Tagawa[1], Kunihito Yamamori[2], Masaru Aikawa[3], Ryo Saito[1]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Faculty of Engineering, University of Miyazaki, Japan)
([3]Technical Center, Faculty of Engineering, University of Miyazaki, Japan)

This study compares and evaluates the performance of machine learning algorithms used in NIDS (Network Intrusion Detection System) in the same environment. NIDS is one of the network attack detection systems, and some researchers try to improve the performance of NIDS by machine learning algorithms. However, these researches evaluate their performance in their unique environments. We pick up five machine learning algorithms suitable for NIDS and evaluate the performance under the same environment. We select three algorithms from the GBDT (Gradient-Boosting-Decision-Tree) family and two from a kind of deep learning algorithm, SAINT (Self-Attention and Intersample-attention Transformer). These algorithms are suitable for tabular-like data. We use the NSL-KDD dataset for training. The NSL-KDD dataset consists of numeric data, character strings for categories, and boolean values. In the experiments, we compare the performance of algorithms in two cases, one with rich training data and the other with poor training data. Performance metrics are accuracy rate, recall rate, relevance rate, and the AUROC (Area Under Receiver Operating Characteristic) curves. Experiments showed that GBDT base algorithms are superior to the deep learning base algorithms such as SAINT and SAINT-S when we can prepare enough samples.

January 27 (Friday), 09:00-10:15

OS1-3 A Highly-Scalable Self-Organizing Map Accelerator Implemented on FPGA

Yusuke Yamagiwa[1], Yuki Kawahara[1], Kenji Kanazawa[2], Moritoshi Yasunaga[3]
([1]Degree Programs in Systems and Information Engineering, University of Tsukuba, Japan)
([2]Institute of Engineering, Information and Systems, University of Tsukuba, Japan)
([3]University of Tsukuba, Japan)

Self-Organizing Map (SOM) is one of artificial neural networks and well applied to datamining or feature- visualization of high dimensional datasets. Recently, SOMs are actively used for market research, political decision-making and social analysis using a huge number of live text-data. The SOM, however, needs a large number of parameters and iterative calculations like Deep Learning, so that specialized accelerators for SOM are strongly required. In this paper, we newly propose a scalable SOM accelerator based on FPGA, in which all neurons in the SOM are mapped onto an internal memory, or BRAM (Block RAM) in FPGA to maintain high parallelism in the SOM itself. We implement the proposed SOM accelerator on an Alveo U50 (Xilinx, Ltd.) and evaluate its performance: the accelerator shows high scalability and runs 101.97 times faster than software processing with Intel Core i7, which is expected to be enough for the real-time datamining and feature visualization.

OS1-4 Performance Evaluation of A Parallel Volunteer Computing System Using Benchmarks

Keiichi Inohara, Yota Kurokawa, Masaru Fukushi
(Yamaguchi University, Japan)

Volunteer computing (VC) is one of the distributed computing paradigms, which exploits idle computing resources provided by vast amount of users on the Internet. In VC, individual nodes are unable to directly communicate with each other; therefore, current VC supports only bag-of-tasks computation, and this prevents widespread use of VC. In the previous study, toward the realization of parallel VC, we have developed a prototype parallel VC system based on the concept of server assisted communication. We have confirmed the correct behavior of communication among nodes and evaluated the communication time. In this paper, we show the feasibility of parallel programs on the prototype system and reveal the performance. To this end, we develop a program conversion tool to automatically generate a parallel program executable on the prototype system from a parallel program written with a standard MPI communication library. The evaluation results using well-known NAS parallel benchmarks.

OS1-5 Adaptive Fault-Tolerant Routing Methods for 3D-Mesh NoCs

Yota Kurokawa, Tsubasa Endo, Masaru Fukushi
(Yamaguchi University, Japan)

This paper proposes novel two fault-tolerant routing methods for 3D-mesh Network-on-Chips (NoCs). The existing method proposed by Boppana et al. combines two routing methods, minimal fully adaptive routing and fault-tolerant routing for detouring faulty regions. However, a detour direction is statically defined for each faulty region; therefore, due to the long detours and use of eight virtual channels, this method has problems of high communication latency and high hardware overhead. To solve the problems, the first proposed method allows adaptive detours for faulty regions and the second proposed method allows passage of them. Simulation results show that, compared with the existing method, the second proposed method enables to reduce latency by about 30% and improve throughput by about 3.1% with half virtual channels.

January 27 (Friday), 09:00-10:00

Room C

OS17 ISBC: Complex processes

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

OS17-1 Consideration of similarity to Birkhoff-Rott equation and Sato's hyperfunction for describing the vortex layer

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)

In the two-dimensional complex flow, many fluid phenomena such as vortices and vortex sheets have singularities, but these phenomena can be mathematically described by the distribution function (δ-function), however, shear layers and vortex layers have not been described by distribution functions yet. On the other hand, although it has been mentioned that these phenomena can be described by the Sato's hyperfunction, their reliability is not guaranteed yet. In this study, we have compared the Sato's hyperfunction with the Birkhoff-Rott equation, which describes the time evolution of the vortex layer, in order to verify whether the Sato's hyperfunction is useful for describing the vortex layer, and have considered the similarity between these two equations.

OS17-2 Fuel Minimization Problem for Spacecraft Trajectory Optimization Made Easy

Kenta Oshima
(Hiroshima Institute of Technology, Japan)

The present paper introduces regularized formulations into the direct multiple shooting method of minimizing fuel expenditure for spacecraft trajectories. Regularizing techniques are applied to the Sims-Flanagan transcription method considering complex low-thrust trajectory optimization. Instantaneous velocity changes approximating low-thrust maneuvers are expressed by regularized variables based on the Levi-Civita or Kustaanheimo-Stiefel transformation. The new formulation removes singularities due to null thrust impulses from derivatives of an objective function and constraints. The method automatically and robustly finds fuel-efficient bang-bang control structures for multi-revolutional transfers between periodic orbits near the Moon without facing the singularities.

OS17-3 Device fabrication for sweat sensor utilizing 3d printer

Marc Josep Montagut Marques[1], Kayo Hirose[2], Kazuyoshi Tsuchiya[3], Hisashi Sugime[4],
Suguru Noda[1], Shinjiro Umezu[1]
([1]Waseda University, Japan)
([2]Tokyo University Hospital, Japan)
([3]Tokai University, Japan)
([4]Kindai University, Japan)

The progress in thin-film materials has enabled the fabrication of flexible sensors opening a wide range of opportunities to create new health monitoring interfaces between complex and dynamic morphologies such as the human body. We have decided to integrate on-skin thin-film electrochemical sensors into a wearable device to provide non-invasive health monitoring by continuously collecting excreted sweat samples. By using digital light processing (DLP) 3D printing we designed microfluidic channel casting molds combined with detailed geometry adaptable elastomer to generate a conformable wearable device. For this research an electro chemical sensor was fabricated and tested to determine sample collection parameters and optimize micro channel design.

January 27 (Friday), 09:00-10:00

OS17-4 Sample Space Reducing Processes Arising from Random Inverse Images of Iterated Maps

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

We propose a new construction of sample space reducing processes producing power-law distributions with a given positive exponent. It is based on taking random inverse images of iterated maps. We describe how to concretely define an iterated map such that the sample space reducing process induced by the map gives a power-law distribution with a given positive exponent. A category theoretical structure of choice for the construction is also discussed.

January 27 (Friday), 09:00-11:10

Room D

OS10 AROB: Robotics with Intelligence and/or Informatics

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

OS10-1 Stereo-vision space perception based on photo model and 3D-projection for fish measurement -Precision evaluation against illumination varieties-

Renya Takahashi, Yejun Kou, Yuichiro Toda, Mamoru Minami
(Graduate School of Natural Science and Technology Okayama University, Japan)

Technologies of space sensing have advanced so far. Many researches have made effort for realizing space sensing ability of animals. We have proposed a 3D space sensing method named Projection-based 3D perception (Pb3DP), which can estimate an arbitrary target's position and orientation without prior knowledge of target's shape. However, without the designation of a specific target, the Pb3DP method is functionless because the Pb3DP cannot have a will which target's pose should be measured. We solved this problem and propose a new system, combining the Pb3DP method with a photo model to define specific targets. Currently, the proposed technology has been extended into measuring fish size swimming in pool. The method enables the fish measurement without any contacts, and therefore it is expected to be useful in the aquaculture field. We verified the durability of the constructed system against changes in the illuminance environment.

OS10-2 Recognition for Orientation of Target Objects Using Object Detection Algorithm

Motoki Akazawa[1], Tomoya Tanaka[1], Masatoshi Hatano[2]
([1]Graduate School, Nihon University, Japan)
([2]Nihon University, Japan)

The purpose of this research is development of a method to identify the positions and orientations of target objects accurately by using an object detection algorithm for rescue robots, surgery robot and so on. In such target robot fields, RGB data and PCD including distances of environments and objects are complex and hard to analyze. Then, it is hard to recognize positions and orientations of target objects to grasp them. On the other hand, people can detect positions and orientations of target objects with only images obtained by eyes and brains. Then, only images with AI can identify positions and orientations of target objects in environments. In this paper, we develop recognition system for orientation of target objects using object detection algorithm such as SSD of AI. It is shown that the system almost detects positions and especially orientation of target objects without precise analysis of PCD.

January 27 (Friday), 09:00-11:10

OS10-3 Robots Traveling on Muddy Terrain for Sampling Bottom Sediment in Tidal Flats

Manami Senzaki[1], Hidetoshi Kawasaki[1], Chiaki Takasu[2], Masaki Yamazaki[2], Masatoshi Hatano[2]
([1]Nihon University, Graduate school, Japan)
([2]Nihon University, Japan)

The purpose of this research is to realize robots that performs mud-sampling on tidal flats automatically. Erosions occur on beaches and sands go away to offshore caused by waves, winds and so on. In addition, the phenomena have not been clarified. Thus, a mathematical model has been proposed. However, parameters in the model are hard to identify with collecting bottom sediments with manpower. In this paper, we have constructed a mud-running robot for collecting bottom sediments on tidal flats. During traveling on terrains, the robot has to avoid obstacles, because there are obstacles, i.e., wastes, driftwoods and so on. Then, the SSD was used to recognize objects with image recognitions. Fundamental experiments were performed and then it is shown that the constructed robot can perform desire tasks in our laboratory.

OS10-4 Evaluation of a hand approach method for a harvesting robot using a 4-DOF arm

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)

When the robot harvests a hanging object, its hand contact with the stem or tufted target objects. Because of it, the target object to shift position due to rotation or vibration. The target object sometimes returns to the before position, however it sometimes remains a different position. It is difficult to estimate the position after such displacement in real time. And it is also difficult that repeatedly instruct the robot arm to move to that position. In this paper, we proposed a harvesting method which the robot approaches the grid like space to harvest the target object without strict positioning.

OS10-5 Analysis of centipede locomotion using a planar dynamic model: Relationship between body stiffness and passive undulation

Tetsuya Kinugasa, Shiori Miyamoto, Tomoya Nishiyama, Koji Yoshida, Ryota Hayashi
(Okayama University of Science, Japan)

The centipede has a long, narrow, and smooth body, which comprises dozens of segments, and each segment has a pair of legs. The interaction between the leg and the ground produces forces on the body, which the centipede might use or prevent in locomotion. If the segments connect with passive elements, the body produces passive undulation, which depends on the motion of the legs and might affect the speed and efficiency. Therefore, it is crucial to clarify the nature of the passive body undulation to elucidate the centipede locomotion and to develop an efficient robot. The centipedes exhibit the leg motion that changes the period between the propulsive and swing phases. Our conventional models cannot analyze how the asymmetric leg motions affect the body undulation and the centipede locomotion. This study, therefore, aims to investigate passive body undulation using a more complicated link system comprising legs that can swing independently.

January 27 (Friday), 09:00-11:10

OS10-6 A Proposal of Training Data Generation Method for Tomato Fruit Recognition using Deep Learning and a Study on Sugar Content Prediction

Masanori Sato, Zhaohui Tan
(Nagasaki Institute of Applied Science, Japan)

In this study, we report the results of two studies on tomato fruit recognition using artificial intelligence. One is the prediction of sugar content of tomatoes by image recognition. By learning the external features of tomatoes, we were able to estimate the sugar content of tomatoes. The second is a proposal for generating training data for deep learning. The training data is generated from virtual data consisting of a fruit image with a transparent background and a background image with only leaves and branches. The model trained on this virtual data was applied to a real environment, and good recognition results were obtained.

OS10-7 Interlocking mechanism in the hindlimb using a passive musculotendinous structure during the high walk of crocodilians: Validation of the effects of iliotibials as passive element using a robot

Kazuki Ito[1], Tetsuya Kinugasa[2], Sayaka Hida[2], Koji Yoshida[2], Ryota Hayashi[2], Koichi Osuka[1]
([1]Osaka University, Japan)
([2]Okayama University of Science, Japan)

Crocodilians have an interesting feature that allows them to use several gaits in sprawling and semi-erect postures. Researchers have studied the role of individual muscles in crocodilian locomotion. The passive interlocking of the musculotendinous system, in addition to the role of individual muscles, may be important in crocodilian locomotion. In this study, we aim to clarify that the crocodilian high-walk is achieved with joint coordination based on a passive interlocking mechanism. We have identified some representative muscles and tendons for joint coordination through dissection and validated the function using a robot. In this report, we empirically investigate the passive role of the iliotibialis, the biarticular muscle connecting the ilium and tibial, in achieving an erect-limb posture when high-walking using the crocodilian hindlimb robot. We demonstrate that the iliotibials provided the function of the hip and knee joint coordination in the erect-limb posture and produced more frictional force around the calcaneus.

OS10-8 Control input design for limit cycle walking machines via PLL circuit

Masatsugu Iribe
(Osaka Electro-Communication University, Japan)

There have been many studies which apply the high locomotion efficiency of passive dynamic walking to general limit cycle locomotion. In this study, we focus on the properties of Phase Locked Loop circuit (PLL circuit) which shows the behavior similar to passive dynamic walking and propose a new method to generate control inputs that cause limit cycle walking. We confirmed that the prototype legged robot shows the desired limit cycle walking motion by applying the periodic control input which are generated by the method of PLL circuit. Furthermore, we confirmed that the walking speed of the limit cycle is controllable. Moreover, when the value of Specific Resistance of the walking motion for each speed was measured, the difference appeared clearly.

January 27 (Friday), 09:00-10:30

Room E

GS28 Robot vision and image processing 1

Chair: Ryuhei Yamada (The University of Aizu, Japan)

GS28-1 Improved Faster R-CNN Marine Fish Detection Algorithm Based on SENet Attention Mechanism

Yuting Wang[1], Seiichi Serikawa[1], Wenwen Shen[2], Lifeng Zhang[1], Aoran Xi[1], Yuliang Gao[1]
([1]Kyushu Institute of Technology, Japan)
([2]Yangzhou University, China)

The exploitation of marine resources has always been a concern. The key to the exploitation of marine resources is to achieve accurate detection of targets in the ocean. Underwater imaging is affected by its own factors such as light absorption and particle scattering, as well as external factors that make it difficult for underwater cameras to capture. Therefore, underwater images often have a series of unique problems such as low contrast and blurred images. This is very detrimental to our detection of marine life. In this paper, an improved Faster R-CNN marine fish detection algorithm based on the SENet attention mechanism is proposed. The algorithm uses the Faster R-CNN as the base framework, replaces the original VGG16 network with the Resnet50 network as the feature extraction network, then concatenates the FPN structure into the Resnet50 network, and finally adds SENet attention modules to the first and last layers of the Resnet50 network and to each of the upsampling layers in the FPN network. Training network models through transfer learning. At the same time, to address the problems of low contrast and blurred images in underwater imaging, we selected a part of the pictures with the above problems from the self-made dataset, and performed the preprocessing operations of MSRCP and bilateral filtering on these pictures for image enhancement. It can be proved by experiments that the enhanced dataset used in the improved Faster R-CNN marine fish detection algorithm based on SENet attention mechanism has better performance than original dataset in Resnet50 with FPN Faster R-CNN algorithm in detection precision and recall rate.

GS28-2 Hardware Development of Virtual Background Scrolling Independent on Physical Resolution in High-level Synthesis

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

We are developing a game software library for high-level synthesis, HLS which generates high-performance and low-power hardware modules automatically. An architecture of mobile terminal which loads dynamic reconfigurable device like Field Programing Gate Array, FPGA, we have proposed will efficiently perform game application instead of power-hungry software execution. The dynamic hardware reconfiguration on a single FPGA can execute many kinds of game applications. In previous research, we have focused on parallax background scrolling which is one of important functions in many existing game programming libraries and have developed HLS-oriented software description method of it. This paper shows HLS-oriented software description for a function which scrolls a virtual background with a resolution larger than that of the display used. Moreover, we evaluated the effects of our description method from the viewpoints of the amount of hardware, the execution time and power efficiency. The images used in experiment were 2x, 4x, 8x and 16x the display size. The hardware at 100MHz clock frequency reduced the execution times by 89%, 91%, 93% and 95% and improved power efficiency at 315, 375, 511 and 628 times from 2x to 16x sized image respectively compared with PC at 3.2 GHz.

January 27 (Friday), 09:00-10:30

GS28-3 Verification of Effectiveness of Image Processing for Object Detection

Hikaru Sudo, Ayako Umeda, Etsuro Shimizu
(Tokyo University of Marine Science and Technology, Japan)

Vessels equip radar and AIS, which are used to confirm safety while underway. However, maritime accidents have occurred due to overlooked obstacles. On the other hand, the development of artificial intelligence technology has made it possible to detect objects in images with object detection. Based on the above background, we carried out the research to realize an obstacle detection system for ships using artificial intelligence. This study focused on image processing as a method to improve the performance of object detection and examined the effect of image processing on object detection. In the verification, changes in object detection results due to image processing were analyzed using color histograms and frequency distribution tables. Verification results show that there are several trends between image features and object detection results, and that image processing according to these trends may improve object detection performance.

GS28-4 Development of image uploading function in Web browser-based FPGA Hardware Verification System

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

In developing an embedded product, verification of actual products using prototypes is very important for verifying operation and making further improvements. The FPGA has been used to prototype a digital hardware processing many kinds of information processing. However, in hardware development using FPGA, in addition to developing the processing hardware, it is necessary to develop the interface to the peripheral devices mounted on the FPGA board as hardware. Since commercial boards with large-scale FPGAs are also expensive, they may hard to be distributed individually to multiple persons in the development team. To tackle these problems, we are developing a browser-based hardware verification environment with virtual peripherals that are independent of FPGA boards and peripherals and can be shared by multiple team members over a network. We have built a web server on a CPU-based FPGA and implemented basic functions for remote hardware verification. This paper attempts to introduce an image uploading function using HTML and PHP.

GS28-5 Effect of Line Segment Size on Pencil Drawing-like Image Conversion Hardware Developed by High-level Synthesis

Honoka Tani, Akira Yamawaki
(Kyushu Institute of Technology, Japan)

Advance of virtual space technology requires to further accelerate the development of high-level image processing on smart glasses. To realize high-performance, low-power embedded image processing devices, it is effective to implement image processing in hardware using high-level synthesis technology that automatically converts software to hardware. In the pencil drawing style image conversion, the former process extracts the edges of the input image, and the latter process convolves the line segments to create a pencil drawing-like atmosphere. In this paper, we created hardware with different line segment sizes and clarified the effects of line segment size on execution time, hardware size, and power efficiency.

January 27 (Friday), 09:00-10:30

GS28-6 Co-occurrence Learning of Spatial and Motion Information for CNNs and Its Application to Hand Gesture Recognition on Edge Devices

Shogo Yoshida, Hironori Kitakaze, Ryo Matsumura
(National Institute of Technology, Oshima College, Japan)

In this paper, we propose a co-occurrence learning method of spatial and motion information for Convolutional Neural Networks (CNNs). Our proposed method is based on the simple idea of using co-occurrence images, which are synthesis of single images and Motion History Images, as training for CNNs. This allows learning the co-occurrence of spatial and motion information in a single CNN model, thereby reducing the computational cost. Therefore, it can be run on edge devices, where computational resources are scarce. We apply our method to hand gesture recognition using edge devices. The experimental results showed that the two-stream CNNs achieved an accuracy of 55.99% and an inference speed of 5 fps. The model trained with our method achieved an accuracy of 66.01% and an inference speed of 11 fps. As a result, our method improves accuracy and inference speed compared to two-stream CNNs.

January 27 (Friday), 09:00-10:30

Room F

GS25 Neural networks 1

Chair: Kenneth J. Mackin (Tokyo University of Information Sciences, Japan)

GS25-1 Few-label Class-wise Domain Adversarial Neural Networks for EEG Emotion Recognition

Shoya Furukawa, Takuto Sakuma, Shohei Kato
(Nagoya Institute of Technology, Japan)

Emotion recognition technology based on EEG has attracted the attention of many researchers because of its advantages, such as its ability to recognize latent human emotions and to express emotions of people who can express their emotions through neither facial nor verbal expressions. However, because of individual differences in EEG, it is challenging to construct emotion recognition models using data from an unspecified number of people. In a previous study, we showed that an effective emotion recognition model could be built with a small number of data from a target subject while reducing individual differences by domain adaptation. However, the model may hurt emotion classification because of domain adaptation regardless of emotion class. In this study, we propose a domain adaptation model considering emotion class, Few-label Class-wise Domain Adversarial Neural Networks (FCDANN).

GS25-2 Vibration-based fault diagnosis of rotating machinery using orthogonalization of features

Ryoya Onishi[1], Michifumi Yoshioka[2], Katsufumi Inoue[2], Keishi Omori[3], Masayoshi Todorokihara[3]
([1]Graduate School of Engineering, Osaka Prefecture University, Japan)
([2]Graduate School of Informatics, Osaka Metropolitan University, Japan)
([3]Microdevices Operations Division, Seiko Epson Corp., Japan)

Vibration-based fault diagnosis of rotating machinery is an important task with a wide range of applications. Recent diagnostic methods using deep learning capture changes in frequency component intensity. On the other hand, phase information can be utilized to capture the correlation between equipment anomalies and failure modes with improved clarity when three-axis vibration data with high synchronization accuracy is available. In this paper, we propose a novel technique that uses LSTM and orthogonalization of features. LSTM can extract features without loss of phase information, and orthogonalization organizes the features to consolidate information on faults. Experiments were conducted on data acquired by a three-axis quartz vibration sensor with excellent synchronization characteristics, and the improvement in diagnostic accuracy by the orthogonalization of features was demonstrated.

January 27 (Friday), 09:00-10:30

GS25-3 I Influence of Class Activations without Activated Neurons on Visual Explanation for Convolutional Neural Network

Teruya Horai[1], Michifumi Yoshioka[2], Katsufumi Inoue[2]
([1]Graduate School of Engineering, Osaka Prefecture University, Japan)
([2]Graduate School of Informatics, Osaka Metropolitan University, Japan)

In recent years, as deep neural network models such as Convolutional Neural Network (CNN) have been developed, the complex internal structure of them has led to a decline in interpretability. In order to solve this black box problem, many methods have been proposed to visualize the evidence of the model inference as saliency maps. In this paper, we propose a visualization method that adopts the split-transform-merge strategy using only class activations with useful information for visualizing. To evaluate the effectiveness of the proposed method, we conducted experiments using CNN models pre-trained by ImageNet. As a result, we confirmed that the proposed method can generate better saliency maps quantitatively and qualitatively.

GS25-4 Introducing inductive bias on Vision Transformers through Gram matrix similarity based regularization

Luiz H. Mormille, Clifford Broni-Bediako, Masayasu Atsumi
(Soka University, Japan)

Vision transformers lack strong inductive biases and, to achieve state-of-the-art results, rely on large architectures and extensive pre-training. Therefore, introducing the appropriate inductive biases to vision transformers can lead to better convergence and generalization on settings with fewer training data. To that end, we propose a self-attention regularization method based on the similarity between different image regions. At its core is the Attention Loss, a new loss function devised to penalize self-attention computation between image patches based on the similarity between gram matrices, leading to better convergence and generalization, especially on models pre-trained on mid-size datasets. We deploy the method on ARViT, a small capacity vision transformer and, after pre-training with a self-supervised pretext-task on the ILSVRC-2012 ImageNet dataset, our self-attention regularization method improved ARViT's performance by up to 13% on benchmark classification tasks and achieved competitive results with state-of-the-art vision transformers.

GS25-5 CNN-based pupil center point detection using infrared face image

Ploywow Nhuthep[1], Takeshi Saitoh[1], Kazuyuki Itoh[2]
([1]Kyushu Institute of Technology, Japan)
([3]Research Institute, National Rehabilitation Center for Persons with Disabilities, Japan)

The ultimate goal of this research is to develop a non-contact eye switch for ALS patients using eye movement based on pupil center detection. The proposed system consists of a stationary infrared camera, infrared LED, computer, relay controller, and nurse call. Prior research had the same function but was of the contact type. The contact type or eyeglasses type captures an image of the eye, whereas this non-contact type captures an image of the entire face. The different captured images result in different model structures. This improved version provides more accessibility and eliminates the discomfort patients experience with the contact type. This paper focuses on CNN-based pupil center point detection from the entire face image. Two experiments were conducted to evaluate the proposed system. As a result, an average error of 1.38 pixels or 0.46 mm in actual distance was obtained showing the effectiveness of the proposed system.

January 27 (Friday), 09:00-10:30

GS25-6 Pattern classification and data augmentation of motor imagery EEG signals based on spectrograms

Kyohei Hamasaki, Jun Kobayashi, Takeshi Saitoh
(Kyushu Institute of Technology, Japan)

This paper addresses the classification of noninvasively measured EEG signals obtained by the motor recall. In a previous study, we measured data and attempted classification by deep learning but could not achieve sufficient accuracy due to a lack of data. In this study, we propose a method using data generated by WGAN-GP from EEG signals. The proposed method applies a band-pass filter, and short-time Fourier transform to the EEG signal, converts it into a spectrogram, and classifies it using a convolutional neural network as input. The effectiveness of the proposed method is demonstrated by applying the proposed method to EEG signals of motion recall in four directions.

January 27 (Friday), 10:45-11:45

Room B

OS2 AROB: Bio-inspired Theory and Applications (2)

Chair: Kunihito Yamamori (Faculty of Engineering, University of Miyazaki, Japan)
Co-Chair: Kentaro Aburada (Faculty of Engineering, University of Miyazaki, Japan)

OS2-1 Investigation of evacuation simulation from Tsunami considering road width in Aosima

Keita Nabeyama, Shotaro Usuzaki, Kentaro Aburada, Hisaaki Yamaba,
Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)

Japan is one of the countries in the world that experiences natural disasters most frequently. Japan is especially prone to earthquakes because of its location at the junctions of the North American Plate, Eurasian Plate, Pacific Plate, and Philippine Sea Plate. Preparation for the next Nankai Trough earthquake is one of the most important issues. A Nankai Trough earthquake is predicted to occur with a probability of 70–80% within 30 years. Therefore, we are focusing on computer-aided evacuation guidance to protect people in Japan from tsunamis generated by earthquakes. This study focused on the impact of road widths on evacuation effectiveness in the Aoshima area of Miyazaki City in Kyushu. In this work, we improved the simulation for developing an evacuation assistance system to make it more realistic, taking into account the road width.

OS2-2 Investigation of PIN authentication schemes resistant to video-based recording attacks

Ryo Masuzawa[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)

Traditionally, PIN and password authentication have been used for personal authentication of smartphones and other devices. These authentication methods are performed by directly manipulating the screen of the terminal. However, using a normal screen for authentication may risk a third party being able to steal confidential information by peeping into the screen. In addition, there are few authentication methods that are resistant to “video attacks,” in which an operation is recorded by a video camera or other means and later analyzed. Therefore, we propose an authentication method that allows the user to enter a passcode by only tapping the back of the device, without directly operating the screen, making it possible to authenticate while hiding the device from the surrounding environment. As a result, it is difficult to steal secret information by prying eyes or video camera recording.

January 27 (Friday), 10:45-11:45

OS2-3 A study of improving the safety of defense system based on whitelist

Tsubasa Waki, Shotaro Usuzaki, Kentaro Aburada, Hisaaki Yamaba,
Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)

When we deal with data on the Internet, there is a possibility of cyber attacks. Even recently, there have been cases of backdoors being installed by targeted attacks and remote control access being granted by infection with malware. To protect computers and networks from such threats, there are several considered effective measures. Based on these considerations, previous studies proposed Autonomous Evolution of Defense (AED) systems that use a whitelist. Some of them also incorporated blockchain technology into their systems. The challenge in those studies was that the whitelisted targets used in the system could later become infected with malware, which could unintentionally allow malicious communications. The present study proposes a method to improve the security of the whitelist used in AED systems that incorporate blockchain technology. The results of operation experiments using the proposed method indicated that our method can indeed improve the security of the whitelist.

OS2-4 On an improvement of hand gesture recognition for realizing a user authentication system using s-EMG

Soichiro Ishibashi, Hisaaki Yamaba, Kentaro Aburada, Tetsuro Katayama, Naonobu Okazaki
(University of Miyazaki, Japan)

In our present era, mobile devices have penetrated deeply into our daily lives. We report on a new user authentication method for mobile devices that uses surface electromyogram (s-EMG) signals. 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, 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 new procedure for inference gestures from a combination of four s-EMG signals was also devised to bring out the potential of the plural measurement. A series of experiments was carried out to evaluate the performance of the method.

January 27 (Friday), 10:45-12:00

Room C

GS31 Security

Chair: Yuichi Yaguchi (University of Aizu, Japan)

GS31-1 Experimental Study on Fault Location Estimation by Acoustic Emission Method

Issei Uohira, Kazuya Okamoto, Nobuo Iwasaki
(National Institute of Technology, Wakayama College, Japan)

In recent years, the occurrence of breakdowns and problems due to aging machinery and equipment has become a problem, resulting in decreased production efficiency, long-term system downtime, and high maintenance costs. Therefore, it is desirable to realize a smart factory that utilizes IoT and early detection of deterioration of machinery and equipment as the next generation of manufacturing at the manufacturing site. In this research, early detection of deterioration of machinery and equipment is performed by monitoring equipment using the AE method, which detects high-frequency acoustic signals emitted by initial deterioration such as material deformation and cracks. In addition, in order to examine whether the condition of machinery and equipment can be monitored spatially, two AE sensors will be attached to the measurement target to estimate the direction of the location where machinery and equipment deterioration occurs.

January 27 (Friday), 10:45-12:00

GS31-2 Security evaluation of Browser Red Pills on Current Internet Environment

Soya Hirukawa, Shu Takemoto, Yusuke Nozaki, Masaya Yoshikawa
(Meijo University, Japan)

Many malicious websites change their operations depending on its access method and browser to evasive the detection or analysis of security function. Grant Ho et al. developed Browser Red Pills that detects whether it is a honeypot or not on the browser. Browser Red Pills utilizes the ratio between the time of which a browser performs baseline operations and the time of which a browser performs differential operations. Although the run time of baseline operations on a host machine and those on a virtual machine are roughly same, the run time of differential operations on a host machine and those on a virtual machine are different. They showed effectiveness of the Browser Red Pills, however, OS and browsers used in evaluations are currently outdated or unsupported such as Windows 7 and Internet Explore. This study verifies the effectiveness of Browser Red Pills on currently used OS and browsers.

GS31-3 Power-Based Tamper Resistance Evaluation for Orthros

Shu Takemoto, Yoshiya Ikezaki, Yusuke Nozaki, Masaya Yoshikawa
(Meijo University, Japan)

In recent years, deep learning, with its dramatically improved performance, has benefited the field of cybersecurity as a core technology for defensive methods. On the other hand, a threat to cryptographic hardware called Deep Learning Side-Channel Attack (DL-SCA) has been reported. Power-based DL-SCA is a malicious attack that efficiently analyzes secret keys from power leakage. Incidentally, lightweight block ciphers for IoT devices have been proposed as a trend in cryptographic hardware. Orthros is an effective algorithm for latency reduction and computationally secure against communication processing time increase and security issues caused by a large number of connected devices. However, the tamper resistance of Orthros as a hardware safety feature has not been evaluated. Therefore, this study proposes a DL-SCA scheme for Orthros and evaluates its tamper resistance using power consumption of an evaluation board.

GS31-4 Biometric Authentication during Walking using Sensor Data Acquired from Smart Devices on the Arm

Yuya Yoshimaru[1], Hiroshi Douzono[2]
([1]Saga University Graduate school of Advanced Health Sciences, Japan)
([2]Saga University, Japan)

With today's spread of smart devices, various services are being provided using smart devices. As a result, many important personal information, etc., is associated with smart devices, and personal authentication, which determines whether the user is the original owner or not, is becoming more and more important. Currently, passcode authentication, fingerprint authentication, and facial recognition are the most common methods of personal authentication, but these methods require the user to operate the device during authentication, which is time-consuming and annoying. Therefore, we considered the possibility of achieving both convenience and security by always authenticating the person himself/herself. In this study, we propose an authentication method while walking, which is a routine activity for people, and we compared the accuracy of three features acquired from sensors equipped with smart devices and investigated the most suitable feature.

January 27 (Friday), 10:45-12:00

GS31-5 Autonomous decentralized lighting control system with enumerative anomaly detection

Kumi Aizawa, Kenji Sawada, Shintaro Fujita, Yoshiki Ikeda, Kanta Ogawa
(The University of Electro-Communications, Japan)

Building systems are one of the most important industrial control systems in society because they control facilities such as offices and hospitals. In recent years, industrial control systems have become more convenient through networking, while at the same time increasing the risk of cyber attacks. For this problem, it is necessary to consider countermeasures against cyber attacks on building systems. In this study, we focus on Lighting control systems in building systems and propose an autonomous decentralized Lighting system using enumerative anomaly detection as a security measure when the controller in the Lighting system is attacked. First, the controller itself determines whether an attack is occurring using an anomaly detection system. When an abnormality is detected, the defense system Switches from decentralized control under normal conditions to autonomous control by a secure controller. We implemented the proposed system in the controller of an actual Lighting control system, and found that the controller was able to control Lighting as originally input even during an attack.

January 27 (Friday), 10:45-12:00

Room F

GS26 Neural networks 2

Chair: Sang-Kyun Kim (Myongji University, Korea)

GS26-1 Unsupervised Plant Disease Detection Using Generative Adversarial Networks Utilizing Feature Representation

Yoshihisa Kamohara, Takuto Sakuma, Shohei Kato
(Nagoya Institute of Technology, Japan)

In the agricultural field, the aim is to increase crop production in response to global economic development and the increase in biofuels. In order to increase crop production, deep learning techniques are being used to reduce losses by early detection of plant diseases, and significant results have been achieved in classification tasks. On the other hand, supervised learning is very costly in collecting and labeling disease data, which increases the burden on extension workers responsible for these tasks. In this paper, we propose a detection system for crop diseases using an unsupervised deep generative model, aiming at low-cost and time-saving automatic diagnosis of plant diseases.

GS26-2 Development of Hardware CPG Model for Biped Gait Control Capable of Changing Gait Cycle and Gait Pattern

Kenji Takeda[1], Motokuni Ishibashi[1], Takumi Ishihama[1], Tatsumi Goto[2], Kentaro Yamazaki[2], Megumi Aibara[2], Minami Kaneko[2], Fumio Uchikoba[2]
([1]Graduate School of Science and Technology, Nihon University, Japan)
([2]College of Science and Technology, Nihon University, Japan)

Robot motion is mainly controlled by a combination of CPU and program. On the other hand, human movement is controlled by a Central pattern generator(CPG). In this case, the human can switch between walking and running according to signals from higher centers and sensory information input to the spinal cord. We are studying robot locomotion control using a hardware neural network to mimic the neural network of the spinal cord with analog electronic circuits as a different method from conventional robot locomotion control. In this paper, we report on a hardware CPG model capable of changing gait cycle time in response to humans switching between walking and running.

January 27 (Friday), 10:45-12:00

GS26-3 Learning Shared Embedding Representation of Motion and Text Using Contrastive Learning

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

Multimodal learning of motion and text tries to find the correspondence between skeletal time-series data acquired by motion capture and the text that describes the motion. In this field, good associations can realize both motion-to-text and text-to-motion applications. However, the previous methods failed to associate motion with text, taking into account details of descriptions, for example, whether to move the left or right arm. In this paper, we propose a motion-text contrastive learning method for making correspondences between motion and text in a shared embedding space. We showed that our model outperforms the previous studies in the task of action recognition. We also qualitatively show that, by using a pre-trained text encoder, our model can perform motion retrieval with detailed correspondences between motion and text.

GS26-4 Research on schedule plan for Cuckoo Search applied to the neural network controller of a 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, an NC optimized by the cuckoo search (CS) method was developed. It was inspired by the mending behavior of the cuckoo, a bird. CS is a type of evolutionary computation algorithm that mimics the ecological behavior of organisms to optimize a controller. Previous studies have shown good evolutionary processes for NCs when the value of the scaling index varies in a stair in the schedule period. Therefore, the schedule plan of the proposed CS adjusts the scaling index as a linear function, nonlinear function, or stair. Computer simulations showed that an NC optimized by the scheduled CS method has superior control performance to an NC optimized by the original CS method. The best results were obtained when the schedule plan was set to a linear or nonlinear function rather than the stair plan.

GS26-5 Development of neural network controller optimized by Cuckoo Search for a jib crane installed on an unstable base

Shiu Oh, Kunihiko Nakazono, Naoki Oshiro, Eiho Uezato, Hiroshi Kinjo
(Graduate school of Engineering and Science, University of the Ryukyus., Japan)

This study proposes a neural network controller (NC) to control the load on a jib crane installed on an unstable base, such as a ship floating on the sea, with the NC optimized by cuckoo search (CS). The jib crane used in this study is controlled by only arm extension and retraction. This study aims to develop a jib crane system that can control the swing of a load equal to or greater than that of a skilled operator handling a jib crane. Simulation results show that the proposed NC has good control and generalization performance.

January 27 (Friday), 13:00-13:45

Room A

GS32 Sensor and multi-sensor data fusion

Chair: Hideki Hashimoto (Chuo University, Japan)

GS32-1 Development of broadband low-noise amplification circuits

Saiki Ueda, Kazuya Okamoto, Nobuo Iwasaki
(National Institute of Technology, Wakayama College, Japan)

In recent years, acoustic emission (AE) sensors are attracting attention for predicting and detecting machine failures. Amplification of small signals such as AE signals requires high amplification factor at high frequencies, and the GB product must be very large. However, operational amplifiers with a huge GB product are rare and expensive. The developed amplifier circuit uses an instrumentation amplifier or FET amplifier to reduce noise and amplify the signal. AE waveforms during operation of the hum slicer were measured using the developed amplification circuit and supply voltage with an AE measurement circuit equipped with a broadband AE sensor and an oscilloscope. The amplification circuit in this study succeeded in reducing the size and cost compared to existing testers. By employing an FFT amplifier, which was not used in the AE tester being compared, the measurement accuracy was confirmed to be improved.

GS32-3 Locomotion Activity Recognition from a Single Insole Sensor

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

In rehabilitation centers, patients are required to stay longer in the hospital to monitor their locomotion activity and recovery. This results in a longer length of stay and adds load to the health centers. Hence, to decrease the hospitalization length of stay, a personalized rehabilitation system is essential to measure and track patient locomotion activity until they gain ambulation. To realize such systems inertial sensors have been playing a great role in most recent studies. However, inertial sensors suffer from magnetization and drift errors. Therefore, in this study, only a plantar pressure sensor is used to measure the pressure change that happens during the interaction between the foot and the ground in a human walking motion. Three motion modes of walking namely: walking straight, turning left, and turning right are analyzed. From the pressure data distribution and its change, motion features are extracted to classify the three motion patterns by utilizing a Convolutional Neural Network (CNN). A good result was obtained which could provide a reference for human motion pattern recognition and a basis for further human motion analysis.

GS32-4 Identifying the principal electrodes in forearm surface EMG experiments via regularized neural networks and PCA

Takamasa Nanno[1], Kenji Leibnitz[2], Ferdinand Peper[2], Naoki Wakamiya[1]
([1]Osaka University, Japan)
([2]National Institute of Information and Communications Technology, Japan)

The estimation of a forearm's movements from surface electromyography (EMG) signals is important for the development of wearable devices embedded in clothes. However, in such applications, measurement is complicated by the complexity of the forearm’s structure, as well as by the difficulty to determine optimal locations for attaching the electrodes. This paper analyzes data obtained from 32 bipolar EMG electrodes by a 3-layer neural network trained by backpropagation with L1 regularization to estimate movements of the forearm, and validates the results by Principal Component Analysis. We find that approximately 20 out of the 32 electrodes characterize the movements. We expect this research to be useful for the development of clothing with a large number of embedded cheap sensors whereby movements of the wearer can be reliably estimated from a small subset of these sensors.

January 27 (Friday), 13:00-14:00

Room B

OS9 AROB: Robot control and HCI

Chair: Masahiro Yokomichi (University of Miyazaki, Japan)
Co-Chair: Nobuya Takahashi (University of Miyazaki, Japan)

OS9-1 Development of a collaborative mobile robot for inspection of monorail track

Yasunobu Hitaka, Keisuke Sato, Toshiya Shimojo
(National Institute of Technology, Kitakyushu College, Japan)

In this paper, the development of an inspection robot for the monorail track is presented. Previously, we proposed an inspection robot which has an automatic steering system in order to simplify the manipulation for the operator. However, there is a risk that the robot departs from the tracking trajectory due to sensor errors. Therefore we modify the robot which is omitted the steering system and runs on the track constraining itself on the track with four arms with guiding wheels. In this case, it is necessary to prevent the skid of one drive wheel. Therefore, we introduces the differential gear mechanism.

OS9-2 Research on Path Planning for UAV based on Geometrical Method

Nobuya Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)

In this paper, we propose a UAV trajectory generation algorithm that considers the geometric features of circles generated in the search space using a circle filling algorithm. Since each circle is generated considering the complexity of the environment and the clearance between the UAV and obstacles, it is possible to generate a more natural route compared to the route generation method based on a grid map that divides the space into a grid. can be done. Finally, the effectiveness of this method is demonstrated through numerical experiments.

OS9-3 A Control System Design based on Automatic Differentiation

Nobuya Takahashi, Fubuki Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)

In this paper, we propose a control system design method that simultaneously achieves the minimization of the quadratic performance index function and the desired response characteristics. It combines automatic differentiation, which is used in the field of machine learning, with LQR, which is a typical design method in modern control engineering. The desired response characteristic is formulated as an objective function. Through the minimization procedure, the value of the objective function obtained as a result of the initial value problem by numerical integration methods such as Euler's method, the weight matrices of LQR are Iteratively rearranged. This processing is performed by a gradient method using a gradient obtained by automatic differentiation. The validity and problems of the proposed method are discussed.

January 27 (Friday), 13:00-14:00

OS9-4 The method for reproducing the haptic feedback of fluid in a virtual space using multiple stimuli

Masataka Yokomichi, Nobuya Takahashi, Yuki Komatsu
(Graduate School of Engineering, University of Miyazaki, Japan)

The objective of this study is to reproduce the situation of touching a falling fluid in a virtual space with bare hands using two stimulation methods: vibration and wind. The fluid was created using Nvidia flex, a particle-based simulation method. The magnitude of the vibrations fed back from the motion of the particles was varied to reproduce the tactile sensation in combination with the warm wind from a hair dryer. Experimental results showed that the vibration and wind each had the effect of increasing the reproduction rate, and that the combination of the two stimulus had an even greater effect.

January 27 (Friday), 13:00-14:15

Room C

GS34 Swarm robotics

Chair: Kazuyuki Ito (Hosei University, Japan)

GS34-1 Proposal of a Bearing-only Shepherding Algorithm with Limited Sensing Capabilities

Aiyi Li, Masaki Ogura, Naoki Wakamiya
(Osaka University, Japan)

Bio-inspired swarm guidance and control offers simple and dynamic solutions to complex problems. Shepherding research provides an approach for manipulating swarms using shepherd agents. In this study, a bearing-only shepherding algorithm for a shepherd with no distance or proximity sensing capabilities is proposed. The proposed algorithm reorients the shepherd toward the flock and performs herding in side-to-side movements. This algorithm enables the shepherd to perform the shepherding task using only orientation information. We confirmed the effectiveness of this algorithm through numerical simulation results. This study could reveal the potential applications of nonlinear control and swarm robotic systems in the future.

GS34-2 Distributed Relative Position Recognition in a Robotics Swarm based on Local Observations by Individual Agents

KaChun Tai, Yuki Origane, Daisuke Kurabayashi
(Tokyo Institute of Technology, Japan)

This paper proposes a decentralized algorithm for each agent in a swarm to estimate its relative position within the swarm using local interactions with neighboring agents only. To achieve this, a local scalar state variable named phase is introduced to each agent of the swarm, and its value is updated using locally observed phase from nearby agents. Across multiple agents, wave-type interaction is observable in phase, which the analysis of its change enables each agent to distinguish its relative position within the swarm. Experiments were conducted on a swarm of multiple real robots with results proving the capability of this algorithm in assisting agents in the extraction of global information solely from locally available information.

January 27 (Friday), 13:00-14:15

GS34-3 Leader Estimation for the Unified Navigation of a Swarm among Multiple Attractive Sources

Mayuko Sunagawa, Yuki Origane, Hiroki Etchu, Daisuke Kurabayashi
(Tokyo Institute of Technology, Japan)

We proposed a leader estimation algorithm with local interactions to navigate the entire swarm to the strongest attractant. We assumed that the robot receiving the strongest sensory input must be the leader of swarm. Each robot is equipped with a phase oscillator and observes the relative phase gaps between neighboring robots. We hypothesized the magnitude of sensory input impacted by attractants is reflected in the angular velocity that drives the oscillator of each robot. Using the proposed algorithm, each robot locally compares its angular velocities with the others and increases its value to catch up to a superior angular velocity. This results in the convergence of the angular velocities of all robots towards a single maximum value. By distinguishing a robot that increases its angular velocity based on local interactions with others, it can identify whether it has maximum sensory input. This algorithm is mathematically guaranteed through an eigenvalue analysis.

GS34-4 tinySLAM-based exploration with a swarm of nano-UAVs

Mattias Vikgren, Johan Markdahl
(Swedish Defence Research Agency, Sweden)

This paper concerns SLAM and exploration for a swarm of nano-UAVs. The laser range finder-based tinySLAM algorithm is used to build maps of the environment. The maps are synchronized using an iterative closest point algorithm. The UAVs then explore the map by steering to points selected by a modified dynamic coverage algorithm, for which we prove a stability result. Both algorithms inform each other, allowing the UAVs to map out new areas of the environment and move into them for exploration. Experimental findings using the nano-UAV Crazyflie 2.1 platform are presented. A key challenge is to implement all algorithms on the hardware limited experimental platform.

GS34-5 A strategy for non-prehensile transportation of an object in a plane using multi-robot system.

Priyank Narvekar, Andrew Vardy
(Memorial University of Newfoundland, Canada)

In this paper, we propose a multi-phase control strategy for cooperative transport of a cage-able object by pushing using a group of omnidirectional vehicles. While an object can be unmanageable for a single robot to push and transport, we demonstrate via simulations that a team of cooperative robots can be used to transport such an object.The proposed control strategy is divided into two phases caging and cooperative transport. In the first phase, the robots start from arbitrary positions and then approach the object to be transported forming a cage around it. The second phase consists of cooperatively transporting the object ensuring it remains caged during transport. In the proposed strategy, the robots take a combination of centralized decisions made by interim leader as well as situations where robots behave autonomously while being in indirect communication. This indirect inter-robot communication is enabled by leveraging data grid as middleware which provides shared data structures. The use of data grid is something we haven’t seen leveraged before in the reviewed multi-robot systems, but believe could provide a promising middleware that can simplify inter robot communication, without having to develop application specific communication protocols. Through this paper we show the theoretical design of the coordinative motion control strategy for transportation using mobile robots leveraging the datagrid and demonstrate using the simulation the effectiveness of the proposed control framework in terms of feasibility.

January 27 (Friday), 13:00-14:30

Room D

GS24 Multi-agent systems & GS13 Evolution of cooperation

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

GS24-1 Evaluation of robustness for demand-responsive transportation (DRT) system

Tanapun SRICHANTHAMIT, Itsuki NODA
(Graduate School of Information Science and Technology, Hokkaido University, Japan)

In this study, we propose a new evaluation method to evaluate the robustness of demand-responsive transportation (DRT) system. The evaluation method is designed based on six objective criteria such as (1) Average riding time, (2) Average waiting time, (3) Average vehicle disutility time, (4) Average number of passengers sharing a vehicle,(5) Cancellation rate, and (6) Total number of drop-off passengers, respectively. A multi-agent simulation is used as a tool for investigating the complexity of transport systems and behavior of individual agents. However, a result of simulation cannot identify a majority view of the evaluation criteria. To get an estimated result, a simulation is conducted in Chiba city (Makuhari area) under varying configurations such as the demand occurrence frequency, the number of vehicles, and vehicle capacities. Then, the results of simulation are used to define a simple equation. By using the equation, the robustness of the DRT system can investigate and the adjustment of configurations can help to balance the relationship between the criteria.

GS24-2 Autonomous Highway Driving Using Reinforcement Learning with Safety Check System based on Time-to-Collision

Xiaotong Nie, Yupeng Liang, Kazuhiro Ohkura
(Hiroshima University, Japan)

Decision-making is an essential component of autonomous vehicle technology and received significant attention from academic and industry organizations. One of the promising approaches in designing a decision-making method is Reinforcement Learning (RL). In order to apply an RL algorithm to an autonomous driving problem, a feature representation of the state must first be chosen. The most commonly-used representation is the spatial-temporal state feature. However, if the number or order of the surrounding vehicles changes, the feature representation will be affected. In this paper, we utilize Time-to-Collision (TTC) as the feature representation and propose a TTC-based safety check system. The action output by the RL controller would be replaced with a safer action chosen by the safety check system when an agent detects a potential collision, i.e., the TTC is below the time threshold. A ramp merging task is used to illustrate the effect. Simulation results show that the proposed method can effectively improve the arrival rate and reduce the collision rate, even in the case of dense traffic situations. Furthermore, we also conducted experiments to examine the performance of the safety check system with different time thresholds.

GS24-3 Acquisition of Cooperative Behavior for Disaster Relief Robots Using Nash Q-Learning

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

Natural disasters such as the 2011 Great East Japan Earthquake and Hurricane Ian in the United States in 2022 caused catastrophic damage over a wide area. After a disaster strikes, saving lives quickly is an important issue. However, fully anticipating the overall effect on society is difficult due to the many as-yet-unrecognized factors at disaster sites. There is a need for autonomous disaster relief robots, which can learn from the conditions they encounter and then take independent actions. A system consisting of multiple disaster relief robots as agents can be treated as a Multi-Agent System (MAS). Reinforcement learning is applied to MAS as a method for agents to adapt to an unknown environment. We propose a method of an overall learning environment for MAS using Nash Q-learning. We examine the effectiveness of acquiring cooperative behavior in Nash Q-learning for the disaster relief problem.

January 27 (Friday), 13:00-14:30

GS24-4 Reinforcement Learning of Coordination with Centralized Critic Using Dual Encoders

Yuki Hyodo, Takuto Sakuma, Shohei Kato
(Graduate School of Engineering, Nagoya Institute of Technology, Japan)

In multi-agent reinforcement learning, all agents act based on their policy, which causes the agents to see other agents and the environment as changing dynamically during training. It is a called problem of non-stationarity that is the cause of unstable learning. A way to counteract non-stationarity is to share observations and actions of all agents during training, such as in a centralized critic. However, as the number of agents increases, the amount of information to be considered also increases. It is a known scalability problem that makes learning difficult. We propose a learning model that facilitates learning by inputting the values of other agents' observations and actions into dual encoders for feature extraction. In addition, the effectiveness of the proposed model is discussed by comparing it with MADDPG, one of the popular models of multi-agent reinforcement learning, in the problem of a cooperative scenario with many agents.

GS13-3 A Mechanism of Novelty Innovation and OEE in Evolution of a Web Service

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

Evolution involves open-endedness with which somewhat novel forms are continuously generated. Although open-ended evolution seems to be common in the nature, the process of novelty productions is unclear. The present study investigates evolutionary phenomena on the Web which are captured in a digital database of a social media platform and analyzes the production of novel tag usages and user activity. Our results suggest two modes of the novelty production; one that produces a large number of novelties around an innovation and another that bridges an innovation to next innovation. Also, users in the former mode showed low novelty production rate while the latter mode is driven by a small number of highly productive users. Although users accounted here are all inventors of novelty, these results suggest there are qualitative differences in the roles of their products in production of ongoing novelty and, potentially, the open-endedness of the system.

GS13-4 The second-order probabilistic pool punishment proportional to the difference of payoff can solve the problem of punishment of previous studies

Tetsushi Ohdaira
(Aoyama Gakuin University, Japan)

The public goods game is one of the models utilized in theoretical studies of social dilemmas where the pursuit of individual interests does not benefit society as a whole. In the context of the public goods game, the optimal response of participants is defection. Therefore, the evolution of cooperation in the public goods game generally requires punishment or reward. There are two types of punishment: peer punishment and pool punishment. The problem of peer punishment is the high cost of punishment, and the problem of pool punishment is that the cost of punishment is always incurred. Here, extending the previously proposed probabilistic pool punishment, we consider the punishment on cooperators (second-order free riders) as well as defectors. Comparing the pool punishment of this study with pool and peer punishment of existing studies, especially in terms of the average payoff, it is superior to pool and peer punishment of existing studies.

January 27 (Friday), 13:00-14:45

Room E

GS29 Robot vision and image processing 2

Chair: Keigo Watanabe (Okayama University, Japan)

GS29-1 Detection of a Boar inside a Trap Using Deep Learning

Besala Ifaso Francis, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Department of Mechanical Engineering, Ehime University, Japan)

Wild Boar is considered as one of dangerous animals for farmers all over the world because boar damage crops and destroys fields. Therefore, capturing wild boar is one of the effective solutions to help the farmer to solve this big problem. Currently, farmers use traps with manual triggers to capture wild boars in general. However, a recognition algorithm is necessary to carry out the capture work more efficiently. Recognizing the presence of boars in traps is an important element for developing a capture system with artificial intelligence. Our previous research was not able to recognize the boar in a trap. Therefore, a new recognition algorithm is needed to recognize a boar in a trap. For that, we collected a new dataset including images of boar in a trap and used it for training a recognition algorithm using deep learning algorithm of YOLO v5 to recognize a boar inside a trap.

GS29-2 Emotional Speech Recognition Based on Time Series Imaging

Zijun Yang, Shi Zhou, Meng Ge, Lifeng Zhang, Seiichi Serikawa
(Kyushu Institute of Technology, Japan)

Recently, more and more attention has been directed to the emotional recognition of speech signals. Many research proposes different proposals of speech emotion recognition. These proposals include test-based recognition and acoustics-based recognition. This research proposes a method that realized speech emotion recognition based on acoustics features. Combining with computer vision recognition technology, this proposal converts the speech signal to an image signal and uses deep learning to finish the emotion recognition. This research compares Piecewise Aggregate Approximation(PAA) with Largest Triangle Three Bucket(LTTB), Douglas Peukcer(RDP), and Visvalingam Whyatt algorithms to preprocess the speech signal. Then uses the Gram matrix to realize the speech-to-image transform. Using this approach, the research obtains the best processing is Visvalingam Whyatt algorithms and best deep learning parameters is Resnet34 with Adam optimizer and 1e-5 learning rate.

GS29-3 Study of a Method for Simultaneous Detection and Location Acquisition of Multiple Valves of the Same Standard by a Depth Camera for a Rescue Robot Arm

Jaefun Seo, Yoshiaki Yamazaki
(Meisei University, Japan)

Disaster rescue robots are required to perform a variety of advanced tasks such as turning valves, depending on the site conditions. When controlling manipulators to perform tasks such as grasping multiple objects, the accuracy of positional information on the object to be manipulated is an important issue. Therefore, we will combine the RealSense D435 depth camera and a newly designed and created 6-DOF manipulator for improve the autonomous search of disaster relief robots. By programmatically linking these two, we aim to automatically measure the distance to the detected valve and automatically control the gripper to grab the valve and rotate it by gripping it, by sending the position information of a specific valve out of the multiple valve position information obtained from the RealSense D435 to the 6-DOF manipulator. Multiple valves were detected from training data obtained by deep learning, and distance data obtained from RealSense D435 at different positions were displayed in 3D space and compared to actual distances to verify accuracy.

January 27 (Friday), 13:00-14:45

GS29-4 Automatic Process for 3D Environment Modeling from Acquired Image Sequences

Taku Matsumoto[1], Toshihide Hanari[1], Kuniaki Kawabata[1], Hiroshi Yashiro[1], Keita Nakamura[2]
([1]Collaborative Laboratories for Advanced Decommissioning Science, Japan Atomic Energy Agency, Japan)
([2]Sapporo University, Japan)

This paper reports on an automatic process for 3D environment modeling from acquired image sequences to quickly understand the situation inside the Primary Containment Vessel (PCV). We have studied methods of 3D environment modeling using an image sequence acquired from a camera to understand unknown situations inside the PCV for retrieving fuel debris safely and quickly. In the case of 3D environment modeling using images shot by the camera inside the PCV, the images are streamed from a camera mounted on a remotely operated robot over a local area network. However, because image acquisition and 3D environment modeling are different processes, each process is usually a tedious task that must be manually executed sequentially. Moreover, reconstruction results cannot be generated quickly because 3D environment modeling is time-consuming when using large numbers of images in an image sequence. In this paper, we develop an automatic process that integrates image acquisition and 3D environment modeling. The automatic process introduces an image selection method to reduce the computation time of 3D environment modeling. Therefore, the automatic process could be worked properly, and the computation time of 3D environment modeling could be reduced by using an image sequence from selected images by the image selection method than using an image sequence from all images.

GS29-5 Growing Neural Gas based Navigation System in Unknown Terrain Environment for an Autonomous Mobile Robot

Yuichiro Toda, Koki Ozasa, Takayuki Matsuno
(Okayama University, Japan)

Recently, various types of autonomous robots have been expected in many fields such as a disaster site, forest, and so on. The autonomous robots are assumed to be utilized in unknown environments. In such environments, a path planning to a target point set in the unknown area is a fundamental capability for efficiently executing tasks. To realize the 3D space perception, GNG with Different Topologies (GNG-DT) proposed in our previous work can learn the multiple topological structures with in the framework of learning algorithm. This paper proposes a GNG-DT based 3D perception method by utilizing the multiple topological structures for perceiving the 3D unknown terrain environment and a path planning method to the target point set in the unknown area. Especially, a traversability property of the robot is added to GNG-DT as a new property of the topological structures for clustering the 3D terrain environment from the 3D point cloud measured by 3D Lidar. Furthermore, this paper proposes a path planning method utilizing the multiple topological structures. Next, this paper shows several experimental results of the proposed method using simulation terrain environments for verifying the effectiveness of our proposed method. Finally, we summarize our proposed method and discuss the future direction on this research.

GS29-6 Effects of a dataset's lighting conditions on the training of a convolutional neural network

Valentin GRAVE, Osamu FUKUDA, Wen Liang YEOH, Hiroshi OKUMURA, Nobuhiko YAMAGUCHI
(Graduate school of Science and Engineering, Saga University, Japan)

Companies for which product quality is crucial still incorporate manual inspections in their manufacturing processes. Indeed, an operator can scrutinise an object from several angles and light intensities, operations that are still relatively problematic for an automated visual inspection system. In order to simulate the movements performed by an operator, we designed a system to carry out ”physical data augmentation” of images. The device allowed us to take pictures with a light source placed at different angles and with distinct intensities. These pictures where assembled as datasets, which were then used to train different YOLOv4 models. Finally, the abilities of these models in detecting scratches were compared to outline the impact of lighting settings on a neural network's training.

January 27 (Friday), 13:00-14:45

GS29-7 Recognizing stacked sheets of paper using an RGB-D camera for physical RPA

Tomohiro Uchimura[1], Hideaki Itoh[1], Hisao Fukumoto[1], Hiroshi Wakuya[2]
([1]Electrical and Electronic Engineering Course, Department of Science and Engineering, Graduate School of Science and Engineering, Saga University, Japan)
([2]Faculty of Education, Saga University, Japan)

Recognizing sheets of paper is important to create physical RPA systems, but it is a challenging problem when multiple sheets of paper are placed on top of each other. Since a sheet of paper is thin, it is hard to use depth information, and undesirable edges of the sheet of paper under the top sheet are visible. In this paper, we try to address this issue by providing a novel method for recognizing the top sheet of paper placed over another sheet of paper. Through experiments, we show that the top sheet of paper can be localized by using the brightness values of the pixels on the edges of the overlapping part of the sheets.

January 27 (Friday), 13:00-14:15

Room F

GS27 Neurocomputing technologies and its application for hardware

Chair: Ken Saito (Nihon University, Japan)

GS27-1 Basic Analog-Digital Circuit for Edge Detection Based on the Vertebrate Retina

Natsumi Kuroda, Kimihiro Nishio
(National Institute of Technology, Tsuyama College, Japan)

In this study, novel analog-digital edge detection circuits were proposed based on the vertebrate retina. The vertebrate retina is a pre-processor for image processing in the brain, and has superior functions such as edge detection and the motion detection. The proposed circuit was evaluated by the simulation program with integrated circuit emphasis (SPICE) with the 0.6 um complementary metal oxide semiconductor (CMOS) process. The simulation results with SPICE showed that the proposed circuits can operate normally. The test circuit of the unit circuit was fabricated with a 0.6 um CMOS process. The measured results showed that the unit circuit can detect the edge position. The novel edge detection circuit can be realized by applying the integrated circuits constructed with the array of the proposed unit circuits. In the future, the realization of new vision sensor can be expected by using the proposed circuit.

GS27-2 Basic Circuit for Motion Detection Based on the Vertebrate Retina with Low Power Consumption

Arisa Fukuda, Kimihiro Nishio
(National Institute of Technology, Tsuyama College, Japan)

In this study, basic analog-digital motion detection circuits with low power consumption were proposed based on the vertebrate retina. The proposed unit circuits for motion detection is constructed with an analog circuit for photoelectric conversion and the digital circuit for generating the motion signal. The proposed circuit was evaluated by the simulation program with integrated circuit emphasis (SPICE) with the 0.6 um complementary metal oxide semiconductor (CMOS) process. The test circuits of basic digital circuits were fabricated with the same process. In the simulation and the experiment, the power supply voltage was set to the low voltage. We found that the digital circuit become low power consumption by setting the low voltage. In the future, the novel motion detection sensor with low power consumption can be realized by applying the integrated circuits constructed with the array of the proposed unit circuits.

January 27 (Friday), 13:00-14:15

GS27-3 TransUNet with Unified Focal Loss for Class-imbalanced Semantic Segmentation

Kento Wakamatsu, Satoshi Ono
(Information Science and Biomedical Engineering Program, Department of Engineering, Graduate School of Science and Engineering, Kagoshima University, Japan)

Class imbalanceness, i.e. the inequality of the number of samples between categories, adversly affects machine learning models including deep neural networks. In semantic segmentation, extracting a small area of minor categories with respect to the entire image include the same problem as class imbalanceness, and such tasks exist in various application areas including medical images. This paper proposes a semantic segmentation method that considers global features and appropriately detects small categories. The proposed method adopts TransUNet architecture and Unified Focal Loss (UFL) function; the former allows considering global image features and the latter mitigates the negative effects of class imbalanceness. Experimental results with real-world applications showed that the proposed method successfully extracts small regions of minor classes without increasing false positives of other classes.

GS27-4 Estimation of Nonlinear Neural Dynamics Through Sequential Monte Carlo Method and Sparse Modeling

Takuma Ihara, Toshiaki Omori
(Kobe University, Japan)

Estimation of neural dynamics is important for elucidating brain function. Therefore, it is essential to solve the inverse problem of estimating the true system from observed data. However, it is difficult to estimate the neural dynamical system since there are many candidates for membrane currents. Furthermore, existing regression methods sometimes diverge due to noise. Therefore, we propose a sparse modeling approach to estimate the neural dynamics from noisy observation data. We employ the sequential Monte Carlo method and sparse modeling for the partial observation problem to extract only substantial membrane currents from a large number of candidates. Using our proposed method, multi-dimensional channel variables and conductances are successfully estimated only from the time variation of membrane potential.

GS27-5 Model Selection for Nonlinear Dynamical Systems Based on Gaussian Process Dynamical Models

Yuki Kishikawa, Toshiaki Omori
(Kobe University, Japan)

With the recent development of measurement technology, large amounts of time series data are handled in various fields, and understanding the important information behind these time series data has become an important issue in time series analysis. Dynamic systems are often nonlinear and the observation process is often unknown. In this paper, we propose a model selection method for nonlinear dynamical systems based on Gaussian processes. Based on Gaussian process, a lowdimensional nonlinear latent dynamical system is estimated from numerically generated high-dimensional observed time series data. Moreover, a model selection framework is realized by evaluating the likelihood derived for each nonlinear dynamical system in order to identify a specific nonlinear dynamical system for newly observed time series data. The results using numerical data show that the proposed method is effective for model selection for observed time series data, which are generated from nonlinear dynamical system.

January 27 (Friday), 14:30-15:15

Room B

GS35 Tele-operation

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

GS35-1 Development and evaluation of an Internet-reachable teleoperation module using the ROS-MQTT bridge for autonomous robot navigation with robotic cloud

Ryuhei Yamada[1], Daishi Yoshino[2], Tomohiro Tannai[3], Yuichi Yaguchi[1], Hiroyuki Kikuchi[3], Norifumi Suzuki[3], Keitaro Naruse[1]
([1]The University of Aizu, Japan)
([2]Compute Co., Ltd., Japan)
([3]East Japan Accounting Center Co., Ltd., Japan)

The present study proposes a new teleoperation framework applicable to autonomous robot navigation: it consists of the mobile robot controlled by ROS, MQTT bridge and server transferring the ROS topics over the Internet, and a robotic cloud to create and provide a navigation map. To teleoperate the autonomous navigation, the ROS topics sent from the control PC in a local site are translated into MQTT messages and transferred to a robot in a remote site through the ROS MQTT bridge module via the Internet. The teleoperation of autonomous robot navigation with the proposed framework was evaluated connecting two cities at distance of about 100 km by measurements of the round-trip-time (RTT) and the travelling time in the navigation. The results indicated that teleoperation with the developed ROS-MQTT bridge module can be performed as well as local control.

GS35-2 MI-Based EEG Classification in End-to-End Multi-Task Learning for Drone Operation in Real Time

Yuminosuke Sato, Yuichi Yaguchi
(University of Aizu, Japan)

Motor Imaging (MI)-based Brain-Computer Interface (BCI) enables control of several applications by decoding neurophysiological phenomena normally recorded by EEG in a non-invasive manner. Among them is the control of drone operations. However, despite significant advances in MI-based BCI, EEG signals are unique to each subject and show various changes over time. In addition, time cannot be devoted to analyzing EEG signals for real-time classification. Therefore, we sought to solve these problems by eliminating preprocessing and feature extraction through end-to-end multi-task classification. Therefore, we compared Min2Net, MI-EEGNet, EEGNet, Shallow Convolutional Network Excel and ERA-CNN, which perform MI-EEG classification with existing end-to-end learning. As a result, we measured classification speed and recorded an improvement in classification accuracy. As a result, Shallow Convolutional Network Excel was the model with the highest accuracy and f1 value. From here, the drone was operated in real-time using Shallow Convolutional Network Excel. Finally, its efficacy is proven a subject, while its performance is also demonstrated in the real-time control of a drone.

GS35-3 Technical Issues of Underwater Surveying in Urban Rivers

Takahiro KUDO, Etsuro SHIMIZU
(Tokyo University of Maritime Science and Technology, Japan)

Maritime Autonomous Surface Ships (MASS) are expected to be used in logistics, traffic, security, etc. in the future. When operating a ship, we must be careful of invisible objects underwater. Objects above water surface can be detected by the camera system. On the other hand, underwater objects are generally detected by acoustic sensors called “sonar”. Almost sonar products are expensive, so it is not realistic to mount them on all MASS. Therefore, it becomes possible for MASS to navigate safely and reasonably, by surveying underwater with a survey ship and preparing charts that includes objects. Because tourism and transportation are needed in urban, MASS are going to navigate in urban rivers. However, urban rivers are too shallow to survey. This paper describes technical issues and some experimental results in underwater surveying of urban rivers, for which the demand for MASS is expected to increase in the future.

January 27 (Friday), 14:30-15:30

Room C

GS7 Bio-inspired robotics

Chair: Tomohiro Hayakawa (University of Toyama, Japan)

GS7-1 Self-Repairing Robots Inspired by Molting

Aiko Miyamoto, Mitsuharu Matsumoto
(University of Electro-Communications, Japan)

In this study, we propose a robot with a self-repair function inspired by the molting of living organisms. It is difficult to maintain the same level of strength before and after repair in the repair methods of many robots with self-repair functions. To realize a robot that can repeatedly reinforce its exterior while maintaining the quality of the initial stage, we studied the structure of a self-repairing robot that can replace the exterior reinforcement by encapsulating the spare reinforcement inside the robot and pushing out the encapsulated reinforcement when the reinforcement is damaged. We show a prototype to show the concept of our study.

GS7-2 Contribution of Sensory Feedback in Swimming Locomotion of a Fish-type Simulation Model with Central Pattern Generators

Takahiro Fukui, Shuto Yoshinaga
(Tokyo Polytechnic University, Japan)

This study aims to develop a fish–type robot for ecosystem research. We develop a method to generate swimming locomotion based on biological concepts using a central pattern generator (CPG) and implement it in a fish–type simulation model. The method consists of joint motion generation based on CPG outputs and joint angle feedback to the CPG. The results of a simulation show that phase differences between joints are generated and fish-like traveling–wave swimming motion emerges even though it is not preprogrammed. Since joint angle feedback is important for the autonomous generation of traveling-wave swimming, we investigate the relationship between the feedback level and the emergent movement. As a result, the phase difference between joints converged in the range of 10 to 20% for a wide range of feedback gain. Swimming speed increases because the rotational frequency of the joints increases with the increase in the feedback gain.

GS7-3 The effects of material ratio scenarios on soft robot design based on co-evolution of morphology, material, and control

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

Soft robots, with their lightness and flexibility, have great potential to do things that are impossible with conventional rigid robots. They are designed primarily by hand, and there is a great need for automatic design methods to create higher-performance soft robots. We approach this challenge with soft robots based on a co-evolution of morphology, material type, and control. They are evolved by NEAT (Neuroevolution of Augmenting Topologies), and their phenotypes are encoded by CPPN (Compositional Pattern Producing Network). Each body is represented as a mass-spring system in 2D particle and rigid-body physics simulation environment. Our previous study on material selection suggested that the material selection scenario may have a significant impact on the final evolved soft robots. Following that result, we performed a deliberate manipulation of material proportion to observe the effects. We clarified the influence of material selection schemes throughout the generations on the final resulting soft robots through manipulation of the fitness function. We believe that these results will contribute to the methodology of automated soft robot design.

January 27 (Friday), 14:30-15:30

GS7-4 A Body-Powered Prosthetic Hand Using the User's Body Weight of a Forearm Amputees

RIHITO OGURA[1], TAKU ITAMI[2], JUN YONEYAMA[2]
([1]Aoyama Gakuin Graduate School of Science and Engineering, Department of Science and Engineering, Electrical and Electronic Engineering Course, Japan)
([2]Aoyama Gakuin University, Department of Electrical and Electronic Engineering College of Science and Enigineering, Japan)

In this study, we focus on the body-powered prosthetic hand, which is a prosthetic hand that utilizes residual functions, and propose a new body-powered prosthetic hand that can transmit the user's own body weight to the grasping function as a power source. It has been reported that the operation of a conventional body-powered prosthetic hand uses the front and middle parts of the trapezius and deltoid muscles. To verify the effectiveness of the new body-powered prosthetic hand, we performed simulated movements of a conventional body-powered prosthetic hand and the prosthetic hand developed in this study, and measured surface EMG in the anterior and middle deltoid muscles. The measurement results showed that the prosthetic hand developed in this study did not cause muscle fatigue in the deltoid muscle compared to the conventional body-powered prosthetic hand. Therefore, the body-powered prosthetic hand using its own weight improved operability.

January 27 (Friday), 14:30-15:30

Room F

GS33 Swarm robot

Chair: Bahar Haghighat (University of Groningen, Netherlands)

GS33-1 The Swarm within the Labyrinth: Planar Construction by a Robot Swarm

Andrew Vardy
(Memorial University of Newfoundland, Canada)

We propose an approach to guide simple robots through arbitrary environments while engaged in a planar construction task. The intent is to mitigate spatial interference between robots which often occurs in distributed robots operating on the same set of objects. Information can also be encoded within the structure of the labyrinth to provide auxiliary guidance, such as the direction in which objects should be incrementally moved to reach their goals. We show results in a simulation environment and study the impact of the number of robots deployed. We also provide validation on physical robots.

GS33-2 Echo State Networks for Embodied Evolution in Robotic Swarms

Motoaki Hiraga[1], Yoshiaki Katada[2], Kazuhiro Ohkura[1]
([1]Hiroshima University, Japan)
([2]Setsunan University, Japan)

Embodied evolution is an evolutionary robotics approach that implements an evolutionary algorithm over a population of robots and evolves while the robots perform their tasks. So far, most studies on embodied evolution utilize relatively simple neural networks as robot controllers. However, a simple structured controller might restrict robot behavior and lead to lower performance. This paper proposes an embodied evolution approach that uses echo state networks as robot controllers. The experiments are conducted using computer simulations, and the controllers are evolved in a two-target navigation task. The results show that the echo state network controllers outperform the conventional controllers.

January 27 (Friday), 14:30-15:30

GS33-3 Simulation of swarm robot synchronization using VDP oscillator

Julie Fromager, Junichiro Tahara, Morito Makoto, Shun Fujii
(Tokyo University of Marine Science and Technology, Japan)

This paper describes a simulation method for creating swarm robots using nonlinear synchronization based on the Van der Pol oscillator. These swarms are used for ocean survey purposes. This nonlinear synchronization is inspired by fireflies or ants, which are able to create colonies by synchronizing signals. Inside the colonies, individuals are able to share information with other means, in the same way that animals share information through pheromones, gene sharing, or breeding. The colonies are efficient in the research of food and the feeding of a large group of individuals. The simulation results showed that the robots were able to synchronize their VDP signal and create large colonies. The robots and colonies were also able to feed themselves by locating food or other robots eating when their food level is low.

GS33-4 The Exploitation of “Unfavorable” Environmental Effects in a Centipede-type Swarm Robot System for Unknown Environment Navigation and Exploration

Runze Xiao, Yusuke Tsunoda, Koichi Osuka
(Osaka University, Japan)

This research proposes a centipede-type swarm robot system "ICT-Swarm" that facilitates the communication, control, and sensing system of robots by taking full advantage of "unfavorable" environmental effects to achieve exploration and navigation of a 2D unknown environment. It is important to emphasize that there is no communication or observation between robots in this system and the direction angle of the goal direction relative to the robot’s forward direction is the only input signal for the robot individual. And the positive impact of "unfavorable" environmental effects like robot collisions, signal noise, and signal interval on navigation and exploration of "ICT-Swarm" in a 2D unknown environment was verified through simulation experiments in the robotics simulator CoppeliaSim.