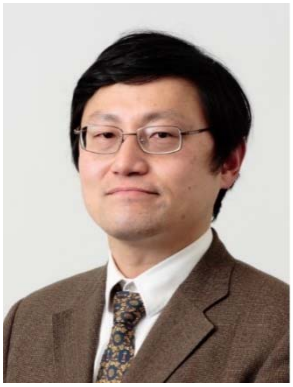
ABSTRACTS

Plenary Speech 1 (Room G)

January 22 (Wednesday), 11:00-11:50

Chair: Ken Naitoh (Waseda University, Japan)



Social simulation on HPC

Nobuyasu Ito

RIKEN Center for Computational Science, Japan

The explosive development of ICT is revolutionizing science and technology and is finally changing society. In this sense, cutting-edge HPC systems called "supercomptuers" are expected to become a force for designing and realizing a better future by linking big data analysis, simulation research, AI, etc. This vision will feeds back into future HPC architectures in the post-Moore era with AI applications and quantum technologies. In this talk, I will share this perspective with examples from simulation research ranging from molecular systems to human society.

Biography:

Education

1986 March	Graduated from Department of Physics, Faculty of Science, The University of Tokyo
1991 March	Graduated from Department of Physics, Graduated School of Science, The University of Tokyo Awarded the degree of D. Sc. for a thesis entitled "Monte Carlo Study of the Ising Model" supervised by Prof. Masuo Suzuki

Employment

1989 April - 1991	MarchJSPS Research Fellowship for Young Scientists(DC)
1991 March	Researcher in Japan Atomic Energy Research Institute
- 1993 September	during this term, Guest Researcher in Institute for Theoretical Physics, University of Cologne(Germany) and in HLRZ, KFA Juelich(Germany)
1993 October	Lecturer in School of Engineering, The University of Tokyo
- 1996 September	during this term, in ESPCI, Paris(France), in Institute for Theoretical Physics, University of Cologne(Germany)
1996 April	Guest Researcher in Polymer Research Center, Boston University, U.S.A.
1996 October	Associate Professor in the University of Tokyo
- 2019 March	during this term, Visiting Associate Professor in Institute of Statistical Mathematics(Japan) and in University of Henri Poincare, Nancy, France
2012 October -	Team Leader of Discrete Event Simulation Research Team, RIKEN Advanced Institute for Computational Science
2023 April -	Unit Leader of Quantum Computing Simulation Unit, RIKEN Advanced Institute for Computational Science

Plenary Speech 2 (Room G)

January 23 (Thursday), 11:00-11:50

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

Recent Advances in Understanding Human Emotion through AI

Dong Seog HAN

Kyungpook National University, Korea

Advancements in artificial intelligence (AI) have significantly improved our understanding of human emotions. Emotion recognition is crucial in healthcare, customer service, and human-computer interaction, offering personalized and practical solutions. This talk will provide an overview of the importance and applications of emotion recognition, setting the stage for an in-depth exploration of the latest neural network architectures. We will examine convolutional neural networks (CNNs), VGGs, Inception, ResNet, and Xception, highlighting their roles in improving emotion recognition accuracy. These advancements bring us closer to reliable emotion detection despite challenges such as irrelevant facial images, diverse backgrounds, and varying image sizes.

Next, we will discuss the facial image threshing (FIT) machine, which was developed to enhance dataset quality by removing irrelevant features and standardizing images. Building on this, we will examine facial landmark-based emotion recognition, which uses deep learning to detect crucial facial points, and context-based emotion recognition, which incorporates contextual information for robust accuracy. Context-based models are particularly significant as they consider environmental and situational factors, leading to a more comprehensive understanding of emotional expressions. The effectiveness of these models, evaluated using datasets like FER2013 and EMOTIC, demonstrates significant improvements in handling diverse emotional expressions.

Overall, this talk will provide a deep understanding of the current state and potential of AI-driven emotion recognition, focusing on its transformative impact on the development of more intelligent systems.

Biography:

Dong Seog Han (Senior Member, IEEE) received his B.S. degree in Electronic Engineering from Kyungpook National University (KNU), Daegu, South Korea, in 1987, and the M.S. and Ph.D. degrees in Electrical Engineering from Korea Advanced Institute of Science and Technology, Daejeon, South Korea, in 1989 and 1993, respectively. From 1987 to 1996, he was with Samsung Electronics Company Ltd., where he developed the transmission systems for HDTV receivers. Since 1996, he has been a professor at the School of Electronics Engineering, KNU, as a professor. In 2004, he was a Courtesy Associate Professor in the Department of Electrical and Computer Engineering at the University of Florida. He was the Director of the Center of Digital TV and Broadcasting at the Institute for Information Technology Advancement from 2006 to 2008. He has been the Director of the Center for ICT and Automotive Convergence, KNU, since 2011. His research interests include intelligent signal processing and autonomous vehicles.

Plenary Speech 3 (Room G)

January 23 (Thursday), 15:00-15:50

Chair: Reiji Suzuki (Nagoya University, Japan)

From "Life-as-It-Could-Be" to "Mind-as-It-Could-Be": Rethinking Reality, Presence, and Consciousness through Virtual and Extended Reality

Keisuke Suzuki

Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN), Hokkaido University, Japan

Artificial Life (ALife) is an interdisciplinary field that seeks to understand life and cognition through a constructive approach—"understanding by building." By recreating biological principles in computational simulations and artificial systems, ALife provides a unique lens through which to examine phenomena such as biological evolution, adaptation, and emergent behavior. While early ALife research focused on fundamental properties of living systems, such as self-replication and metabolism, it has since expanded to encompass a diverse range of topics, including language, social interaction, art, and architecture [1].

In parallel, cognitive psychology and neuroscience have begun leveraging virtual reality (VR) technologies, such as head-mounted displays, to produce highly realistic and immersive environments. This shift allows researchers to move beyond simple two-dimensional stimuli, enabling the systematic manipulation of embodied experiences [2,3]. As a result, the bodily dimensions of perception and cognition have gained increasing prominence.

Despite apparent differences in methodology and philosophy, ALife and VR share a key commonality: both replace aspects of the natural world—whether biological life or lived experiences—with artificial constructs. Just as ALife simulates "life-as-it-could-be," VR experiments can be viewed as explorations of "mind-as-it-could-be" by substituting naturally occurring sensory information with artificial stimuli. Rather than merely reproducing existing phenomena, both fields strive to distill and abstract the essential features of complex systems.

Recently, the rapid development of VR and generative AI technologies has blurred the line between physical reality and virtual environments. These technologies produce highly realistic, immersive experiences that compel us to revisit long-standing philosophical questions: What is reality, and how do we perceive it? We are now able to more directly investigate some of these questions using the state-of-the-art VR and AI methods, leveraging the constructive approach shared by ALife and VR research.

In this talk, I will first introduce experimental approaches that utilize VR to explore cognitive and computational mechanisms underlying our perception of reality. Of particular interest is the subjective feeling of "being here and now"—a fundamental sense of presence [4,5]. Our VR-based experiments demonstrate that real-time sensorimotor contingencies enhance the perceptual presence and salience of virtual objects, as measured by their ability to break through binocular visual suppression paradigms [6]. These findings highlight the importance of sensorimotor contingency in shaping our subjective sense of reality.

I will also present the "Hallucination Machine," a computational framework designed to simulate the phenomenological characteristics of visual hallucinations [7]. By employing deep convolutional neural networks, the system artificially synthesizes hallucinatory imagery that participants can experience in immersive 360° VR environments. The reported experiences closely resemble those induced by psychedelics, suggesting that the Hallucination Machine is not only a promising new tool for studying altered states of consciousness but also a means of approximating top-down and bottom-up processes in perception.

Taken together, this interdisciplinary approach—integrating XR, generative AI, and neuroscience— sheds new light on the cognitive and neural underpinnings of how we perceive reality. These findings contribute to longstanding philosophical debates about the nature of reality, bear clinical relevance for disorders involving dissociation, and offer new directions for designing more immersive virtual environments.

Since the first international ALife conference in the 1980s, the field's constructive approach has significantly influenced embodied cognitive science, which emphasizes the continuity between life and cognition and engages with philosophy of mind and cognitive neuroscience. Within this expanding landscape, VR emerges as a powerful tool for manipulating embodied interactions and advancing a phenomenological understanding of consciousness.

By applying ALife's foundational principles to virtual reality, we begin to chart a path toward realizing "Mind-As-It-Could-Be" and opening new frontiers for cognitive science and beyond.Each paper must consist of two parts. The first part contains the paper title, authors' names, abstract, and keywords. The second part is the main body of the paper.

Biography:

Keisuke Suzuki obtained his Ph.D degree on the subject of artificial life from the University of Tokyo in 2007. He stayed as a research fellow in RIKEN Brain Science Institute, where he carried out research into human cognitive functions in virtual reality environments (2008-2011). After leaving Japan, he worked as a research fellow at the Sackler Centre for Consciousness Science in University of Sussex, UK (2011-2021), where he developed various virtual reality platforms for the experimental study of embodied self-consciousness. In 2021, he joined the Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN) in Hokkaido University, Japan as a specially appointed lecturer to continue his work in embodied cognition and conscious presence. One of Keisuke's key research focuses is about conscious presence; i.e. the subjective feeling of being "here and now". The sense of presence is one of the important aspects of our subjective conscious experience, but its underlying neural mechanisms remain poorly understood. His approach builds on state-of-the-art virtual reality to experimentally manipulate the bodily and mental states, which is complimented by theoretical modeling.

Invited Talk 1 (Room A)

January 22 (Wednesday), 13:00 - 13:30

OS11 AROB: Human-Centered Robotics

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

Human-Centered Robotic Emotional Support

Alexis E. Block

Assistant Professor, Case Western Reserve University (CWRU),
Cleveland, US

Hugs are one of the first forms of contact and affection humans experience. Receiving a hug is one of the best ways to feel socially supported, and the lack of social touch can have detrimental effects on an individual's well-being. However, hugs are complex affective interactions that are easy to get wrong because they need to adapt to the approach, height, body shape, and preferences of the hugging partner, and they often include intra-hug gestures like squeezes. We created HuggieBot, an interactive hugging robot, to better understand the intricacies of close social-physical human-robot interaction and as a stepping stone to providing emotional support. Through the iterative, human-centered design process of creating HuggieBot, we developed 11 tenets of robotic hugging, which ensure a robot can provide its partner with a high-quality embrace. These guidelines can be abstracted to guide designing other robots for emotional support. My new lab, the SaPHaRI (social and physical human-robot interaction) Lab, is looking to support humans through various robotic morphologies and interactions.

Biography:

Aexis E. Block is an Assistant Professor at Case Western Reserve University (CWRU) in Cleveland, OH. She leads the Social and Physical Human-Robot Interaction (SaPHaRI) Lab, where they are working to advance robotics by fostering meaningful social and physical interactions by integrating emotional intelligence to address mental health challenges and provide emotional support. Her goal is to create innovative technologies that enhance human well-being through empathetic, responsive robots. Before joining CWRU, she supported her two-year post-doc at UCLA with a competitive Computing Innovations (CI) Fellowship. She obtained her Dr. sc. In Computer Science from ETH Zurich and the Max Planck Institute for Intelligent Systems. Prior to her Dr. sc., she earned her Bachelor's (Mechanical Engineering and Applied Mechanics) and Master's (Robotics) degrees in 2016 and 2017, respectively, both from the University of Pennsylvania. She was named an inaugural "Microsoft Future Leaders in Robotics and AI" (2023), a Rising Star in Mechanical Engineering (2020), and an HRI Pioneer (2018). She has served as the General Chair for the Gordon Research Seminar in Robotics (2022) and HRI Pioneers (2019). She won the Best Hands-On Demonstration at EuroHaptics (2022) and was awarded the Max Planck Society Otto Hahn Medal (2022) for outstanding scientific achievement by a junior scientist.

Invited Talk 2 (Room A)

January 22 (Wednesday), 15:00-15:30

OS10 AROB: F-REI New Research Unit in the Robotics Field: Autonomy, Intelligence and Swarm Control

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)
Co-Chair: Satoshi Suzuki (Chiba University, Japan)

What is F-REI? The trends and prospects for swarm control with high levels of autonomy and intelligence

Kenzo Nonami

Field of Robotics, Fukushima Institute for Research, Education and Innovation (F-REI), Japan

First of all, this presentation will introduce what F-REI is and what kind of organization it is. Also, I will introduce the field of robotics in F-REI. This talk will also discuss the aims of this session's focus on autonomy, intelligence, and swarm control. In particular, I will discuss the current state of research and near-future prospects for swarm control, which has a high degree of autonomy and intelligence.

This talk will introduce a distributed control, mutual communication, and self-organization, which are the main concept and components of swarm control. Finally, I will also introduce areas of application such as peacetime logistics, environmental monitoring, and disaster response in emergencies.

Biography:

In 1979, **Dr. Kenzo Nonami** got a Ph.D at Tokyo Metropolitan University. From 1985 to 1988, he was a researcher and senior researcher at the National Aeronautics and Space Administration (NASA). In 1988, he was an associate professor at Chiba University, and he was promoted to professor at Chiba University in 1994. In 2008, he served as director and vice president (for research) at Chiba University. In 2013, he founded the university-based venture, Autonomous Control Systems Laboratory Co., Ltd. (ACSL) and became its CEO and representative director. In 2014, he became a distinguished professor at Chiba University (professor emeritus at Chiba University). In 2018, he became chairman of the board of directors at ACSL. In 2019, he founded the Advanced Robotics Foundation, a general incorporated foundation, 2022, he founded his second venture company, Autonomy Co., Ltd. (now Autonomy HD Co., Ltd.). Dr. Kenzo Nonami has been serving as director, field of robotics at the Fukushima International Research and Education Institute (F-REI) since 2023.

Invited Talk 3 (Room A)

January 23 (Thursday), 9:00 - 9:30

OS7 AROB: Construction of lunar bases and lunar exploration by AI-powered robots

Chair: Ryusuke Fujisawa (The University of Kitakyushu, Japan)
Co-Chair: Yuichi Ambe (Osaka University, Japan)

A Hierarchical Learning Method for Modular Robot Control

Jun Morimoto

Graduate School of Informatics, Kyoto University, Japan

Such as in a space environment where it is difficult to send or produce many robot components, it is necessary to combine a limited number of robot modules to accomplish multiple tasks with multiple body configurations. However, as the body configuration changes, a controller is needed to be designed for each body. In this study, we propose a component-wise learning approach to transfer the acquired policies of each component to a different robot configuration. To evaluate our proposed method, we used a manipulator model composed of multiple heterogeneous modules. In the first stage of our learning approach, each module acquired policies to cope with multiple tasks. Then, in the second stage, we hierarchically connect the trained modules by using an encoder-decoder network to transfer acquired skills in each component to control the combined robot model. We discuss the usefulness of transferred policies in reducing the number of samples required to accomplish the tasks with the combined robot system.

Biography:

Jun Morimoto is a professor at the Graduate School of Informatics, Kyoto University. He received his Ph.D. in information science from Nara Institute of Science and Technology (NAIST), Nara, Japan, in 2001. From 2001 to 2002, he was a postdoctoral fellow at the Robotics Institute, Carnegie Mellon University, Pittsburgh, PA, USA. He Jointed ATR in 2002. From 2019 to 2021, he was a team leader of the Man-Machine Collaboration Research Team, Robotics Project, RIKEN. He is also currently the Head of the Brain-Robot Interface Department at ATR Computational Neuroscience Laboratories.

Invited Talk 4 (Room A)

January 23 (Thursday), 13:00 - 13:30

OS8 AROB: Construction of lunar bases and lunar exploration by AI-powered robots

Chair: Ryusuke Fujisawa (The University of Kitakyushu, Japan)
Co-Chair: Yuichi Ambe (Osaka University, Japan)

TRIAL FOR SPACE HABITATION: HOMEOSTATIC INFLATABLE DECENTRALIZED AUTONOMOUS STRUCTURE (HIDAS)

Shinichi Kimura

Tokyo University of Science, Japan

Recently, human space activities, such as lunar exploration and habitation, have attracted widespread interest. To enhance human space activities, especially for long-distance missions, improving the technologies needed to live in space environments for long periods is essential. Many of these technologies overlap with terrestrial habitation technologies. The Tokyo University of Science (TUS) has established the Research Center for Space System Innovation (SSI) to link technologies being studied for terrestrial applications with their potential utilization in space to achieve dual space–terrestrial development.

As for construction of habitation space, inflatable structure has merits to construct space system because of high compression ratio and light weight, but it still had problems in case that it is partially damaged. It is also difficult to control it deploying process and shape. HOMEOSTATIC INFLATABLE DECENTRALIZED AUTONOMOUS STRUCTURE (HIDAS) is a concept to overcome these problems using multiple autonomous inflatable cell. HIDAS can mitigate affects of partial damage controlling inflatable patterns of cell. Enhancing such decentralized autonomous intelligence, HIDAS can control its inflate sequence. In addition, HIDAS can emerge various functions by changing its shape dynamically, such as to adapt autonomously unevenness of the ground and dynamically changing environment, and locomoting changing its shape dynamically like a swam. We develop 5m diameter and 5m long concept model of HIDAS and demonstrated its functions. In this presentation, the trial of SSI, the concept of HIDAS and its functions are introduced.

Biography:

Shinichi Kimura received the B. S. degree in chemistry on drug manufacturing from Tokyo University, Tokyo, Japan, in 1988 and M. S. and Ph. D. degrees in pharmacology from Tokyo University, Tokyo, Japan, in 1990 and 1993 respectively. In 1993 he joined the Communications Research Laboratory (which was converted to the National Institute of Information and Communication Technology in 2004). In 2007, he moved to Tokyo University of Science. He has been engaged in the visual guidance and navigation system for the space debris removal. He made experiments on Manipulator Flight Demonstration on STS-87, Engineering Test Satellite VII which is the first tele-robotic satellite, visual monitoring system for the Hayabusa-2 and IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun). He is engaging various missions, developing on-orbit cameras and research on space habitation.

January 22 (Wednesday), 09:00-10:30

Room A

GS29 Multi-agent systems

Chair: Mari Nakamura (AIST, Japan)

GS29-1 LLM-mediated Dynamic Plan Generation with a Multi-Agent Approach

Reo Abe, Akifumi Ito, Kanata Takayasu, Satoshi Kurihara
(Keio University, Japan)

Planning methods with high adaptability to dynamic environments are crucial for the development of autonomous and versatile robots. We propose a method for leveraging a large language model (GPT-4o) to automatically generate networks capable of adapting to dynamic environments. The proposed method collects environmental "status," representing conditions and goals, and uses them to generate agents. These agents are interconnected on the basis of specific conditions, resulting in networks that combine flexibility and generality. We conducted evaluation experiments to compare the networks automatically generated with the proposed method with manually constructed ones, confirming the comprehensiveness of the proposed method's networks and their higher generality. This research marks a significant advancement toward the development of versatile planning methods applicable to robotics, autonomous vehicles, smart systems, and other complex environments.

GS29-2 Improved Cooperative Evacuation Guidance Model using Multiple Mobile Robots

Kazuki Watanabe, Ryoma Toyomi, Atsuo Ozaki
(Osaka Institute of Technology, Japan)

Effective evacuation guidance is an important issue in disaster management, and cooperation among multiple guides (agents) is indispensable. In this paper, we propose an improved distributed cooperative search method that assumes virtual forces among multiple agents and evaluate it by measuring average steps taken by evacuees to complete evacuation and the number of successful evacuations attempts in multiple cases. As a result, we confirmed that the model in which the forces of attraction and repulsion are equal when the distance between the current location and the destination is proportional to one-square of the distance between the current location and the destination was the most effective because the number of successful evacuation attempts was high, and the accuracy was high. In the future, we plan to further improve the method and conduct evaluations in an environment close to that of the real world.

GS29-3 Generating Cooperative Behavior of the Multi-agent System in the Volleyball Game with Communication

Mingyuan Ni[1], Daichi Morimoto[2]
([1]Hiroshima University, Japan)
([2]Kyushu Institute of Technology, Japan)

This paper focuses on generating cooperative behavior of a multi-agent system(MAS) in a volleyball game scenario. In the field of MAS, cooperation among agents is essential to operate the system efficiently in tasks. To discuss designing cooperation, we employed the volleyball game as the new testbed. The agents in volleyball games face more dynamic situations; agents have to trace the moving ball in 3D space and determine the next action before the ball falls down. To design an agent controller, we focused on reinforcement learning techniques. Additionally, communication among agents is an important factor in designing cooperation. This study aims to design the communication protocol automatically by simple reinforcement learning. The proposed approach was examined by the computer simulations that emulate two vs two volleyball games. The experimental result showed that simple reinforcement learning successfully trained the agent's behavior. Additionally, agents using communication outperformed the team without communication.

January 22 (Wednesday), 09:00-10:30

GS29-4 Reactive Persistent Surveillance by Heterogeneous Multi-agents with Energy Constraint

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

When natural disasters occur, accurately assessing the situation in a changing environment requires rapid and persistent observation. Replenishing energy resources such as batteries and fuel is necessary for the multi-agents to continue covering the vast area and making observations. In this research, we discuss a method for selecting the direction of movement for observation by calculating utility values based on mutual information and remaining energy. Through utility value-based action determination, agents fundamentally decide their movement directions based on mutual information, but as their energy levels decrease, they become more likely to choose the shortest path to a supply station. To verify the proposed method, we conducted experiments on persistent observation simulations in a changing environment. The experimental results demonstrated that heterogeneous multi-agents can perform reactive observations while resupplying energy through the proposed method.

GS29-5 Designing controllers of robotic swarms using offline reinforcement learning with attention mechanism

Atsushi Fujita[1], Kaito Yamane[1], Arumu Iwami[1], Daichi Morimoto[2]
([1]Hiroshima University, Japan)
([2]Kyushu Institute of Technology, Japan)

This study focuses on designing controllers of robotic swarms using offline reinforcement learning (offline RL) with attention mechanism. This offline RL is the method to train policies using previously collected datasets. This mechanism enables high data efficiency in the training process. Therefore, offline RL can utilize large-scale datasets to enhance the generalizability of the agent. In this study, we employed Scaled Q-Learning (Scaled QL) which is one of the offline RL methods, to design a controller of robotic swarms. This approach aims to improve the flexibility of the robotic swarms for environmental variations captured by robot-POV images. The performance of Scaled QL was compared with Neuroevolution which is the evolutionary robotics approach. The results of computer simulations showed that the Scaled QL exhibited better performances than Neuroevolution for environmental variations. The results also indicated that the controllers trained by Scaled QL focused more on other robots than Neuroevolution.

GS29-6 Deep Reinforcement Learning Method Considering Vehicle Sizes for Cooperative Autonomous Driving

Akito Takenaka[1], Tomohiro Harada[2], Yukiya Miura[1], Kiyohiko Hattori[3], Johei Matuoka[4]
([1]Tokyo Metropolitan University, Japan)
([2]Saitama University, Japan)
([3]Tokyo Denki University, Japan)
([4]Tokyo University of Technology, Japan)

This study proposes a DRL method that considers vehicle size to achieve more cooperative autonomous. Specifically, we incorporate two approaches to utilizing size information and three vehicle size encodings as input of vehicle size into the conventional method. We conducted simulation experiments using vehicles of sizes corresponding to standard cars and medium-sized trucks. We examined seven learning methods, including the conventional method and the combinations of two approaches to utilizing size information and three input encodings. Experimental results show that the proposed method using the size of a standard-sized vehicle as a reference to calculate the size ratios of other vehicles relative to the reference vehicle and using only own vehicle size demonstrated the highest performance. However, its advantage over the conventional method was not statistically significant, and no conclusive evidence was found to suggest that incorporating size information is beneficial for acquiring cooperative driving behavior.

January 22 (Wednesday), 09:00-10:15

Room C

GS12 Control and analysis techniques

Chair: Jae Hoon Lee (Ehime University, Japan)

GS12-1 Anisotropic Texture Control in 3D Food Printing With Variable Pitch

Koki Fujiwara, Jun Ogawa, Hidemitsu Furukawa
(Yamagata University, Japan)

In conventional 3D food printing, variations in texture are generally achieved either by utilizing two types of food inks with differing hardness or by modifying the infill structure using a single material. However, for care foods, it is crucial to maintain an appearance consistent with that of regular meals. This study introduces a variable pitch technique to produce textural variations while preserving the same visual appearance and weight, using only a single type of food ink. By adjusting the layer height, this method induces anisotropy in hardness within the printed structure, enabling texture differentiation without the need for multiple materials. Specifically, in the Z-direction, the measured hardness values were 3.34 ± 0.29 N at a pitch of 0.3 mm, 3.00 ± 0.33 N at 0.6 mm, and 1.89 ± 0.37 N at 0.9 mm, with hardness increasing as the pitch decreased.

GS12-2 Detection of conductor break position by high-frequency signal

Daichi Dezaki, Kazuya Okamoto, Nobuo Iwasaki
(National Institute of Technology, Wakayama College, Japan)

In recent years, electronic devices require smaller and lighter printed wiring boards and mounted ICs for convenient portability. As a result, the lead spacing of ICs is becoming narrower and the PWBs are becoming denser. When narrow pitch ICs are soldered, there is a high possibility of disconnection failures between IC leads and lands on the PWB due to poor soldering. In this study, we consider a more reliable method to inspect disconnection failures. In this inspection method, a detection circuit using the electrical characteristics of CMOS inverter gates was assembled on a breadboard. An inspection probe from the detection circuit is brought into contact with the leads for logic signal input in the target circuit. By comparing the current detected when the probe is applied and the voltage at the point of failure, a disconnection failure in the IC lead is detected.

GS12-3 Social Networking and Firm Performance: Evidence from Taiwan

Wen-Jhan Jane, Ya-Chu Chang, Chia-Ching Chang
(Shih Hsin University, Taiwan)

The study analyzes the impacts of board members' and key managers' social networking on company performance in Taiwan, focusing on firms listed in the FTSE TWSE Taiwan 50 Index. Our results show that social networking among board members and key managers has a negative impact on firm performance, as evidenced by significant negative correlations in net income (NI), return on equity (ROE), and return on assets (ROA). This finding implies that expanding social networks may increase the external dependence of board members or divert their attention from the firm's internal affairs, which could adversely affect financial performance.

January 22 (Wednesday), 09:00-10:15

GS12-4 Automated grasping and releasing of pollen in microscope

Ryodai Yata, Kenta Tabata, Renato Miyagusuku, Koichi Ozaki
(Utsunomiya University, Japan)

This work focuses on the automation of pollen selection operations using a microscope. Using readily available equipment, we developed an automated system. In the automating of pollen selection operation, it is necessary to detect pollen and end-effectors and position end-effectors in the 3-D direction. Depth distance cannot be measured directly on a microscope because the camera can only be mounted vertically. Therefore, we automated the process by using a method for estimating depth distance using the contour blur width. The grasp and release motion was automated based on a mechanical approach. We showed 100% performance for the contour blur width extraction and 70% for depth positioning. Also, we also showed 95% and 21% pollen grasp and release performance.

GS12-5 Proportional-Integral-Derivative Enhancement for Horizontal Pod Autoscaling in Kubernetes

Wen-Tin Lee[1], Wei-Ting Jian[1], Shang-Pin Ma[2]
([1]National Kaohsiung Normal University, Taiwan)
([2]National Taiwan Ocean University, Taiwan)

Microservices architecture and containerization technologies have been widely adopted in developing large-scale systems, with Kubernetes emerging as the preferred platform for ensuring reliable service operations. Despite its widespread use, the native Horizontal Pod Autoscaling (HPA) often falls short of handling sudden traffic surges effectively. Its default scaling mechanism can result in delayed or insufficient Pod adjustments, leading to service degradation. To overcome these limitations, we propose PIDC-HPA, a PID-Controller-based HPA algorithm that introduces a rapid scaling strategy for increased responsiveness and a gradual descaling approach to enhance service stability while minimizing operational costs. Experimental results demonstrate that PIDC-HPA significantly enhances scaling performance compared to the standard Kubernetes HPA. It reduces the frequency of scaling adjustments while boosting request processing capacity by approximately 20% to 30%. By improving scaling efficiency and system stability, PIDC-HPA minimizes the time and technical resources required for resource management, providing essential support for applications that require rapid responsiveness and high reliability.

January 22 (Wednesday), 09:00-10:30

Room D

GS1 Artificial intelligence I

Chair: Ryuichi Matoba (National Institute of Technology, Toyama College, Japan)

GS1-1 Classifying MCI with rs-fMRI and deep learning

Ryosuke Minami, Narumi Yoneda, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering,
Graduate School of Science and Technology, Tokyo University of Science, Japan)

Early diagnosis of mild cognitive impairment (MCI) is crucial for effective treatment. Hence, resting-state functional magnetic resonance imaging (rs-fMRI) combined with deep learning has shown promise for MCI diagnosis. However, because the number of available rs-fMRI of possibly patients of MCI instances tends to be limited, using large amount of rs-fMRI data once is challenging, often resulting in poor generalization performance of machine learning models. Therefore, to develop high generalization model despite small dataset, we propose to use the combination of rs-fMRI data and transfer learning. Specifically, we made heatmaps about functional connectivity (FC) among regions of interest (ROI) from rs-fMRI data and used them as training and test data for the pre-trained model. We used correlation matrices of FC and dynamic adjacent matrices of FC as the indices with respect to the strength of FC. The result was better when using the dynamic adjacent matrix and the best performance was the loss of 0.535, the accuracy of 0.833, and the recall of 0.400.

January 22 (Wednesday), 09:00-10:30

GS1-2 Design of Eye Gaze Evaluation System Based on Automatic Classification of Attention and Distraction Areas in Driving

Jagat Thakulla, Hironori Hiraishi
(Ashikaga University, Japan)

This paper proposes a gaze evaluation system for driving, implemented using Unity and YOLOv8x for real-time object detection. Objects that could not be recognized by YOLOv8x were annotated manually. The system automatically identifies regions to be observed as must-see areas and regions that should be avoided as must-not-see areas. The must-see areas are marked with green bounding boxes, whereas the must-not-see areas are marked with red bounding boxes. Three experiments were conducted to assess gaze comparison, YOLO accuracy, and score comparison, respectively. Experiments with beginner and experienced drivers revealed significant differences in gaze patterns, with experienced drivers exhibiting wider gaze movements. In contrast, beginner drivers normally focusing straight on the road, showing insufficient hazard checks while driving. Finally, a comparative score evaluation was performed with beginner and experienced drivers. The findings of this paper support the development of training mechanisms to improve driving skill in beginners.

GS1-3 Simulating Effects of Interoceptive Accuracy on Decision-Making in Open-World Survival Games

Takato Kishida[1], Chie Hieida[2], Yosuke Taniuchi[2], Kazuki Miyazawa[1], Takato Horii[1]
([1]Osaka University, Japan)
([2]Nara Institute of Science and Technology, Japan)

Interoception, the perception of internal bodily states, is linked to emotion, decision-making. Recent research has focused on interoceptive accuracy, but the anatomy of interoceptive pathways complicates direct measurement or manipulation in humans. To address this, computational models are inportant for predicting future experiment and conducting virtual experiments. In this study, we developed a sensory integration model based on DreamerV3 incorporating interoceptive accuracy as a parameter and simulated its impact on decision-making using Crafter. Through simulation, we demonstrated that lower interoceptive accuracy decreases the survival steps of agents and differentially affects two interoception-related achievements: collect drink and wake up. Specifically, the number of wake up increases inversely with interoceptive accuracy, while collect_drink is highest in the highest interoceptive accuracy model. These results suggest that interoceptive accuracy plays an important role in the survival behavior of agents and that there is a complex relationship between task-oriented behavior and interoceptive accuracy.

GS1-4 A Preliminary Study on Constraint Extraction and Exception Exclusion in Care Worker Scheduling

Koki Suenaga, Tomohiro Furuta, Satoshi Ono
(Information Science and Biomedical Engineering Program, Department of Engineering,
Graduate School of Science and Engineering, Kagoshima University, Japan)

Technologies for automatically generating work schedules have been widely studied; however, in long-term care facilities, conditions vary between facilities, and it is necessary to interview the managers who create shift schedules to design facility-specific constraint conditions. The proposed method uses constraint templates to extract combinations of various components, such as shift patterns for consecutive days or combinations of staff. The templates can extract a variety of constraints by changing the number of days and the number of staff to focus on and changing the extraction target to patterns or frequency. Experiments demonstrated that our proposed method successfully created the schedules that satisfy all hard constraints and reduced the number of violations for soft constraints by circumventing the extraction of exceptional constraints.

January 22 (Wednesday), 09:00-10:30

GS1-5 Microservice Identification Using Large Language Models: A Code-Centric Analysis Framework

Chih-Yu Hsieh[1], Tzu-Yu Huang[1], Shang-Pin Ma[1], Wen-Tin Lee[2], Shin-Jie Lee[3]
([1]National Taiwan Ocean University, Taiwan)
([2]National Kaohsiung Normal University, Taiwan)
([3]National Cheng Kung University, Taiwan)

The microservices architecture has garnered widespread attention due to its high scalability, modularization capabilities, and business-centric structure. As a result, many organizations plan to migrate their monolithic systems to microservices architecture. Identifying and organizing microservices is the most critical step in this migration process. To address this need, this study proposes a novel approach for identifying microservices, called MICDA (Microservice Identification based on Code semantics and Data Access). MICDA primarily uses code analysis tools and Large Language Models (LLM) to extract service metadata and generate information such as code semantics and data access patterns. To evaluate clustering quality objectively, we propose the Average Intra-cluster Similarity (AIS) metric, which demonstrates a strong correlation with expert assessment. Through automated analysis of text embeddings and clustering strategies based on microservice design principles, MICDA generates multiple suggested service boundaries. Experimental results from applying the MICDA approach to six real monolithic systems demonstrate that the automated AIS metric aligns well with human expert judgment. The results show that MICDA could provide organizations with reliable microservice identification recommendations that balance technical and business requirements.

GS1-6 EEG-Based Power Spectral Analysis for AI-Driven Detection of Neurocognitive Disorders

Kusum Tara[1], Ruimin Wang[2], Yoshitaka Matsuda[3], Satoru Goto[2], Ayame Oishi[4], Takao Yamasaki[4,5], Takenao Sugi[2]
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Graduate School of Science and Engineering, Saga University, Japan)
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Faculty of Science and Engineering, Saga University, Japan)
([3]Institute of Ocean Energy, Saga University, Japan)
([4]Minkodo-Minohara Hospital, Fukuoka, Japan)
([5]International University of Health and Welfare, Fukuoka, Japan)

Early detection of neurocognitive disorders (NCDs) is essential for timely intervention to prevent severe cognitive decline. This study presents an EEG-based approach using power spectral analysis and AI-driven models to classify healthy controls (HC), mild cognitive impairment (MCI), Alzheimer's disease (AD), and epilepsy (Ep) during eyes-closed (EC) tasks. Power spectral features such as left (LP) and right (RP) hemispheric powers, hemispheric asymmetry (HA), and organization score (OS) across delta, theta, alpha, and beta frequency bands were extracted for machine-learning RF models, while power spectral mapping images were used for CNN model. CNN model achieved 98.12% accuracy and F1-score, outperforming RF model (94.93% accuracy, 94.68% F1-score). HA and OS progressively increased from HC to Ep, reflecting declining hemispheric communication and cognition. The study's novelty lies in its image-based CNN classification approach, leveraging spectral maps to enhance NCD detection accuracy and providing deeper understanding of non-linear hemispheric interactions linked to cognitive decline.

January 22 (Wednesday), 09:00-10:15

Room E

GS15 Human-machine interaction and collaboration I

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

GS15-1 Dialogue Smoothness Indicators Based on Emotional Synchronization and Similarity Between Interlocutors

Shosei Nakamura[1], Takeshi Takano[1], Shota Takashima[1], Nobuhito Manome[2],
Tatsuji Takahashi[1], Shuji Shinohara[1]
([1]Tokyo Denki University, Japan)
([2]The University of Tokyo, Japan)

Recent advancements in technologies, such as speech recognition, facial recognition, and natural language processing, have led to the development of numerous systems capable of interacting with humans. However, these systems have yet to achieve truly smooth conversations that fully consider the emotions and states of their counterparts. This study proposes dialogue smoothness indicators based on the synchronization and similarity of emotions extracted from audio data. For the analysis, we employed the Utsunomiya University Spoken Dialogue Database (UUDB), in which human annotators evaluated the emotional content of recorded speech using the Valence, Arousal, and Dominance (VAD) model. Synchronization was evaluated using cross-correlation coefficients between VAD time series data of interlocutors, whereas similarity was assessed based on differences in average VAD values. The results revealed a positive correlation between synchronization and similarity of Valence and Arousal, suggesting that the synchronization and similarity of emotional states correspond to more harmonious dialogues.

GS15-2 Textual Annotation of a Dyadic Conversation using the Body Motion Pairs

Simon Andreas Piorecki[1,2,3], Yutaka Nakamura[2,3], Takashi Minato[3], Yuya Okadome[3,4], Hiroshi Ishiguro[2]
([1]Technische Universitaet Berlin, Germany)
([2]Graduate School of Engineering Science, Osaka University, Japan)
([3]GRP, Riken, Japan)
([4]Tokyo University of Science, Japan)

The advancement of deep learning has accelerated systems using spoken language akin to human communication, evident in smart speakers and linguistically-driven robots. Contrasting the question-answer format of voice-command systems,human interaction is full-duplex, permitting feedback like nodding during speech. While models for single human behaviors exist, less research targets recognizing interactions within dialogues.This report proposes a data-driven method to identify dialogue situations based on CLIP (Contrastive Language-Image Pre-Training) which requires limited labeled datasets.The training process involves pre-training on automatically extracted features and captions from video clips,followed by manual context-based annotations to train a classifier for interaction categorization. Applied to face-to-face dialogues,results show improved behavior recognition by considering mutual interactions, validated by blation studies.This approach also efficiently identifies dialogue roles.Future work aims at context-aware dialogue robots through enhanced online recognition algorithms.

GS15-3 Realization of A Supernumerary Robotic Finger for Grasping and Its Evaluation with Vibrotactile and Squeeze Haptic Feedback

Faimul Haque, Jacob Char, Connor McGregor, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

This study presents a tendon-driven supernumerary magnetic finger (SRF) that extends human grasping capabilities by seamlessly integrating with natural movements. Mounted on the wrist, this underactuated 1-DOF SRF adapts flexibly to objects, functioning as an intuitive extension of the human hand. The tendon-driven mechanism simplifies the device, reducing its weight by using only a single motor. From force gauge measurements, a maximum of 5.5N of grasping force was produced by the SRF. Moreover, said device incorporates force-sensitive resistors (FSRs) to sense grasped objects. The feedback from these sensors were delivered to the user through a forearm-mounted haptic armband with either vibrotactile or squeeze feedback. Through user trials, it was determined that squeeze feedback was easier to feel and more intuitive than its vibrotactile counterpart.

January 22 (Wednesday), 09:00-10:15

GS15-4 Design of Human Motion Detection for Nonverbal Collaborative Robot Communication Cue

Wendy Cahya Kurniawan, Yeoh Wen Liang, Hiroshi Okumura, Fukuda Osamu
(Saga University, Japan)

The integration of modern manufacturing systems has promised increased flexibility, productivity, and efficiency. In such an environment, collaboration between humans and robots in a shared workspace is essential to effectively accomplish shared tasks. Strong communication among partners is essential for collaborative efficiency. This research investigates an approach to non-verbal communication cues. The system focuses on integrating human motion detection with vision sensors. This method addresses the bias human action detection in frames and enhances the accuracy of perception as information about human activities to the robot. By interpreting spatial and temporal data, the system detects human movements through sequences of human activity frames while working together. The training and validation results confirm that the approach achieves an accuracy of 91%. The sequential testing performance showed an average detection of 83%. This research not only emphasizes the importance of advanced communication in human-robot collaboration, but also effectively promotes future developments in collaborative robotics.

GS15-5 Development of Smart Navigation Robot for Visually Impaired

Jin Yien Lee, Taiga Eguchi, Wen Liang Yeoh, Hiroshi Okumura, Osamu Fukuda
(Saga University, Japan)

Individuals with visual impairments frequently depend on assistive tools such as white canes and guide dogs to navigate obstacles and perceive their surrounding environment during daily activities. However, despite the extensive training required to use these tools effectively, they may not function optimally in complex or rapidly changing environments. To address this limitation, we have developed a smart navigation robot that utilizes artificial intelligence for object detection, providing a viable alternative to conventional assistive tools. Our research has shown that the robot is capable of avoiding obstacles in the user's path, recognizing important elements such as elevators, intersections, and doors that are essential for navigating living spaces. Furthermore, the robot provides real-time assistance through auditory alerts, all while allowing the user to maintain full control over the robot's direction according to their intentions. These findings suggest that the robot has the potential to significantly enhance the autonomy and quality of life for individuals with visual impairments, offering them a greater degree of freedom than was previously attainable.

January 22 (Wednesday), 09:00-10:00

Room F

GS21 Machine learning I

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

GS21-1 Acquisition of Cooperative Behavior of Multi-Agents Using Multi-Layer Q-Learning

Tomonari Kimura, Mengchun Xie, Mitsuki Nakashima
(National Institute of Technology (KOSEN), Wakayama College, Japan)

Japan is prone to natural disasters such as earthquakes, tsunamis, typhoons, and landslides. During these disasters, many people need to be rescued, but prompt human-led rescue operations are extremely challenging. Therefore, the use of disaster rescue robots has attracted attention. In this study, disaster rescue robots are treated as agents, forming multi-agent system (MAS). In MAS, when agents learn individually without cooperation, they may prioritize their own interests, which leads to a decrease in the overall system performance. Therefore, this study proposes a method for constructing a learning environment for MAS using multi-layer Q-learning, targeting disaster rescue problems, and investigates the effectiveness of acquiring cooperative behavior to improve the performance of the entire MAS. In addition, this study proposes a different field from previous studies and investigates rescue activities in environments closer to real-world scenarios.

January 22 (Wednesday), 09:00-10:00

GS21-2 Reinforcement Learning with a Focus on Adjusting Policies to Reach Targets

Akane Tsuboya, Yu Kono, Tatsuji Takahashi
(Tokyo Denki University, Japan)

The objective of a reinforcement learning agent is to discover better actions through exploration. However, typical exploration techniques aim to maximize rewards, often incurring high costs in both exploration and learning processes. We propose a novel deep reinforcement learning method, which prioritizes achieving an aspiration level over maximizing expected return. This method flexibly adjusts the degree of exploration based on the proportion of target achievement. Through experiments on a motion control task and a navigation task, this method achieved returns equal to or greater than other standard methods. The results of the analysis showed two things: our method flexibly adjusts the exploration scope, and it has the potential to enable the agent to adapt to non-stationary environments. These findings indicated that this method may have effectiveness in improving exploration efficiency in practical applications of reinforcement learning.

GS21-3 Construction of Regression Model of eGFR by Data Partitioning Based on Trend of Time Series Data

Shuhei Hamashima[1], Noritaka Shigei[1], Masanobu Miyazaki[2], Yoichi Ishizuka[3], Shinichi Abe[4], Tomoya Nishino[5], Hiromi Miyajima[1]
([1]Graduate School of Science and Engineering, Kagoshima University, Japan)
([2]Miyazaki Medical Clinic, Japan)
([3]Graduate School of Engineering, Nagasaki University, Japan)
([4]Nagasaki Kidney Hospital, Japan)
([5]Department of Nephrology, Nagasaki University Hospital, Japan)

This paper proposes constructing a regression model to predict the following year's estimated Glomerular Filtration Rate (eGFR) value, an indicator of kidney function (KF), using time-series annual health checkup data. The proposed method exploits trends in the variation of KF in time-series health checkup data. Specifically, it divides the data into subsets based on the trend of KF variation and then constructs regression models using a subset or sum of subsets for each trend. Then, several regression models are combined to form a hybrid regression model. The combined regression model predicts eGFR using an internalized regression model corresponding to the trend of the given data. Multiple ways of combining the models are examined. Further, we propose selecting the best model for each trend and combining these models into a single regression model. Numerical experiments show that the proposed methods are more effective than naive methods and methods using data augmentation.

GS21-4 Validation of the Application of Object Detection Technology Using YOLOv9 for Rescue Robots in Disaster Environments

Anyu Ishizaka[1], Jehun Seo[1], Yoshiaki Yamazaki[2]
([1]Graduate School of Science and Engineering, Meisei University, Japan)
([2]Meisei University, Japan)

Many disaster sites are difficult environments for people to enter due to the high risk of secondary disasters, such as fire or hazardous chemicals. For this reason, object detection technology using machine learning has attracted attention as a means of assisting information gathering in rescue operations and understanding the disaster situation. However, there are issues where detection accuracy is reduced due to environmental factors such as multiple detection targets, lighting conditions, perspective distortion of images, camera angle, blurring of images and changes in contrast. In this study, the detection performance of hazardous material labels in disaster environments was verified using You Only Look Once. Furthermore, the influence of the dataset structure, such as the presence or absence of background images, on the detection accuracy was clarified. This demonstrated the effectiveness of the model, with the aim of improving its practicality in rescue operations.

January 22 (Wednesday), 13:00-14:45

Room A

OS11 AROB: Human-Centered Robotics

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

Invited Talk 1 Human-Centered Robotic Emotional Support

Alexis E. Block (Case Western Reserve University (CWRU), Cleveland, US)

See page 15

OS11-1 Identifying Influential Actions in Human-Robot Interactions

Haoyang Jiang[1,2], Chenfei Xu[1,3], Yuya Okadome[1,4], Yutaka Nakamura[1]
([1]Guardian Robot Project, R-IH, Riken, Japan)
([2]Monash University, Australia)
([3]Osaka University, Japan)
([4]Tokyo University of Science, Japan)

Human-robot interaction combines robotics, cognitive science, and human factors to study collaborative systems. This paper introduces a method for identifying influential robot actions using transfer entropy, a statistic that measures directed information transfer between time series. TE is effective for capturing complex, nonlinear interactions. We apply this method to analyze how robot actions affect human behavior during a conversation with a remotely controlled robot avatar. By focusing on the impact of proximity, our approach demonstrates TE's capability to identify key actions influencing human responses, highlighting its potential to improve the design and adaptability of robotic systems.

OS11-2 Proposal for Social Implementation of Smart Glasses in the Field

Takeru Ito[1], Naru Tsuritani[1], Hyuga Yokohori[1], Shuntaro Mori[2], Masamoto Tafu[1], Ryuichi Matoba[1]
([1]National Institute of Technology, Toyama, Japan)
([2]Toko Metal Co., Ltd., Japan)

This research aims to develop a smart glasses system to assist workers in distinguishing objects that are visually challenging to identify, such as polyvinyl chloride (PVC) in mixed plastics and weeds among ground cover plants. Smart glasses provide real-time visual assistance by overlaying processed information onto the user's field of view. A computer performs image recognition and infrared data analysis, transmitting results wirelessly to the glasses. The system builds on existing technology that aids colorblind individuals by highlighting difficult-to-see colors. For PVC detection, infrared reflectance analysis is used, while machine learning supports weed identification. By leveraging data from sensors and cameras, this system enhances worker accuracy and efficiency in tasks requiring visual judgment, offering a cost-effective alternative to fully automated solutions in factories and farms.

OS11-3 Basic Research on Vibration-Induced Kinesthetic Illusion, Tonic Vibration Reflex, and Antagonist Vibratory Response for Human-Assistive Robot Development

Hiraku Komura[1], Koki Honda[2]
([1]Kyushu Institute of Technology, Japan)
([2]The University of Tokyo, Japan)

When vibration stimulation is applied to tendons or muscles, phenomena such as kinesthetic illusion (KI), Tonic Vibration Reflex (TVR), and Antagonist Vibratory Response (AVR) may occur. KI refers to the phenomenon in which a stimulated muscle is perceived to move in the direction of its extension, despite no actual movement taking place. TVR describes the contraction of the stimulated muscle accompanied by the relaxation of its antagonist muscle. In contrast, AVR refers to the relaxation of the stimulated muscle and the contraction of the antagonist muscle. These illusions and responses are reported to be influenced not only by the frequency, amplitude of vibration stimulus, and pressing force against tendon but also by the condition of the tendon and muscle. They may occur independently or simultaneously, making selective elicitation a complex challenge. This study aims to explore the conditions that selectively induce KI, TVR, and AVR.

January 22 (Wednesday), 13:00-14:45

OS11-4 Pedestrian Modeling Using the Koopman Approach and Investigation into the Effects of Autonomous Mobile Robot Intervention

Go Nakamura[1], Kazuma Sekiguchi[2], Kenichiro Nonaka[2], Hideaki Takayanagi[3]
([1]Graduate School of Integrate Science and Engineering, Tokyo City University, Japan)
([2]Department of Mechanical Systems Engineering, Tokyo City University, Japan)
([3]Department of Urban Life Studies, Tokyo City University, Japan)

Today, the population concentrated in urban areas has led to a situation in which crowding is likely to occur. In large commercial facilities and large-scale events, crowds must be guided safely and comfortably to avoid crowding. Therefore, we propose the introduction of autonomous robots to replace the guides. However, it is difficult to predict pedestrian flow in environments where robots intervene because there is no knowledge of how human flow changes with the intervention of robots. Therefore, we used Koopman linearization using the Koopman operator to construct a linear model of a pedestrian with characteristics of motion that include uncertainty. Then, we conducted a simulation using the model to see if it is possible to actively change the pedestrian flow by intervening obstacles that simulate a robot in the pedestrian space. The results suggested that it is possible to actively change the pedestrian flow in environments where the robot intervenes.

OS11-5 The Simulation for Firefighting Training in the VR Space Using mocopi

Taro Kanasaki, Mengchun Xie, Mitsuki Nakashima
(National Institute of Technology (KOSEN), Wakayama College, Japan)

In Japan, there are approximately 35,000 fire-related incidents every year, resulting in around 1,500 deaths. To minimize damage when a fire occurs, it is crucial to conduct training, such asl firefighting training. However, firefighting training has problems such as the necessity of a large space and some costs. This study attempts to create a firefighting simulation in a Virtual Reality (VR) space. So, it can be conducted at any time with the goal of actually experiencing and learning the actions necessity in the event of a fire. In addition, a questionnaire using the MOS method will be administered to those who experienced the simulation to verify whether they felt immersed in the firefighting simulation and whether it is useful as firefighting training.

January 22 (Wednesday), 13:00-14:45

Room B

OS25 ISBC: Complex and Collective Systems: Theory and Data Analysis

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

OS25-1 Example of Equipment Removal Simulation using Point Cloud Data and 3D CAD Model in Public Works

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

This study explores the application of Information and Communication Technology (ICT) in Japan's "i-Construction" initiative, focusing on dimensional measurement during the pre-construction phase using point cloud data and 3D models. A case study was conducted on the renovation of the Takahashi drainage pump station in Takeo City, Saga Prefecture. Suspension clearance verification, crucial for avoiding interference during crane operations, was traditionally hampered by inaccuracies in 2D drawings. Utilizing a cost-effective Matterport Pro3 camera for 3D scanning, the study integrated point cloud data with a 3D pump model in a virtual reality (VR) environment. This approach improved accuracy, reduced surveying time by five days, and enabled precise clearance verification. Challenges include optimizing simulations for standard devices and automating interference detection. The method shows potential for broader adoption, supporting the integration of point cloud data into BIM/CIM frameworks to enhance efficiency across the construction industry.

January 22 (Wednesday), 13:00-14:45

OS25-2 On foreknowledge of life

Ken Naitoh, Shun Tomita, Koichi Shibazaki, Kaori Morita, Kami Okazaki
(Waseda University, Japan)

While examining biological and abiological processes, the research team of mine devotes much effort to reveal theoretically the essential physical mechanism underlying living systems, which leads to prognostic medication of heavy sickness of mammals including human beings. In the present report, we will show a further study on this theoretical model. An important point is to predict sickness in childhood and also to reveal influence of individual differences, based on biological data including DNA and enzymes and abiological chemical reaction theories such as those in combustion engines. This will be possible because we have clarified that biochemical processes in living systems are physically similar to abiological ones in combustion engines, i.e., because water as the main part of living systems and also air in combustion engine are described by the Navier-Stokes equation. Thus, we will also examine more on RINNE (samusara), because engine cycle repeats like RINNE, although being with chaotic processes.

OS25-3 Dynamical System in Elliptical Pursuit and Evasion

Sota Yoshihara
(Graduate School of Mathematics, Nagoya University, Japan)

This paper aims to explain the difference between the circular and elliptical cases in one-on-one pursuit and evasion problems. We use the simultaneous differential equation derived by Barton and Eliezer. This equation allows us to derive a dynamical system based on the assumption that the shape of the pursuer's trajectory is unaffected by the evader's speed. The dynamical system involves the angular difference between the velocity vectors of the players and their separation distance. When the evader orbits a circle, the dynamical system is autonomous with an asymptotically stable equilibrium point. By contrast, if the evader orbits an ellipse, the dynamical system becomes non-autonomous and lacks an equilibrium point. In conclusion, the shape of the trajectory determines the asymptotic stability in the pursuit and evasion.

OS25-4 Community structure of social tagging on an online video sharing system

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

We study data of Japanese YouTube-like video sharing platform Niconico which contains over 21 million videos and 10 million unique tags. Niconico hosts various niche contents such as games and anime, providing an environment where internal network effects and community structures are prominent while external factors remain limited. Previous studies have revealed that on this platform, rank-size distributions and time-series relaxation processes of video views exhibit two distinct dynamical modes for top- and lower-ranked videos. To elucidate the mechanism behind these modes, we construct an interaction matrix α_{ij} by comparing observed tag co-occurrences with theoretical expectations under no correlation assumption. Applying t-SNE for dimensionality reduction and hierarchical clustering, we visualize how attractive ($\alpha_{ij} < 0$) and repulsive ($\alpha_{ij} > 0$) interactions form distinct community structures. This work suggests that the macroscopic emergence of collective attention on Niconico arises from self-organized community structures formed by tag interactions, laying a foundation for future universal models of collective attention dynamics.

January 22 (Wednesday), 13:00-14:45

OS25-5 VR sickness reduction method by selective blurring considering self-motion direction

Itsuki Takeshita, Hideo Miyachi
(Tokyo City University, Japan)

The cause of VR sickness is believed to be the sensory mismatch between self-motion perception from visual stimuli and both somatosensory and vestibular sensations. Following this theory, many studies have investigated field-of-view restriction methods that reduce self-motion perception from visual imagery as a technique to decrease VR sickness. However, many conventional field-of-view restriction methods tend to apply filters uniformly to all information, including unnecessary elements in the imagery. In this research, we proposed a method that applies filters only to optical flow generated by self-movement. We implemented this method in Unity and measured its VR sickness reduction effects compared to cases without field-of-view restriction methods. Measurement results showed no significant difference in VR sickness between the two approaches based on SSQ (Simulator Sickness Questionnaire) and the peripheral area of center of gravity sway indicators.

OS25-6 A driver's sensitivity designed for next-level performance of autonomous vehicles

Md Anowar Hossain, Nobuyasu Ito
(RIKEN Center for Computational Science, Japan)

In this study, a new driver sensitivity function that reacts to real-time phenomena is established. The developed driver sensitivity function is formulated with the following two components: (i) the driver sensitivity depends on the distance between the focal vehicle and the leading vehicle; (ii) the driver sensitivity changes based on the speed difference between the focal vehicle and the leading vehicle, which can be quantified according to the taillights of the leading vehicle. In the first case, a very simple formulation of driver concentration was introduced according to the methodology of the Optimal Velocity model. The driver's sensitivity changed according to the inverse trend of the optimal velocity function, that is, the driver's awareness gradually increases as the distance between the vehicles decreases to avoid a collision with the leading vehicle, and the driver's attention gradually decreases as the distance between the vehicles increases, since the collision risk probability decreases with the increase in the distance between the vehicles. In the second part, the driver's sensitivity was formulated according to the taillight phenomenon, which turns on and off based on the vehicle's acceleration and deceleration, respectively. Here, the driver's concentration varies with the speed difference between the focal vehicle and the leading vehicle, and the driver's sensitivity increases smoothly as both the positive speed difference, where the leading vehicle is faster than the focal vehicle, and the negative speed difference, where the focal vehicle is faster than the leading vehicle, increase. As the positive and negative speed differences increase, the driver's sensitivity increases because they fill the gap immediately created by the leading vehicle and prevent a collision with the leading vehicle, respectively. Furthermore, a linear analysis of the model was carried out using neutral stability theory, suggesting a clear critical line of the stability region that is different from traditional traffic models. A nonlinear analysis was carried out on the first part of the model, and the flow pattern was obtained that can be described by the mKdV wave equation. Finally, a series of numerical simulations were carried out on the model, which clearly depicted the internal structure of the flow field.

OS25-7 Evacuation simulation in Kobe Harborland area

Kanato Takeuchi[1], Nobuyasu Ito[2]
([1]Keio University, Japan)
([2]Riken Center for Computational Science, Japan)

In the event of a disaster or accident, safe and effective evacuation from dangerous places is important, and for that purpose, evacuation plans are necessary. In this study, we simulated evacuation on foot along the streets as part of an evacuation plan for the Kobe Harborland area, a bustling commercial and business hub that was redeveloped from the waterfront, to aid in evacuation planning from a tsunami that is predicted to strike after a major earthquake.There are many places along the seafront where people gather around Kobe Harborland, including umie, mosaic, the Anpanman Museum, and the brick warehouse. We conducted a simulation in which approximately 11,000 people (4,065 people around mosaic, 2,067 people around the Anpanman Museum, and 5,235 people around the brick warehouse) evacuate to the parking lot, which is an evacuation site. We found that it is better to evacuate in a dispersed manner, since evacuating in a straight line would cause congestion and make the flow very slow. In particular, dispersing to the Education Center and using the corridor on the second floor of mosaic were effective. We also report on what would happen if people headed in the opposite direction.

January 22 (Wednesday), 13:00-14:15

Room C

OS20 AROB: System Sensing and Its Applications 1

Chair: Hirotoshi Asano (Kogakuin University, Japan)
Co-Chair: Atsushi Shibata (Advanced Institute of Industrial Technology, Japan)

OS20-1 Estimation of Stress-Responsive Hemodynamics Based on NIFI with Applied Dimensionality Reduction Methods

Shonosuke Ohyama, Kent Nagumo, Akio Nozawa
(Aoyama Gakuin University, Japan)

This study aims to develop a non-contact method to estimate stress coping styles by analyzing facial skin blood flow using near-infrared imaging. Current methods for measuring hemodynamic indices are contact-based and time-consuming. By applying dimensionality reduction techniques to near-infrared facial images, the researchers observed that the images diverged according to different stress coping styles. These findings will contribute to building a machine learning-based stress coping estimation model.

OS20-2 An Attempt to Estimate Resting Blood Pressure Using Low-Resolution TFI

Hana Furudate, Kent Nagumo, Akio Nozawa
(Aoyama Gakuin University, Japan)

In recent years, the number of hypertensive patients has been increasing, and routine blood pressure monitoring is essential for early detection and prevention. However, in conventional measurement, the stress caused by the tightening of the cuff and the measurement time are burdensome to the person being measured. Therefore, a technology that can measure blood pressure remotely and quickly without stressing the patient is desired. Our research group has focused on facial skin temperature, one of the cardiovascular indicators that can be remotely measured using infrared thermography, and has attempted to estimate blood pressure without contact based on the spatial features of the captured Thermal Face Image (TFI). In previous studies, blood pressure at rest has been estimated based on spatial features extracted by applying Independent Component Analysis (hereinafter referred to as ICA) to measured TFI. In the application of these blood pressure estimation techniques, the use of low-resolution TFI is expected to be cost-effective and to reduce the burden of data management due to the reduced amount of information. Therefore, blood pressure estimation using low-resolution TFI is considered more practical. However, the low resolution may cause missing information necessary for blood pressure estimation. Therefore, it is necessary to examine whether low-resolution TFI can provide estimation accuracy that can withstand practical use. In this study, I constructed a resting blood pressure estimation model using a low-resolution TFI of 160 x 120 pixels. And then, I attempted to compare its accuracy with that of a conventional model using 320 × 256 pixel TFI. …

OS20-3 Gesture-Based Character Input Method for Smartwatches Considering Screen Design

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

Smartwatches have problems with touch input due to screen size limitations and voice input due to noisy environments and privacy issues. In this study, we propose a touch input screen design optimized for smartwatches and a gesture input method using a motion sensor built into the device. Experimental results showed that the proposed screen design for touch input improved input accuracy and speed compared to previous studies, and that the proposed gesture input can discriminate with high accuracy. By combining these two methods, we investigated a more accurate and easy-to-use character input method that utilizes the advantages of touch input and gesture input.

January 22 (Wednesday), 13:00-14:15

OS20-4 Investigation of real-time BCI using a compact device without averaging method

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

This study investigates real-time BCI using compact devices without averaging method. In our laboratory, while averaging methods have been used for fast blinking analysis, they can lower discrimination accuracy if users unintentionally shift their gaze. To address this, the study applied a bandpass filter to raw data, improving robustness to noise, reducing computational load, and shortening discrimination time. Traditional BCIs are large and costly, limiting practical use outside laboratories. To overcome this, the research team developed a compact, low-cost electroencephalograph. Previous experiments using 10-Hz blinking demonstrated that their device achieved accuracy comparable to or better than conventional systems when applying the averaging method. Building on these findings, this study aims to develop a real-time BCI system using bandpass filtering with the compact device, improving efficiency and practicality for real-world applications.

OS20-5 Examination of the Possibility of Evaluating the Effect of Muscle Training Using Multi-channel Surface Electromyography with Active Electrodes

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

Previous studies have used the m-ch method and ladder-type electrodes to evaluate the effects of strength training on the biceps brachii muscle, a parallel muscle, and have used active electrodes in multiple directions for measurement. However, there is no previous study that evaluated the effects of strength training using that active electrode. Therefore, in this study, we investigated the possibility of evaluating the effects of strength training on the parallel and pinnate muscles by measuring them using the m-ch method and passive and active electrodes. The muscles to be tested will be the biceps brachii and triceps brachii (medial head of gastrocnemius muscle). The experimental results suggest the possibility of evaluating the effects of strength training from the propagating waves extracted from the rows of electrodes affixed in the direction of the muscle fibers by measurement with active electrodes.

January 22 (Wednesday), 13:00-14:15

Room D

GS2 Artificial intelligence II

Chair: Shin-Jie Lee (National Cheng Kung University, Taiwan)

GS2-1 EAW-YOLO11: Enhanced YOLO11 Network for Small-Object Detection in Underwater Weak Lighting and Low-Quality Environments

Dang Thanh Cong, Hiroshi Sato, Masao Kubo
(Department of Computer Science, National Defense Academy, Japan)

Underwater robotic systems face significant challenges in object detection due to the complex marine environment, which is characterized by underwater light absorption, scattering, and dynamic lighting conditions. In this research, we propose EAW-YOLO11, an advanced underwater object detection model that enhances the original YOLO11 framework. Our approach introduces key improvements, including an EC3k2 module with Efficient Multi-scale Attention (EMA), a C2AIFI module for better feature combination, and the Wise-IoU v3 loss function for improved target localization. Experimental results on the URPC2019 dataset demonstrate a 1.6% improvement in mean Average Precision (mAP@0.5) compared to the original YOLO11, with exceptional performance in low visibility and challenging lighting scenarios. The EAW-YOLO11 network represents a significant advancement in artificial intelligence and robotics, offering a compact, efficient solution that enables more reliable and accurate underwater operations for marine exploration, environmental monitoring, and autonomous navigation.

GS2-2 Real-World Application of gMLP for Long Sequential Robot Behavior

Koki Sato, Ryoma Tanaka, Ryo Kobayashi, Sho Yamauchi, Keiji Suzuki, Sho'ji Suzuki
(Future University Hakodate, Japan)

This study aims to create appealing robots capable of diverse motions by proposing a foundational framework for robot motion, upon which motion generation was verified. The two-phase approach involves training a large language model(LLM) and then using it to control robot motions. During the learning phase, the dataset was generated by extracting 2D keypoints from cat videos, converting these 2D keypoints into 3D keypoints, and calculating joint angles using inverse kinematics based on joint positions. This data, consisting of joints and their positions, was transformed into a language like format, termed "motion language." This converted data was then used to train the gMLP, an LLM. This study employs a trained gMLP to control the robot’s movements and examines the differences compared to the simulation. The results indicate that the robot exhibits movements nearly identical to those observed in the simulation.

GS2-3 Intelligent Information Gathering and Analysis in Sustainable Energy: A Generative-AI-Enhanced and Microservice-Based Approach

Shang-Pin Ma[1], Chen-Hao Chao[1], Wei-Kai Lin[1], Guan-Hong Lai[1], Yue-Jun Lai[1], Shih-Ying Chang[2], Zihjin Ciou[2], Jones Hung[2]
([1]National Taiwan Ocean University, Taiwan)
([2]Industrial Technology Research Institute, Taiwan)

This paper introduces AICS (Automated Information Collection Service), a microservice-based system for intelligent information gathering and analysis in sustainable energy. AICS leverages GPT technology for content processing and features a TLIMT scoring mechanism for content prioritization. AICS also incorporates automated mind map generation to visualize complex industry relationships. Experimental results demonstrate AICS's effectiveness in handling concurrent users, processing multilingual content, and generating organized and comprehensive visualizations for gathered information.

January 22 (Wednesday), 13:00-14:15

GS2-4 First-Person View to Third-Person View Generation Using Pix2pix in Driving

Hiroki Tomura, Hironori Hiraishi
(Ashikaga University, Japan)

This study aims to evaluate a driver's usual driving situation using driving footage, such as that from a drive recorder. The drive recorder provides a first-person image depicting the front view of the driver's seat. However, to evaluate one's own driving, the movement of a car can be understood more accurately by viewing a third-person video of the car captured from behind. This requires the cooperation of the car driving behind, which is impossible with a car alone. To resolve this, pix2pix, a generative adversarial network model, was used to generate third-person viewpoint images from first-person images captured using a dashcam. A driving simulator was used to generate first and third-person videos, and evaluations were performed using these videos.

GS2-5 Supervised Collaborative Learning System Using a Wire-Connected Two-Wheeled Rover for Planetary Exploration

Clive Jancen Kawaoto[1], Tenta Suzuki[1], Mao Tobisawa[1], Junya Hoshino[1], Yuki Itoh[1], Kaito Kumagae[1], Kenji Matsuda[1], Johei Matsuoka[1], Kiyohiko Hattori[2]
([1]Tokyo University of Technology, Japan)
([2]Tokyo Denki University, Japan)

In recent years, research and development of planetary exploration rovers have become more active. However, two significant challenges exist: limitations in remote control due to communication delays and decreased exploration efficiency due to risk-avoiding route selection. This paper proposes a method for efficient route selection by connecting two small two-wheeled rovers with a wire to actively traverse ruts and depressions. The system determines terrain traversability using the k-nearest neighbor method based on camera and angle sensor data from the front rover. If the front rover gets stuck, the rear rover pulls it out, using the obtained image data as training data for autonomous learning. Evaluation on Unity3D physics simulation with randomly placed shallow and deep ruts demonstrated a maximum 20% reduction in travel distance and 100% travel efficiency compared to conventional risk-avoiding routes, particularly in environments with many shallow ruts.

January 22 (Wednesday), 13:00-14:30

Room E

GS30 Neural networks I

Chair: Filippo Grassia (LTI - University of Picardie Jules Verne, France)

GS30-1 Increase throughput of AST model by using token merging technique based on audio data features

Tomonori Mikasa, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering,
Graduate School of Science and Technology, Tokyo University of Science, Japan)

The Audio Spectrogram Transformer (AST), developed for audio classification, achieves superior classification accuracy compared to conventional CNN-based methods. However, Transformer-based approaches are inherently computationally intensive. To address this issue, we propose a modified AST model incorporating a token merging method tailored to the characteristics of audio data. We evaluate the model's classification accuracy and throughput i.e., the total number of test samples divided by the inference time. Experimental results demonstrate that throughput can be improved by up to fivefold maintaining an accuracy degradation of approximately 6%. Furthermore, the proposed token merging method shows potential effectiveness in scenarios where a significant reduction in the number of tokens is required.

January 22 (Wednesday), 13:00-14:30

GS30-2 Rotary crane control using neural network optimized by improved adaptive Cuckoo Search

Ryoma Araki[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)

This study developed an optimized neural network controller (NC) for rotary crane control based on the adaptive cuckoo search (ACS) algorithm, which is inspired by cuckoo egg-laying habits. Cuckoo search (CS) is an evolutionary algorithm that mimics cuckoos' strategy of laying eggs other birds' nests to ensure survival while discarding low-value solutions in favor of higher-value ones. Previous research has shown improved NC performance when the scaling index is adjusted in a scheduled stepwise manner. In this study, we improved the ACS by linearly adjusting the scaling index in response to the evaluation of NC, resulting in more efficient optimization. According to the simulation results, the linear adjustment strategy outperformed the fixed and non-linear methods, effectively minimizing crane load sway.

GS30-3 Unsupervised learning of coincidences for network operation in non-stationary environments

Hannah Kerger[1], Florentin Wörgötter[1], Minija Tamosiunaite[1,2]
([1]University of Göttingen, Third Institute of Physics, Germany)
([2]Department of Informatics, Vytautas Magnus University, Lithuania)

Detecting input coincidence is important for meaningful self-organization in neuronal networks in biological as well as in artificial systems. Here we consider weight stabilization of artificial neurons in an unsupervised manner, so that the neuron becomes a coincidence detector. To achieve this we are introducing a novel mechanism for synaptic plasticity that combines a learning rule for synaptic potentiation and depression with mechanisms that change the learning rate. The latter depends on the neuron's output and the learning rate is reduced with growing output ("learning rate annealing"). The rate can, however, also increase again ("learning rate recovery") and this relies on the fact that synaptic weights will slowly get reduced by simulated forgetting. Such weight reduction will in turn reduce the neuron's output and trigger learning rate recovery. We show that linear learning rate recovery allows attaining weight stabilization and coincidence detection in a variety of situations.

GS30-4 Study on a Deep Learning-Based Method for Enhancing the Clarity of Cloud Images for Weather Prediction Support

Naoki Funama, Atsuo Ozaki
(Osaka Institute of Technology, Japan)

In recent years, the frequency of localized torrential downpours has been increasing, resulting in flood damage across municipalities nationwide. To address this issue, research has been conducted on systems that utilize machine learning to predict near-future weather images without relying on expensive equipment, making them accessible to organizations such as local governments. However, a common challenge with these methods is that the predicted images often lack clarity. In this study, we propose and evaluate two methods for generating clear and accurate future weather images using low-cost equipment and machine learning. The results show that one method excels in producing sharp forecast images with minimal blurring, while the other demonstrates higher predictive accuracy.

January 22 (Wednesday), 13:00-14:30

GS30-5 Puzzle-Based Self-Supervised Learning for Video Classification with Vision Transformers

Ruqin Wang[1], Wataru Noguchi[2], Yasumasa Tamura[3], Masahito Yamamoto[3]
([1]Graduate School of Information Science and Technology, Hokkaido University, Japan)
([2]Education and Research Center for Mathematical and Data Science, Hokkaido University, Japan)
([3]Faculty of Information Science and Technology, Hokkaido University, Japan)

The rapid growth of video data highlights the importance of video classification, but the scarcity of labeled data and high annotation costs remain key challenges, especially for Transformer-based models. To address this problem, we proposed a modified self-supervised learning method based on an existing space-time cubic puzzle, which predicts the correct order of shuffled video segments. This task capture critical spatio-temporal dependencies while leveraging Transformers' global attention mechanisms. Our approach is evaluated on Kinetics-400 (K400) datasets, with experiments on a randomly sampled 30% subset of K400 to simulate limited labeled data scenarios. Results demonstrate that our method outperforms baselines, achieving higher classification accuracy even under data-scarce conditions. This work presents the potential of puzzle-based self-supervised learning for advancing video classification.

GS30-6 Spatial Depth Super-Resolution Framework for Rock CT Images Using Sparse Modeling

Ryogo Kagawa[1], Atsushi Okamoto[2], Toshiaki Omori[1]
([1]Kobe University, Japan)
([2]Tohoku University, Japan)

Rock CT images obtained from geological studies have been attention in earth and environmental science. Rock CT images suffer from low resolution in depth direction while structure in both spatial and depth directions are important. Therefore, it is important to establish a super-resolution method for rock CT images in both spatial and depth directions. In this study, we propose a spatial depth super-resolution framework for estimating rock CT images using sparse modeling. We conduct dictionary learning by using observed three-dimentional CT image data and then estimate unobserved high resolution CT image data by employing the sparse modeling approach. We verify the effectiveness of the proposed method by using rock CT image data recorded in Oman drilling project. We show that the proposed super-resolution method enhances image resolution for both spatial and depth directions more accurately, compared with conventional nonlinear interpolation-based methods.

January 22 (Wednesday), 13:00-14:30

Room F

GS37 Sensor and multi-sensor data fusion

Chair: Kazuya Okamoto (National Institute of Technology, Wakayama College, Japan)

GS37-1 Detection model of acupuncture points on hands through current measurement

Takuya Watanabe, Geunho Lee, Yusuke Hayakawa
(University of Miyazaki, Japan)

Various approaches to Oriental medicine exist, including acupuncture, moxibustion, and Chinese herbal medicine. A key concept is the acupuncture point, and since 2003, international efforts have aimed at standardizing these points. In 2006, the World Health Organization established a global standard for 361 acupuncture points. These points are specific, invisible parts of the body that, when stimulated, produce specific effects. However, their identification often relies on subjective methods and rules of thumb. Despite their importance, research from the perspectives of natural science and engineering remains limited. Therefore, we propose a model focusing on the characteristics of hand acupuncture points in Oriental medicine to provide a more objective and scientific understanding of these crucial elements.

January 22 (Wednesday), 13:00-14:30

GS37-2 Human Pose Estimation Using Wearable IMU Sensors and Deep Learning

Melaku Abebayehu Abebe, Jae Hoon Lee, Shingo Okamoto
(Ehime University, Japan)

Human pose estimation plays a vital role in computer vision, with applications in healthcare, motion analysis, VR/AR, sports, and entertainment. While wearable IMU sensors offer a portable and affordable alternative to traditional motion capture systems, using multiple sensors can be time-consuming and error-prone due to issues like misalignment or drift. Our research proposes a technique that uses a minimal number of IMU sensors, reducing cost and complexity without sacrificing accuracy. We leverage the AMASS dataset, which provides realistic 3D human models using the SMPL model—a detailed representation of the human body organized in a kinematic tree structure. By placing six virtual IMU sensors on key joints (wrists, lower legs, head, and pelvis) of the SMPL model, we generate synthetic sensor data that mimics real-world IMU readings. Using forward kinematics and second-order differential equations, we calculate realistic orientation and acceleration data. This synthetic data trains our deep learning model to understand the nuances of human motion, enabling more accessible and cost-effective motion-tracking solutions. Applications include patient monitoring and rehabilitation in healthcare, real-time performance feedback in sports and fitness, realistic avatar movements in VR/AR, and improved workplace ergonomics. Achieving high accuracy with fewer sensors broadens the practical use of human pose estimation in real-world scenarios.

GS37-3 People Detection and Tracking Using Multiple Ground LiDARs Based on 1D-CNN/Background Subtraction and Distributed IMM Methods

Sakura Iizawa[1], Masafumi Hashimoto[2], Kazuhiko Takahashi[2]
([1]Graduate School of Science and Engineering, Doshisha University, Japan)
([2]Faculty of Science and Engineering, Doshisha University, Japan)

This paper presents a people detection and tracking method using multiple light detection and ranging sensors (LiDARs) set in an environment. People detection and tracking are performed in a distributed manner without a central server by exchanging information among LiDARs. A one-dimensional convolutional neural network-based method is applied to detect people located near LiDARs. In contrast, a background subtraction and rotating calipers-based method is applied to detect people located far away from LiDARs. A distributed interacting multimodel estimator is applied to estimate the poses of people under various motion modes, such as stopping, walking, and suddenly running and stopping, Simulation experiments of five people tracked by two LiDARs in an intersection environment where people and cars move evaluate the performance of the proposed method.

GS37-4 Cooperative Object Tracking Using Multiple Ground LiDARs Based on Multiplicative Error Model Extended Kalman Filter and Information Filter

Yoshihiro Nakatani[1], Masafumi Hashimoto[2], Kazuhiko Takahashi[2]
([1]Graduate School of Science and Engineering, Doshisha University, Japan)
([2]Faculty of Science and Engineering, Doshisha University, Japan)

This paper presents a cooperative tracking of objects, such as cars, two-wheelers, and pedestrians, using multiple light detection and ranging sensors (LiDARs) set in a road environment. Each LiDAR detects objects from its measurements using a background subtraction method on an elevation map and estimates their motions, such as positions and velocities, and shapes, such as heading angles and sizes. A central server collects and fuses the estimates received from LiDARs. The extended object tracking (EOT) method using multiplicative error model extended Kalman filter is used to simultaneously estimate both the motions and shapes of objects detected by each LiDAR. Furthermore, the information filter is used by the central server to fuse these estimates effectively. Simulation results of object tracking with two LiDARs in an intersection environment demonstrate the effectiveness of the proposed method.

January 22 (Wednesday), 13:00-14:30

GS37-5 Evaluation of an Anomaly Detection Method for Elderly People Using Body Surface Temperature

Tasuku Hanato[1], Shin Morishima[1], Akira Urashima[1], Hiroshi Minematsu[2], Takashi Yamamoto[2], Tomoji Toriyama[1]
([1]Toyama Prefectural University, Japan)
([2]Shikino High-Tech Co., Ltd., Japan)

Japan's aging population is facing a shortage of caregivers. To address this, we propose an anomaly detection method for the elderly to reduce the burden on caregivers. While body temperature is used to detect anomalies, it requires prolonged contact, making it unsuitable for continuous monitoring. In contrast, body surface temperature can be measured continuously, although it is influenced by individual differences and environmental factors. We propose a method to detect anomalies by learning the normal change patterns of individuals through clustering, based on combinations of environmental conditions and body surface temperature over a certain period. Experiments were conducted to determine the suitable features and window size. The results showed that the feature size was the amount of change which was the value obtained by subtracting the first value from the last, and the window size was 15 minutes, with an F-score of 0.73 and an accuracy of 0.86.

GS37-6 Implementation and validation of a two-dimensional target positioning method using Hall sensors for a new docking system for small satellites

Yuto Hara[1], Katsuyoshi Tsujita[2]
([1]Graduate School of Sustainability Science, Tottori University, Japan)
([2]Department of Engineering, Tottori University, Japan)

In this study, we suggest a new post-tether-docking system using a deployable mast and electromagnetic actuation to realize docking for such satellites. The system can avoid direct contact with satellites and reduce the risks of attitude disruption by external forces. As we developed the whole system and components, we built a 2-DoF positioning hall sensor array to detect a permanent magnet on the tip of docking deployable masts at a low computational cost. This paper reports the evaluation of positioning performance and feasibility of the proposed method and algorithm for the actual docking procedure from an experimental approach. From the experimental results to measure the accuracy of the sensor system, we concluded that the proposed sensor-array positioning system and algorithm can measure and track the target position dynamically and statically.

January 22 (Wednesday), 15:00-16:45

Room A

OS10 AROB: F-REI New Research Unit in the Robotics Field: Autonomy, Intelligence and Swarm Control

Chair: Fumitoshi Matsuno (Osaka Institute of Technology, Japan)
Co-Chair: Satoshi Suzuki (Chiba University, Japan)

Invited Talk 2 What is F-REI? The trends and prospects for swarm control with high levels of autonomy and intelligence

Kenzo Nonami (Field of Robotics, Fukushima Institute for Research, Education and Innovation (F-REI), Japan)

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OS10-1 Decadal Trends and Future Prospects in Wheeled and Tracked Mobility for Rough Terrain Applications

Genya Ishigami
(Keio University, Japan)

Rough terrain mobility is essential for manned and unmanned applications across agriculture, construction, search and rescue, and extraterrestrial exploration. Rough terrain includes diverse environments, such as deserts, forests, disaster areas, and even the Moon and Mars, composed of various geological features and materials. Despite significant research efforts for rough terrain mobility in the last decades, a clear and unified definition of {it rough terrain} remains limited. This paper proposes a definition of rough terrain based on environmental scale and complexity and clarifies the types of mobility mechanisms suitable for different terrain types. The mechanical similarities between wheeled and tracked mobility systems are then highlighted, offering an overview of their mechanical components, vehicle designs, analytical approaches, and control strategies. This paper also discusses future research directions and potential technological advancements of the rough terrain mobility.

OS10-2 Scalable Domain Randomized Reinforcement Learning for Sim-to-Real Policy Transfer in Complex Robot Tasks

Yuki Kadokawa, Takamitsu Matsubara
(Nara Institute of Science and Technology, Japan)

Sim-to-real Reinforcement Learning (RL) enables control policies learned in simulation to be applied to real-world robotic environments and has gained significant traction in recent years. Domain Randomization (DR) is a key technique in this framework, enhancing policy robustness by training on a diverse set of simulation parameters to bridge the reality gap between simulated and real-world conditions. However, in complex tasks such as earthwork automation, effective policy learning is challenging due to two key issues: (1) the extensive range of parameters and (2) the significant simulation time required, which complicates the straightforward application of DR-RL. To cope with it, this paper discusses scalable DR-RL frameworks for learning policies for complex tasks.

OS10-3 Research on Cooperative Manipulation using Multiple Drones with Winch Mechanism

Yuki Ohira, Satoshi Suzuki
(Chiba University, Japan)

In recent years, drones for aerial manipulation have been developed. Most drones that perform aerial manipulation are designed to work alone. However, there is a limitation to the payload that can be carried by a single drone, and thus there is a limitation to the work that can be performed by using single drone. Therefore, cooperative manipulation system using multiple drones are attracting attention. In this study, a cooperative manipulation system that achieves independent control of payload’s position and attitude with a minimum number of drones is proposed. The system is designed by using two drones with winch mechanism to change the length of the string. The effectiveness of the system is verified through simulations and experiments using actual drones.

January 22 (Wednesday), 15:00-16:45

OS10-4 Model-Free UAV Navigation in Unknown Cluttered Environment Using Vision-Based Reinforcement Learning

Hao Wu, Wei Wang, Tong Wang, Satoshi Suzuki
(Chiba University, Japan)

With the rapid advancement of UAV technology, its application scenarios are continuously expanding, yet UAVs also face numerous challenges in unknown and complex environments. To enhance UAVs' autonomous navigation and obstacle avoidance capabilities in such settings, researchers have proposed various navigation methods. However, mainstream methods still rely on pre-constructed environmental maps, resulting in high computational resource consumption. This paper presents an end-to-end UAV navigation system based on a reinforcement learning algorithm combined with UAV vision. The system takes the UAV's own state and depth images from an onboard camera as inputs to generate control commands, which are then transmitted to a low-level controller to accomplish navigation tasks in complex environments. A range of environments with varying obstacle distributions and lighting conditions were designed for training and testing. Results show that the proposed algorithm effectively achieves navigation tasks in complex environments, demonstrating great potential for applications in various challenging unknown settings.

OS10-5 No Tower Information Needed: An Autonomous Inspection Route Generation Method based on Target Detection

Wei Wang[1], Qi Wang[2]
([1]Chiba University, Japan)
([2]NanJing XiaoZhuang University, China)

With the development of UAV technology, UAVs play an important role in power transmission line inspection work. In recent years, solutions that synthesize tower coordinates and features to generate inspection routes have gained popularity. However, such solutions rely on a prior tower knowledge such as latitude, longitude, and altitude, even though such information may be difficult to obtain accurately. To address this situations, this report proposes an autonomous planning method for inspection routes based on target detection: 1) We propose a lightweight detector based on YoloV8, by introducing a Gelan module in the neck structure, and incorporating PIoU to improve the accuracy of the bounding box regression. 2) Based on the detection results, we design a path planner that contains three stages, to complete the initial tower information estimation and correction, as well as the subsequent towers information estimation. The designed Yolo model can be run at 56 fps on an on-board computer equipped with RK3588 with about 2% improvement compare to the base method in mAP 0.5 : 0.95. Multiple flight experiments of continuous tower inspection also proved the effectiveness of the designed navigation information estimator, which provides an important reference for the development of power inspection technology.

January 22 (Wednesday), 15:00-16:45

Room C

OS21 AROB: System Sensing and Its Applications 2

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

OS21-1 Estimation of driver's psychological state based on NST variation using infrared thermography

Hiroto Nishizaka, Minobu Takahashi, Dan Mikami, Hirotoshi Asano
(Kogakuin University, Japan)

According to the Cabinet Office, 52.3% of traffic fatalities in FY2022 were caused by driver distraction, including distracted driving, looking aside, and not checking safety. Temporary drowsiness while driving has been cited as a factor in distracted accidents. 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 using a contact-type skin thermometer to maintain the driver's transient arousal level by using nasal skin temperature, which reflects sympathetic nerve activity and is known to correlate with psychological state. However, current contact-type measurement devices present practical challenges due to the discomfort caused by direct skin contact. Therefore, we propose a non-contact measurement method using infrared thermography and a webcam to estimate the driver's mental state by detecting nasal temperature changes.

OS21-2 Evaluation of EEG around the ear, employing the non-cephalic reference method

Natsumi Watanabe[1], Hiroshi Arao[2], Shugo Suwazono[3], Akio Kimura[4], Hirotoshi Asano[1]
([1]Kogakuin University, Japan)
([2]Taisho University, Japan)
([3]Okinawa National Hospital, Japan)
([4]Digital Medic, Inc., Japan)

This study evaluates the feasibility of using brainwave electrodes around the ear for EEG measurement, bearing in mind a possibility of its application in epilepsy monitoring. Conventional EEG recording requires electrode placement on the scalp, which is too outstanding and may not be accepted by the patients to keep such electrodes on while everyday life. This research addresses these challenges by investigating noise contamination arising from muscle activities, as well as event-related potentials (ERP), using the conventional surface electrodes at A1 and A2 according to the 10-20 method. Two experiments were conducted with 10 normal participants: noise induction, and ERP induction. We successfully detected ERP components including P300, N100 and P200. Notably, P300 amplitudes were much higher (4.0μV) than those reported with ear canal electrodes (0.4μV), probably attributed to the distances between earlobes and the reference. These findings have potential applications in seizure prediction and in the broader medical context.

OS21-3 Measuring the Gait Cycle of the Elderly using Walking Videos

Yutaka Aoyama, Hisaya Tanaka
(Department of Informatics Graduate School of Technology, Kogakuin University, Japan)

Our study developed a system to measure gait cycles from video. The system classifies each frame into two phases: stance and swing, and further divides these into 7 phases based on Jacquelin Perry's definitions. The stance phase is divided into 4 phases, and the swing phase into 3 phases. By reducing unnecessary classifications and increasing the number of classifiers, we aimed to improve the accuracy of the 8-phase classification. Walking data from 22 young and 30 elderly subjects were used, with 19 young and 19 elderly for training and 3 young and 11 elderly for validation. The system achieved 96.3% accuracy for the right leg and 94.9% for the left leg in the 2-phase classification. For the 8-phase classification, accuracy was 84.7% for the right leg and 83.9% for the left leg.

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OS21-4 Detailed Analysis of Processing Time for Blink Type Classification Based on 3D-CNN

Hironobu Sato[1,3], Shogo Matsuno[2], Kiyohiko Abe[3]
([1]Kanto Gakuin University, Japan)
([2]The University of Electro-Communications, Japan)
([3]Tokyo Denki University, Japan)

In several previous studies, methods based on input video images of the face or periocular area were proposed to classify blink types. We propose a machine learning method based on three-dimensional convolutional neural network (3D-CNN) to achieve blink-type classification. The 3D-CNN takes an image sequence of the blink process and classifies it into one of three states of blinking (“voluntary,” “involuntary,” or “not blinking”). Assuming real-time blink classification, the processing time for the classification was investigated using a 3D-CNN on a laptop computer. In our preliminary experiments, we found that a certain percentage of samples had particularly long processing times. In this study, we present a detailed analysis of time-series data and processing times for blink-type classification, further discussing methods for reducing the occurrence of samples with large processing times.

OS21-5 Can non-verbal sound convey the robot's intentions?

Yuji Tamayose[1], Hirotoshi Asano[1], Atsushi Shibata[2]
([1]Kogakuin University, Japan)
([2]Advanced Institute of Industrial Technology, Japan)

As an initial step in the process of using the cries of plush robots to enhance fatigue reduction, we investigated sound feature changes and the impressions they convey to humans. The emotional expression is important in communication between humans and social robots. On the symbolic aspect of sound, it has been shown that there is a possibility of a relationship between the image of a sound and its acoustic characteristics. We processed the sound of a 440Hz sine wave and the sound of a cow's mooing at around 390Hz, and conducted a questionnaire about impressions. It was found that a common perception of positive or negative emotion could be created simply by listening to the sound, and that the frequency of change in volume could be related to the negative impression. Some common emotion selection was observed for specific emotions, but it was difficult to find commonalities among them.

OS21-6 Automatic bug fixing using optimization methods

Yugo Tabata, Kiyohiko Abe
(Tokyo Denki University, Japan)

Current debugging procedures in software development require a considerable amount of human resources. Although GenProg has emerged as a breakthrough automatic bug fixing technology that uses genetic programming, no prior studies have examined the use of other optimization methods for debugging. To fill this research gap, the present study examines five methods for automatic bug fixing: Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Immunity Algorithm (IA), Simulated Annealing Method (SA), and Tabu Search (TS). In the evaluation experiments, AtCoder competition programs were modified and compared using the modification time, number of programs generated, and error rate as indicators. ACO, PSO, and SA all outperformed the random setting, confirming the potential of automatic bug fixing with different optimization methods.

OS21-7 A model of R-R intervals of ECG using the autocorrelation function

Masanori Shiro, Yu Sekiguchi, Rina Kagawa, Hiroshi Sato
(National Institute of Advanced Industrial Science and Technology, Japan)

We propose two elemental methods to create a synthesized time series of R-R intervals that is consistent with the results of well-known analysis. The first is to express the autocorrelation function as the sum of two exponential functions and a sine wave, and the second is a method for quickly creating a time series that follows a correlated Gaussian distribution determined by two parameters SD1 and SD2 on a Poincaré plot.

January 22 (Wednesday), 15:00-16:30

Room D

GS38 Swarm intelligence

Chair: Yasumasa Tamura (Hokkaido University, Japan)

GS38-1 Boosting Accuracy and Explainability in Swarm Anomaly Detection with Vision Transformer

Yohei Fukuyama, Masao Kubo, Hiroshi Sato
(National Defense Academy, Japan)

Efficient operations in swarm systems heavily rely on the timely detection of anomalies and the identification of the individuals responsible for those anomalies. However, this process is often hindered by the high costs and relatively low accuracy of existing methods. While several approaches based on Explainable AI (XAI) have been proposed, their performance has often remained limited in practical applications. To address these challenges, we propose an enhanced XAI-based method that incorporates the Vision Transformer (ViT) and its corresponding Attention Map, significantly improving both the detection of anomalies and the identification of anomalous individuals with high accuracy at low cost.

GS38-2 Path Planning of a UAV Using Ant Colony Optimization with Penalty for Environment Including No-fly Zone

Yoshiaki Katada, Takumi Kato, Nao Nakajima
(Setsunan University, Japan)

Most commonly, a UAV passes through each waypoint, including the destination, and returns to the departure point. This route planning is equivalent to the well-known mathematical optimization problem, the Traveling Salesman Problem. When there are no-fly zones, such as airports, or obstacles like tall buildings and towers within the planned flight area, it is essential to plan routes that avoid these hazards. This study addresses route planning that accounts for such restricted areas. We apply Ant Colony Optimization to this problem. In this study, we set up several flight environments and conducted a series of computer simulations to plan the shortest routes that avoid restricted areas. Additionally, we performed automated flight experiments with a UAV following the routes obtained in the simulations. We confirmed that desirable routes avoiding no-fly zones could be generated and that automated flight was successfully executed along these routes.

GS38-3 Stable scalable patterns with symmetric structures generated by heterogeneous boid

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

A Boid, a simple model of animal group movement, is a multiagent system that communicates locally. A heterogeneous boid is composed of different types of agents. This study explains two variations of heterogeneous boid (the simplest model and retrograde model). By tuning the local interactions among the types of agents, these models generate scalable stable patterns of agent clusters with large-scale symmetrical structures (such as, cluster shapes and agent flows). When these models are simulated with the large number of agents, they often generate metastable states which transition to stable patterns with disturbances. This study identified and classified the scalable stable patterns and metastable states generated by these models, and suggested how to remove the metastable states.

January 22 (Wednesday), 15:00-16:30

GS38-4 Group dynamics of Plecoglossus Altivelis under different light-environments

Kohei Ohashi[1], Shoma Kamata[1], Rei Hiraoka[1], Hiroaki Kawashima[2], Hitoshi Habe[3], Takayuki Niizato[1]
([1]University of Tsukuba, Japan)
([2]University of Hyogo, Japan)
([3]Kindai University, Japan)

Collective behavior in nature exemplifies self-organization through local interactions, with fish schooling being a compelling case. While illuminance affects both individual physiological traits and group dynamics, light wavelength has been shown to influence individual physiological traits, such as growth and endocrine secretion. However, its role in shaping collective behavior remains unclear. In this study, we used Plecoglossus altivelis to investigate schooling behavior under three light conditions: darkness, blue light, and red light. The key findings included: (1) fish formed fewer groups in darkness, with larger inter-individual distances and lower orientation alignment, and (2) under blue light, fish exhibited tighter, more aligned schools than the fluid and variable group formations under red light. These results suggest that light wavelengths significantly impact schooling behavior and have potential applications in aquaculture and fish guidance systems.

GS38-5 Using AI to optimize a swarm's information network for use in disaster response

Logan S Joslin, Yoshihiro Sato
(Kyoto University of Advanced Sciences, Japan)

Swarm robotics offers a promising solution for complex, large-scale tasks such as disaster response and exploration. However, the efficiency and scalability of swarm systems are often hindered by computational power limitations and the complexity of coordinating autonomous agents. This paper presents a novel framework that leverages artificial intelligence (AI) to optimize exploration, communication, and coordination among agents. The system enables explorer agents to autonomously navigate a simulated urban environment while maintaining communication with a central mother agent. Preliminary results demonstrate efficient exploration with minimal overlap and high adaptability, achieving up to 80 percent coverage in five minutes. While the system performs well in controlled simulations, challenges remain for real-world deployment, including sensor integration, communication latency, and movement modeling. Future work will address these limitations and enhance scalability. These findings provide a foundation for advancing swarm robotics in dynamic, resource-constrained environments.

GS38-6 Reinforcement Learning-based Autonomous Driving Control for Efficient Road Utilization in Lane-less Environments

Mao Tobisawa[1], Kenji Matsuda[1], Tenta Suzuki[1], Tomohiro Harada[2], Junya Hoshino[1], Yuki Itoh[1], Kaito Kumagae[1], Johei Matsuoka[1], Kiyohiko Hattori[3]
([1]Tokyo University of Technology, Japan)
([2]Saitama University, Japan)
([3]Tokyo Denki University, Japan)

In recent years, advancements in autonomous driving technology have enabled new possibilities for traffic control and road utilization. This study proposes a cooperative control method for autonomous vehicle groups on roads without lane or directional separation, aiming to improve road utilization efficiency. Using deep reinforcement learning and inter-vehicle communication, the method was evaluated in simulated Single and Dual Carriageway environments. Results showed the Single Carriageway achieved a 65% increase in throughput and 59% higher vehicle density compared to the Dual Carriageway. Even with traffic imbalances, Single Carriageways demonstrated 37% better performance. While vehicle collisions increased in Single Carriageways, limiting density to match Dual Carriageways reduced accidents by over 80% while maintaining high throughput. The findings highlight the potential of the proposed method to enhance road utilization and respond to traffic fluctuations. Future work will focus on further improving safety and testing more complex scenarios.

January 22 (Wednesday), 15:00-16:45

Room E

GS34 Robotic mechanism I

Chair: Ken Saito (Nihon University, Japan)

GS34-1 Development of Robotic Flapping Mechanism: Lessons from Ladybug

Kazuki Takeshita[1], Kota Okabe[2], Geunho Lee[1]
([1]Unversity of Miyazaki, Japan)
([2]Miyazaki Airport Building CO. LTD., Japan)

Disaster rescue robots have been widely studied by scientists and engineers. Among these robots, various mobility mechanisms are utilized to dive into rubble and search for buried humans. However, there exists some limitations in the approach only from the ground. Therefore, flight mechanism is attracted as a new method that can realize not only walking but also flying such an environment. This study aims to elucidate the motion mechanism of flapping flight inspired by ladybug. As a first step, the observation and motion analysis of flapping ladybugs are conducted to identify the features of flapping flight motions. Subsequently, a kinematic model is created. To confirm the generation of lift force, evaluation experiments are performed. Next, flapping flight experiments are demonstrated by using the developed prototype. Finally, the effectiveness of this model is validated and future directions are considered.

GS34-2 Design and Realization of A Surgical Manipulator based on 2-DoF Remote-Center-of-Motion Planar Mechanism

Anuragi Thapliya[1], Maggie Kirwan[1], Gajitha Nanayakkara[2], Adam Powell[1], Constantinos Chamzas[1], Sajid Nisar[2]
([1]Worcester Polytechnic Institute, United States)
([2]Kyoto University of Advanced Science, Japan)

This paper presents the design and implementation of a novel surgical manipulator for applications in Robot-Assisted Minimally Invasive Surgery (RMIS). The manipulator is based on a previously developed two degrees-of-freedom (DoF) remote- center-of-motion (RCM) mechanism that provides pitch and translation through its mechanical design. This innovative approach enhances kinematic performance and reduces the overall footprint of the system. A physical prototype was constructed to evaluate the manipulator's performance in simulated telesurgical tasks, including peg transfer and zigzag path-following. The mechanism's capabilities were successfully demonstrated via teleoperated commands, showcasing its ability to maintain the RCM. The manipulator achieved the MIS workspace with a DoF range of 35◦ in pitch and yaw. These evaluations provide insights into the manipulator's stability, precision, and usability under surgical-like conditions. Future work will focus on completing the integration with haptic devices, enhancing adaptability for more complex surgical maneuvers, and improving compatibility with advanced imaging systems to further refine the user experience.

GS34-3 Design of a Multi-Link Minimally Actuated Serial Robot Upper-Limb Exoskeleton

Alan Villalejo Cota, Rene Manuel Suarez Flores, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Exoskeletons hold immense potential across various fields, particularly arm exoskeletons, which promise enhanced lifting capacity, improved mobility, and more. However, achieving these benefits often necessitates multiple degrees of freedom (DoFs), requiring numerous actuators. This increases the size and weight of the device, limiting its assistive capabilities. This paper introduces a novel minimally actuated serial robotic (MASR) arm exoskeleton designed to reduce the actuator count while supporting multi-DoF movements. The proposed mechanism employs a single motor to control multiple links using clutches and continuously variable transmissions (CVTs), minimizing weight and simplifying control for efficient movement. The design and simulation of the MASR exoskeleton, capable of five DoFs, were carried out using computer-aided design software. The exoskeleton can perform shoulder abduction-adduction, inward-outward rotation, flexion-extension, elbow flexion-extension, and forearm pronation-supination with fewer actuators. Model-based kinematic simulations confirm that the proposed design achieves the desired range of motion for the targeted upper-limb DoFs.

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GS34-4 Modeling of Half-drone wheeled inverted pendulum Prototype 2

Hector Gautier, Shoichi Maeyama
(Kagawa University, Japan)

This paper discusses the early-stage development of a half-drone wheeled inverted pendulum robot. We outline the process of modeling the linear dynamics of the robot, the computation of control gains using the Linear Quadratic Regulator (LQR) strategy, and the implementation of these gains across a range of systems by addressing an optimization problem through Linear Matrix Inequalities (LMIs). Additionally, we provide an initial analysis of the impact of propeller integration on the robot's performance.

GS34-5 Development of Edible Modular Robots with Thermal Repairability and Reconfigurability

Moe Kakegawa, Jun Ogawa, Hidemitsu Furukawa
(Yamagata University, Japan)

Edible materials have gained attention in soft robotics due to their potential applications in food safety and healthcare, where safety and consumability are crucial. However, engineering challenges such as maintaining moldability, mechanical strength, and surface texture often limit their practical use. Existing edible robots are typically monolithic, relying heavily on self-healing materials for durability, which can vary in effectiveness. To address these limitations, we propose a modular design that allows for reconfiguration and part replacement, minimizing dependency on material-specific properties. In this study, we developed a modular edible robot, employing edible materials for all components except the power source and cords. A deformable, wire-driven soft actuator was designed using gelatin-glycerol hydrogels, leveraging their thermoresponsive and self-healing properties. The actuator demonstrated adaptability to various movements and durability under repeated deformation. To ensure human safety and appeal, we used food-grade materials and molds to construct the robot from popular confectioneries, including candies and gummies. This approach improves human-robot interaction, establishing edible robots as practical and interactive tools for consumer applications.

GS34-6 Fundamental experiments for adjustable DOF mechanism using vibration and jamming transition

Souta Niga, Toshihiko Shimizu
(Kobe City College of Technology, Japan)

Soft robotics offers a promising approach as an alternative to rigid robotics, particularly excelling in tasks requiring adaptability, such as object grasping. This adaptability arises from the ability of soft robots to passively deform to match the shapes of various objects. However, this capability is effective only when the robot’s structure can appropriately conform to the target object. In other words, soft robots often rely on pre-determined or passive structural adaptability rather than actively controlled precise behavior. Notably, the nearly infinite degrees of freedom in soft robots pose a significant challenge, making it difficult to dynamically adjust their structural configuration to optimize performance for specific tasks. To address this issue, we propose a mechanism that dynamically adjusts passive degrees of freedom using granular materials. By redistributing these materials within a flexible, elastic structure under external vibrations, we present a novel approach to enabling temporary structural control.

GS34-7 A proposal of a moving chair with six driving wheeled legs

Kazuhiro Hamamoto, Hirokazu Matsui
(Mie University, Japan)

In this report, we propose the proposed moving chair with six legs, each with a driving wheel at its tip. With the aging population, the demand for wheelchairs is increasing; however, conventional wheelchairs face significant challenges on uneven terrain and steps, greatly impacting quality of life, particularly in historical areas with stairs and rough surfaces. This study introduces the proposed six-legged moving chair designed to maintain seat stability while overcoming uneven terrain and obstacles, enhancing safety, comfort, and user independence. The six-legged structure offers superior load distribution and adaptability to various terrains. A mathematical model analyzed static forces, leading to the selection of carbon fiber reinforced plastic (CFRP) for its lightweight and strength. Motor torque was optimized to ensure stability, mobility, and energy efficiency on difficult terrains. The independent leg movement was implemented for flexibility, while motor requirements were tailored to specific terrain challenges, improving system functionality.

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Room F

GS22 Machine learning II

Chair: Noritaka Shigei (Kagoshima University, Japan)

GS22-1 Wood Ear Mushroom Detection Using Data Augmentation with 3D-CG Images and Generative AI Images

Ryuki Yamada[1], Ryo Matsumura[2], Hironori Kitakaze[1]
([1]National Institute of Technology (KOSEN), Oshima College, Japan)
([2]Faculty of Information Science, Shunan University, Japan)

The shortage of successors in the farming industry has recently become a critical issue in Japan. Consequently, smart agriculture, which incorporates robotics and other advanced technologies, has garnered significant attention. We have collaborated with local producers to develop an automated harvesting system for wood ear mushrooms. Accurate position estimation of wood ear mushrooms based on images captured from a camera is a key component of this system, which is essential for enabling effective automation. Generative AI was utilized to generate training imagesfor the deep learning models to enhance the accuracy of this estimation. This paper presents the results of our wood ear mushroom detection experiments, which achieved an accuracy of 89%.

GS22-2 Improving Prediction Accuracy by Modifying Kernel Functions in PILCO

Kunikazu Kobayashi, Takato Kato
(Aichi Prefectural University, Japan)

PILCO has been proposed to approximate the state transition model of model-based reinforcement learning with a small amount of data using a Gaussian process, thereby reducing the cost of data collection. However, because PILCO uses Gaussian process regression to train the state transition model, it is necessary to analytically calculate the expected value of the output each time the kernel function is changed. In this paper, we propose a method to solve the above problem of analytically obtaining the expected value of the output of Gaussian process regression by using a Hamiltonian Monte Carlo method to estimate the expected value of the output of Gaussian process regression. The effectiveness of the proposed method is verified using the continuous value problems of the Gymnasium. The results show that the proposed method can easily change the kernel function and improve the prediction accuracy through comparison with the conventional PILCO.

GS22-3 Modification of Single-Input Rule Modules Fuzzy Models for Multi-Class Classification

Tomoharu Nakashima, Takumi Matsumoto, Yoshifumi Kusunoki
(Osaka Metropolitan University, Japan)

This paper proposes two modifications to the SIRMs fuzzy models. First, we propose that each fuzzy if-then rule has multiple consequent values. Then, the loss function for tuning model parameters in the steepest descent algorithm is changed from mean squared errors to cross-entropy. We provide each modification's details and show its effectiveness using benchmark datasets.

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GS22-4 Sentiment Analysis Based on Ratings of Product Reviews Using BERT and SHAP

Takahiro Hayashi, Ryo Hatano, Hiroyuki Nishiyama
(Department of Industrial and Systems Engineering,
Faculty of Science and Technology, Tokyo University of Science, Japan)

In this study, we analyzed the relationship between sentiments and review ratings in product reviews. First, we created a sentiment classifier using BERT. Next, we constructed a machine learning model with review ratings as the target variable and sentiment scores as features. The LightGBM model demonstrated the best performance, achieving an R2 value of 0.458. We then applied SHAP analysis to this model, revealing that sentiments such as "joy," "sadness," "surprise," and "fear" impacted review ratings. Specifically, we found that "sadness" had a negative effect on ratings, with its impact amplified by "surprise." On the other hand, we found that "joy" positively influenced ratings, and its effect was similarly amplified by "surprise." Furthermore, we conducted a TF-IDF analysis to examine terms related to sentiments that influence ratings. The results suggested that negative sentiments were associated with problematic terms such as "crack" on a product, while "joy" reflected positive product attributes.

GS22-5 Depth Image Generation Algorithm Using Monocular Camera and Tiny Distance Sensor

Kenta Kikuno[1], Teklay Asmelash Gerencheal[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)

Monocular depth estimation algorithms enable the acquisition of 3D information from 2D images. These algorithms are gaining attention due to their cost-effectiveness and ability to operate without complex sensors, such as LiDAR. This research focuses on developing a depth estimation algorithm for collision avoidance in drones designed for indoor inspections. We propose an enhanced depth estimation algorithm that combines RGB images with input from tiny distance sensors, aiming to improve the accuracy of depth measurements. The system was tested in indoor environments, including scenarios where relative distances were challenging to measure. Its performance was compared against MiDaS and an improved version of MiDaS. While standard MiDaS can only provide relative distance measurements, often influenced by object color, it cannot estimate absolute distances. In contrast, the improved MiDaS leverages data from the tiny distance sensors to estimate absolute distances, demonstrating significant improvements in depth image accuracy.

January 22 (Wednesday), 17:00-18:15

Room A

OS12 AROB: Interdisciplinary Approaches to Data-Driven Biological and Medical Research

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

OS12-1 Tomato Phenotyping from Daily Video Footage Using 3D Reconstruction Point Cloud and Growth Status Assessment

Warut Timprae, Stefan Baar, Satoshi Kondo, Yoshifumi Okada, Kazuhiko Sato, Shinya Watanabe
(Muroran Institute of Technology, Japan)

Efficient tomato growth monitoring is crucial for greenhouse management and yield forecasting. This study presents a 3D phenotyping method using daily video footage to analyze tomato growth and morphology. The YOLOv8x-seg model performs instance segmentation with high precision, classifying tomatoes by ripeness stages. Combining Structure-from-Motion (SfM), Multi-View Stereo (MVS), and the Nerfacto framework, high-resolution 3D point clouds are generated. Individual tomatoes are identified via clustering, and ellipsoid fitting estimates parameters like size and growth rates. Metric calibration using a spherical reference ensures 3D measurement accuracy, with minimal errors (8.459%, 1.093%, 0.990%). Morphological traits, including volume, surface area, vertical diameter, and color, are analyzed to estimate growth. Despite challenges like occlusions and complex plant structures, the approach demonstrates reliability and scalability for real-time agricultural monitoring. This study advances non-invasive 3D phenotyping, offering valuable insights for improving crop management and productivity.

OS12-2 Impact of Encoder Architecture Variations in U-NET on Cell Nucleus Labeling

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

The morphology and distribution of cell nuclei are crucial for disease diagnosis and predicting patient outcomes. Manual evaluation of histological images faces challenges such as low throughput and observer variability. Deep learning models like U-Net have been widely used to overcome these limitations in computational pathology. This study examines how different encoder architectures in U-Net affect the semantic segmentation of nuclear instances using the PanNuke dataset, a benchmark for multi-class nuclear segmentation. Six encoder architectures, including EfficientNet-B1 and Mix-ViT, were evaluated for their ability to classify and segment nuclear categories, such as tumor and non-tumor cells. EfficientNet-B1 showed superior performance for classes with larger nuclei, while Mix-ViT excelled with smaller, scattered nuclei. Optimizing hyperparameters and balancing the dataset further improved performance, addressing class imbalance issues effectively. These findings highlight the potential of tailored encoder architectures for enhanced nuclear segmentation tasks.

OS12-3 Optimization of Crossover in SMILES-Based Genetic Algorithms for Organic Compound Design

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

In this study, we optimized a genetic algorithm (GA) crossover technique based on SMILES notation to explore novel organic compounds. Traditional naive crossover methods often suffer from generating chemically invalid offspring and reduced diversity. To address these issues, the proposed method incorporates constraints on crossover point selection and grammatical adjustments to ensure the generation of chemically valid offspring. Numerical experiments were conducted using compounds selected from the ZINC20 database to compare the proposed method with naive crossover. The proposed approach significantly improved the rate of chemically valid offspring to 92.73%, far surpassing the 7.62% achieved by naive crossover. Additionally, the proposed method enabled the discovery of novel compounds among the generated offspring, with their effectiveness validated. Fingerprint analysis further demonstrated enhanced offspring diversity. These results highlight the potential of the proposed method to improve chemical space exploration efficiency and facilitate the discovery of novel compounds, with promising applications in drug discovery and materials design.

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OS12-4 Asymptotic regression analysis of COVID-19 infections

Hiroshi Furutani, Tomoyuki Hiroyasu
(Doshisha University, Japan)

This paper reports the application of the regression equation for estimating the time series data of COVID-19 outbreak. Our analysis uses the asymptotic regression equation proposed by Stevens. His model has three parameters with a non-linear term. Interestingly, Gompertz and the logistic distributions can be brought to this equation by simple transformation. The adopted method uses the Fisher information matrix with some modification by Stevens for estimating three parameters and can describe the epidemic curve. We investigate the spreading of infection in the period from July to September in 2021. As a statistical model, this study employs the logistic distribution, which has been widely used for analyzing infectious diseases. The asymptotic regression of Stevens demonstrates that our approach successfully fit the time series data of six prefectures, Saitama, Shizuoka, Miyagi, Ehime, Kyoto and Mie.

OS12-5 Estimation of Low-Rank Correlation Matrix Based on a Thresholding Approach and the L1 Norm

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

Estimating interpretable correlation matrices is crucial for understanding complex relationships, particularly in small sample sizes or noisy datasets, as seen in fields like finance and genomics. Traditional low-rank approximation methods based on least squares emphasize strong correlations and reveal clustering structures. However, there is a challenge where the estimation results are influenced when the number of variables is large compared to the sample size or when outliers are present.To address these issues, we propose a novel L_1 norm-based method for estimating sparse, low-rank correlation matrices. Unlike least-squares approaches that rely on the L_2 norm and are more sensitive to noise, the L_1 norm enhances robustness, improving interpretability while maintaining accuracy. Combining a thresholding approach with the MM algorithm, our method achieves optimal balance between sparsity and interpretability through cross-validation-based threshold selection. Numerical simulations demonstrate the robustness and effectiveness of this approach compared to traditional methods.

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Room B

OS15 AROB: Mobile Robot Control

Chair: Shinichi Sagara (Kyushu Institute of Technology, Japan)
Co-Chair: Yuta Hanazawa (Kyushu Institute of Technology, Japan)

OS15-1 Position control of a 3-link dual-arm underwater robot using model error compensator - Considering the difference in response speed between a vehicle and manipulators -

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

Research and development efforts are ongoing to control underwater robots equipped with manipulators (known as Underwater Vehicle-Manipulator Systems, or UVMS) that can perform underwater tasks in place of humans. We have also proposed a Resolved Acceleration Control (RAC) method, a position control approach for UVMS, and have validated its usefulness through experiments using a free-floating, 3-link dual-arm underwater robot. Now, the model of fluid forces used to control underwater robots has modeling errors. Furthermore, the response speed of the vehicle is much slower than that of the manipulator. To solve these problems, we propose a RAC method for UVMS with MEC, which takes into account the difference in response speed between the vehicle and manipulator, and demonstrate its effectiveness through experiments on the position control of a robot affected by periodic wave disturbances.

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OS15-2 Force control experiment of a 3-link dual-arm underwater robot with model error compensator

Kensho Osugi[1], Reo Nishio[1], Yuta Hanazawa[1], Shinichi Sagara[1], Radzi Ambar[2]
([1]Kyushu Institute of Technology, Japan)
([2]Universiti Tun Hussein Onn Malaysia, Malaysia)

The development of underwater robots equipped with manipulators (UVMS: Underwater Vehicle-Manipulator System) to perform tasks in place of humans has been pursued. We have proposed Resolved Acceleration Control (RAC) methods for UVMS as position control methods. Additionally, as a force control method for UVMS end-effectors, we have proposed position-based impedance control methods using the RAC methods for UVMS. However, accurately modeling the fluid forces acting on the robot underwater is challenging, resulting in modeling errors. To compensate for such errors, the Model Error Compensator (MEC) has been proposed. In this paper, we construct a control system for a 3-link dual-arm underwater robot by adding MEC to a position-based impedance control method using the RAC method for UVMS and verify the usefulness of the constructed control system through force control experiments.

OS15-3 Coronal Plane Control of Biped Robots Using Nonlinear Model Predictive Control for Realizing Quasi-Limit Cycle Walking

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

To perform three-dimensional simulations for bipedal robots, it is necessary to consider control strategies for both the coronal and sagittal planes. In our previous work on sagittal plane control, we implemented limit-cycle walking using nonlinear model predictive control (NMPC) and confirmed its effectiveness. This paper presents our approach for controlling the coronal plane. In coronal plane control, we aimed to prevent the robot from tipping over by employing a stepping-in-place strategy that keeps the Zero Moment Point (ZMP) within the foot sole. To achieve this motion, we compared the conventional method of output-zeroing control based on input-output linearization with our proposed NMPC approach, validating the effectiveness of NMPC for maintaining stability in the coronal plane.

OS15-4 Design of a Motion and Force Controller Based on Composite Error for a Manipulator Mounted on a Surface Vehicle

Yuichiro Taira, Toyoyuki Honjo
(National Defense Academy, Japan)

In this paper, we develop a motion and force control scheme for a manipulator (a robotic arm) that is mounted on a surface vehicle (e.g., a boat). Its features are (1) to simultaneously control the motion and force of the manipulator's tip by means of a composite error that consists of a motion error and the output of a linear filter whose input is a force error, (2) to theoretically ensure that all signals in the closed-loop control system are bounded in the presence of environmental disturbances such as water waves and a wind, and furthermore the composite error is ultimately bounded under the same conditions, and (3) to acquire evaluation inequalities that relate the magnitudes of motion and force errors to design parameters.

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Room C

GS10 Biomedical database & Medical informatics

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

GS10-1 A hybrid model for arrhythmia classification based on Convolutional Neural Network and Extreme Learning Machine without ECG preprocessing

Chotirose Prathom[1], Ryuhi Fukuda[2], Yuto Yokoyanagi[2], Shinya Watanabe[3], Satoshi Kondo[3], Kazuhiko Sato[3], Yoshifumi Okada[3]
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([2]Division of Information and Electronic Engineering, Muroran Institute of Technology, Japan)
([3]Muroran Institute of Technology, Japan)

The electrocardiogram (ECG) is a primary diagnostic tool for cardiovascular diseases (CVDs), including arrhythmias. However, accurate ECG interpretation demands specialized expertise due to the intricate and often ambiguous nature of the signal. Machine learning (ML), particularly deep learning, has emerged as a promising approach to assist in ECG interpretation. While deep learning models have demonstrated impressive performance, their high computational complexity and vulnerability to imbalanced data remain significant challenges. To address these challenges, we propose a novel hybrid model, the Convolutional Neural Network-Extreme Learning Machine (CNN-ELM). This model directly leverages ECG images as input, eliminating the need for extensive preprocessing steps and simplifying the data preparation process. Additionally, we integrate an ensemble learning approach within the ELM component to enhance classification performance, particularly for underrepresented arrhythmias. We evaluate the proposed CNN-ELM on the classification of four arrhythmic beat types. Experimental results demonstrate that our model outperforms existing approaches, achieving competitive accuracy without requiring extensive data preprocessing. Notably, CNN-ELM reduces the number of trainable parameters by approximately 78% compared to conventional 2D-CNN architectures. These findings underscore the potential of CNN-ELM for real-time CVDs classification on resource-constrained devices.

GS10-2 A Preliminary Study on Surgical Skill Classification from Laparoscopic Surgery Videos Using Multi-Instance Learning

Rara Deguchi[1], Kan Tanabe[2], Tsubasa Hidaka[1], Kenji Baba[2], Naoki Kuroshima[2], Masumi Wada[2], Mashiho Mukaida[1], Takao Ohtsuka[2], Noritaka Shigei[1], 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 Digestive Surgery, Graduate School of Medical and Dental Sciences, Kagoshima University, Japan)

The demand for objective methods to evaluate surgical skill has risen, especially for training surgical residents and conducting technical certification assessments. Currently, experienced surgeons perform these evaluations using predefined metrics; however, this process is time-consuming, and subjectivity is difficult to eliminate. Recent studies have begun leveraging deep learning to analyze surgical videos for skill evaluation, though a lack of explainability in the result remains an issue. Therefore, this study proposes a method for quantitatively evaluating surgical skills by extracting features from time-series data representing surgical instrument movements and applying multi-instance learning. The proposed method focuses on localized temporal segments and features within the time-series data, enabling the identification of motion segments that provide the basis for classification results.

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GS10-3 Exploring the Correlation Between Visible, Near-infrared, and Thermal Facial Images and Chronic Stress Indicators

Masahito Takano[1], Kent Nagumo[1], Yasushi Nanai[2], Kosuke Oiwa[3], Akio Nozawa[1]
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([3]Nagaoka University of Technology, Japan)

This study investigates the relationship between facial images at various wavelengths and stress scores, focusing on chronic stress assessment using Independent Component Analysis (ICA). Facial images from different wavelengths—infrared, near-infrared, and visible (R, G, B)—were analyzed. ICA revealed significant correlations between component weights and stress scores, particularly for infrared and visible (R, G) wavelengths, with stronger associations in more participants compared to near-infrared. Independent components with high correlation to stress scores exhibited broad facial features, contrasting with localized features linked to acute stress in previous studies. These findings suggest that chronic stress affects larger facial regions and demonstrate the potential of multi-wavelength imaging for non-invasive chronic stress monitoring, paving the way for future research.

GS10-4 Application of Machine Learning in Preoperative Prediction of Coils Preference in Cerebral Aneurysm Treatment

Takumi Kawauchi[1], Soichiro Fujimura[2,3], Toshiki Koshiba[1], Genki Kudo[3], Niken Prasasti Martono[1], Toru Sano[4], Michiyasu Fuga[4], Gota Nagayama[4], Issei Kan[4], Naoki Kato[4], Toshihiro Ishibashi[4], Yuichi Murayama[4], Hayato Ohwada[1]
([1]Department of Industrial and Systems Engineering, Tokyo University of Science, Japan)
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([3]Division of Innovation for Medical Information Technology, Jikei University School of Medicine, Japan)
([4]Department of Neurosurgery, Jikei University School of Medicine, Japan)

Coil embolization is a treatment for aneurysms, requiring physicians to select suitable coils. While prior studies focused on the first coil, multiple coils are often used in practice. This study introduces a machine learning system to recommend an optimal list of coils preoperatively. Using clinical data, the system predicts the size and length of the second to tenth coils, comparing various algorithms. Predictions were matched against a catalog, and a required coil list was generated. Performance was evaluated using RMSE for prediction accuracy, correct answer rate, and reduction rate for the coil list. Among algorithms, SVM performed best, achieving an 81.4% correct answer rate and a 66.8% reduction rate. This study successfully developed a preoperative prediction system for necessary coils, offering practical clinical benefits.

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Room D

GS13 Control techniques

Chair: Kunikazu Kobayashi (Aichi Prefectural University, Japan)

GS13-1 Automatic Control of Magnetic Adhesion to Metal Wall for an Inspection Drone

Motoya Sumino, Jae Hoon Lee, Shingo Okamoto
(Graduate School of Science and Engineering, Ehime University, Japan)

Drones have emerged as indispensable tools in inspection tasks due to their exceptional maneuverability and ability to access areas that are otherwise difficult or hazardous for humans to reach. These capabilities make drones ideal for applications in challenging environments, such as factory interiors and high-altitude locations. This study introduces an automated inspection method utilizing a drone equipped with magnetic adhesion wheels. By processing point cloud data from a depth camera, the system identifies inspection targets and enables automated control of magnetic adhesion and detachment at user-specified points, remotely operated. The proposed system was validated through experimental flights using a prototype drone in a laboratory setting, successfully demonstrating its ability to adhere to and detach from designated targets for inspection tasks.

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GS13-2 Control Simulation of a 5-DOF Rotary Crane System with Flexibility Simplified in Two Inertia System along the Rotational Direction

Hosuk Yeon[1], Kazuki Umemoto[2], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]University of Fukui, Japan)

This paper proposes a control strategy for a five degree of freedom rotary crane system with flexibility of the boom in the rotational direction. Rotary cranes are widely used in the construction and maritime industries, where precise control and stability are important. However, in conventional control techniques, a boom is considered as rigid. The conventional control may not ensure stability due to the flexibility of the boom in real industrial cranes. To address this issue, this study designs a control system that models the boom's flexibility as a two-inertia system. The effectiveness of the proposed control system design is verified through numerical simulations.

GS13-3 Invention of a path following method for unmanned surface vehicle that includes dead time and lag as control input

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

The problem with coastal surveys with conventional vessels equipped with main thrusters and steering is the lack of sufficient turning distance during path following control. In this study, we devised a path following control system for unmanned surface vehicle (USV) equipped with side thrusters that can move in all directions. In the general path following control, the path is smoothed between waypoints to reduce the curvature of the path in advance in the path planning stage. This path following control method is based on Model Predictive Control (MPC), which implicitly switches from speed control to position control at points with large curvature by switching weight parameters. This enables path following control even on paths where there are no turning sections where path is not smoothed. The simulation confirmed that this control method is capable of path following even in USV control where wind disturbance, control input lag, and dead time exist.

GS13-4 Reduced-Order Observer-Based Output Feedback Control For Four-Wheeled Vehicle

Taichi Nakamura, Yutoku Takahashi, Jun Yoneyama
(Aoyama Gakuin University, Japan)

In recent years, automated driving has developed remarkably and methods for automatic control of vehicles to get to their destinations are required. Vehicle control becomes easy when all the information on its position and angles is known. However, in most cases, only the position of the vehicle is measurable and angles are not available. In this situation, we use an observer to estimate the angles of both the vehicle and its steering wheel from the measured position of the vehicle. In particular, we use a reduced-order observer and design an output feedback control based on such an observer. Finally, we give an illustrative example to show the effectiveness of our control design approach.

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Room E

GS35 Robotic mechanism II

Chair: Ryota Hayashi (Okayama University of Science, Japan)

GS35-1 Design and Evaluation of a Wearable Electromagnetic Tendon-Driven Module for Kinesthetic Haptic Feedback

Rene Manuel Suarez Flores, Karan K C, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

This research presents a new mechanism for providing kinesthetic haptic feedback using an electromagnetic tendon-driven module. The system utilizes two electromagnets positioned facing each other, with a tendon connected to the tip of a soft finger pad between them. By adjusting the current supplied to the electromagnets, variable locking forces are generated to modulate finger movement. FEM simulations were conducted to optimize the electromagnet design, ensuring sufficient locking force at low voltages. A prototype was fabricated, and experiments validated the system's performance, demonstrating low power consumption (0.2A max current) and sufficient locking force (5.8N). User studies in a VR environment showed that users could accurately identify different stiffness levels in eight out of ten trials, with the device deemed comfortable. This method has potential applications in VR experiences and robotic teleoperation maintaining a small size and simplified control.

GS35-2 Design of A Modular 6-DoF Robotic Surgical Instrument with Tool Modularity and Decoupled Degrees of Freedom

Cole Welcher[1], Kevin McCrudden[1], Rene Manuel Suarez Flores[2], Yihao Zheng[1], Loris Fichera[1], Sajid Nisar[2]
([1]Worcester Polytechnic Institute, United States)
([2]Kyoto University of Advanced Science, Japan)

This paper presents the design and development of a new 6-degrees-of-freedom (DoF) robotic instrument aimed at enhancing precision and adaptability in Robot-Assisted Minimally Invasive Surgery (RMIS), where surgical access is limited to sub-1.5 cm incisions. To address the design challenges posed by these constraints, the proposed instrument incorporates a flexible transmission system and an elbow mechanism, ensuring precise control ability to access locations obstructed by other organs. The design's novel features include a tool interchange mechanism and a decoupled kinematic structure. This allows seamless replacement of the distal unit, including the end effectors, without requiring manual intervention. This modularity is expected to grant surgeons immediate access to specialized tools, streamlining surgical flow. Building upon our existing work, the instrument’s design enables effective navigation around obstructions, expanding RMIS capabilities in challenging anatomical regions. The paper describes the design, kinematic modeling, prototype development, control, and experimental validation, highlighting the instrument’s manipulation precision, grip force measurements, end-effector resolution, and overall accuracy in dummy surgical tasks.

GS35-3 Development of Neuromorphic Circuit Driving Rat-Type Robots Using Shape Memory Alloy

Yuki Yasuda[1], Futo Igei[1], Shuxin Lyu[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 the use of analog circuits to mimic biological neurons and incorporate them into robot control systems. Previously, the authors successfully developed a quadruped robot using neuromorphic circuits to control its movement. The robot generates gait patterns without using computer programs based on input from the toe’s pressure sensors and moving speed. However, the previous quadruped robot used servo motors for actuation and a movement style that did not fully mimic biological muscles. To achieve better biomimicry, the authors are developing a quadrupedal rat-type robot in which muscles are mimicked by shape memory alloy (SMA). This paper develops the neuromorphic circuits that can drive the leg of a rat-type robot. The proposed neuromorphic circuit was implemented as a discrete circuit and compared with simulations performed in PSpice. As a result, we confirmed that the proposed neuromorphic circuit can alternately contract and extend one joint of rat-type robots.

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GS35-4 Dynamics Analysis of SMA-driven MEMS Multi-legged Mobile Robot During Walking Motion

Yifan Yang, Zhuo Deng, Fumio Uchikoba, Minami Kaneko
(Nihon University, Japan)

With the advancement of microtechnology, microrobots are expected to find applications in various fields, such as medicine, manufacturing, and beyond. Microrobots can extend the capabilities of existing robots and human intent into confined spaces that are otherwise unreachable, thereby expanding human abilities. In our previous study, we develop quadruped and hexapod MEMS microrobots with independent legs using a compound 4-bar linkage mechanism. In this paper, we simulated the walking motion of the multi-legged microrobot using a dynamic simulator and analyzed its gait to achieve stable walking. We measured the actuator speed and imported it into the simulator, then simulated the walking speed of the multi-legged robot under varying leg movement periods. Additionally, we evaluated the walking performance of the multi-legged robot under different gait patterns.

GS35-5 Development of an Automatic Staple-Removing Robot

Toshiki Matsuo[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)

In recent years, many organizations such as companies and government offices have been promoting the implementation of Robotic Process Automation (RPA) to enhance productivity. However, because RPA can only automate tasks performed on computers, it cannot automate physical tasks such as handling paper documents. Therefore, physical RPA, which combines RPA with physical robots to automate physical tasks, is becoming necessary. This study developed a robot that can automatically remove staples and sort documents after staple removal to expand the scope of physical RPA. We developed a YOLOv10 model for detecting staples, a YOLOv8 model for estimating the orientation of business cards, a removal mechanism for removing staples, and electroadhesive pads for holding business cards.

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Room F

GS28 Model estimation

Chair: Changook Park (Seoul National University, Korea)

GS28-1 A Quantitative Analysis of Financial Distress Propagation in International Networks Utilizing DebtRank and a Multi-layer Approach

Junhyun Chae[1], Hiroyasu Inoue[1,2]
([1]Graduate School of Inforamtion Science, University of Hyogo, Japan)
([2]Center for Computational Science, RIKEN, Japan)

Modern financial systems operate through complex interactions within multilayered structures, such as lending and trade, with financial risks propagating through interconnected layers. We addresses the limitations of single-layer models, which fail to sufficiently explain the complexity of real-world systems due to their inability to account for inter-layer interactions, by analyzing financial risk propagation using multilayer networks. A multilayer network was constructed using cross-border lending and trade data, extending the concept of DebtRank to trace risk propagation pathways and quantitatively analyze the influence of each country. The analysis utilized BIS LBS and UN Comtrade data, covering a total of 20 countries, including 19 OECD member states and Brazil. As a result, assigning layer-specific weights based on transaction volumes significantly enhanced the correlation between leverage matrices and DebtRank scores. This study provides critical data for deepening the understanding of financial risk propagation pathways.

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GS28-2 Evaluation of space rover's mobility performance regarding the mounting angle of the lugs for crawlers using the mechanics model

Kazuki Maeda, Katsuyoshi Tsujita
(Tottori University, Japan)

In this study, we analyzed the causes of differences in running performance depending on the installation angle of the lugs on a crawler-type space rover and, in particular, the phenomenon of maximum running performance in a specific lug installation angle. Since the current experimental environment does not allow for experimental observation of the mechanical effects of the lugs on the sand on the road surface, we formulated a hypothesis from a simple mechanical model. The model was based on the model used in terramechanics and assumed that known physical parameters of the road surface sand, such as the angle of incidence of the lugs on the road surface sand, are related to changes in running performance. Based on the constructed model, we analyzed the running performance of crawlers from the viewpoints of processing science and material mechanics.

GS28-3 Proposal of Mathematical Model of Dielectric Elastomer Actuator for Vibration Suit

Hajime Yokoyama, Hirokazu Matsui
(Mie University, Japan)

This study proposes the “Vibration Suit,” an innovative wearable device that uses dielectric elastomer actuators (DEAs) to induce localized deformations, enabling applications such as muscle stimulation, stress-relief massage, and immersive VR/AR experiences. The device takes advantage of DEAs’ flexibility, high responsiveness, and ability to generate vibration and stretching, providing a promising solution for medical, rehabilitation, and entertainment fields. The research formulates DEA control as a surface deformation problem and introduces models for linking DEAs in one dimension. It also addresses challenges related to sliding motions and traveling wave generation, which are essential for creating dynamic and functional wearable devices. While individual control of DEAs remains complex, this work lays the groundwork for the development of advanced wearable technologies, enhancing comfort and functionality in various domains, including healthcare, sports, and entertainment.

January 23 (Thursday), 9:00-10:45

Room A

OS7 AROB: Construction of lunar bases and lunar exploration by AI-powered robots

Chair: Ryusuke Fujisawa (The University of Kitakyushu, Japan)
Co-Chair: Yuichi Ambe (Osaka University, Japan)

Invited Talk 3 A Hierarchical Learning Method for Modular Robot Control

Jun Morimoto (Graduate School of Informatics, Kyoto University, Japan)

See page 17

OS7-1 Development of a Compact Board for Wired Communication Between Modules for Lunar Activity Modular Robots

Kiona Hosotani[1], Akio Noda[2], Fumitoshi Matsuno[2]
([1]Kyoto University, Japan)
([2]Osaka Institute of Technology, Japan)

As part of the Moonshot Research and Development Program's lunar exploration project, we are developing modular robots for lunar activities. The modular robots currently under development are aimed at wired communication (1000Mbps Ethernet communication and 2Mbps RS485 communication) between modules when connected, and for this purpose, we have developed a compact communication board. While the communication board developed last year had a ring shape with an outer diameter of 120mm and an inner diameter of 105mm, the newly developed board has a smaller diameter of 35mm. The developed board allows both communication methods to be conducted at the intended communication speeds. Furthermore, the board developed last year did not meet the standards of Ethernet physical transmission characteristics. In contrast, the newly developed board meets these standards.

OS7-2 A Simulation Framework for Modular Self-Reconfigurable Robots Using Isaac Sim

Guang Yang[1], Xixun Wang[1], Koki Harada[2], Shuhei Sugiura[2], Ryota Kinjo[1], Hiroshi Oku[1], Ryo Ariizumi[3], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]Nagoya University, Japan)
([3]Tokyo University of Agriculture and Technology, Japan)

Modular self-reconfigurable robots are capable of rapidly adapting their configurations to meet diverse applications and environmental challenges. While simulation is effective for improving development efficiency and training learning-based models, it presents challenges for modular robots, such as addressing closed-loop constraints during reconfiguration. This work addresses these challenges by first developing a modular robot simulator in Isaac Sim capable of handling these constraints. We then establish modularized controllers that enable effective control of various robot configurations, including considerations for self-reconfiguration. Several tasks involving polymorphic configurations and self-reconfiguration were evaluated in the simulator to validate the proposed approach. Finally, the controllers developed in the simulation environment were tested in real-world scenarios to assess sim-to-real performance.

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OS7-3 Simultaneous Optimization of Module Combination and Task Scheduling for Modular Robots in the Construction of Lunar Bases

Yuki Tanigaki
(Osaka Institute of Technology, Japan)

Modular robots consist of interchangeable modules, enabling task-specific configurations for diverse missions. This adaptability is vital in resource-limited, uncertain scenarios like lunar base construction, where module failures and replenishment issues arise. Deploying modular robots effectively requires solving two optimization problems: module combination and task scheduling. The first determines optimal module configurations based on mission needs, such as a single robot with modules A, B, C, D or two robots with AB and CD combinations. The second optimizes task scheduling to ensure efficiency, accounting for uncertainties like module failures. This study proposes a framework using evolutionary multi-objective optimization to predict promising configurations without real-time scheduling. Task scheduling is then applied to selected configurations, reducing computational costs while maintaining performance. Simulations confirm its effectiveness in complex missions.

OS7-4 Design of GNN-Based AI and Encoding Techniques for Autonomous Transitions of Modular Robots

Kenichiro Satonaka[1], Ryusei Nishii[1], Ryota Kinjo[1], Yuki Takagi[1], Hiroshi Oku[1], Yuki Tanigaki[1], Koki Harada[2], Shuhei Sugiura[2], Ryo Ariizumi[3], Tomohiro Shimomura[1], Guang Yang[1], Xixun Wang[1], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]Nagoya University, Japan)
([3]Tokyo University of Agriculture and Technology, Japan)

The Moonshot R&D project, “Self-evolving AI robot system for lunar exploration and human outpost construction,” aims to realize AI robots that integrate advanced physical capabilities with self-evolving AI learning. Modular robots face significant challenges in achieving optimal and rapid shape transitions due to the vast number of possible configurations. To address this, various isomorphism determination methods, including GNN and mathematical models, are employed to identify optimal transition paths. In the first stage, connection structures are converted into graph structures, enabling efficient transition search algorithms. Validation using GNN demonstrates high accuracy in isomorphism detection, reducing costs caused by combinatorial explosion. In the second stage, the physical feasibility of transitions is verified through simulations in NVIDIA Isaac Sim, integrating inverse kinematics and control libraries. Future work focuses on improving adaptability to unknown lunar environments using deep reinforcement learning. This research strengthens self-evolving robotic systems capable of autonomous operation in extreme lunar environments.

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OS7-5 Development of a Remote Operation Platform with Self-organized Modular Robots for Lunar Exploration

Xixun Wang[1], Kotaro Kanazawa[2], Haruki Aoyama[2], Ching Wen Chin[3], Yuya Shimizu[4], Guang Yang[1], Ryohei Michigawa[5], Kiona Hosotani[5], Noritaka Sato[2], Akio Noda[1], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]Nagoya Institute of Technology, Japan)
([3]The University of Electro-Communications, Japan)
([4]Okayama University, Japan)
([5]Kyoto University, Japan)

This paper presents a remote operation platform that remotely controls modular robots as long as basic abilities of self-organization and autonomy for lunar exploration. The modular robots are variable which means the modular robots are assembled by several heterogeneous modules with variable degrees of freedom (DoF) and variable combinations. Since it is impossible to manually teleoperate each module over a long distance, we shall teleoperate assembled modules as a single robot with a simple command. For this purpose, the self-organization is expected to recognize the configuration of modules, select a leader to manage the information transmission, and choose a suitable control method to command modules for the given task. Considering the communication from the base does not support some tasks, such as mining, a decentralized robot configuration investigation and leader concession are developed. All modules have the ability to become leaders. Each module exchanges the connection information with the nearby or connected module, figures out the robot configuration itself, and authorizes leadership a leader module to make itself controlled. By the decentralized method, the module at least has a leader for the worst situation including the connection being physically damaged or communication between modules having mistakes. We applied a prototypic remote operation platform mentioned above to real-world modular robots that have several different kinds of modules. The platform successfully illustrated the reconfiguration of modules, displayed the surrounding environment, and teleoperated the assembled module.

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Room B

GS31 Neural networks II

Chair: Fumio Uchikoba (Nihon University, Japan)

GS31-1 Dynamic Gaussian Splatting with Temporal Offsets for 3D Scene Reconstruction from Unsynchronized Multi-View Videos

Yusuke Saito
(HoloLab.Inc, Japan)

To achieve photorealistic spatial reproduction, some methods for spatiotemporal reconstruction of dynamic scenes using Gaussian Splatting has also been proposed. However, these methods generally assume fully synchronized multi-view video frames as training data. In contrast, in the reconstruction of dynamic 3D scenes using Neural Radiance Fields (NeRF), it has been found effective to introduce temporal offsets for each camera view in datasets that are not frame-synchronized. However, considering real-time rendering for virtual reality headsets or game engines, Gaussian Splatting is more suitable in terms of computational speed and memory efficiency. Therefore, we propose a method to train dynamic Gaussian Splatting using unsynchronized multi-view video footage. In this study, we introduce and optimize the temporal offsets for each camera view in dynamic Gaussian Splatting reconstruction methods. In addition, we validate the effectiveness of the proposed method using a dataset composed of unsynchronized multi-view videos.

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GS31-2 Anatomic Classification of Medical Image Findings Using UTH-BERT and Attention Mechanisms

Saya Narita[1], Shoji Kido[2], Shingo Mabu[1]
([1]Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan)
([2]Graduate School of Medicine, Osaka University, Japan)

Deep learning relies on large volumes of annotated data, but creating such data is highly labor-intensive. Thus, developing an efficient annotation system is crucial. In this study, we prepare PET-CT image findings to build a dataset with machine-learning-compatible class labels. In previous research, UTH-BERT was used in a classification network to assign anatomic region labels to each sentence of image findings. Previous research utilized UTH-BERT, to classify each sentence of image findings into anatomical regions, considering both the target sentence and the preceding one. The method considers both the target and preceding sentences, but the preceding sentence sometimes improves classification and sometimes has adverse effects. Therefore, in this study, we integrate an attention mechanism into UTH-BERT to assess the importance of the previous sentence and enhance classification accuracy. Experimental results using AUC showed the proposed method outperformed the conventional approach.

GS31-3 Segmentation of Diffuse Lung Diseases in Computed Tomography Images Using Partially Supervised Learning: A Model Construction and Learning for Feature Extraction Considering Lung Opacities

Takuya Hamada[1], Shoji Kido[2], Shingo Mabu[1]
([1]Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan)
([2]Graduate School of Medicine, Osaka University, Japan)

In deep learning in the medical field, it is difficult to prepare a sufficient amount of data with fully pixel-wise labels because labeling requires medical expertise and enormous labor. Therefore, learning methods from incomplete annotated data have been developed. In this study, we propose a model structure and a learning method for efficiently learning lung opacity segmentation using partially annotated chest CT images. The proposed model structure is based on U-net, and shares the encoder and most of the decoder layers for all the opacities. The proposed learning method uses two loss functions, which are designed to increase or decrease the similarity between the predicted (segmented) and labeled (annotated) areas. In the experiments, we trained the model on partially annotated images and evaluated the segmentation results for the images with multiple opacities. The proposed methods showed better segmentation performance evaluated by mean dice coefficient, while reducing the network size.

GS31-4 Optimizing Neural Coding in Spiking Neural Networks for Mammography Image Processing

Kenza Garreau[1,2], Brad Niepceron[2], Emmanuel Bellenger[1], Filippo Grassia[1]
([1]University of Picardie Jules Verne, Laboratory of Innovative Technologies (LTI, EA 3899), France)
([2]Kaptios, France)

The main challenge in breast cancer detection is interpreting whether a microcalcification on the images is suspicious. Spiking neural networks (SNNs) offer a promising alternative, providing results comparable to artificial neural networks (ANNs) but with lower computational costs. However, converting pixel intensity values into binary spikes in SNNs can lead in information loss, limiting their ability to detect subtle features on high-resolution images, like microcalcifications. To address this limitation, we compared three encoding methods: Leaky Integrate-and-fire, Poisson rate coding, and Time-to-First-Spike (TTFS) coding schemes using a three-convolutional layer SNN for breast anomalies classification. Our results show that the network performs competitively with the existing SNN model designed for a similar task, achieving comparable classification accuracy in a low latency regime. There was no statistically significant difference in maximum classification accuracy across the three encoding methods.

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GS31-5 Pseudo Abnormal Image Generation to Improve Classification Performance of Small Abnormal Opacities in Chest X-ray Images

Michi Nishio, Shingo Mabu
(Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan)

Previous studies of classification systems of chest X-ray images using deep learning have shown that while detection and classification performance of a large area of abnormal opacities is relatively good, there are still issues with detection and classification performance of small areas of abnormal opacities. Therefore, in this study, we generated pseudo abnormal images with small areas of abnormal opacities and used them as training images for convolutional neural networks. Then, we aimed to improve classification performance of images with small areas of abnormal opacities by training on a variety of training data, and we investigated how to generate more effective pseudo abnormal images and how many of them should be generated. By adding pseudo abnormal images to the training data, both AUC for all the test images and AUC for those including abnormal images with small abnormal opacity showed better performance.

GS31-6 Design of Stabilizing Controller Using Neural Network for Nonlinear Output Feedback Systems

Keisuke Sugiyama, Jun Yoneyama, Yutoku Takahashi
(Aoyama Gakuin University, Japan)

This paper proposes a design method for stabilizing nonlinear systems using neural networks. The proposed method consists of a neural network controller and a neural network observer that estimates the state in the case where only the output is observable, and determines the control input from the estimated state. The proposed controller guarantees stability by satisfying Lyapunov's stability theorem, and the control gain is optimized by a bundle method. Simulations demonstrate the effectiveness of the approach and its practicality for nonlinear systems.

GS31-7 Development of an artificial spinal cord circuit for a musculoskeletal humanoid robot mimicking the neural network involved in human gait control

Tatsumi Goto, Kentaro Yamazaki, Yugo Kokubun, Ontatsu Haku, Ginjiro Takashi,
Minami Kaneko, Fumio Uchikoba
(Nihon University, Japan)

Artificial neural networks, which mimic the neural networks of living organisms, are being applied as advanced information processing systems in various fields such as robotics. Conventional artificial neural networks use CPUs and software programs, which require enormous numerical computations as the scale increases. On the other hand, hardware artificial neural networks have been proposed that can mimic neural signals without the need for numerical calculations by using analog electronic circuits. We are attempting to mimic the neural network of the human brainstem and spinal cord using analog electronic circuits, and to apply these circuits to humanoid robots that mimic human muscles and skeletons. In this paper, we propose an artificial spinal cord circuit for gait control of a musculoskeletal humanoid robot. Focusing on the movement of stepping over an obstacle, we confirmed through circuit simulations that the artificial spinal cord circuit can generate stepping-over patterns arbitrarily while walking and running.

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Room C

GS23 Machine learning III

Chair: Tomoharu Nakashima (Osaka Metropolitan University, Japan)

GS23-1 Neural Risk-sensitive Satisficing in Contextual Bandits

Shogo Ito, Tatsuji Takahashi, Yu Kono
(Tokyo Denki University, Japan)

The contextual bandit problem, which is a type of reinforcement learning tasks, provides an effective framework for solving challenges in recommendation systems, such as satisfying real-time requirements, enabling personalization, addressing cold-start problems. However, contextual bandit algorithms face challenges since they need to handle large state-action spaces sequentially. These challenges include the high costs for learning and balancing exploration and exploitation, as well as large variations in performance that depend on the domain of application. To address these challenges, Tsuboya et~al. proposed the Regional Linear Risk-sensitive Satisficing (RegLinRS) algorithm. RegLinRS switches between exploration and exploitation based on how well the agent has achieved the target. However, the reward expectations in RegLinRS are linearly approximated based on features, which limits its applicability when the relationship between features and reward expectations is non-linear. To handle more complex environments, we proposed Neural Risk-sensitive Satisficing (NeuralRS), which incorporates neural networks into RegLinRS, and demonstrated its utility.

GS23-2 Estimating equipment failures using vibration sensors and machine learning

Shuma Sakaguchi, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

In recent years, manufacturers that develop and produce mechanical equipment have been facing problems such as the occurrence of long-term system downtime in the event of a breakdown of the mechanical equipment. Therefore, the aim of this study was to prevent long-term system downtime in the event of mechanical equipment failure. For this purpose, machine vibration measurements were carried out using an acceleration sensor and a microcontroller board. The vibration data of the mechanical equipment was then learnt by an autoencoder, a method of machine learning, and inferences were made to estimate the mechanical equipment failure. The results showed that pseudo-fault vibrations with only the mounting position of the acceleration sensor changed could be discriminated. This suggested that mechanical equipment failure could be predicted, and long-term system downtime could be prevented.

GS23-3 Flow prediction by condenser microphone

Shunta Koike, Nobuo Iwasaki, Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

Today, pipelines are widely used in many industrial fields, including water supply and drainage systems, cooling systems, and oil pipeline systems. It is extremely important to measure the flow rate of fluid flowing through pipelines from the viewpoints of maintenance, safety, and high-efficiency operation of these systems. In this study, as a first step to realize a simple and inexpensive indirect flow measurement method, flow rate prediction is performed using a microcomputer with a condenser microphone and an edge AI embedded. The results of the prediction experiments showed that high prediction accuracy was obtained at all flow rates tested. The prediction accuracy was higher at lower flow rates, and as the flow rate increased, the prediction accuracy became worse.

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GS23-4 Ocean Currents Estimation Using Genetic Algorithm the Fuzzy Controlled AUV Equipped with Relearning Method

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

Japan, an island nation composed of over 6,800 islands, has seabeds surrounding it that are believed to contain resources such as oil and rare metals. However, due to harsh underwater environments and high costs, seabed exploration remains challenging. To address this, the development of Autonomous Underwater Vehicles (AUVs) is advancing, with technologies such as fuzzy control and Genetic Algorithms (GA) gaining attention. This study proposes a method to efficiently control AUVs even when the strength of tidal currents is unknown. Specifically, the AUV is navigated in a straight line for two seconds, and its positional deviation is recorded. Using this data, a controller is trained via GA to estimate the tidal current strength. This technology is expected to enable AUVs to reach their destinations effectively, even in unknown tidal current environments.

GS23-5 Tracking control of a AUV using two neural network controllers with initial and tidal current learning

Kano Kubo[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 autonomous underwater vehicle (AUV) controller was developed using a neural network optimized by a genetic algorithm. In previous studies, the proposed AUV was controlled using the generalization function of neural networks. However, the initially trained controller alone could not accurately follow the specified path. To address this issue, this study proposes a control system design utilizing two neural network controllers: one for initial learning and another for additional learning. First, the AUV is navigated for 2 s, and its position coordinates are recorded. Subsequently, it is assumed that the AUV is stopped, and a randomly generated tidal current is applied to move the AUV for 2 s. The error between the recorded AUV position coordinates and the actual position coordinates is then calculated. This process is repeated, and the tidal current that results in the smallest error is recorded.

GS23-6 BP Learning Method using Secure Distributed Processing with Decomposition Data and Parameters Divided into Updated and Non-updated Portions

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

From the viewpoint of developing machine learning as a safe and secure AI method for users, research on Secure Multiparty Computation, Homomorphic cryptography, and Federated Learning has been conducted. However, there are few studies on learning methods that achieve both confidentiality and usability of data at a high level. In this context, learning methods that reduce risk by decomposing or distributing data to multiple servers have been attracting attention. As one of such studies, a learning method based on secure distributed processing using decomposed data has been proposed. In this method, the decomposition parameters are updated on multiple servers. However, it has a problem of increasing the amount of communication as in other distributed processing methods. In this paper, we propose a BP method in which decomposition parameters are placed on the central and local servers, and learning is performed by updating only the decomposition parameters on the central server.

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Room D

OS18 AROB: Robotics with Intelligence and/or Informatics I

Chair: Tetsuya Kinugasa (Okayama University of Science, Japan)
Co-Chair: Masatoshi Hatano (Nihon University, Japan)

OS18-1 Design of Robotic Arm Using Topology Optimization with Serial Periodic Structures

Seiji Furuno, Ririka Hamamura, Shotaro Hisano
(National Institute of Technology, Kitakyushu College, Japan)

This study proposes a method for designing robotic arms using topology optimization with serial periodic structures. The approach reduces computational costs and manufacturing complexity by replicating identical modules. Applied to a two-link robotic arm, the method achieved uniform stress distribution, minimized deformation, and reduced material usage, demonstrating its suitability for 3D printing.

OS18-2 Comparative Analysis of AI-Based Methods for Crack Detection in Cherry Tomatoes

Zhaohui Tan[1], Masanori Sato[1], Takahiro Naruse[1], Masaharu Tanaka[1], Ryuki Ogawauchi[2], Riho Tasaki[2]
([1]Nagasaki Institute of Applied Science, Japan)
([2]Nagasaki Agriculture and Forestry Tech. Devel. Center, Japan)

In this study, we investigated the application of artificial intelligence for crack detection in cherry tomatoes using two approaches: YOLO-based detection and Few-shot learning with a Siamese network. YOLO was evaluated with two labeling methods: marking the entire crack area and segmenting cracks into detailed parts. While the latter approach improved detection precision, it also faced challenges such as misclassifications caused by stem hairs and water droplets. Few-shot learning enabled accurate classification with minimal training data, making it particularly suitable for agricultural scenarios where labeled data is limited. The proposed system demonstrated effective real-time detection performance, offering a practical solution for automating sorting processes in smart farming environments.

OS18-3 Developments of Autonomous Robots for Collecting Bottom Sediments from Tidal Flats

Masaki Yamazaki[1], Haruki Fukuda[2], Kousuke Miyamori[2], Yukiyoshi Hoshigami[3], Masatoshi Hatano[3]
([1]Nihon University, Graduate school, Japan)
([2]Nihon University, Undergraduate school, Japan)
([3]Nihon University, Japan)

The purpose of this research is to realize a robot for autonomous operations to collect bottom sediments travelling on muddy terrain of tidal flats. Beach erosion, which occurs throughout Japan, is a serious problem, and this phenomenon has not been elucidated. Therefore, a mathematical model has been proposed to analyze this phenomenon. Currently, humans enter tidal flats to identify the parameters of this mathematical model, but there are many issues to be addressed in the collection of bottom sediment. In this research, we propose a robot system for collecting bottom sediment on tidal flats. A new collection mechanism has been developed to collect mud from tidal flats. In fundamental experiments, the robot was shown to recognize and avoid obstacles during collection using SSD, and to drive to the collection point using RTK-GPS. The results of bottom sediment sampling on an actual tidal flat are then reported.

January 23 (Thursday), 9:00-10:30

OS18-4 Determination of an Optimal Posture to Improve Hand Generating Forces Using Genetic Algorithm on Constant Angle Terrain

Shimon Matsuzaki[1], Fumiya Takano[2], Yuya Fujibayashi[2], Masatoshi Hatano[3]
([1]Nihon University, Graduate school, Japan)
([2]Nihon University, Under Graduate school, Japan)
([3]Nihon University, Japan)

The purpose of this research is to propose an optimal posture determination method for improving the hand generating force by the sub-crawler of a rescue robot. In buildings that have been damaged by disasters such as earthquakes, doors may become unable to open due to scattered debris. At this time, the hand power of the manipulator mounted on the rescue robot is insufficient. Rescue robot is equipped with a sub-crawler that allows the robot to change its posture and overcome obstacles. When a robot opens a target broken door, we propose a method in which the torque generated from the sub-crawler is used as hand force via a link mechanism. We also propose a method to search for the optimal posture using genetic algorithm. In this paper, motions on a slope are simulated and experimented. It is shown that our proposed method is valid in the situation of a slope.

OS18-5 How can the trap-jaw ants lock their mandibular joint? -Elucidating the mandible latch mechanism with Agitoid, a trap-jaw ant robot-

Kazuki Yukiue[1], Tetsuya Kinugasa[1], Keisuke Naniwa[2], Hitoshi Aonuma[3], Ryota Hayashi[1], Koji Yoshida[1]
([1]Okayama University of Science, Japan)
([2]Hokkaido University of Science, Japan)
([3]Kobe University, Japan)

Trap-jaw ants exhibit an extraordinary latch mechanism enabling ultra-fast mandible movements to capture prey and perform high-acceleration jumps, surpassing the capabilities of direct muscle contraction. This study introduces Agitoid, a robotic prototype modeled after the ant's mandibles and head, reconstructed from CT imaging data. By integrating a muscular system, the robot replicates the latch mechanism. Experiments revealed that the functionality of the latch depends critically on precise directional tension and highlighted the need for coordinated interactions between the exoskeleton and musculature. The analysis also estimated the rotational axis of the mandible, which is inclined relative to the yaw axis, and confirmed its dependency on muscle-pulling directions. The findings not only advance understanding of the biomechanics behind the trap-jaw ant's ultra-fast motion but also offer insights for engineering applications, such as developing complex latch mechanisms and achieving high-speed motion with slow actuators.

OS18-6 Maneuvering Support System for Air Cushion Vehicle - Effects of Anti-runaway System on Maneuverability of Air Cushion Vehicle -

Ryota Hayashi[1], Hisanori Amano[2], Tetsuya Kinugasa[1], Koji Yoshida[2]
([1]Okayama University of Science, Japan)
([2]Tokushima Bunri University, Japan)

In this study, we have developed a maneuvering support system for an air cushion vehicle (ACV) model. A driver can maneuver the ACV model without its drift motion. The ACV model aims to track the trajectory which is generated from the driver's maneuvering inputs. In our previous study, the behavior of the ACV model became frequently unstable and it resulted to be a runaway ACV model in the case of the presence of some disturbance. In this paper, we propose an anti-runaway system of the ACV model in the case of the presence of some disturbance. Then we investigate the effects of the anti-runaway system on the maneuverability of the ACV model.

January 23 (Thursday), 9:00-10:45

Room E

GS3 Artificial intelligence III

Chair: Yuki Kadokawa (Nara Institute of Science and Technology, Japan)

GS3-1 Enhancing Robotic Perception of Complex Bimanual Actions through Hierarchical Graph-Based Modeling

Fatemeh Ziaeetabar[1], Minija Tamosiunaite[2], Florentin Wörgötter[2]
([1]School of Mathematics, Statistics and Computer Science,
College of Science, University of Tehran, Iran)
([2]III Physikalisches Institut - Biophysik Georg-August-Universität Göttingen, Germany)

Robotic systems often face challenges in accurately perceiving and interpreting complex bimanual human actions, critical for advanced applications in manufacturing, healthcare, and service industries. This paper introduces a novel hierarchical graph-based modeling approach that enhances robotic perception of these actions. Our approach leverages a multi-layered Graph Attention Network (GAT), employing sophisticated attention mechanisms to analyze and segment video sequences of bimanual actions into distinct, interpretable components. This methodology facilitates a granular analysis of intricate hand interactions and their temporal dynamics, enhancing the precision of action recognition. We tested our approach on several benchmark datasets, demonstrating improved accuracy and efficiency in action recognition compared to existing models. The results validate our model's capability to effectively recognize complex actions, providing a robust framework for enhancing robotic learning and operational efficiency. This contribution is a step forward in refining robotic perception systems for better human robot interaction and task performance.

GS3-2 Artificial Intelligence as Art Critic: Design and Comparative Turing Test of Human vs. AI Critiques

Wenxian Zheng, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

We investigate the ability of AI to generate insightful art critiques. Using Noël Carroll's framework and 15 theories of art criticism, we developed a methodology for synthesizing critiques and evaluated them using a Turing test. Participants compared AI-generated critiques to human-authored ones, with results showing an average identification accuracy of only 51.4%, indicating that the critiques were indistinguishable. Knowledge and content accuracy emerged as key factors in judgment, and approximately 25% of participants preferred AI-generated critiques, even when recognizing them as AI. These findings suggest that AI is approaching human-level capabilities in art criticism, with the potential to serve as a valuable auxiliary tool in the field.

GS3-3 Person Semantic Information-Integrated StarGAN for Unsupervised Domain Adaptive Person Re-Identification

Dau Anh Dung, Yasuhiro Nakamura
(National Defense Academy, Japan)

Person Re-Identification (Person Re-ID) has seen significant advancements due to the use of deep learning and large amounts of annotated training data. However, adapting a model trained in a fully annotated source domain to an unannotated target domain remains a challenge. This is primarily because of non-overlapping labels, substantial variation between the source and target domains (between-domain variation), and significant differences between camera views within the same domain (within-domain variation). Previous studies have addressed this issue by employing multi-domain translation using StarGAN, which translates source domain images into the style of target camera domains, leading to notable performance improvements for Re-ID models. However, the effectiveness of addressing both within-domain and between-domain variations using multi-domain translation in the image translation process has not been fully explored. In this study, we investigated this impact by validating two experimental configurations: treating datasets as domains (dataset-as-domain) and treating camera views as domains (camera-as-domain). Furthermore, we propose Person Semantic Information-Integrated StarGAN (PSI StarGAN), an enhanced version of StarGAN that integrates person semantic information and significantly improves the quality and reliability of translated images. …

January 23 (Thursday), 9:00-10:45

GS3-4 A Study on a Situation-Dependent Motion Generation Framework Using a Generative Model of Motion and Observation

Chenfei Xu[1,3], Yuya Okadome[2], Hiroshi Ishiguro[1], Yutaka Nakamura[3]
([1]Osaka University, Japan)
([2]Tokyo University of Science, Japan)
([3]RIKEN, Japan)

In an unstructured environment, it is not easy to exhaustively enumerate situations a priori and design control laws. Many studies focus on transferring skills from humans to address these difficulties. In this paper, we constructed a generative model for a series of observations and actions collected during teleoperated robot control and a feasible system that utilizes this model for autonomous mobile robot control in human coexisting environments. This model allows the mobile robot to roam automatically in an unstructured environment, actively responsive to all dynamic changes without manually assigned tasks. We also studied the framework that it interacts with human beings by imitating the recorded human behaviors. Our experiments show that the robot can perform the movements generated by the system in an indoor environment while avoiding collisions and exploring the area. It also shows that the robot imitates human behaviors and exhibits the ability to avoid dynamic obstacles robustly.

GS3-5 Model Predict Commands and Embodied Knowledge Assist Deep Reinforcement Learning in Dodge Actions of Quadruped Robot

Jiayu Zeng, Yilin Zhang, Jianan Xie, Kenji Hashimoto
(Waseda University, Japan)

This study addresses dynamic obstacle avoidance for quadruped robots using a novel dodge motion control framework. By integrating model-predict commands and embodied knowledge into Deep Reinforcement Learning (DRL), the proposed method enhances real-time responsiveness and computational efficiency. Leveraging environmental perception, collision prediction, and reward functions based on artificial potential fields, the robot learns to perform agile dodge actions in scenarios with high-speed obstacles. Experiments conducted in ISAAC Gym demonstrate the model's robustness, achieving high dodge success rates across varied obstacle speeds. The results highlight the adaptability and effectiveness of the approach, paving the way for deploying quadruped robots in complex and dynamic real-world settings.

GS3-6 Deep Reinforcement Learning-Driven PID Optimization for Robotic Manipulation

Junyang Zhang, Hongming Chen, Zhen Xu, Jiayu Zeng, Kenji Hashimoto
(Waseda University, Japan)

The Proportional-Integral-Derivative (PID) controller is widely used in robotics due to its simplicity and effectiveness. Properly tuned PID parameters can effectively solve most control problems. However, in practice, PID parameters are often manually adjusted through trial and error or based on empirical methods, making it challenging to adapt to different tasks and environments. In this paper, we propose a method for optimizing PID controllers using Deep Reinforcement Learning (DRL). The algorithm autonomously learns the optimal control strategies by introducing DRL and dynamically adjusting PID parameters to improve performance across various tasks. Utilizing the Proximal Policy Optimization (PPO) algorithm, the control system automatically tunes the PID parameters, ensuring high stability and accuracy in robot manipulation. This DRL-driven PID controller is applied to a manipulator and trained through simulations, demonstrating a good ability to execute tasks.

January 23 (Thursday), 9:00-10:45

GS3-7 Evaluating Risk Factors Affecting Employee Overload in Healthcare Institutions Using Machine Learning Models: Predictions Based on Health Screening Indicators

Ming-Shu Chen[1], Wen-Jen Yang[2], Chih-Te Yang[3], Tzu-Chi Liu[4], Ching-Tan Yang[2], Chi-Jie Lu[4]
([1]Asia Eastern University of Science and Technology, Taiwan)
([2]Chi Hsin Clinic, Taiwan)
([3]Tamkang University, Taiwan)
([4]Fu Jen Catholic University, Taiwan)

Taiwan's National Health Insurance (NHI) system only utilizes 6-7% of the nation's GDP, yet it provides high healthcare quality and highly affordable services. However, healthcare staff are under considerable pressure, further exacerbating the strained workforce. This study applies six machine learning algorithms to explore important risk factors related to the excessive workload (overload) of healthcare institution staff, highlighting the significance of understanding these factors. Workload overload refers to the physiological state caused by long-term high stress, a serious 21st-century health issue. In Taiwan, the standard for recognizing overwork is based on workload during the six months and before the onset of illness, as outlined by the "Guidelines for Preventing Diseases Triggered by Abnormal Workload" from the Occupational Safety and Health Administration (OSHA) of the Ministry of Labor, Taiwan. These guidelines serve as a reference for defining working hours and overwork for both employers and employees. The Ministry of Labor mandates annual health checkups for workers across various industries in Taiwan, which includes an assessment of employee overload using the "Employee Overwork Assessment Scale."

January 23 (Thursday), 9:00-10:45

Room F

GS16 Human-machine interaction and collaboration II

Chair: Kenji Hashimoto (Waseda University, Japan)

GS16-1 Toward a Moral Theory for Society of Metasapiens: Exploring the Philosophy of Diverse Embodiment

Shoji Nagataki[1], Takashi Hashimoto[2], Tatsuya Kashiwabata[3], Koji Tachibana[4], Takeshi Konno[5]
([1]Chukyo University, Japan)
([2]Japan Advanced Institute of Science and Technology, Japan)
([3]Keio University, Japan)
([4]Chiba University, Japan)
([5]Kanazawa Institute of Technology, Japan)

In this paper, we propose the concept of "metasapiens," which encompasses future Homo sapiens and their intellectual newcomers, including AI, intelligent robots etc. In a society of metasapiens, a new moral theory will be necessary because conventional moral theories are based on the assumption of humans with similar embodiment and comparable abilities. We focus on embodiment to construct a moral theory for this metasapiens society. Our conception of embodiment precludes isomorphism with other bodies, as our proposed normative framework must enable the coexistence of entities with heterogeneous bodies. However, we argue that despite their heterogeneity, these bodily entities share certain fundamental properties. The purpose of this paper, therefore, is to posit fundamental principles for reconceptualizing embodiment and, on this basis, to conceive the basis of a moral theory suitable for metasapiens.

January 23 (Thursday), 9:00-10:45

GS16-2 Emotional Impact on Rhythm Game Performance: A Cross-Cultural Analysis of Japanese and Filipino Players

Candy Espulgar, Kaoru Sumi
(Future University Hakodate, Japan)

This study aims to determine the effects of induced emotions on player achievement and emotional expressivity between Japanese and Filipino students. Player achievement is measured as accuracy in a randomized rhythm game. The experiment consisted of 9 Japanese and 8 Filipino students. Participants were tasked to watch emotion-inducing videos, before playing the game. Target emotions were limited to: sadness, fear, and happiness. Induced emotions were analyzed through the Positive and Negative Affect Schedule (PANAS) self-report and a Vision Transformer (ViT) module. Results from both methods were compared against player accuracy. The study found a significant positive correlation between positive affect and player accuracy for Japanese students, and a significant negative correlation between negative affect and player accuracy for Filipino students. Finally, the study determined that the Japanese group were more receptive but less expressive to sadness and happiness, while the Filipino group were more receptive but less expressive to fear.

GS16-3 Development of a Real-Time Dialogue System with Large Language Models Using EEG Devices

Eisuke Chatani, Yoshihiro Sato
(Kyoto University of Advanced Science, Japan)

Brain-Computer Interfaces (BCIs) are used in the medical and welfare sectors. These have expanded into the entertainment field. Interactive applications using Large Language Models (LLMs) are increasing, however they rely on sequential interactions. We developed and evaluated a BCI for real-time, human-like communication with LLMs using EEG devices based on SSVEP. Additionally, we proposed a method to visualize textual content in a three-dimensional space defined by "Affirmation," "Concreteness," and "Relevance". We also introduced a communication evaluation metric, the ”EngagementScore”, to evaluate the rhythm and liveliness of conversations. We developed a voice chatbot using OpenAI's Realtime API, the NextMind EEG device, and the Unity game engine. The responses generated by the ChatGPT were analyzed, and Neurotags were displayed on the GUI. The input text was converted to speech to facilitate the conversation. This system allows for input during output, reducing conversational monotony and enabling human-like.

GS16-4 Training Core Muscle Endurance With Vibrotactile Haptic Feedback

Nishita Ranadive, Connor McGregor, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Core muscles are vital for maintaining body stability and preventing injuries. However, beginners often find it difficult to improve core endurance due to a poor mind-muscle connection and slow progress. This study examines the potential of vibrotactile haptic feedback to enhance neuromuscular control and endurance. A vibrotactile belt providing targeted vibrations was tested on 6 participants, showing an average endurance improvement of 19.69% in assisted trials, compared to a 44.27% decrease in unassisted trials. These findings demonstrate that vibrotactile feedback can make core training more accessible, effective, and sustainable for beginners. Future work will refine the approach and include advanced muscle activity tracking.

January 23 (Thursday), 9:00-10:45

GS16-5 Finite Element Analysis of Highly-Flexible 3D Printable TPU: Evaluation of Material Properties and Hyperelastic Parameters of 60A and 70A Grades

Khalid Meitani, Gajitha Nanayakkara, Rene Manuel Suarez Flores, Sajid Nisar
(Department of Mechanical and Electrical Systems Engineering,
Kyoto University of Advanced Science, Japan)

Thermoplastic Polyurethane (TPU) with Fused Deposition Modeling (FDM) has gained significant attention in soft robotics due to the ability to fabricate more complex geometries relative to other fabrication methods. Despite their potential, there is a lack of sufficient available hyperelastic material data to be able to accurately simulate the softest commercially available TPU filaments. This research systematically investigates their stress-strain characteristics through tensile and compression tests, providing empirical data to calibrate hyperelastic models, including Mooney-Rivlin and Ogden formulations. Finite element analysis (FEA) simulations validate these models, enabling optimized designs for 3D-printed soft robotic components. By bridging experimental characterization and computational modeling, this research addresses critical gaps and empowers researchers to design, optimize, and analyze novel 3D-printable soft robotic systems using CAD tools.

GS16-6 Developing Explainable Feature Selection Scheme using Machine Learning and SHAP for Multi-Step Ahead Patient Queue Length Prediction in Outpatient Phlebotomy Units

Tzu-Chi Liu[1], Yi-Chen Lee[2,3], Chih-Te Yang[4], Chien-Chih Wang[5], Chi-Jie Lu[1,2]
([1]Graduate Institute of Business Administration, Fu Jen Catholic University, Taiwan)
([2]Department of Information Management, Fu Jen Catholic University, Taiwan)
([3]Department of Clinical Pathology, Far Eastern Memorial Hospital, Taiwan)
([4]Department of Business Administration, Tamkang University, Taiwan)
([5]Department of Industrial Engineering and Management, Ming Chi University of Technology, Taiwan)

In large hospitals, outpatient phlebotomy units (OPUs) often face overcrowding during peak hours due to limited resources, leading to longer patient queues and compromised care quality. Factors such as service capacity, patient age, and wheelchair usage can significantly impact queue length. Accurately predicting queue lengths and identifying key influencing factors is essential for effective resource management. Machine learning (ML) methods are commonly used in clinical settings for their ability to handle complex feature interactions. However, ML methods provide limited explanations of how a key factors influencing the predictive outcome. These detailed insights could help managers to be more informed when planning resources allocations. Moreover, sufficient time is required to respond to and mobilize resources when managing a real-case scenario. Proactively forecasting future queue lengths can provide information to support managers in reacting effectively during real-time service operations. It is a challenging and complex task for managers to manage OPUs as wide variety of aspects are needed to be considered. To address the challenges, this study develops a feature selection scheme that incorporates SHapley Additive exPlanations (SHAP) to gain more detailed feature insights and direct strategy of multi-step ahead forecasting to predict future queue length at different time steps in OPUs. Using OPU data from a Taiwanese medical center (2017–2019) and three well-known ML methods of random forest (RF), least absolute shrinkage and selection operator regression (Lasso) and extreme gradient boosting (XGB) under the proposed scheme, RF emerged as the most accurate model across all horizons. Wheelchair usage was consistently the most influential feature, while elder patients became critical in three-step ahead forecasting. SHAP provided detailed insights into how these features affect queue length, supporting better resource planning and operational decision-making.

January 23 (Thursday), 9:00-10:45

GS16-7 Dual-Channel Supply Chain Inventory Optimization Using Teaching-Learning-Based Algorithm for Carbon Efficiency

Ruey-Chyn Tsaur[1], Nei-Chih Lin[1], Chi-Jie Lu[2,3], Tzu-Hsuan Chen[3], Chih-Te Yang[4]
([1]Department of Management Sciences, Tamkang University, Taiwan)
([2]Graduate Institute of Business Administration, Fu Jen Catholic University, Taiwan)
([3]Department of Information Management, Fu Jen Catholic University, Taiwan)
([4]Department of Business Administration, Tamkang University, Taiwan)

The impact of global climate change and shifting consumption patterns has made managing multinational supply chain inventory crucial, especially in light of net-zero carbon emission goals. The adoption of dual-channel marketing models, combining online and physical channels, adds complexity to supply chain management. A key challenge for enterprises is balancing environmental sustainability with profitability, while facing global pressure to reduce carbon footprints. In dual-channel supply chains, the profits of manufacturers and retailers offering substitutable products are interdependent, further complicating inventory management and efforts to optimize profit alongside meeting carbon reduction targets. This study proposes sustainable production-inventory models for multinational supply chains with dual channels and multiple physical retailers, incorporating collaboration on carbon reduction investments among supply chain members. The model calculates the total profit and carbon emissions of manufacturers and retailers separately, and then optimizes selling prices, material supply, production, delivery, investment strategies, and replenishment strategies to maximize overall supply chain profit under a carbon cap-and-trade policy. Due to the complexity introduced by multiple physical retailers, traditional mixed-integer nonlinear programming models become difficult to solve as the number of retailers increases. Therefore, the study employs the Teaching-Learning-Based Optimization (TLBO) algorithm to find optimal solutions effectively. Numerical and sensitivity analyses validate and illustrate the proposed models, providing insights for managers to optimize production, shipping, ordering, investing, and pricing strategies across channels while responding to national carbon reduction policies. This research offers a comprehensive framework for balancing sustainability and profitability in modern supply chain management.

January 23 (Thursday), 9:00-10:30

Room H

OS13 AROB: Intuitive Human-System Interaction I

Chair: Masao Yokota (Fukuoka Institute of Technology, Japan)
Co-Chair: Akio Doi (Iwate Prefectural University, Japan)

OS13-1 Development and evaluation of an automatic update system for 3D-CAD models using point cloud data

Akio Doi[1], Meguru Yamashita[2], Hiroki Takahashi[2], Toru Kato[2], Takashi Imabuchi[3]
([1]Iwate Prefectural University, Japan)
([2]Freelancer, Japan)
([3]Japan Atomic Energy Agency, Japan)

We propose a system to build a digital twin that is resistant to time-series shape changes. We then implemented a prototype system and confirmed that the original CAD model could be automatically updated. We also verified its effectiveness using test data for a large-scale facility.

January 23 (Thursday), 9:00-10:30

OS13-2 3D Scene Reconstruction from Video Images Using NeRF and 3D Gaussian Splatting: Methodologies and Comparative Evaluation

Zhiyi Gao[1], Hiroki Takahashi[2], Toru Katoh[2], Meguru Yamashita[2], Akio Doi[3]
([1]Shanxi Vocational University of Engineering Science and Technology, China)
([2]Freelancer, Japan, Japan)
([3]Iwate Prefectural University, Japan)

In this study, we explore the integration of 3D Gaussian Splatting (3DGS) with Neural Radiance Fields (NeRF) for 3D scene reconstruction from video images. Building upon prior work that utilized NeRF-based technologies like Instant-NGP and Neuralangelo to generate 3D models from video data, we extend the methodology by incorporating 3DGS, a technique known for its superior real-time rendering capabilities. This hybrid approach leverages the strengths of both NeRF and 3DGS to achieve high-quality 3D reconstructions with enhanced accuracy and computational efficiency. Using a combination of synthetic and natural landscape video datasets, we demonstrate how 3DGS can significantly improve the fidelity and detail of 3D models while maintaining manageable computational costs. Comparative evaluations between NeRF and 3DGS-based models are presented, highlighting the improvements in rendering speed and model precision. Our results indicate that integrating 3DGS not only enhances the quality of the reconstructed scenes but also opens new possibilities for real-time applications in fields like virtual reality, gaming, and digital content creation.

OS13-3 CAD-based labeling of point cloud data using deep learning and its evaluation

Toru Kato[1], Hiroki Takahashi[1], Meguru Yamashita[1], Akio Doi[2], Takashi Imabuchi[3]
([1]Freelancer, Japan)
([2]Iwate Prefectural University, Japan)
([3]Japan Atomic Energy Agency, Japan)

This study enhances the efficiency of structural shape recognition at decommissioning sites by leveraging point cloud data obtained from laser scanners. Currently, operators manually associate categorical information with point cloud data, a process that becomes extremely time-consuming when dealing with large-scale areas. To address this issue, we used mock-up data representing plant structures and trained two deep learning models, PointNet++ and PointNeXt-s, on labeled datasets generated with CAD data and the Virtual Cloud Creator (VCC) tool. Both models were tested on downsampled point clouds containing approximately 37 million points. While PointNet++ faced challenges with label overlap and boundary precision, PointNeXt-s delivered better results, achieving higher mIoU scores, faster inference, and better differentiation of tanks, structures, and pipes.

OS13-4 Study on 360-Degree Texture Mapping for Meshes of Building Interiors

Meguru Yamashita[1], Hiroki Takahashi[1], Toru Kato[1], Akio Doi[2], Takashi Imabuchi[3]
([1]Freelancer, Japan)
([2]Iwate Prefectural University, Japan)
([3]Japan Atomic Energy Agency, Japan)

In this paper, we consider a method to generate a mesh with texture mapping applied in all directions when viewed from the inside, using point cloud data of the internal shape of a building obtained by a laser scanner and 360-degree panoramic image data taken at the same time. Moreover, in the case of point cloud data and 360-degree images measured at multiple locations, each data is integrated into a specified coordinate system, and the 360-degree image suitable for that point cloud data is used. This integration process allows for consistent texture mapping.

January 23 (Thursday), 9:00-10:30

OS13-5 Noise Removal in Underwater Video Using Segment Anything Model and Generative Image Inpainting

Hiroki Takahashi[1], Toru Kato[1], Meguru Yamashita[1], Akio Doi[2], Takashi Imabuchi[3]
([1]Freelancer, Japan)
([2]Iwate Prefectural University, Japan)
([3]Japan Atomic Energy Agency, Japan)

To create accurate 3D models from video footage, it is essential to use high-quality videos without floating objects that could interfere with the process. In this study, we applied the Segment Anything Model (SAM) and Generative Image Inpainting (Inpainting) to enhance the quality of video frames by detecting and removing floating objects on a frame-by-frame basis. The results demonstrated the effectiveness of this approach in detecting and eliminating such objects, contributing to the improvement of video quality.

OS13-6 Exploring social facilitation and inhibition effects induced by avatars in virtual environment

Koji Furukawa, Tetsuro Ogi
(Keio Univirsity, Japan)

In the real world, the presence of others in the environment can influence an individual's performance, a psychological effect known as social facilitation and inhibition. This effect forms the basis of social psychology and has been incorporated into marketing strategies. Similarly, it is essential to understand human behavior accurately in virtual environments. Therefore, this study investigates the impact of social facilitation and inhibition on performance in a putting game within a virtual environment. We compared scenarios where participants performed the task alone versus when accompanied by avatars different from themselves.

January 23 (Thursday), 13:00-14:45

Room A

OS8 AROB: Construction of lunar bases and lunar exploration by AI-powered robots II

Chair: Ryusuke Fujisawa (The University of Kitakyushu, Japan)
Co-Chair: Yuichi Ambe (Osaka University, Japan)

Invited Talk 4 TRIAL FOR SPACE HABITATION: HOMEOSTATIC INFLATABLE DECENTRALIZED AUTONOMOUS STRUCTURE (HIDAS)

Shinichi Kimura (Tokyo University of Science, Japan)

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January 23 (Thursday), 13:00-14:45

OS8-1 On implementation of a statistics-based detection algorithm for abnormal operation on mechanical connection mechanisms

Kazuki Shibata[1], Yuki Takagi[1], Hiroshi Oku[1], Xixun Wang[1], Ryohei Michikawa[2], Fumitoshi Matsuno[1]
([1]Osaka Institute of Technology, Japan)
([2]Kyoto University, Japan)

Modular robots have a variety of functions depending on the connection and separation of their modules. The correct mechanical connections between modules are crucially important in modular robot activities. Therefore, early detection of faulty connection of modules is an indispensable function for modular robots. In this paper, we develop a method for detecting the faulty connection using statistical hypotheses testing based on the generalized likelihood ratio (GLR) algorithm.

OS8-2 Development of a reversible gripper hand mechanism for a modular robot of the lunar exploration project

Katsuyoshi Tsujita
(Tottori University, Japan)

In this study, we developed a reversible gripper hand as one of the modules of this lunar surface activity robot. the gripper hand must be detachable and freely interchangeable with other end-effector modules for the limb module to realize the function of an arm and walking motion as a leg. The hand developed in this study is a two-finger hand mechanism. It has two module connector points, and its finger part can be reversed 180 degrees to connect to the robot arm through any of the two connector points. This design requirement allows the limb module to be interchanged with multifunctional and other end-effector modules as needed. We report on the results of hardware experiments to evaluate the mechanism and operation of the developed reversible gripper module.

OS8-3 Proposal on the Design Limitations of Reduction Ratio to Volume in Gear Reducers

Masahiro Ikeda[1], Ryouga Takaguchi[1], Takashi Takuma[2], Ryohei Michikawa[3]
([1]Kindai University, Japan)
([2]Osaka Institute of Technology, Japan)
([3]Kyoto University, Japan)

In a low-gravity environment like the lunar surface, robots may need to perform quasi-static movements, requiring very low speeds. Despite the low gravity, maximizing output torque is crucial for handling various tasks. Thus, gear reducers must meet higher reduction ratio standards. Designing high-reduction-ratio gear reducers involves efficiently packing multiple transmission mechanisms into a confined space, relying heavily on engineering expertise. Understanding the design limits is essential. This study proposes a method to determine the maximum reduction ratio of a gear reducer by considering the required volume, component strength, weight, and friction.

January 23 (Thursday), 13:00-14:45

OS8-4 Experimental validation of the wheel function in a transformable multi-functional end-effector

Mihiro Nakabayashi[1], Tomohiro Hayakawa[2], Ryohei Michikawa[3],
Toshiyuki Yasuda[4], Fumitoshi Matsuno[5]
([1]University of Toyama, Japan)
([2]Shizuoka University, Japan)
([3]Kyoto University, Japan)
([4]University of Toyama, Japan)
([5]Osaka Institute of Technology, Japan)

For the purpose of weight-space saving, we have developed a multi-functional end-effector that can realize multiple functions by transformation. This end-effector has shovel, gripper, drill, and wheel functions to be used in various situations such as planetary exploration and rescue activities. In this study, we improved the wheel function in a transformable multi-functional end-effector. We investigated a high-strength structure in wheel function in a transformable multi-functional end-effector. In addition, experiments were conducted in translational and turning movements to evaluate the performance of the function. As a result, it is capable of supporting a load of 21.99 kg in translational movement and 20.11 kg in turning movement.

OS8-5 Investigation of Distributed Wave-Gait Generation in Multi-Legged Robots with Asymmetrical Leg Configurations

Yuichi Ambe[1], Shinya Aoi[1], Fumitoshi Matsuno[2]
([1]Department of Mechanical Science and Bioengineering, Osaka University, Japan)
([2]Osaka Institute of Technology, Japan)

Insects and multi-legged animals can adaptively modify their wave-like gaits in response to changes in speed, environment, and morphology. Moreover, their control systems are suggested to operate within a distributed control framework that utilizes sensory feedback. Inspired by this, many bio-inspired robots have been developed to replicate adaptive movements. However, the functional roles of sensory feedback in enabling adaptive movements remain complex and are not yet fully understood. In contrast, we have analytically investigated the mechanisms of gait generation in multi-legged models based on sensory feedback, using a simplified symmetric model. In this study, we extend our analysis to cases where the model exhibits asymmetry, particularly when the body's center of mass (COM) is shifted. We examine whether phase resetting can generate interlimb coordination in a hexapod model with an asymmetric COM position. Furthermore, we propose new sensory feedback to accommodate body asymmetry and verify that this feedback generates interlimb coordination even under conditions of severe asymmetry.

January 23 (Thursday), 13:00-14:45

Room B

OS6 AROB: Co-creation in research and education

Chair: Kenneth J. Mackin (Tokyo University of Information Sciences, Japan)
Co-Chair: JongGeol Park (Tokyo University of Information Sciences, Japan)

OS6-1 Co-creation in inclusive design -developing an audio-based typing game-

Kenneth J. Mackin, Takeshi Fujiwara, Yukiyo Ikeda, Daisuke Akimoto
(Tokyo University of Information Sciences, Japan)

Co-creation is the development of products where the user is included from the design stage. Tokyo University of Information Sciences (TUIS) recently established the Co-creation Laboratory, in which professors, students, local governments and firms work together to co-create a research and education environment. In this paper, we introduce the initial results of one of the co-creation projects in progress, in which students were given the task of how to make esports more inclusive. Project members included both visually impaired and unimpaired students, and the initial goal of the project was to design and develop a new audio-based keyboard typing game with inclusive design, in which both the visually impaired and unimpaired students can compete fairly against each other. We give a description of the design decisions of the audio-based typing game and explain the developed prototype program and conclude with a discussion on the co-creation project and future works.

OS6-2 Evaluation of a Learning Feedback System and Community Activity Practices for Providing Career Experience Opportunities to Children

Yoshiha Goto[1], Yoshihiro Kawano[2], Eriko Harada[2]
([1]Graduate School of Informatics, Tokyo University of Information Sciences, Japan)
([2]Department of Informatics, Tokyo University of Information Sciences, Japan)

In the context of career education during elementary years, the focus lies on nurturing "basic and generic abilities," which encompass four critical domains: "interpersonal and social skills," "self-understanding and self-management skills," "problem-solving skills," and "career planning skills." Among these, career planning skills are particularly vital, and foundational for functioning effectively in society. Collaboration between schools and the community through learning activities is crucial to cultivating children's career planning skills. In this study, we have developed a Learning Feedback System (LeaFeS hereafter) with gamification method to support community activities that create opportunities for children to gain work experience. This research posits that learning feedback-an approach that stimulates reflective practice through tailored feedback post-activity-plays a crucial role in enhancing children's awareness of diverse occupational roles and their unique strengths within the framework of the “Children's City”.

OS6-3 Detection and Visualization of Optimal Image Resolution in Crop Classification Using Machine Learning

Souichirou Toyota, Jonggeol Park
(Tokyo University of Information Sciences, Japan)

Labor shortages in agriculture have become increasingly severe, while smart agriculture using robotics, AI, and IoT is rapidly advancing. This study investigates the minimum resolution needed for crop identification and the key features required when resolution is reduced. Using drone-captured data, we conducted object detection at varying resolutions to determine the threshold for individual crop identification. Grad-CAM visualization was then applied to reveal the regions utilized by the deep learning model for classification. By adjusting drone image resolution and applying visualization techniques, we identified the resolution and features necessary for crop detection in peanuts, cabbages, and broccoli. Future work will focus on developing a versatile model capable of detecting diverse crops under varying conditions.

January 23 (Thursday), 13:00-14:45

OS6-4 Analysis of the Impact of Posture Changes on Badminton Shuttle Speed

Hongyu Zhou, Jonggeol Park
(Tokyo University of Information Sciences, Japan)

In badminton, smash is widely regarded as the most common and effective scoring technique due to its high speed and explosive power. This study employs YOLOv8 to detect the shuttle's position in real-time and accurately calculate its speed by analyzing positional changes between frames. TThe analysis focused on the smash actions performed 15 times by each of the 5 participants. Based on joint coordinate data obtained using MediaPipe, angular changes, angular velocity, and angular acceleration of the waist, shoulders, elbows, and wrists were calculated. The motion characteristics were quantitatively analyzed. As a result of comparing multiple nonlinear regression models, the random forest regression model demonstrated optimal performance and was adopted for shuttle speed prediction. An evaluation of feature importance revealed through SHAP analysis that the angular velocity and angular acceleration of the shoulder exert the largest negative impact on shuttle speed. Conversely, the angular velocity and angular acceleration of the wrist were found to have the largest positive impact on shuttle speed.

OS6-5 A Proposal for Visualization System to Support Understanding of Object Composition as a Basic Structure in Object-Oriented Design using Python

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

The authors have proposed a visualization system for programs that supports programming learning. In this study, we propose additional support functions for our Python visualization system to learn object composition, which is a core structure in many design patterns. Since object composition structures exist in many design patterns that use object-oriented features, understanding them is important as a first step in learning object-oriented design. This system detects and highlights object composition structures. It also shows the boundary between the generalization layer, which is written in the superclass, and the specialization layer, which uses the subclass name, and when a reference occurs from the generalization layer to the specialization layer, it displays an arrow that indicates the reference in red to warn the user. By using these visualization functions, it is expected that it will be easier to understand the basics of being able to perform advanced object-oriented design in Python.

OS6-6 Investigating the effect of learning activities with force presentation on fingertips in virtual space

Tomoe Ozeki[1], Tetsuya Mouri[1], Paloma Mansilla Navarro[2]
([1]Gifu University, Japan)
([2]Universidad Carlos III de Madrid, Spain)

The purpose of this study is to systematically examine how haptic feedback in teaching and learning environments, particularly the perception of hardness felt at the fingertips, affects the learner's learning experience and educational effectiveness. The experimental environment developed in this study uses a haptic device capable of high-precision force presentation to realize interaction within a three-dimensional virtual space displayed on a display. Using this experimental environment, we report the results of a preliminary experiment to determine whether the effects of different degrees of force presentation on the memorization task can be examined.

January 23 (Thursday), 13:00-14:45

OS6-7 An Eye-Tracker Analysis of Viewpoint Differences between Experts and Novices in the Birthing Assistance

Yurina Wada[1], Nozomi Uchie[2], Haruka Morotomi[3], Takahiro Koga[3], Ami Nakazawa[2], Masayo Shima[2], Yumiko Namizaki[2], Naoko Umeda[2], Natsuki Hata[2], Tomoki Taniguchi[3], Rena Kato[3], Junko Yotsuya[2], Wagatsuma Hiroaki[3], Kazushi Ikeda[1]
([1]NARA Institute of Science and Technology, Japan)
([2]University of Fukui, Japan)
([3]Kyushu Institute of Technology, Japan)

This paper describes viewpoint and heart rate variability differences between experts and novices in the birthing assistance. Expert midwives use a different method than the textbook method. Expert midwives' skills and decision-making processes have been assessed in several qualitative evaluations, but quantitative evaluation has been rarely investigated. To clarify and improve birthing assistance skills for the safety of mothers and babies, we present viewpoint and heart rate variability differences between experts and novices in the Birthing Assistance. We measured the gazes and heart rate variability of expert and novice midwives using a wearable device in the second stage of labor along the interval between seizure and cycle and delivery and compared their statistical properties to clarify their differences. Clarifying the transition characteristics of gaze position has the potential to reveal fundamental differences between experts and novices, which could enhance trainees' self-efficacy through successful experiences and promote positive behavioral changes.

January 23 (Thursday), 13:00-14:15

Room C

OS9 AROB: Evolving Robotics and Machine Learning Applications

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

OS9-1 A Study on the Effective Use of Supervised Data Using Contrastive Learning in Defect Detection

Hirohisa Kato, Fusaomi Nagata
(Sanyo-Onoda City University, Japan)

This paper examines how to effectively utilize contrastive learning and supervised learning for defect recognition tasks in industry. Because the probability of defective products occurring in the manufacturing process is very low, it is difficult to prepare a sufficient amount of training data for training a deep learning model. Therefore, it is necessary to effectively train a defect recognition model for industrial products using a limited training dataset. This study combines contrastive learning, autoencoder, and binary classification to verify how to effectively implement a small amount of supervised data. In experiments, the effectiveness of the proposed method is verified using the CDS2K dataset. As a result, it was found that using these methods did not improve the AUC compared to binary classification, but they improved the model learning speed and training stability.

January 23 (Thursday), 13:00-14:15

OS9-2 Defect Detection and Its Visualization of Industrial Products Using Transfer Learning-Based CNN Models and Fully Convolutional Data Description Models

Shingo Sakata[1], Fusaomi Nagata[1], Hisami Tamano[2], Hitoshi Nakamura[2], Takeshi Ikeda[1],
Keigo Watanabe[3], Maki K. Habib[4], Ahmad Shahrizan Abdul Ghani[5]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Mitsubishi Pencil Co. Ltd., Japan)
([3]Okayama University, Japan)
([4]The American University in Cairo, Egypt)
([5]Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

In this paper, fully convolutional data description (FCDD) approach is applied to the defect detection and its concurrent visualization of industrial products. Our developed MATLAB application for building defect detection models has already allowed users to efficiently design, train and test various kinds of models such as an originally designed convolutional newral network (CNN), transfer learning-based CNN, suport vector machine (SVM), convolutional auto encoder (CAE), variable auto encoder (VAE), fully convolution network (FCN), and YOLO, however, FCDD has not been supported yet. This paper includes the software development of the MATLAB application extended to build FCDD models. The usefulness and effectiveness of FCDD models in terms of concurrent defect detection and its visualization of understanding are compared with conventional transfer learning-based CNN models.

OS9-3 Analysis and Improvement of Rotary-Type Electrostatic Motors for MEMS Microrobots

Shuxin Lyu[1], Yuyou Kaku[2], Jun Sato[2], Rihito Yamashita[2], Yudai Tominaga[1], Yuya Tamaki[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)

Microrobots have attracted increasing attention due to their ability to operate in confined spaces, such as pipeline inspections and medical applications. Electrostatic motors with compact structure, low energy consumption, and the ability to integrate with MEMS technology are ideal as actuators for microrobots. In our previous work, we developed a rotary-type electrostatic motor that achieved initial rotation but encountered reverse rotation issues, limiting precise control of the motor. This paper utilizes a dynamics simulator (Siemens Simcenter) to analyze the rotary-type electrostatic motor in detail. Factors such as rotor-arm friction dynamics and abrupt changes in voltage waveforms were identified as causes of reverse rotation. To resolve the reverse rotation issue, we implemented structural optimizations and adjusted the actuator layout. Additionally, we modified the waveforms, transitioning from square waves to sawtooth and triangular waves. Experimental results showed improved rotor stability and directional control, enhancing overall performance.

OS9-4 AI-Driven Cognition, Learning, and Adaptive Behavior in Next Generation Autonomous Robotics

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

Integrating Artificial Intelligence (AI) into robotics has revolutionized the field, innovatively developing highly autonomous systems capable of cognition, learning, and adaptive behavior. This paper explores the latest advancements in AIdriven robotics, focusing on how deep learning, reinforcement learning, and neural networks contribute to intelligent decisionmaking and real-time adaptation. Key topics include AI-based perception systems for enhanced environment understanding, adaptive learning techniques enabling robots to handle dynamic and unpredictable scenarios, and cognition models facilitating human-robot collaboration. The study also investigates how these technologies improve the autonomy and efficiency of robots in real-world applications, such as manufacturing, healthcare, and autonomous navigation. In addition to evaluating current capabilities, this paper projects future trends in robotic intelligence, addressing the evolving landscape of autonomous systems. It also emphasizes the critical necessity of ethical considerations in AI integration, particularly concerning safety, decisionmaking autonomy, and the societal impact on human employment and privacy. Comparative analyses with existing state-of-theart models reveal that AI-driven robotic systems demonstrate superior adaptability, …

January 23 (Thursday), 13:00-14:15

OS9-5 Automated Wild Boar Detection in Fence Traps Using Deep Learning

Francis Ifaso BESALA, Ryunosuke Niimoto, Jae Hoon Lee, Shingo Okamoto
(Ehime University, Japan)

Wild boars are the most destructive animals to crops worldwide, causing significant agricultural damage. In Japan, this results in annual economic losses amounting to billions of yen, as well as serious social impacts in areas with high wild boar activity. To mitigate these negative effects, many farmers use manually triggered traps to capture wild boars. However, implementing a recognition algorithm can greatly improve the efficiency of these capture methods. Therefore, a recognition algorithm was developed in this study to identify the presence of wild boars in fence traps. The algorithm developed using YOLOv7 successfully detected wild boars inside and outside the fence traps. This advancement demonstrates an important step toward developing an AI-based system for automatic capture of wild boars in fence traps

January 23 (Thursday), 13:00-14:00

Room D

OS19 AROB: Robotics with Intelligence and/or Informatics II

Chair: Tetsuya Kinugasa (Okayama University of Science, Japan)
Co-Chair: Masatoshi Hatano (Nihon University, Japan)

OS19-1 Image Segmentation of Cloud Images using Deep Learning

Kosei Yamasaki, Masaharu Tanaka, Masanori Sato
(Nagasaki Institute of Applied Science, Japan)

This paper presents image segmentation of cloud images using deep learning for cloud prediction. Cloud prediction is an important technique used to forecast solar radiation in renewable energy management. This paper proposes an approach to apply image segmentation to the image classification part in a method that combines cloud image classification using sky images and solar radiation prediction. The first step in this study is to conduct a feasibility study of image segmentation of cloud images. The U-Net, which has been successfully developed for the medical field, is applied and evaluated through case studies to confirm its usefulness.

OS19-2 Experimental Evaluation of Locomotion Efficiency in a Centipede-Inspired Multi-Legged Robot

Masatsugu Iribe
(Osaka Electro-Communication University, Japan)

Biological organisms demonstrate remarkable efficiency in traversing uneven and unpredictable environments by skillfully utilizing inherent physical characteristics such as elasticity and skeletal structure. This efficient locomotion is thought to result from organisms interacting with their surrounding environment while generating optimal movement patterns through periodic inputs, like those from the Central Pattern Generator (CPG). These movement principles are expected to enhance the efficiency and performance of mobile robots, particularly in challenging terrains. This study centers on the physicality of biological organisms, focusing on experimentally investigating the structural characteristics and movement principles of centipedes. In the motion experiments, we found that introducing elasticity between the segments reduced SR, thereby improving movement efficiency of the robot. Furthermore, the experiments identified an optimal movement frequency that aligns with physical structure of the robot, demonstrating that both the physicality of centipedes and the optimal drive frequency significantly contribute to effective locomotion.

January 23 (Thursday), 13:00-14:00

OS19-3 Experiment on changing harvesting order based on ranking of harvesting areas for a tomato harvesting robot

Takeshi Ikeda[1], Kazuki Morita[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)

Smart agriculture, which utilizes advanced technologies such as robots, AI, and IoT in agriculture, is expected. Harvesting work is time-constrained and a large amount of harvesting must be done in a short period of time, so automation is expected to reduce the burden. In this study, we focused on automating harvesting work using robots. To harvest instead of people, the thought process of humans harvesting is required. Therefore, by focusing on having a wide field of vision, we consider capturing multiple work areas from a bird's-eye view, rather than capturing the work area in front of them. By doing this, we propose a strategy of moving back and forth on the rail and harvesting from the area that is easiest to pick, rather than harvesting what is captured from the edge.

OS19-4 Development of a bed-leaving motion detection system using depth image and deep learning

Masanori Sato[1], Zhaohui Tan[1], Masaharu Tanaka[1], Manabu Yamaji[1], Takeshi Ikeda[2]
([1]Nagasaki Institute of Applied Science, Japan)
([2]Sanyo-Onoda City University, Japan)

In this study, we have described a bed leaving detection system based on deep learning. In our previous research, we proposed two methods: one used the discrete Fourier transform for feature extraction, and the other used the discrete wavelet transform. Both methods used a Self-Organizing Map (SOM) for feature classification. In this paper, we applied YOLO (You Only Look Once), a deep learning-based method, for both feature extraction and classification. Experimental results show the effectiveness of the proposed approach.

January 23 (Thursday), 13:00-14:30

Room E

GS4 Artificial intelligence IV

Chair: Kazuyuki Ito (Hosei University, Japan)

GS4-1 Estimating Difficulty of Bouldering Problems Using Skeletal Features from Climbing Videos by Regression Approach

Toshimasa Tahara, Ryo Hatano, Hiroyuki Nishiyama
(Tokyo University of Science, Graduate School of Science and Technology,
Department of Industrial and Systems Engineering, Japan)

Bouldering, a climbing sport using artificial holds, has gained popularity with the rise of gyms and its Olympic inclusion. Bouldering problems have predetermined holds, with difficulty influenced by factors like hold shape, wall angle, and distance. Climbers' moves, shaped by hold arrangements and physical abilities, further affect difficulty. This study uses machine learning to estimate bouldering problem difficulty from video data. The Kaggle MoonBoard dataset, based on user-voted difficulty, was used. Skeletal features were extracted via MediaPipe, calculating coordinate differences at intervals from 15 to 25 second videos. Unlike prior classification methods, this study employs a regression model for nuanced difficulty estimation, capturing variations within the same grade. Experiments followed the French grading system. Results suggest potential for standardized difficulty ratings, providing climbers consistent feedback, reducing injury risks, and supporting motivation by aligning problem difficulty with abilities.

January 23 (Thursday), 13:00-14:30

GS4-2 Optimization of Vehicle Collision Avoidance Behavior by Variable Directional Sensor Control Using Reinforcement Learning

Kaito Kumagae[1], Mao Tobisawa[1], Kenji Matsuda[1], Tenta Suzuki[1], Tomohiro Harada[2], Junya Hoshino[1], Yuki Itoh[1], Johei Matsuoka[1], Kiyohiko Hattori[3]
([1]Tokyo University of Technology, Japan)
([2]Saitama University, Japan)
([3]Tokyo Denki University, Japan)

In recent years, autonomous driving control has become active due to improved sensor and on-board computer performance. Many studies have focused on replacing human driving with autonomous driving. Autonomous vehicles can acquire real-time information through sensors and vehicle-to-vehicle (V2V) communication, enabling driving control different from human control. This allows optimal control through autonomous driving group coordination. One existing study involves maximizing throughput using reinforcement learning in a lane-less environment. However, frequent vehicle collisions occurred due to detection omissions from vehicle sensors. In this research, we proposed a method that includes adding on-board sensors and seven distance sensors with controllable directionality, utilizing reinforcement learning to achieve sensor control. We constructed an environment on the Unity physics engine and adopted the Proximal Policy Optimization algorithm. The simulation achieved a 77% reduction in cumulative collision count.

GS4-3 Improving the Factuality Evaluation Method SAFE for Large Language Models

Shota Yamashita, Hideaki Itoh, Hisao Fukumoto, Hiroshi Wakuya
(Saga University, Japan)

Large Language Models (LLMs) have improved in engaging with humans but often provide factually inaccurate responses, particularly regarding dates and statistics. To enhance the reliability of LLM outputs, methods such as fine-tuning and Retrieval-Augmented Generation (RAG) are being researched. However, automated evaluation for LLM responses remains challenging, especially for complex queries. The Search-Augmented Factuality Evaluator (SAFE) addresses these challenges by breaking down responses and verifying facts via Google searches. SAFE, however, encounters issues like high costs and errors due to flawed reasoning and insufficient search data. This study proposes substituting Google with DuckDuckGo Search API and converting LLM outputs into a knowledge graph (KG) for evaluation. Through this change, the cost was reduced by approximately 1.7 to 3.0 times compared to the conventional evaluation method by SAFE, while the accuracy was maintained.

GS4-4 Automatic Counting of Chlorella Algae Cells with AI Deep Learning

Supaporn Worsoongnern, Witoon Yindeesuk, Surachart Kamoldilok, Keerayoot Srinuanjan
(King Mongkut's Institute of Technology Ladkrabang, Thailand)

Chlorella algae is a small single-celled algae measuring approximately 2 to 10 micrometers in size. Normally, Chlorella algal cell counts are done manually under a microscope, which can be time-consuming and prone to errors. This research presents an automatic Chlorella algae cell count using an AI deep-learning model. The researchers cultivated Chlorella algae in the laboratory by an LED light source for seven days. After the cultivation samples of the cultured algae were collected and dropped into the Hemocytometers. The photographs of the Chlorella algal cells spread out in the grid of the Hemocytometers were recorded by the digital microscope camera and all of the images were labeled by the labeling program. One hundred of the images were separated into three categories, train, test, and, validation. Eighty percent of the images were used for training the model. The model was trained by YOLO v5 for ten to two hundred eposes. After training the model, twelve percent of the images were tested by the model, and some Chlorella algae cells for each image were shown. The created model was tested for validation and found to be able to count the number of algal cells quickly and accurately.

January 23 (Thursday), 13:00-14:30

GS4-5 Machine Learning Polynomial Regression Model to Predict the Number of Two-Spotted Crickets (Gryllus bimaculatus) in Each Growth Stage

Nitipoom Nutnoi, Witoon Yindeesuk, Surachart Kamoldilok, Keerayoot Srinuanjan, Pichet Limsuwan
(King Mongkut's Institute of Technology Ladkrabang, Thailand)

This study proposed a method for predicting the population and body size of the Two-spotted cricket (Gryllus bimaculatus) using a Polynomial Regression model over a 49-day rearing period. Two hundred crickets were raised in controlled environments with temperatures between 28-35°C, and their population and body size were recorded every 7 days. The data was used to train the model, which accurately predicted both population numbers and body size. The results revealed a Mean Absolute Error (MAE) of 2.30 and Mean Squared Error (MSE) of 8.44 for population prediction, and an accuracy of 98.52% for body size prediction. The model achieved prediction accuracies of 94.49% for body width and 93.99% for body length. These findings suggest that the Polynomial Regression model can effectively forecast cricket growth, making it a valuable tool for optimizing rearing processes and improving production efficiency in cricket farming.

GS4-6 Machine Learning-Based Multiple Linear Regression for Analyzing Leaf Size and Stem Circumference of Butterhead Lettuce Grown Under Varying Illuminance

Supaporn Worsoongnern, Witoon Yindeesuk, Surachart Kamoldilok, Keerayoot Srinuanjan, Pichet Limsuwan
(King Mongkut's Institute of Technology Ladkrabang, Thailand)

This research proposes a deep learning model that predicts the relationship between leaf width, leaf length, and stem circumference of Butterhead lettuce cultivation under different constant light illuminances: 2000, 4000, 6000, and 10000 Lux for fifty days. Leaf size and stem circumference data were collected throughout the growth period and recorded data under various light illuminances were used to train the model. This research found that the model accurately predicts the leaf size and stem circumference of butterhead lettuce at various illuminances and aids in optimizing light conditions to achieve the best light absorption in controlled environment agriculture. In the future, this could be applied to adjust lighting based on the different growth stages of Butterhead lettuce.

January 23 (Thursday), 13:00-14:30

Room F

GS6 Artificial life I

Chair: Kei Wakabayashi (University of Tsukuba, Japan)

GS6-1 Evolution of Acoustic Signaling for Frequency-Dependent Resources in Virtual Creatures under Information Asymmetry

Yamato Miura, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

This study investigates the influence of shared resource characteristics on the evolution of acoustic interactions under information asymmetry, where only some individuals can directly detect resources. In a three-dimensional virtual environment where sounds are generated through physical collisions, we evolved the population of resource detecting and non-detecting individuals with resources having positive and negative frequency dependence. Results revealed that in homogeneous-resource (positive) environments and mixed environments with low negative resource contribution, resource detectors produced acoustic signals facilitating gathering. In homogeneous-resource (negative) environments, they produced signals promoting dispersal. Meanwhile, incidental sounds from non-detectors served as resource acquisition cues. However, in mixed environments with high negative resource contribution, acoustic behaviors showed no influence on adaptive behavior.

January 23 (Thursday), 13:00-14:30

GS6-2 Metamorphic Transitions in Lenia Through Dynamic Growth Mechanisms

Yoshihiko Kayama
([1]BAIKA Women's University, Japan)

This study investigates dynamic transitions within the Lenia framework, a continuous cellular automaton that enables complex, autonomous lifeforms. We introduce Dynamic Growth Mechanisms (DGM), a novel approach consisting of three extensions: Dual-phase Growth, Kernel Growth, and Kernel Shape Transcription. These mechanisms aim to promote self-organization and metamorphosis-like transitions from simple initial configurations. Dual-phase Growth combines Original and Asymptotic Lenia's growth rules, while Kernel Growth treats the kernel as an evolving cell attribute. Kernel Shape Transcription breaks rotational symmetry by applying an offset vector to the kernel. Simulations of Dual-phase Lenia and DGM Lenia reveal complex behaviors, including pair production, fusion, and transitions reminiscent of insect metamorphosis. DGM Lenia exhibits a variety of stable lifeforms and their transitions, suggesting a potential evolutionary pathway from simple to more complex structures. Our findings highlight the potential of dynamic transitions between lifeforms, providing new avenues for exploring evolutionary mechanisms and stability in artificial life.

GS6-3 Exploring the Effects of Interactions Between Hierarchical Layers in Biological Systems Using Lenia

Tatsuki Furukawa, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

Biological systems have a hierarchical structure ranging from molecules to ecosystems, and emergent phenomena are generated by interactions between the layers. Such hierarchical nature of life and emergent phenomena are prominent features of living systems and continue to be a central theme in artificial life research. Lenia (Chan, 2019, 2020) is an extension of Conway's classical two-dimensional cellular automaton Game of Life, which allows for more flexible configurations through continuous time/space/state, and generalized state transition rules. In this study, we extend Lenia to have a hierarchical structure in order to understand hierarchy and emergent phenomena in biological systems. This study shows that Lenia can be a powerful tool for studying hierarchical dynamics and emergent phenomena, which are essential features of biological systems.

GS6-4 Towards Open-Ended Cultural Evolution Using LLM-Based Agents Enhancing Creativity in Science Fiction Plot Generation

Mahiro Kato, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

In recent years, Large Language Models (LLMs) have provided new opportunities for simulating cultural evolution in artificial societies. This study introduces a platform leveraging LLM-based agents to explore open-ended cultural evolution. The model involves agents iteratively modifying science fiction plots through individual learning and four social learning strategies: Random, Attraction-Based, Conformist, and Anti-Conformist Copying. Each agent refines its story by enhancing its narrative or imitating others based on its strategy. Outcomes were evaluated using LIWC metrics, and UMAP visualization. Results show that combining social and individual learning strategies leads to a broader distribution of diverse stories, while social learning-only settings often result in convergence towards specific themes. This research advances understanding of cultural evolution mechanisms and showcases the creative potential of LLMs in generating culturally diverse and innovative narratives.

January 23 (Thursday), 13:00-14:30

GS6-5 Detecting Visually Disrupted Text Overlaps on Webpage Using CNN

Ti-Mo Lin[1], Jhong-Yun Liu[1], Shin-Jie Lee[1], Ci-Yin Zhang[1], Wei-Ta Chu[1], Wen-Tin Lee[2]
([1]National Cheng Kung University, Taiwan)
([2]National Kaohsiung Normal University, Taiwan)

The article delves into the persistent problem of text overlapping in web page layouts, particularly noticeable on mobile devices despite the prevalence of responsive design features. These overlaps not only create confusion for users, especially those with visual impairments, but also impair readability and disrupt user interactions, particularly when clickable elements are involved. Traditional methods of detecting overlaps often produce false positives due to the difficulty in distinguishing between intentional and problematic overlaps, such as those caused by popup effects or transparent design elements. In response, we propose an innovative solution leveraging convolutional neural networks (CNNs) to identify visually disrupted text overlaps. The approach involves analyzing the webpage's DOM tree, capturing screenshots of potential overlaps, labeling these instances to build a dataset, and training a CNN model. This approach effectively detects visually disrupted overlaps with high precision (0.864) and recall (0.859), offering a promising avenue for improving overall web page usability.

GS6-6 How does indirect reciprocity based on image scoring work among large language model agents?

Mikiteru Nakamura, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

Advances in large language models (LLMs) are significantly impacting various academic fields, including the humanities and social sciences. We focus on indirect reciprocity based on image scoring, investigating its effectiveness among LLM agents through a series of stepwise experiments. We also conduct additional experiments to evaluate the fundamental mechanism designed to promote cooperative behavior. We use the prisoner's dilemma game to examine the effect of image scoring, the significance of its sharing, and the effect of expressing gratitude. The experimental findings demonstrate the efficacy of indirect reciprocity in LLM agents, while concurrently highlighting the limited effectiveness of motivation based on game-like fun in an LLM agent society. These observations underscore the potential value of incorporating this perspective into the methodology of subject experiments using LLM agents as an alternative to human subjects.

January 23 (Thursday), 13:00-14:30

Room H

OS14 AROB: Intuitive Human-System Interaction II

Chair: Masao Yokota (Fukuoka Institute of Technology, Japan)
Co-Chair: Akio Doi (Iwate Prefectural University, Japan)

OS14-1 Proposal of Anomaly Detections with Kalman Filters for Early Heavy Rain Warnings

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

In recent years, sudden heavy rainfalls have caused increasing damage to human lives or crops, and microclimate prediction technology has been gaining attention. However, when considering disaster prevention, it is crucial to account for changes in atmospheric factors and geographical factors such as terrain and buildings, which vary between regions. Therefore, this study proposes an Early Warning System for heavy rainfalls that integrates the microclimate changes captured by cloud-based microclimate prediction data and the geographical changes captured by many IoT sensors. This system also proposes anomaly detections by employing an Extended Kalman Filter, which uses a time-series state-space model to analyze both atmospheric and geographical factors. Then, this paper reports on the implementation of IoT devices such as a 3-axis accelerometer, flood, and soil moisture sensor to sense the flow of water, and the ongoing field experiments for proposed anomaly detections were reported for the future works.

OS14-2 Analysis of sentimental characteristics of posters on SNS for supporting female cancer

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

Peer support is a support activity in which people who have experienced cancer share their know-how from the perspective of their peers, and those who have the same problems share their distress and ways of life to support each other. In recent years, SNS services that enable online communication using the Internet have become widespread. As a way to reduce the anxiety and worries of cancer patients, it is important to spread the peer support through online communication using SNS. In this paper, we analyzed the sentimental characteristics of posters in the post articles on Peer Ring, SNS for supporting female cancer. As these results, it was found that the top 50 posters tend to make positive posts, and the bottom 50 posters make negative posts rather than positive ones. Moreover, we analyzed the trend of the posters by counting the ratio of the number of representative sentiments for posted articles of each poster, and posters could be classified into four groups.

January 23 (Thursday), 13:00-14:30

OS14-3 Analysis of verbatim data in psychological counseling using generative AI

Akira Higuchi, Yasuo Ebara
(Osaka Electro-Communication University, Japan)

Verbatim data, which records conversations between client and counselor in psychological counseling, serves as an important resource for understanding the flow of conversation. In previous studies, we developed a system to visualize the flow of conversation by categorizing the utterances of client and counselor into predefined categories based on verbatim data. However, the specific meanings of contents are abstracted by classifying utterances into predefined categories, it is difficult to understand the nuance and contextual details of the conversation. In recent years, studies on conversation analysis in psychotherapy using large language models (LLMs), such as OpenAI's GPT series is progressing. Additionally, they are applied in a wide range of psychotherapy study, such as assistants for counselors and chatbots for interacting with clients. Furthermore, GPT-4 has shown promising results in evaluating the appropriateness of counselor responses it generates and the effectiveness of LLMs in summarizing mental health counseling sessions. In this study, we applied analysis methods for verbatim data in psychological counseling using generative AI and developed a visualization system based on the findings. As a result, we clarified which parts of each session deal with specific content in the counseling and identify the changes in the client's cognition.

OS14-4 Watching Support System for Elderly People Living Alone

Takato Ikeda, Tomoyuki Ishida
(Fukuoka Institute of Technology, Japan)

We developed a watching system for elderly individuals living alone by equipping their rooms with a depth camera and Internet of Things sensors. The system tracks their movements and visualizes room conditions such as humidity and temperature, enabling family members and relatives living remotely to check the elderly person's safety in real time. The system offers three key features: an “abnormality detection function,” an “alert function for detected abnormalities,” and a “visualization function for living conditions.” To assess its effectiveness, we performed tests focusing on operability, readability, functionality, relevance, and applicability. The system received high ratings in most categories; however, participants identified some functionality issues that needed to be addressed in future improvements.

OS14-5 Dual Task Virtual Reality System using a Fitness Bike

Kaisei Komoto, Tomoyuki Ishida
(Fukuoka Institute of Technology, Japan)

In this study, we developed a dual task virtual reality system using a fitness bike. The dual task VR system employs a head-mounted display device to allow the users to experience the VR space and perform hand tracking. In addition, a cadence sensor is employed to measure the number of revolutions of a fitness bike’s pedals. The proposed system realizes the cycling function by obtaining the pedal revolution data from the cadence sensor and synchronizing it with a VR avatar. Furthermore, the dual task VR system implements a function that allows the user to perform and evaluate multiple-choice calculation problems displayed in the VR space by capturing the gestures using the HMD’s hand tracking function. Evaluation results indicate that the proposed system realizes effective dual tasking in VR space.

OS14-6 Historical Transition Visualization System

Yuki Takashima, Tomoyuki Ishida
(Fukuoka Institute of Technology, Japan)

In this study, we implement a system for visualizing historical transition that allows users to experience historical changes using virtual reality (VR) technology. The proposed system has the function for switching between the current and past states of important buildings that have been reproduced using VR technology. Users can visually experience histories and characteristics of the buildings and their surroundings. Our proposed system provides users with a high-quality touristic experience that allows them to understand the historical value of the region and provides them with an opportunity to rediscover its traditions and culture. By utilizing our proposed system as an educational tool, we also aim to contribute to regional development and to passing knowledge to the next generation.

January 23 (Thursday), 16:05-17:20

Room A

GS7 Artificial life II

Chair: Hiroki Kojima (The University of Tokyo, Japan)

GS7-1 The Role of Direct Utility for Signaling in Communication Emergence: Insights from Temporally Extended Communication Game

Naoki Inoue, Kei Wakabayashi
(University of Tsukuba, Japan)

This study investigates the evolutionary mechanisms of communication emergence by using temporally extended communication games, which are implemented as a multi-agent reinforcement learning environment. Our experimental results provide three key insights: (1) The distribution of reward delays is an essential factor that affects the possibility of communication emergence. (2) Direct utilities that facilitate the ritualization process become necessary for establishing communication when the reward delay tends to be sufficiently large. (3) The sender's well-established policy to perform patient signaling is more critical than the receiver's pre-evolved reaction policy for establishing communication when the reward delay is large. This insight explains why ritualization is more commonly observed in nature than sensory manipulation from a novel perspective.

GS7-2 Effects of cultural niche construction on cooperative and collective dynamics in the social particle swarm model

Noboru T. Hamano, Reiji Suzuki, Takaya Arita
(Graduate School of Informatics, Nagoya University, Japan)

This study aims to clarify how cooperative and collective dynamics in social populations are influenced by cultural niche construction, where individuals modify their cultural environment through activities and artifacts, shaping future interactions. We extend the Social Particle Swarm (SPS) model, which maps agents' spatial proximity to social closeness, agents engage in game-theoretical interactions (Prisoner’s Dilemma) and move according to their payoffs. We introduce local cultural niches within a grid overlaying the 2D space. Each grid cell contains two modifiable niche types: a cooperation niche (propensity to cooperate or defect) and a mobility niche (propensity to increase movement). These values can propagate to neighboring cells and decay over time. Comparative experiments revealed that cooperation and mobility niches independently drive unique behaviors, while their combination fosters novel social dynamics. Our findings suggest that strategically designed interaction histories on social platforms could sustain large-scale collective dynamics, mitigating fragmentation and stagnation in interactions.

GS7-3 Floatiles: proposal to use 3d printed floating elements as building blocks for 2d modular swarm robots

Georgii Karelin
(Okinawa Institute of Science and Technology (OIST), Japan)

This project aims to create a modest, macroscopic-scale physical experiment that explores how random, simple machines can emerge from minimal mechanical principles. Propelled by surface tension and random agitation, floating elements can self-assemble into simple mechanical contraptions reminiscent of Rube Goldberg devices or “useless machines.” The objective is to determine whether such minimal, physically driven arrangements might exhibit emergent behaviors akin to those studied in artificial life, using only simple forces and connectivity at a macroscopic scale. In this setup, the Cheerios effect potentially causes floating gears and other parts to stick together, forming simple assemblies that can build into more complex contraptions.

January 23 (Thursday), 16:05-17:20

GS7-4 Studying RuBisCO in Liquid-Liquid Phase Separated Droplets

Milena Dobronos[1], Samuel Hauf[1], Paola Laurino[1,2]
([1]Okinawa Institute of Science and Technology Graduate University, Japan)
([2]Institute for Protein Research, Osaka University, Japan)

Membrane-less compartments are distinct units of living cells not surrounded by a membrane. They usually form through liquid-liquid phase separation (LLPS) and contain high local concentrations of biomolecules like proteins and nucleic acids. They can assemble and disassemble in response to various cellular signals, helping to organize the cell's biochemistry. Membrane-less droplets are particularly interesting from a biochemical and biophysical standpoint because they can concentrate specific molecules and regulate biochemical reactions. The phenomenon of LLPS can be recreated in the laboratory to create membrane-less droplets loaded with different proteins. Those artificial droplets can mimic some important properties of living cells, namely self-differentiation from the environment, compartmentalization, active chemical processes, and internal circulation. For this reason, LLPS can be used to create simple models of cellular processes and can be one potential avenue to explore abiogenesis. In this project, we focus on an LLPS system containing RuBisCO — the most abundant enzyme on Earth. The function of RuBisCO is to fix carbon dioxide into biomass, but it is not a good catalyst. Interestingly, some photosynthetic organisms have independently evolved mechanisms that phase separate RuBisCO to increase CO2 fixation rates (e.g., carboxysomes, pyrenoids). Mixing RuBisCO with the polymer PEG4000 and the blood plasma protein bovine serum albumin (BSA) in specific ratios triggers LLPS. The resulting protein droplets have a characteristic size on the micrometer scale and are highly enriched with BSA and RuBisCO. Such droplets with high local RuBisCO concentration can act as artificial pyrenoids, which can be used to study the mechanisms of increasing the efficiency of photosynthesis. One of the goals may be to re-create these efficient systems in plants that normally lack them, like most C3 crop plants, potentially improving photosynthesis rates and crop yields. By exploring and quantifying of RuBisCO-BSA droplets system, we could better understand the boundary between living systems and non-living material. This understanding is critical for addressing questions about the origin of natural or artificial life.

GS7-5 An evolutionary model of animats based on subjective evaluations using large vision-language models

Shota Miyazaki, Reiji Suzuki, Takaya Arita
(Nagoya University, Japan)

This study aims to significantly extends the capabilities of evolutionary computation by mitigating the enormous costs associated with human-based evaluation, a key challenge in Interactive Evolutionary Computation (IEC). As a first step towards this goal, we conducted evolutionary experiments on animats (artificial animals) using Large Vision-Language Models (LVLMs). In these experiments, LVLMs performed both fitness evaluation and selection within a genetic algorithm, using subjective evaluation such as “move more adorably” and “move more weirdly” to guide the evolutionary process. Our results showed that animats subjected to selection pressure favoring “adorable” movements tended to evolve quadrupedlike morphologies with foot-like structures. In contrast, animats subjected to selection pressure favoring “weird” movements tended to have a constricted structure and move by swaying the upper part of the body from side to side.

January 23 (Thursday), 16:05-17:35

Room B

GS11 Cognitive science & Complexity

Chair: Shoji Nagataki (Chukyo University, Japan)

GS11-1 Evaluation of confidence for probabilistic production rule selection using language models in multi-step reasoning

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

A cognitive architecture is an integrated framework for developing intelligent agents, and its research is being conducted towards artificial general intelligence. Production systems have long served as the central control system within such architectures, but due to their limited flexibility, probabilistic production systems utilizing language models have been proposed in recent years. Systems that employ language models have demonstrated improved multi-step reasoning capabilities and have proven effective in various reasoning tasks. In this study, we aimed to improve the reasoning capabilities by utilizing confidence measures. However, there are many confidence measures, and the effectiveness of each confidence measure in plan generation remains unclear. Therefore, in this study, we propose multiple confidence measures for goal-oriented planning problems, and demonstrate the effectiveness and ineffectiveness of each measure.

GS11-2 Research on Human Unconscious Motion Using a Drawing Robot

Asuka Yoshida, Katsuyoshi Tsujita
(Tottori University, Japan)

Paralysis is a typical symptom of stroke. Strokes occur more often in the elderly people, so this is an important issue in Japan, which is a super-aging society. To rehabilitate paralysis, it is first necessary to understand how patients perceive their own bodies. Much of this research has investigated “conscious movements: movements intended to initiate behavior.” However, in this study, we focused on “unconscious movements: movements that do not intend to initiate a behavior. Exploring unconscious movement provides clues to the consciousness of human movement, which is even more fundamental than conscious movement. This time, we considered the method and conditions for measuring unconscious movement and conducted an experiment.

GS11-3 Anne-Boleyn Illusion of one-handed stimulation using Virtual-Reality

Yuma Chiba, Takayuki Niizato
(University of Tsukuba, Japan)

Anne-Boleyn Illusion is the illusion of the presence of a sixth finger that does not exist. This illusion, like Rubber-Hand Illusion, is thought to be caused by sensory remapping due to spatiotemporally synchronized stimulation of the visual and tactile senses. However, the experimental system by Newport et al. does not measure only sensory re-mapping, since the stimuli are applied to both hands. Therefore, in this experiment, we used VR to test whether Anne-Boleyn Illusion occurs in only one side of the body. The results suggest that Anne-Boleyn Illusion can occur on only one side, although we did not observe the same significance as in previous studies.

January 23 (Thursday), 16:05-17:35

GS11-4 The information structure of boredom via Integrated information theory

Takayuki Niizato[1], Yuta Nishiyama[2], Shusaku Nomura[2]
([1]Univeristy of Tsukuba, Japan)
([2]Nagaoka University of Technology, Japan)

Boredom is a complex psychological state that can enhance creativity but is also linked to negative outcomes like self-harm behaviour. In this study, we applied Integrated Information Theory (IIT) to explore boredom's information structure through interactions between brainwave activity (EEG) and autonomic signals (EDA, ECG) during arithmetic tasks of varying difficulty. We found that system integration (Φ) increased from Easy to Difficult tasks, while main complex dynamics showed the opposite trend, indicating stronger body-brain coupling during moderate tasks. Using Earth Mover's Distance (EMD), we detected significant task-related shifts, particularly during Moderate tasks, while the Easy condition exhibited minimal shifts. Correlations indicated that irritation and tiredness related to main complex transitions, but boredom did not correlate as Φ. Our results suggest boredom emerges from body-brain decoupling, despite increased arousal (i.e., high system's integrity Φ), while stronger coupling of body-brain may reduce subjective stress.

GS11-5 Revealing Technological Complexity in Japan: A Bipartite Network Approach on Corporate Patents

Rintaro Karashima[1], Hiroyasu Inoue[1,2]
([1]Graduate School of Information Science, University of Hyogo, Japan)
([2]Center for Computational Science, RIKEN, Japan)

As international competition intensifies, nations need to identify key technologies to foster innovation through efficient industrial policies. Here, this study aims to assess the entire spectrum of technological fields by applying the Technological Complexity Index (TCI) from a corporate perspective, addressing its underutilization in Japan despite its potential. By utilizing carefully processed patent data from fiscal years 1981 to 2010, we analyze the bipartite network which consists of 1938 corporations and 35 or 124 technological fields. Our findings provide quantitative characteristics of ubiquity and sophistication for patent fields, the detailed technological trends that reflect the social context, and methodological stability for policymakers and researchers, contributing to targeted innovation strategies in Japan.

GS11-6 Self-corrective behavior for turn repetition in pill bugs

Yuta Miyama, Ayaka Fujimoto, Toru Moriyama
(Shinshu University, Japan)

Pill bugs (Armadillidium vulgare) demonstrate a behavior called turn repetition. For example, this behavior is seen when they repeat their path choice on successive trials of the T-mazes with long distance between T-junctions. However, sometimes they stop after turning and change their direction. The function of this directional change has not been investigated. The present paper shows that pill bugs use directional changes to prevent them from turning in the different direction on two successive turns, a behavior called turn alternation. We examined the behavior of 20 pill bugs that each completed 49 successive combinations of L-corner and T-junction trials in an experimental pathway with long distance between the corner and the junction. Directional changes appeared more frequently when individuals began a turn alternation than when they did a turn repetition. These results suggest that pill bugs have an inherent mechanism that acts to maintain turn repetition behavior.

January 24 (Thursday), 16:05-17:20

Room C

GS24 Machine learning IV

Chair: Minija Tamosiunaite (Georg August University of Göttingen, Germany)

GS24-1 A Human Motion Recognition System for Robot Command Using Inertial Sensors

Noboru Fujino, Hirokazu Matsui
(Mie University, Japan)

In this study, we introduce an innovative human motion recognition system designed to enhance robot command execution by leveraging inertial sensor technology. Our approach involves wearable armbands equipped with inertial sensors that capture motion data, allowing for the precise interpretation of user gestures and intentions. By focusing on specific motion features such as roll, pitch, and yaw, and employing robust machine learning techniques like Random Forest algorithms, we aim to accurately distinguish between various user-defined gestures, including beckoning and waving goodbye. Our findings highlight the potential of this system to significantly improve the fluidity and accuracy of human-robot interaction. This work not only demonstrates the feasibility of integrating wearable sensor technology with intelligent recognition algorithms but also establishes a foundation for seamless collaboration between humans and robots in diverse applications ranging from industrial automation to assistive robotics.

GS24-2 Achieving Real-Time Gait Recognition for Lower-Limb Exoskeletons Through Feature Selection and Model Evaluation at Reduced Window Sizes

Majumder Anas, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Lower-limb exoskeletons hold significant potential for assisting individuals with impaired mobility, particularly in rehabilitation and daily support. Despite advancements in gait recognition, real-time adaptability remains a challenge. Many models achieve high accuracy with longer data windows but suffer performance drops with smaller window sizes, which are critical for dynamic exoskeleton control. This research addresses this limitation by improving gait recognition accuracy for smaller time windows, ensuring low-latency responses necessary for practical applications. We employ feature engineering techniques to identify core features influencing gait recognition within reduced windows. Feature correlation analysis is combined with dimensionality reduction methods to maintain model accuracy while optimizing computational efficiency. Wrapper methods, such as Recursive Feature Elimination (RFE), further refine feature selection. Complementing this, we explore lightweight sequential models like Temporal Convolutional Networks (TCN) and Gated Recurrent Units (GRU), known for efficient processing of sequential data. Additionally, Adaptive Neuro-Fuzzy Inference Systems (ANFIS), recognized for their adaptability to new users, are implemented to maintain accuracy under diverse conditions. By integrating feature optimization with lightweight architectures, this research seeks to enhance model performance for real-time gait recognition. Our findings aim to ensure reliable, swift, and accurate control for lower-limb exoskeletons, advancing their usability in real-world scenarios. The results of this study indicate a feasible gait event classification method capable of predicting instantaneous gait change.

January 24 (Thursday), 16:05-17:20

GS24-3 Pre-training Deep Neural Networks with 3D Fractal Structures for COPD Stage Classification

Kohei Harada, Wataru Noguchi, Yasumasa Tamura, Kaoruko Shimizu,
Satoshi Konno, Masahito Yamamoto
(Hokkaido University, Japan)

In this study, we propose a novel pre-training approach using a 3D fractal dataset for the classification of three-dimensional CT images, specifically focusing on Chronic Obstructive Pulmonary Disease (COPD) spirometric staging. The proposed method leverages mathematically generated fractal structures to enhance feature extraction, addressing the limitations posed by the high cost and ethical concerns associated with the availability of labeled medical image datasets. We applied this approach to both the COVID-CT-MD and COPD datasets, comparing the performance of models pretrained with the 3D fractal dataset against those trained from scratch. The experimental results demonstrated that the fractal-based pretraining consistently outperformed the scratch-trained models, confirming the potential of fractal-based pretraining to improve feature extraction in medical image tasks. These findings suggest that fractal-based pretraining could serve as an effective alternative to traditional pretraining methods using labeled medical data, providing a cost-efficient and ethical solution for improving performance in medical image classification tasks.

GS24-4 Proposal of a Brain Activation Five–Layer Network with Five Types of EEG for Classification of Artificial Responses in NEO-FFI by Utilizing Graph Fourier Transform

Yuto Ashikawa, Yosuke Kurihara
(Aoyama Gakuin University, Japan)

The NEO-FFI is a psychological scale widely used in psychology to quantitatively evaluate personality traits. However, its reliability can be compromised by psychological bias, leading test-takers to respond artificially to appear favorable. This study proposes a method to classify artificial responses by analyzing brain activity through EEG signals. A five-layer brain activation network corresponding to five EEG types (alpha, beta, theta, delta, gamma) is constructed. Each layer includes eight nodes representing brain regions defined by the international 10-20 method, with node values reflecting EEG content rates and edges representing coherence values. Artificial responses are hypothesized to increase EEG content rates and coherence in fast-wave bands. The Graph Fourier Transform (GFT) is applied to extract features, which are classified using a support vector machine (SVM). Validation with 23 participants yielded an accuracy of 0.65 and an F1-value of 0.73. Future work will improve classification using dynamic network models and response latency as features.

GS24-5 Variance Control for Black Box Variational Inference Using The James-Stein Estimator

Dominic B. Dayta, Takatomi Kubo, Kazushi Ikeda
(Nara Institute of Science and Technology, Japan)

Black Box Variational Inference is a promising framework in a succession of recent efforts to make Variational Inference more "black box". However, in its basic version it either fails to converge due to instability or requires some fine-tuning of the update steps prior to execution that hinders it from being completely general purpose. We propose a method for regulating its parameter updates by re-framing stochastic optimization as a multivariate estimation problem. Borrowing from estimation theory, we examine the properties of the James-Stein estimator as a replacement for the arithmetic mean of Monte Carlo estimates of the gradient of the evidence lower bound. Theoretical guarantees for its variance reduction properties are also given. We show through simulations that the proposed method provides relatively weaker variance reduction than Rao-Blackwellization, but offers a tradeoff of being simpler and requiring no prior analysis on the part of the user. Comparisons on benchmark datasets also demonstrate a consistent performance at par or better than the Rao-Blackwellized approach in terms of resulting model fit.

January 23 (Thursday), 16:05-17:05

Room D

GS36 Robotic mechanism III

Chair: Yoshiaki Katada (Setsunan University, Japan)

GS36-1 Design of a robotic gripper with two servo motors for infinite wrist rotation and performance evaluation for valve operation

Jehun Seo, Yoshiaki Yamazaki
(Meisei University, Japan)

In this study, we proposed a robot gripper with a parallel linked fingertip mechanism and unlimited rotation of the wrist by two actuators. This robot gripper is intended to be used as a rescue robot. When a disaster occurs, this research proposed a robot gripper with two actuators that can rotate its wrist with a parallel link fingertip mechanism without any limitation. This robot gripper is designed to be used as a rescue robot and is designed to continuously rotate valves in a plant where a disaster has occurred. A camera in the center of the fingertip allows the robot to check the condition of the valve. The fingertips are connected by a 5-joint linkage and two fingers are operated by a feed screw mechanism to perform all the different tasks. The performance was verified and analyzed by measuring the gripping force of the fingertips and the rotational torque of the wrist. The design was made with the work of continuously rotating a valve in a plant. A camera in the center of the fingertip allows the operator to check the condition of the valve. To accommodate different tasks, the fingertips are equipped with a 5-joint linkage, and two fingers are operated by a feed screw mechanism. Performance was verified and analyzed by measuring the gripping force of the fingertips and the rotational torque of the wrist.

GS36-2 Posture transition control of electrically-driven Tri-star wheelchair toward stair climbing

Takumi Sakai, Naoto Sato, Gaku Miyazima, Masami Iwase
(Tokyo Denki University, Japan)

In this study, the postural transformation of an electrically-driven wheelchair with a Tri-Star wheel mechanism is presented toward stair climbing. The Tri-star wheel mechanism uses planetary gears and is designed to lift and lower stairs in combination with a center-of-gravity control mechanism of an actuated user seat. The feasibility of the operation of the developed wheelchair was evaluated by experimentation. The results show that the Tri-star wheel mechanism can realize the mode transition from a four-wheel stable mode to a two-wheel unstable inverted mode.

GS36-3 Study of a moving mechanism for a robot working on the exterior surface of a structure

Shuya Hashimoto, Nobuhiro Okada
(The University of Kitakyushu, Japan)

The purpose of this research is to develop a wall-moving robot that performs home window cleaning. There are two types of moving mechanisms: a magnetic type and a negative pressure adsorption type, and the negative pressure adsorption type was selected. The negative pressure adsorption type is easy to install but has the risk of tipping over due to power supply problems, so a leg-type moving mechanism, part of the negative pressure adsorption type, was chosen. Previous studies have employed a triangular cam mechanism using a Reuleaux triangle, but the problem was that the speed of the legs was not constant. Therefore, in this study, the left-right and up-down movements of the legs were considered separately, and a movement mechanism using a rack and pinion and a missing-tooth gear was proposed.

January 23 (Thursday), 16:05-17:05

GS36-4 Bipedal Robot with Flexible Joints Combining Passive and Active Mechanisms

Ryo Takagi, Kazuyuki Ito
(Hosei University, Japan)

Various types of bipedal robots have been developed, including passive walkers and those with actuators for all joints. In this study, we develop a new bipedal robot that incorporates and combines these features with the flexibility provided by silicone rubber. The robot has two legs and a trunk, which contains a motor to control the robot's center of gravity. Each leg has three joints: the hip, knee, and foot joints, which are moved by two motors. The hip joint is flexible owing to the use of silicone rubber, and the knee joint is connected to the motor via strings. This mechanism is inspired by musculature. To demonstrate the effectiveness of the proposed mechanism, we developed a prototype biped robot and conducted experiments involving walking on a gentle, flat slope. The results showed that the proposed robot could perform a few steps using its dynamics without requiring sensors or feedback.

January 23 (Thursday), 16:05-17:20

Room E

GS32 Robot vision and image processing I

Chair: Yoshitaka Matsuda (Saga University, Japan)

GS32-1 Simple Motion Detection Circuits Inspired by the Vertebrate Retina with Low Power Consumption and Array Configurations

Thanaphat Imkrajang, Lalitphat Rodsrisamut, Kimihiro Nishio
(National Institute of Technology, Tsuyama College, Japan)

In this study, simple analog-digital motion detection circuits with low power consumption were proposed based on the vertebrate retina. It was clarified from the simulation results that the proposed circuits can detect edge positions and movements although the power supply voltage was set to the low value. A one-dimensional array of the proposed circuit was evaluated by simulation. We found that the one-dimensional array can be used to detect the speed at which an object is moving. We fabricated the Large Scale Integration (LSI) of the proposed basic circuit using 0.6 μm Complementary Metal Oxide Semiconductor (CMOS) process. From the measurement results of the fabricated LSI, it was confirmed that the circuit was able to generate edge signals and motion signals. In the future, the detection sensor with low power consumption can be realized by applying the proposed circuits.

GS32-2 An Estimation of the Position for Automous Mobile Robots when lostting the moving Marker on the Display

Yohei Isomura, Hirokazu Matsui
(Intelligent Robotics Lab., Department of Mechanical Engineering,
Faculty of Engineering, Mie University, Japan)

In this report, we propose a self-pose control for a mobile robot on an upward-facing LCD display. In the above environment, we have studied ”Foreign language conversation learning with direct method by using mobile robots” as previous works. But, we have a problem that an observer treats the same gestures of movements as the different gestures, if the mobile robots move unstably. So, we display a marker on the display and a camera is attached underneath the robot to track the marker. In this report, we aim to position estimation when marker gone to out of robot camera’s view.

January 23 (Thursday), 16:05-17:20

GS32-3 Heat Conduction for Enhanced Thermal to RGB Conversion in 3D Reconstruction via a Distance-Time Based Thermal Model

Fumiya Nakao, Potchara Ratsamee
(Graduate School of Robotics and Design, Osaka Institute of Technology, Japan)

To enhance perception in low-visibility environments, this study introduces a "distance-time based thermal model" to enhance the capabilities of thermal imaging for 3D reconstruction. Typically, thermal images are grayscale and rely on temperature gradients, which can result in a lack of sufficient feature points for effective 3D mapping, especially in environments with minimal temperature variations. By systematically applying controlled temperature changes using warm air at specified distances and durations, and integrating depth data obtained from mmWave radar, we significantly improve the edge detectability in thermal images. Deep learning techniques are subsequently used to convert these enhanced thermal images into RGB images, aiming to refine the accuracy of this conversion process. Our findings demonstrate that such temperature modifications not only improve the accuracy of image conversion but also substantially enhance the overall quality of 3D map generation.

GS32-4 Reconstruction of 3D Point Cloud Maps in Forests Using Terrain Information: Automatic Extraction of Ground Points for 3D Map Reconstruction

Riki Usukura, Saya Adachi, Rui Ozawa, Masami Iwase
(Tokyo Denki University, Japan)

In this research, we aim to enhance the accuracy of three-dimensional point cloud maps for forestry use. The point cloud map is reconstructed by a forest measurement system inplemented on a multi-copter. The efficient carbon dioxide absorption quantification in forest interiors requires the precise shape measurement of each tree in the forest. Data filtering and correction are important to divide ground and tree point clouds from measurement points when reconstructing the precise point cloud map. The proposed method is evaluated by applying it to the LiDAR data of a forest area, and reconstructing the point cloud map.

GS32-5 Fast Crowd Counting System Based on CSRNet

Xiaochuan Tian, Hironori Hiraishi
(Ashikaga University, Japan)

An advanced crowd counting algorithm based on CSRNet has been proposed in this study to improve the long training and convergence times. In the case of high-density images, the accuracy was observed to be very close to the original CSRNet. Moreover, the average training time per sample was three times faster and average testing time per image was six times faster. In the case of low-density images, the accuracy was not close to that of the original CSRNet. However, the training time was 10 times faster and the testing time was six times faster. The experimental results show that the improved CSRNet performs well. The processing time is much faster since it does not use dilated convolution. This indicates that it is more suitable for the actual needs of real-time detection. A system with improved CSRNet for counting people in real-time has also been designed in this study.

January 23 (Thursday), 16:05-17:20

Room F

GS17 Human-machine interaction and collaboration III

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

GS17-1 Power steering control for compensating bicycle dynamics variation due to front basket loading

Takaatsu Kihara, Yuzuki Sugasawa, Keigo Kuriyama, Masami Iwase
(Tokyo Denki University, Japan)

This study is related to realize a power steering control that recovers the maneuverability of the bicycle which is deteriorated due to loading baggage to the front basket, by assisting the handlebar operation. According to the analysis of the effect of loading children and baggage in the front basket on maneuverability, it is found that the cause is an increase in the moment of inertia around the handlebar axis and a change in the position of the center of gravity. To solve the issue, previous studies have proposed a power steering mechanism that applies an assist torque proportional to the user's steering torque to the handlebar axis. This mechanism has been shown to recover reduced maneuverability. However, when a rider rides a bicycle, the rider does not only operate the handlebars but also tilts the bicycle in the roll direction. Therefore, in this study, to propose a control method to assist the steering torque of the handlebar, a mathematical model of the bicycle is considered to that both handlebar operation and bicycle tilt. To verify the effectiveness of the proposed model, we develop an electrically power assisted bicycle with the power steering mechanism and implement an assist algorithm. Experimental results demonstrate the derived bicycle model is useful to design the steering assist control.

GS17-2 Construction of a measurement system focusing on time-series changes in frozen powder

Shunsuke Nagase, Koki Fujiwara, Jun Ogawa, Hidemitsu Furukawa
(Yamagata University, Japan)

This study addresses the challenge of assessing time-dependent changes in texture, such as the phase transition from solid to liquid. Traditional methods, such as image recognition and electronic tongue systems, achieve high accuracy in food and beverage identification; however, they require extensive datasets and encounter difficulties with real-time tracking. To overcome these limitations, this study employs piezoelectric sensors in combination with flexible materials to monitor state changes in frozen powders, analyzing the data through logistic regression. Piezoelectric sensing is utilized under cyclic motion to track temporal changes and classify critical moments during the thawing process. Furthermore, a chatbot interface was developed using Python and OpenAI to enable users to interactively access detailed information about the melting process via LINE. By scanning QR codes, users can effortlessly and intuitively evaluate the process, enhancing the accessibility and practicality of this approach.

GS17-3 Development of robot teleoperate system using neck motion to construct a data collection platform

Yuto Hattori[1], Yutaka Nakamura[2], Yuya Okadome[1,2]
([1]Tokyo University of Science, Japan)
([2]RIKEN Information R&D and Strategy Headquarters, Japan)

Many teleoperation robots have been developed for use in an actual environment. For such robots, the operation interface with a low workload is required to move in various situations. In this paper, we propose a robot teleoperation system that uses the operator's body movements to reduce the workload on the operator. The proposed teleoperation system employs the operator's neck movements to control the camera's position. In the experiment, we compared the proposed system and one fitted camera system (conventional). Participants perform two tasks: a checking numerical values task, and a searching objects task. The difficulty levels of these tasks are different, and participants' workload for these tasks is measured for each interface. The experimental results suggest that the proposed system can reduce the workload on the participants compared to the conventional system. The experimental results suggest that the proposed system can reduce the workload of the participants.

January 23 (Thursday), 16:05-17:20

GS17-4 Minimalist IMU-Based Glove for Real-Time Finger Tracking for Robot Teleoperation

Gajitha Nanayakkara, Pasut Suriyasomboon, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

This study introduces a minimalist IMU-based glove designed for real-time finger tracking in robotic teleoperation. The glove employs a single IMU sensor at the fingertip, complemented by reference sensors at the finger joints, to capture precise finger movements. By utilizing forward and inverse kinematic modeling, the system effectively controls a 4-degree-of-freedom (DoF) robotic finger, replicating human finger gestures without the complexity and expense of camera-based tracking systems. The glove integrates data from angular velocity, linear acceleration, and orientation measurements, employing sensor fusion and machine learning algorithms to translate human motions into robotic actions. The Denavit-Hartenberg (D-H) parameters are utilized for precise kinematic modeling, enabling detailed control of the robotic finger's MCP, PIP, and DIP joints. Experimental results demonstrate the system's ability to accurately map human gestures to robotic movements, with noise-reduction filtering ensuring responsive and precise operation. This work highlights the potential of cost-effective, wearable solutions for enhanced human-robot interaction in teleoperation applications.

GS17-5 3D Printing of High-Fidelity Monolithic Soft Robotic Grippers Using Highly Flexible TPU

Khalid Meitani, Sajid Nisar
(Department of Mechanical and Electrical Systems Engineering,
Kyoto University of Advanced Science, Japan)

Soft manipulators have emerged as a beneficial field for applications that require delicate interactions with objects and safety around humans. In this research we present the design, fabrication techniques, and evaluation of two high-fidelity monolithic soft grippers fully fabricated using Fused Deposition Modeling (FDM) technology which offers rapid prototyping, customization, and the ability to fabricate complex geometries, using Thermoplastic Polyurethane (TPU) filaments with shore hardness values of 70A and 60A. The grippers were developed to demonstrate the capabilities of low shore hardness and flexible FDM 3D printing in producing soft robots, and to explore the impact of material flexibility on adaptive grasping. Detailed techniques for successfully printing with these highly flexible materials are discussed, addressing common challenges such as extrusion inconsistencies. The results demonstrate the possibilities of using FDM 3D printing with TPU for fabricating cost-effective, customizable soft grippers, and show the potential of these materials in various applications.

January 24 (Friday), 9:00-10:30

Room A

OS2 AROB: Bio-inspired theory and applications (1)

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

OS2-1 A study of Collaborative malware detection using item response theory

Takuro Inada[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)

In this paper, we propose a detection system that incorporates a mechanism that reflects the reliability of votes based on detection accuracy metrics for each anti-virus engine calculated using item response theory and the statistically weighted majority voting, overcoming the problem of collaborative malware detection. Collaborative malware detection can be more effective at detecting zero-day malware than a single anti-virus engine because it increases the likelihood of detecting malware that a single engine might miss. A key component of collaborative malware detection is a mechanism that makes an optimal decision by using multiple detection results from multiple anti-virus engines. We implemented a prototype system incorporating the VirusTotal API and evaluated it with malware samples from MalwareBazaar and benign files obtained from websites providing free software. Through experimentation, we have confirmed that the proposed system improves detection accuracy for unknown malware.

OS2-2 Investigation of Detection Methods for Trojaned DNNs under Specific Conditions

Shunya Izaki[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)

Machine learning models using DNNs (Deep Neural Networks) are widely utilized, but they are vulnerable to adversarial attacks. Among them, an attack called a Trojan Attack creates a trojaned model by using poisoned training data. This model is designed to cause misclassification under conditions intended by the attacker, hindering the adoption of DNN models in systems where safety and reliability are paramount. This paper investigates whether using neurons from multiple layers can improve detection accuracy based on Karan et al.'s method, which detects whether a DNN model is trojaned by observing the behavior of neurons in the final intermediate layer.

OS2-3 Introduction of Feature Points in Images for Improvement of Finding Letters Type CAPTCHA Based on Neural Style Transfer

Ramu Kiura[1], Hisaaki Yamaba[1], Shotaro Usuzaki[1], Kentaro Aburada[1], Masayuki Mukunoki[1],
Mirang Park[2], Naonobu Okazaki[1]
([1]University of Miyazaki, Japan)
([2]Kanagawa Institute of Technology, Japan)

With the rapid advancement of computer technology in recent years, traditional CAPTCHAs face an unfavorable situation, as automated programs can now easily solve them. One proposed solution is Font-CAPTCHA, which utilizes neural style transfer technology. This CAPTCHA asks users to click Chinese characters embedded in an image in the designated order. However, Font-CAPTCHA faces the challenge of high character position detection accuracy by machines. We aim to enhance the resistance of character position estimation by adopting the idea of feature points as the selection of characters to be embedded. Also, a style around the feature point is transferred onto the corresponding character image. The experimental system was implemented based on the proposed CAPTCHA and a series of experiments was carried out in order to evaluate the effectiveness of the proposed method using the system. The results show that the proposed method is promising.

January 24 (Friday), 9:00-10:30

OS2-4 Introducing Generative AI into Unrealistic Image CAPTCHA for Effective Image Generation

Kana Saiki[1], Hisaaki Yamaba[1], Shotaro Usuzaki[1], Kentaro Aburada[1], Masayuki Mukunoki[1], Mirang Park[2], Naonobu Okazaki[1]
([1]University of Miyazaki, Japan)
([2]Kanagawa Institute of Technology,, Japan)

New CAPTCHA is needed to counter attacks by advanced computing technology. In this study, we explored a novel CAPTCHA approach that uses human cognitive abilities. Specifically, it focuses on a Multi-model CAPTCHA that utilizes unrealistic images. Multi-model CAPTCHA has a weakness in that problem images are generated almost manually. To solve this problem, we propose a method that utilizes image generation AI to enable mass generation of problems, thereby making problem generation easier. Experiments were conducted to examine the practicality and machine resistance of the proposed CAPTCHA method.In the usability experiment, the average correct response rate was 88.44%.In the experiment examining machine resistance, it was found that the proposed CAPTCHA method is resistant to simulated attacks using image recognition systems.

OS2-5 A Node-Passage-Based Packet Routing Method for 2D Mesh NoCs

Takuma Kawasaki, Yota Kurokawa, Masaru Fukushi
(Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan)

Network-on-Chips (NoCs) is a novel communication paradigm designed for many-core systems. In NoC architectures, nodes consisting of cores and routers are connected through an on-chip network, and data transfer between cores is realized by forwarding packet. In this paper, we propose a routing method for 2D mesh NoCs. In most conventional methods, communication is performed by forwarding packets to neighboring nodes. In contrast, the proposed method performs routing by passing through a node. Simulation results show that the proposed method reduces latency by 34.3% for a 5 × 5 network and by 25.7% for a 10 × 10 network compared to conventional methods.

OS2-6 An Efficient Voting Method for Parallel Volunteer Computing

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

Volunteer Computing (VC) is an Internet-based distributed computing paradigm, which leverages idle computing resources on the Internet, and is expected to provide high-performance computing capability for various research and development fields at a low cost. With recent research progress, it has shown the capability of handling not only distributed computing (i.e. distributed VC) but also parallel computing (i.e. parallel VC). However, due to the inherent nature of participants and parallel computing, traditional redundant computing methods employed for distributed VC are not effective for parallel VC.In this paper, we propose a new voting method for parallel VC in order to improve reliability and efficiency in parallel processing. The proposed method focuses on the property of server assisted communication to realize parallel VC and performs voting for communication data at a subjob level, synchronizing the communication data.Simulation results show that, the proposed method can maintain computation accuracy rates of 100%, while reducing total cycle counts to complete computations by up to 79.63% compared with the traditional voting methods.

January 24 (Friday), 9:00-10:15

Room B

OS4 AROB: Biomimetic Machines and Robots I

Chair: Keigo Watanabe (Okayama University, Japan)
Co-Chair: Kiyotaka Izumi (Saga University, Japan)

OS4-1 Application of Variational Autoencoder Modeler for Systematically Analyzing Training Process - Its Application to Image Generation and Anomaly Detection -

Zhelin Zheng[1], Fusaomi Nagata[1], Hisami Tamano[2], Hitoshi Nakamura[2], Akimasa Otsuka[1], Hirohisa Kato[3], Keigo Watanabe[4], Maki K. Habib[5], Ahmad Shahrizan Abdul Ghani[6]
([1]Graduate School of Engineering, Sanyo-Onoda City University, Japan)
([2]Mitsubishi Pencil Co. Ltd., Japan)
([3]Department of Mechanical Engineering, Faculty of Engineering, Sanyo-Onoda City University, Japan)
([4]Okayama University, Japan)
([5]The American University in Cairo, Egypt)
([6]Faculty of Manufacturing & Mechatronic Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia)

In this paper, to cope with the need from industrial fields in terms of automatic defect detection, a variational vutoencoder (VAE) modeler is implemented in a MATLAB application to systematically increase the limited number of original images. The VAE modeler is developed for users to help their design, training and test tasks for building VAE models. The VAE modeler provides users to analyze the training process based on (Kullback Leibler divergence) KLD loss and reconstruction loss (MSE loss). In our proposed training method for VAE, the two losses are separately and individually processed and visualized. The effectiveness of the VAE modeler is evaluated through two building processes of VAE models. One is an image augmentation experiment including surface crack defects. The other is the crack-type defect detection experiment.

OS4-2 Hybrid PSO and Its Application to Equilibrium Temperature Search for OTEC Plant Systems

Keigo Watanabe[1], Shilin Yi[2], Kiyotaka Izumi[3], Yasuyuki Ikegami[3]
([1]Okayama University, Japan)
([2]University of South China, China)
([3]Saga University, Japan)

Goto et al. modeled an OTEC system using ammonia as the working fluid in a Rankine cycle, developing a dynamic model with state variables including outlet temperatures and heat exchange amounts at the evaporator and condenser. To enable continuous control simulation, equilibrium temperatures must be computed at each sampling time. This study evaluates methods for achieving this, including iterative methods (bisection and false position), pseudo-gradient methods (secant, Broyden, and Steffensen), a hybrid method (Brent), and population-based optimization methods (real-coded GA and PSO). For PSO, parameters such as inertia weight and acceleration coefficients are time-varying with a nonlinear crossover strategy. Additionally, hybrid approaches are explored, combining iterative (bisection) and pseudo-gradient (Steffensen) methods with probabilistic integration to enhance performance.

January 24 (Friday), 9:00-10:15

OS4-3 Path planning with wireless power transfer system

Kiyotaka Izumi, Yusuke Mouri
(Saga University, Japan)

This paper proposes a new path planning method for mobile robots that selects the optimal path between the shortest path to the goal and the charging path.
The proposed method can be applied to both dynamic and conventional static power supplies, and experiments show that mobile robots can autonomously determine when they need to recharge.

OS4-4 Investigation of Model Characteristics and Convergence Parameter for a Quasi-Continuous Exponential Stabilizing Controller for Four-Wheeled Vehicles Based on a Nonholonomic System

Tomoya Ishii, Shogo Nonaka
(NIT, Tsuyama College, Japan)

In recent years, there has been a growing demand for the automation of articulated vehicles such as trailers. However, the existence of unique inertia problems such as the jackknife phenomenon makes automation very difficult. On the other hand, it is expected that the control theory of non-holonomic systems can be extended to cope with the inertia problems of articulated vehicles. Therefore, we are conducting research with the aim of constructing a control system that incorporates a solution to the inertia problem of articulated vehicles. In this paper, we propose a controller that enables continuous control of a four-wheeled vehicle model. First, we derive a chained form, a modified deviation system, and an invariant manifold from the equation of state of the model. Using these, we construct a quasi-continuous exponential stabilizing controller and confirm its effectiveness through numerical simulations.

OS4-5 Skin model shape generation by incorporating machining error into topology optimization results

Yuma Hino, Fusaomi Nagata, Akimasa Otsuka
(Sanyo-Onoda City University, Japan)

There are various mechanical products in the world, and each of these mechanical products is composed of various parts of various sizes. The shape and weight of mechanical products must be optimized to be high strength with lightweight. However, there are inevitable machine errors in producing the product parts. By introducing the machining errors into topology optimization as shape deviations, robust design of the shape to the machining error can be achieved. In this study, the copper material is machined experimentally using NC wire electrical discharge machine, and the surface of the machined object is measured to check the error characteristic from the ideal shape. Therefore, the measured results of shape deviation due to machining error are incorporated into the ideal shape. This enables more accurate reproduction of machining errors at the design stage, leading to improved quality prediction accuracy during manufacturing.

January 24 (Friday), 9:00-10:30

Room C

OS16 AROB: New Developments in Data Science for Cognition, Design, and Learning

Chair: Shimpei Matsumoto (Hiroshima Institute of Technology, Japan)
Co-Chair: Tomoko Kashima (Kindai University, Japan)

OS16-1 A Study on Improving View Counts of Micro-Events on Social Media - Detecting the Relationship Between Color Schemes and View Counts -

Kayu Morishige[1], Daichi Inoue[2], Shimpei Matsumoto[1]
([1]Hiroshima Institute of Technology, Japan)
([2]R&D Department, D2C Inc., Japan)

This study aims to explore the relationship between the color schemes of promotional images and the view counts on real-world platforms, with the goal of identifying strategies to increase the view counts of micro-events. Clustering and visualization were conducted using k-means and Gaussian Mixture Models (GMM) based on the dominant colors of promotional images and their corresponding view counts. The results provided valuable visual insights; however, they also revealed inadequacies in data preprocessing methods and clustering conditions. This indicates the need for further refinement to enable a more detailed and comprehensive analysis. This research offers valuable insights for the next steps in understanding the relationship between visual elements and view counts more deeply.

OS16-2 Research on discovering common factors behind crowdfunding success - A machine learning approach -

Kazuki Munehisa, Runo Nakabayashi, Tomoya Nishita, Shimpei Matsumoto
(Hiroshima Institute of Technology, Japan)

This study examines the influence of specific words on the success of reward-based crowdfunding projects, providing quantitative evidence to identify desirable words in successful patterns. Leveraging data from 10,000 projects across four major Japanese crowdfunding platforms (CAMPFIRE, Booster, ReadyFor, and Makuake), the study classified and analyzed frequently used words by parts of speech to determine their impact on project success. The research also introduced a model that outperforms prior approaches in explaining the factors contributing to successful fundraising. These findings enhance the understanding of reward-based crowdfunding and offer actionable insights for establishing effective fundraising strategies.

OS16-3 Development of Learning Analytics Methods in Constructive Learning -Achievements in Descriptive and Diagnostic Analysis within the COPS System and Future Challenges-

Natsumi Tanabe, Toshikazu Kiyotaki, Shimpei Matsumoto
(Hiroshima Institute of Technology, Japan)

In modern programming education, constructive learning methods, such as Scratch, provide an intuitive way to assemble program components, reducing cognitive load and improving novices' understanding of algorithms. Tools like the Card Operation-Based Programming Learning Support System (COPS) have proven effective in enhancing algorithmic comprehension. However, challenges remain, such as learners solving problems without deeply engaging with their underlying structure, necessitating early identification and guidance. To address these issues, this study focuses on implementing learning analytics tailored to constructive learning environments. By systematically tackling sub-objectives, including analyzing learning patterns and developing predictive tools, the research aims to enhance the accuracy and effectiveness of learning support systems. This paper presents initial results, highlighting progress toward establishing efficient learning analytics methods for constructive programming education.

January 24 (Friday), 9:00-10:30

OS16-4 Simulation of multilevel evacuation considering various evacuees and verification of the usefulness of information transmission media

Hiroyoshi Matsumoto, Negai Nakamoto, Yusuke Yamauchi, Shimpei Matsumoto
(Hiroshima Institute of Technology, Japan)

This study aims to simulate efficient evacuation strategies within multi-layered structures by leveraging a Multi-Agent System (MAS) that accounts for the diversity of evacuee attributes. Specifically, it compares evacuation times between scenarios where evacuee movement is regulated through a web application and scenarios without such regulation, thereby assessing the application's utility in alleviating congestion. Utilizing the versatility of the SIR model, the research proposes an effective approach to congestion mitigation and seeks to quantitatively evaluate the efficacy of the application designed for this purpose. To achieve this objective, it is necessary to construct a simulation model based on MAS, with a particular emphasis on validating the appropriateness of the variables defined for the agents' behavioral rules. As a preparatory step, introducing a mathematical model-based simulation is indispensable for enabling high-precision analyses. Ultimately, the research aspires to quantitatively assess the effectiveness of the application for congestion mitigation through its design and empirical validation, focusing on the application's capacity to alleviate bottlenecks effectively.

OS16-5 A Study on the Effects and Improvements of UI Design Theory in Product Promotion

Nozomi Fujiwara, Ryouga Yamamoto, Shimpei Matsumoto
(Hiroshima Institute of Technology, Japan)

This study explores how usability improvements in UI design impact learning outcomes and ease of use in educational and smartphone applications. Focusing on proximity, alignment, repetition, and contrast, the research analyzes how these design principles affect information transmission and user engagement using eye-tracking technology. It is divided into three areas: enhancing comprehension and reducing cognitive load in educational slides, improving visibility and usability in smartphone UIs, and examining how visual elements of online marketplace images influence purchasing decisions. The findings aim to guide effective UI design for both educational and digital marketing applications.

OS16-6 Development of a Metaverse World for Regional Resource Promotion and Investigation of the Effectiveness of VR-Based Videos

Kazutoshi Hatsuzaki, Shimpei Matsumoto, Shuichi Yamagishi
(Hiroshima Institute of Technology, Japan)

This study uses VR and the metaverse to promote Hatsukaichi’s cultural assets, including Miyajima woodcraft and an Edo-period farmhouse. 3D models were created via photogrammetry and optimized for VRChat. By engaging youth through immersive digital platforms, this research highlights VR's potential in revitalizing regional communities.

January 24 (Friday), 9:00-10:00

Room D

OS22 AROB: Vehicle and Mobile Robot Technology I

Chair: Kenji Sawada (The University of Electro-Communications, Japan)
Co-Chair: Yuki Minami (Osaka University, Japan)

OS22-1 Visual Quality Enhancement in Robotic Animation Display Systems through PID Controller Tuning

Masahiro Ishikane, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

A multi-agent system is composed of multiple autonomous agents working together to achieve a global goal. As an entertainment application of multi-agent systems, a robot mass game in which multiple small robots draw still images has been investigated. The authors' previous study focused on robot mass games and proposed a method for displaying animation on a group of robots. This paper aims to tune appropriate PID gains for each frame or robot to improve the animation's quality. In this paper, we first proposed a PID gain-tuning method based on Bayesian optimization and Optical Flow. Then, we verified that the proposed method improves animation quality and suppresses unnecessary robots' movement.

OS22-2 Event-Triggered Switching with Self-Triggered Sampling for Discrete-Time Switched Linear Systems

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

With the development of information and communication technology, cyber-physical systems (CPS) have been attracting attention. In this paper, a Lyapunov-based method of event-triggered switching with self-triggered sampling is proposed for switched linear systems. This method enables energy conservation, making it suitable for CPS. A switched system is a dynamical system where the dynamics can be switched by a switching signal (mode). In the proposed method, based on the upper bound of the Lyapunov function, the switching signal and the next sampling time are determined. The advantage of the proposed method is that each subsystem is allowed to be unstable. As a control specification, it is guaranteed that the closed-loop system is uniformly ultimately bounded.

OS22-3 Crosswind Disturbance Compensation by Integrating Disturbance Observer and Vehicle-to-Infrastructure Communication

Kotaro Ishihara, Yuki Minami, Masato Ishikawa
(Osaka University, Japan)

One of the key challenges to improving vehicle safety is to suppress the effects of disturbances, such as crosswinds. This paper focuses on a method of crosswind disturbance compensation using Vehicle-to-Infrastructure(V2I) communication, a technology for communicating information on the road to vehicles. In this paper, we first developed a disturbance compensation method based on the conventional observer and the shaping method called prediction governor. The prediction governor shapes the disturbance estimates using actual information obtained from V2I. Then, the effectiveness of the proposed method was verified via several numerical simulations.

January 24 (Friday), 9:00-10:00

OS22-4 Cost Function Tuning for Ideal Vehicle Motion Planning Considering Motion Sickness

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

In motion planning for autonomous vehicles, Model Predictive Control (MPC) is commonly employed. However, the tuning of MPC cost functions is often performed manually, making it challenging to ensure the optimality of weight parameters. Nevertheless, achieving the most optimal MPC weights is desirable in scenarios such as planning ideal vehicle trajectories for reference in real-world motion planning. In this paper, we build upon our previous research on ideal vehicle motion planning and propose a method to enhance the performance of MPC-based motion planning by optimizing the cost function weights using Bayesian optimization. We compare three objective functions of Bayesian optimization to evaluate the proposed tuning method and investigate the essential elements needed to balance motion sickness suppression with the validity of motion planning.

January 24 (Friday), 9:00-10:30

Room E

GS5 Artificial intelligence V

Chair: Florentin Wörgötter (Georg August University of Göttingen, Germany)

GS5-1 Proposition of Affordance-Driven Environment Recognition Framework Using Symbol Networks in Large Language Models

Kazuma Arii, Satoshi Kurihara
(Keio University, Japan)

In the quest to enable robots to coexist with humans, understanding dynamic situations and selecting appropriate actions based on common sense and affordances are essential. Conventional AI systems face challenges in applying affordance, as it represents implicit knowledge derived from common sense. However, large language models (LLMs) offer new opportunities due to their ability to process extensive human knowledge. This study proposes a method for automatic affordance acquisition by leveraging LLM outputs. The process involves generating text using LLMs, reconstructing the output into a symbol network using morphological and dependency analysis, and calculating affordances based on network distances. Experiments using ``apple'' as an example demonstrated the method's ability to extract context-dependent affordances with high explainability. The results suggest that the proposed symbol network, reconstructed from LLM outputs, enables robots to interpret affordances effectively, thereby bridging the gap between symbolized data and human-like situational understanding.

GS5-2 HomoFusion: Homogenous Multi-modal Feature Fusion for Multi-view 3D Object Detection

Weixin Mao, Osamu Yoshie
(Waseda University, Japan)

Fusing camera and LiDAR information is pivotal for enhancing 3D perceptual capabilities. Many advanced techniques currently focus on merging image and point cloud features within the Bird's-Eye-View (BEV) space. However, this approach tends to neglect the substantial differences and the shallow-layer information existing between the two modalities. In response to this, we propose a homogenous framework, named HomoFusion, for the fusion of image features and point cloud features. We have designed a point cloud branch that mirrors the structure of the image branch, which aids in the extraction of point cloud features and reduces the gap between the two modalities. Additionally, leveraging their shared structure, we have developed a shallow feature fusion that serves to further enhance model performance.

January 24 (Friday), 9:00-10:30

GS5-3 Creating a Plant Disease Identification Application Using Yolo

Kanta Omori[1], Eigo Hirao[1], Tomohiro Morizane[2], Takehide Nakagawa[3], Hiroaki Niwa[4], Masamoto Tafu[1], Ryuichi Matoba[1]
([1]National Institute of Technology, Toyama, Japan)
([2]TOYAMA SHOJI CO.,LTD, Japan)
([3]Yatsuo Kogyo Co., Ltd, Japan)
([4]Hokuetsu acetylene Co., Ltd, Japan)

This study develops a smartphone-based application for plant disease detection using YOLOv5, offering a practical and user-friendly alternative to complex setups like Google Colaboratory. The app identifies diseases in real-time and provides detailed information, including treatment recommendations. Initially tested with crapia, the project shifted to maize due to its rapid growth and abundant disease data. Corn plants are cultivated under controlled conditions to generate diverse data for model training. The app processes images via a Python server and returns results within two seconds. While initial accuracy was low due to limited datasets, the system operated smoothly. Ongoing data collection aims to enhance model precision. Future improvements include optimized dataset loading, enhanced disease cause analysis, and expanded functionality. This application seeks to empower farmers and gardeners by simplifying disease detection and improving plant health management.

GS5-4 Improved Smart House System For Elderly People Living Alone Based on Sensor Fusion

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

With the rise in elderly people living alone, safety concerns have increased due to delayed rescue times in emergencies. To address this, we developed a smart house system using cameras and PIR sensors to monitor behavior and alert families of potential emergencies. The system, described in the AROB2024 journal, tracked movements, identified visitors, and monitored indoor activities. However, limitations included errors in detecting multiple people and delays in emergency response when relying solely on PIR sensors. Privacy concerns with cameras also arose. To improve, we made three key updates: 1) Enhanced image recognition with IoU for better accuracy with multiple people; 2) Integrated PIR sensors and cameras for improved movement detection and privacy protection; 3) Introduced flexible emergency logic, switching between sensor modes. These improvements led to a more reliable and effective smart house system for elderly safety.

GS5-5 CLAHE-based fusion filter image preprocessing for enhancing YOLOv8l accuracy in autonomous driving

Fangjun Liu, Yutoku Takahashi, Jun Yoneyama
(Aoyama Gakuin University, Japan)

In recent years, the technology related to automatic driving has become the focus of attention, and the deep learning framework led by YOLO plays an important role in the field of fast obstacle recognition. However, due to various weather and road conditions, images with a lot of noise affect the effect of deep learning training models to a certain extent. Therefore, this study focuses on the pre-processing in the deep learning training process and proposes a new fusion filter based on the MOCS algorithm and the fusion of CLAHE and median filter. The results of this study show that the images processed by the fusion filter exhibit sharp color contrasts and the blocking of the objects, and this feature improves the evaluation indexes related to the YOLOv8l model. The data results show that compared to the model without pre-processing and the model with the single median filter the map 50, precision, and recall values are improved

January 24 (Friday), 9:00-10:30

GS5-6 Adaptive AI for Multiplayer Games: Using Swarm Intelligence and Reinforcement Learning with Behavior Tree

Valeriya Sergeyeva, Almaskhan Baimyshev
(Kazakh British Technical University, Kazakhstan)

We propose presenting our research on a hybrid approach of behavior trees with machine learning for artificial intelligence in a multiplayer game bot that can operate independently and in collaboration with other bots in real-time." Traditional bots also need help making complex decisions, especially in changing environments, limiting them to simple tasks. Additionally, some AI bots need help finding the best routes, often getting stuck or taking longer paths, which makes them less efficient. When faced with many enemies or obstacles, traditional bots often need help to respond effectively and are unable to adapt to increased difficulty or more challenging conditions. These problems highlight the need for more advanced AI approaches to make bots more responsive, adaptable, and efficient. For each agent's artificial intelligence, we use a combination of behavior trees for basic movement or positioning in cover and reinforcement learning to adapt behavior strategies in a changing game environment. This approach is predictable in its logic, with movement or inactivity set by a rule-based system while also being flexible in adapting to surrounding conditions. We added swarm intelligence to help agents work together. Ant colony optimization lets agents share information about enemy locations, safe paths, and available resources in real-time. With this shared information, agents can act as a team to complete tasks like finding the best routes, scouting areas, tracking enemies, or taking on roles as scouts or guards. This teamwork approach makes bots more efficient and creates a more exciting player experience. We tested our system with a game prototype built in Unity to see how well the agents worked together in different situations. The prototype allowed us to measure important results, like the average and best time to complete a level and amount of damage how much damage by comparing setups with one agent and multiple agents. Outside of gaming, this research can be useful in other areas where groups of agents need to work independently in changing environments. Our research has applications beyond gaming in fields where groups of agents need to operate independently in changing environments. For instance, in swarm robotics, similar methods could help drones coordinate in real-time for tasks like search and rescue or surveillance. In fleets of autonomous vehicles, collaboration between agents can improve route planning, traffic management, and group decision-making. This research demonstrates the potential of a hybrid AI system combining behavior trees, reinforcement learning, and swarm intelligence principles. Such a system makes both individual agents and the entire AI team more adaptable and effective in multiplayer games. By adding real-time teamwork inspired by swarm behavior, NPCs become more responsive, intelligent, and engaging for players.

January 24 (Friday), 9:00-10:45

Room F

GS19 & GS20 Identification and estimation I & II

Chair: Takehito Kikuchi (Oita University, Japan)

GS19-1 Identification of Mixed Plastics Using Optical Properties and Smart Glasses

Naru Tsuritani[1], Takeru Ito[1], Hyuga Yokohori[1], Shuntaro Mori[2], Masamoto Tafu[1], Ryuichi Matoba[1]
([1]National Institute of Technology, Toyama College, Japan)
([2]Toko Metal Co., Ltd., Japan)

Polyvinyl chloride (PVC) is challenging to remove from waste due to its visual similarity to other plastics, and its combustion produces toxic substances. This study aims to develop a smart glasses system to highlight PVC for manual extraction. Using near-infrared light, we measured the reflectance of five plastics (PVC, PP, PS, PET, acrylic) at wavelengths of 1000 nm, 1150 nm, 1200 nm, and 1400 nm. Results showed PVC has a reflectance >0.02 and unique changes in reflectance at 1200 nm and 1400 nm compared to 1000 nm and 1150 nm. These findings support creating a machine learning database to identify PVC using spectral characteristics. This technology will enable real-time PVC detection with smart glasses.

January 24 (Friday), 9:00-10:45

GS19-2 Heart Rate Variability Analysis for Stress Induced with Cybersickness in Virtual Reality Environments

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

Stress induction methods have been developed in order to provide experimental protocols and rules to acquire physiological data for stress evaluation and analysis. Mental stress can be recognized as an accompanying response of motion sickness induced by virtual reality (VR) contents. Recently, VR contents of space traveling have been applied in the previous research, attempting to induce cybersickness in subjects and the consequent mental stress responses. Since the VR contents have only 60 sec. in length, the heart rate variability (HRV) data are short and traditional HRV indices are not proper for data analysis. Alternatively, short-term HRV analysis, which is based on evaluation window length shorter than 60 sec., is required to investigate relationship between variations of stress levels and the corresponding VR contents. This paper utilized five evaluation indices to achieve short-term HRV analysis using window length less than 30 sec.

GS19-3 Robust Pig Extraction Using Ground Base Depth Images for Automatic Weight Estimation

Khin Dagon Win[1], Kikuhito Kawasue[1], Tadaaki Tokunaga[2]
([1]Faculty of Engineering, University of Miyazaki, Japan)
([2]Faculty of Agriculture, University of Miyazaki, Japan)

Dark colored pigs (Berkshire and Duroc etc.) are widely recognized nationwide in Japan for their exceptional taste, with the southern Kyushu region being a renowned production area for these esteemed breeds. However, estimating the weight of these pigs using a camera presents a unique challenge. The key process in a camera-based weight estimation system is the precise extraction of the target pig from the background. Typically, cameras capture images from above, as the top-view images provides the most specific growth indicators. However, the image from above contains a ground image. Since Berkshire and Duroc pigs are black and red respectively, they blend into the ground, making it difficult to accurately segment the pigs in the images. Thus, it is crucial to perfectly distinguish between the ground and the pigs. Therefore, a new extraction method is proposed to distinguish between the ground and pigs by converting depth data based on the pig's position. To enhance the efficiency of pig farming and alleviate the burden on workers, our goal is to develop a system that automatically measures the weight of Berkshire pigs for shipment without background interference. In this study, we installed the system at a Berkshire pig farm and demonstrated the effectiveness of this innovative extraction method for camera-based weight estimation.

GS19-4 A Stress Detection Model from Multimodal Physiological Signals Using LightGBM

Kota Sakaguchi, Takuto Sakuma, Shohei Kato
(Nagoya Institute of Technology, Japan)

This study proposes a machine learning model to detect stress using physiological signals collected by smartwatches, offering a more objective alternative to traditional self-administered questionnaires like BJSQ. Using the WESAD dataset, which contains Empatica E4 measurements from 15 participants under different conditions, we analyzed Electrodermal Activity (EDA) and Blood Volume Pulse (BVP) signals. Using a sliding window approach, we extracted 116-dimensional features from 120second segments and classified stress using LightGBM with Optuna for hyperparameter optimization. Half of the features were selected based on the feature importance. The model achieved comparable performance to BJSQ (sensitivity: 0.84 vs. 0.90, specificity: 0.86 vs. 0.86), demonstrating its effectiveness in objective stress detection. The most important features included short-term (SCR) and long-term (SCL, RR interval, pNN25) stress indicators.

January 24 (Friday), 9:00-10:45

GS20-1 Detecting Medication-Taking Motions from Smartwatch Accelerometer Data Using Deep Learning with Topological Data Analysis

Yuki Takekoshi[1], Akira Masuo[2], Takuto Sakuma[1], Shohei Kato[1]
([1]Nagoya Institute of Technology, Japan)
([2]Seijoh University, Japan)

Medication adherence is crucial for effective treatment, yet poor adherence causes complications, increased costs, and delays in the treatment of patients. In recent years, various technological approaches to medication management have been studied to improve adherence. Existing methods, such as using multiple accelerometers or detecting medication-taking motion including unrelated motions (e.g., smoking, jogging), limit practicality. Considering these issues, we analyzed accelerometer data from a smartwatch worn on a single wrist, focusing on motions highly related to medication taking. Ten participants (mean age 22.0 years) wore an AppleWatch on their dominant wrist, and triaxial accelerometer data were collected at a sampling frequency of 20 Hz for four labeled motions: taking medication, eating, drinking water, and brushing teeth. We compared four models to classify these motions. The first, the LSTM Model, utilizes the final hidden state of an LSTM network to capture long-term dependencies in the time-series data. The second, the LSTM-TDA Integration Model, combines the final hidden state of the LSTM network with topological features extracted using TDA. In the third, the LSTM-TDA Boosting Model, the outputs from the LSTM-based classifier and an SVM trained on TDA features are independently obtained and subsequently aggregated by averaging their class probabilities. Finally, the LSTM-TDA Stacking Model first calculates class probabilities using the LSTM network and then concatenates these probabilities with the topological features, which are used as input for an SVM to perform the final classification. Input sequences were 6.4 seconds (128 points), with 10-dimensional topological features (Betti numbers, birth-death pairs) extracted via persistent homology. The LSTM-TDA Integration Model achieved the highest F1 score (0.74), suggesting its feasibility for detecting medication-taking motions from smartwatch accelerometer data. In addition, these results suggest the effectiveness of TDA for identifying specific motion patterns.

GS20-2 Proposal of Echography Support System for Breast Cancer Screening with Image-based Localization of Probe

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

Breast cancer screening using echography faces challenges due to the dependency on examiner skill and the difficulty in ensuring complete breast coverage. To address these issues, we proposed a system combining a motion sensor with echography processing, aiming to confirm full area scanning with visual feedback. The study evaluated the motion detection capabilities of template matching and optical flow methods. Using an electronic linear-class echo probe, B-mode ultrasound images were captured during transverse and back-and-forth scans of a subject's abdomen. Preprocessing included grayscale transformation and noise reduction with median filtering. Optical motion captures provided reference data. Results suggest that the combination of template matching and optical flow have potential to classify transvers and back-and-forth motions of the echo probe.

January 24 (Friday), 9:00-10:45

GS20-3 Development and Evaluation of a Portable Crowd-Estimation System using Wi-Fi

Ryoma Toyomi[1], Atsuo Ozaki[2]
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([2]Department of Computer Science, Osaka Institute of Technology, Japan)

The real-time monitoring of crowd size is essential for accurate and efficient evacuation guidance and other disaster response efforts in large-scale events. Hence, we developed a portable and cost-effective crowd monitoring system with environmentally friendly features, including waterproofing and dustproofing, using Wi-Fi technology. This system can cope with media access control (MAC) address randomization in detected Wi-Fi devices to enhance headcount detection accuracy. To assess the precision of this method in crowd size estimation, we conducted comparative experiments at the large-scale event “Gorokuichi” in 2021 and 2022. The mean absolute percentage error was 5.86% in 2021 and 8.56% in 2022, demonstrating high consistency, with correlations exceeding 80% between the estimated numbers and human observer counts (true values), thus confirming the effectiveness of our system.

January 24 (Friday), 10:45-11:45

Room A

OS3 AROB: Bio-inspired theory and applications (2)

Chair: Kunihito Yamamori (University of Miyazaki, Japan)
Co-Chair: Hisaaki Yamaba (University of Miyazaki, Japan)

OS3-1 Interior layout image generation by the combination of GrabCut and Large-mask inpainting algorithm with 3D furniture models

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

AR (Augmented Reality) technology enables seamless integration of virtual 3D objects into real-world scenes. An interior coordination system allows users to arrange 3D furniture models freely. When new furniture overlaps existing objects, the system must erase the object, restore the background, and harmonize the scene. However, AR images often feel unnatural due to incomplete object removal, background restoration, and color inconsistencies. Our method addresses these issues using GrabCut for object erasing, LAMA for background restoration, and a diffusion model for blending objects with their surroundings. We evaluate the synthesized images using BRISQUE, a no-reference image quality assessment metric and gather user feedback through questionnaires to assess perceptual quality.

January 24 (Friday), 10:45-11:45

OS3-2 An approach for driving manner improvement by a gamepad-controlled driving simulator

Kotaro SHIIKI[1], Shuta YAMANE[1], Kunihiko YAMAMORI[2]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Faculty of Engineering, University of Miyazaki, Japan)

While serious accidents have significantly reduced, minor accidents remain still. To reduce minor accidents, we must review our daily driving habits. One solution is driving simulators, which can reproduce various conditions like weather, time, and traffic jams. Although simulators are commonly used in Japanese driving license schools to train for dangerous situations, they often do not focus on minor traffic violations. To fill this gap, we developed a PC-based driving simulator that can detect minor traffic rule violations using a gaming device for casual use. The simulator includes some tutorial missions and an evaluation mission. A questionnaire survey was conducted with eight subjects to evaluate the developed simulator. As a result, all subjects improved their driving awareness. However, there are problems such as difficulty in operating the gamepad.

OS3-3 An active listening and responding system with empathy enhancing filter using ChatGPT

Daisuke AMAKI[1], Shuta YAMANE[1], Kunihito YAMAMORI[2]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Faculty of Engineering, University of Miyazaki, Japan)

Modern society is stressful for us, and it causes us private, hidden mental troubles. This is why AI counseling is expected because it accepts problems and reduces the embarrassment of talking. The active listening and responding approach is a popular technique for counseling. In this approach, the counselors put effort into empathizing with the person having mental trouble without denials. In this research, we try to implement and evaluate an AI-based active listening and response system. We propose combining a chatbot such as ChatGPT with a novel empathy enhancing filter for this objective. Active listening and responding systems should return the same emotional response as the user, and the empathy enhancing filter derives such a response from the AI. The evaluation results of the proposed system successfully selected the appropriate response for the emotion “proud” but sometimes chose inappropriate sentences for other emotions.

OS3-4 Constaria: a chatbot for long-term consistent conversation

Shuta Yamane[1], Daisuke Amaki[1], Kunihito Yamamori[2]
([1]Graduate School of Engineering, University of Miyazaki, Japan)
([2]Faculty of Engineering, University of Miyazaki, Japan)

In 2022, the research on LLM will arrive at a goal; the name is ChatGPT. ChatGPT can understand the context of the conversation and generate appropriate responses based on the preceding conversation. However, LLM occasionally generate inconsistent responses far from the previous conversations. In this study, we developed a chatbot, Constaria, that responds consistently to the previous conversation history. We compared the following three methods: (1) sending a full conversation history to ChatGPT, (2) the same as the previous works, and (3) our proposed method. The experiments showed that our method successfully achieved the highest average score for the evaluation questionnaire. These results suggested that our method could successfully take consistent answers out from ChatGPT. This will give us a better user experience and also bring trusted AI in the near future.

January 24 (Friday), 10:45-11:45

Room B

OS5 AROB: Biomimetic Machines and Robots II

Chair: Keigo Watanabe (Okayama University, Japan)
Co-Chair: Kiyotaka Izumi (Saga University, Japan)

OS5-1 Evaluation of Anomaly Monitoring System for Numerical Control Machine Tools Using Neural Networks

Tomoaki Morimoto[1], Fusaomi Nagata[2], Takamasa Kusano[3], Hisami Tamano[4], Hitoshi Nakamura[4], Keigo Watanabe[5], Maki K. Habib[6]
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([3]SOLIC Co. Ltd., Japan)
([4]Mitsubishi Pencil Co. Ltd., Japan)
([5]Okayama University, Japan)
([6]The American University in Cairo, Egypt)

The authors have been developing a design, training and building application with a user-friendly operation interface for convolutional neural network (CNN), convolutional autoencoder (CAE), support vector machine (SVM), YOLO, fully convolutional network (FCN), fully convolutional data description (FCDD) and so on, which can be applied to the defect detection of various kinds of industrial products even without deep skills and knowledges concerning information technology. In those models, images are basically used for training data. In this paper, intelligent anomaly diagnosis system for numerical control (NC) machine tools is considered, i.e., what structures of neural networks should be applied. Mechanical sound and vibration generated from a machine tool itself or machining sound and vibration generated from a router bit, i.e., end mill cutter is recorded and used for training data. For experimental evaluation, nine kinds of mechanical sounds are collected from several machine tools, and then training datasets consisting of sound blocks are prepared. Each sound block is time series data extracted from WAVE (Waveform Audio File Format) files (.wav). For example, if a WAVE file is recorded with a sampling rate 44100 [Hz] and an extracted time for forming a sound block is set to 0.005 [s], then the data length of the sound block becomes 220. The extracted sound blocks from a WAVE file are employed for training three types of NN models. As for the NN models for comparison, conventional shallow NN, RNN and 1D CNN are designed and trained. Classification results of test sound blocks by the three models are shown. Furthermore, an autoencoder is designed and considered for anomaly detection by training it using only normal sound blocks of a machine tool.

OS5-2 On the Hysteretic Control of the Posterior Joint of Fish Robot

Naoki Kimura, Ivan Tanev, Tatsuaki Kimura
(Doshisha University, Japan)

Currently, propellers are predominantly used for the propulsion of autonomous underwater vehicles (AUV). However, the propeller-driven AUV are inferior to the nature-inspired AUV as they feature a lower energy efficiency and poorer environmental friendliness due to higher cavitation, vibrations, noise, and wake. In our study we consider a fish robot – a special case of a nature-inspired AUV – and, especially, an approach of improving both the energy efficiency and speed of its locomotion by hysteretic control of undulation of its posterior joint. The approach is based on the dynamic lift theory of fish locomotion, in which the moving tail fin – due to the its angle of attack – produces a lift (thrust) and a drag during the two consecutive phases of undulation – thrusting and braking. The proposed hysteretic control is intended – by altering the angle of attack of the moving posterior fin – to shift favorably the balance between the thrust and the drag generated by the fin. The experimental results verified that for a frequency of undulation 0.8 Hz, compared to the canonical harmonic control, the proposed hysteretic control yields a maximum improvement of both the speed and energy efficiency of more than 1.4 times.

January 24 (Friday), 10:45-11:45

OS5-3 Three-dimensional Flow Structures of Fish-School-Inspired Piezoelectric Fans in a Rectangular Housing

Naoki Mizumoto[1], Kazunori Hosotani[1], Yoichi Ogata[2]
([1]National Institute of Technology, Tsuyama College, Japan)
([2]Hiroshima University, Japan)

The tail fin propulsion mechanism of schooling fish increases propulsion efficiency and generates jet-like flows and branching wake patterns. Inspired by this phenomenon, the flow patterns generated by piezoelectric fans (PE fans) with oscillating resin plates arranged in a staggered pattern on the floor were experimentally investigated. The results confirmed the characteristics of these fans, which can be either jet or branching flow along the floor, with slight adjustment of the fan spacing. However, when this fan unit was contained within a narrow enclosure, the development of a wake flow was suppressed, suggesting a three-dimensional complex flow pattern was observed. In this study, the three-dimensional structure of the flow produced by the fan unit was understood using a hot-wire anemometer traversed by an arm robot.

OS5-4 Proposal of Shoe Sole to Promote Standing Stabilization on Uneven Terrain for Lower Limb Prosthesis Users

Kyusei Shimoma, Takehito Kikuchi
(Faculty of Science and Technology, Oita University, Japan)

Many commercially available prosthetic feet possess only plantar flexion and dorsiflexion, making it difficult for users to walk or stand on uneven terrain. This study aims to develop shoe soles with inversion and eversion functions to assist prosthesis users in standing stably on such terrain. This report describes the mechanism of a prosthetic shoe sole, the manufacturing process of fluid cells used in its development, as well as an evaluation of their mechanical properties. The shoe sole consists of tubes, a non-return valve, a flexible pillar, a heel section, and two fluid bags. Each bag consists of four fluid cells with a dual structure of silicone and an inner mold made from Thermoplastic Polyurethane Urethane. Based on compression test results, we conclude a fluid cell with an inner thickness of 1.5 mm and water as the internal fluid is the most suitable option for developing the shoe sole.

January 24 (Friday), 10:45-12:00

Room C

OS1 AROB: Advanced AI Applications and Robotics

Chair: Kiyota Hashimoto (Shunan University, Japan)
Co-Chair: Hidekazu Yanagimoto (Osaka Metropolitan University, Japan)

OS1-1 CSI-based Change Detection Using Anomaly Detection

Teppei Otsuki[1], Hidekazu Yanagimoto[1], Kiyota Hashimoto[2]
([1]Osaka Metropolitan University, Japan)
([2]Shunan University, Japan)

In this paper, we propose a method for detecting state changes using anomaly detection with Channel State Information (CSI). In existing research on environment sensing with CSI due to influence of the target and surrounding environment on CSI, we require extensive observations to construct classifier based on their observation area. However, it is impractical to anticipate and observe all possible states in advance, especially rare scenarios that are difficult to predict comprehensively. To address this issue, we aim to detect environment changes by using the concept of anomaly detection, distinguishing between normal and anormal states. Collecting data for normal states is feasible and does not require adding labels or supervisory signals to individual data points, reducing the associated burden. Based on this idea, we propose a method using anomaly detection.

January 24 (Friday), 10:45-12:00

OS1-2 Scene-Focused Video Caption Generation

Sorato Nakamura[1], Hidekazu Yanagimoto[1], Kiyota Hashimoto[2]
([1]Osaka Metropolitan University, Japan)
([2]Shunan University, Japan)

In this paper, we propose a method for generating video captions based on user-specified scenes. Current large language models, such as ChatGPT, are capable of handling multimodal information, including text, image, and videos. However, these methods primarily generate captions considering the entire image or video, making it challenging to create captions based on specific objects or scenes without interpreting images or videos and expressing them as prompts. To address this issue, our research aims to generate captions tailored to specific scenes by providing sequences of frames automatically extracted as characteristic scenes during video analysis. Specifically, we build the system using a Transformer-based architecture. For evaluation, we conduct experiments using datasets where videos are annotated with multiple captions and corresponding frames.

OS1-3 CSI-based Position Estimation Using Transformers

Hidekazu Yanagimoto[1], Kiyota Hashimoto[2]
([1]Osaka Metropolitan University, Japan)
([2]Shunan University, Japan)

This paper proposes an indoor position estimation system using Channel State Information (CSI) and Transformer models. Conventional approaches primarily rely on statistical machine learning methods or deep learning models like Convolutional Neural Network (CNNs). However, the latest deep learning technique, Transformers, has not been extensively applied in this domain. Specifically, the proposed system employs a Transformer encoder to extract the features necessary for position estimation from observed CSI data. Through evaluation experiments, the effectiveness of the proposed method has been validated.

OS1-4 A Survey of First-Year University Students on Their Use of Generative AI and Their Expectations of an AI Student Advisory Service

Tetsuya Sakai, Keiji Tabuchi
(Shunan University, Japan)

This study investigates the usage patterns and expectations of first-year university students regarding generative AI, particularly for AI student advisory services. A survey of 84 computer science students revealed that 83 had prior experience with generative AI, with variations in adoption timing and frequency. Early adopters, especially those using AI before university, tended to engage daily, emphasizing the impact of early exposure on usage habits. Generative AI was primarily used for programming support, research, and improving learning efficiency. This highlights its versatility. Students highlighted expectations for academic chatbots, such as continuous availability and reliable information, though satisfaction varied with usage frequency. Challenges like information reliability and ethical concerns were notable barriers. Using the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), this study identifies critical factors influencing generative AI adoption and provides recommendations for developing effective AI-driven educational tools.

January 24 (Friday), 10:45-12:00

OS1-5 A Preliminary Study on Immersion Levels in Various Work Processes for Collaboration between Remote Operators and Semi-Autonomous Robots

Takumi Kawamura[1,4], Toru Mizuya[2], Kenichi Abe[2], Kiyoshi Asakawa[3], Rina Ishiwata[4], Takenobu Inoue[4]
([1]Shunan University, Japan)
([2]Kanagawa Institute of Industrial Science and Technology, Japan)
([3]Hosei University, Japan)
([4]Research Institute of National Rehabilitation Center for Persons with Disabilities, Japan)

This study explores how semi-autonomous robots can take over specific processes to enhance collaborative tasks from the subjective perspective of human operators. Because excessive automation might affect operator satisfaction or accomplishment, this study focuses on Flow theory and evaluates the immersion level of teleoperation. The immersion level is a key component of satisfaction and accomplishment. Simultaneously, operators in the Flow state can achieve higher performance. We analyzed the evaluation results of ten operators' subjective experiences and performance in an experiment involving four processes within pick-and-place tasks. The analysis indicated that operators perceived more difficult processes as relatively more immersive. Moreover, this study identified a process that balances immersion level and efficiency. These results indicate that we can identify the processes that benefit more from active human engagement. Adjusting the operator's role in balancing immersion levels and potential efficiency could help determine the optimal role distribution between humans and semi-autonomous robots.

January 24 (Friday), 10:45-11:45

Room D

OS23 AROB: Vehicle and Mobile Robot Technology II

Chair: Kenji Sawada (The University of Electro-Communications, Japan)
Co-Chair: Yuki Minami (Osaka University, Japan)

OS23-1 On the Enforcement for Structural Opacity of Dual Control Systems

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

In this research, we propose a method to evaluate the vulnerability of dual control systems to communication eavesdropping and to enforce opacity. The authors abstractly model the dual control system using Petri nets and define the secret information that defines the structural opacity. Furthermore, we propose a method to derive the information region that can be estimated by an attacker by using P-invariants (Place-Invariants), which is a numerical property unique to Petri nets. In addition, we devise an approach for enforcing structural opacity, and apply and verify our method on a sample asymmetric dual control system. Through this, we discuss the effectiveness of the structural opacity analysis and its forcing method.

January 24 (Friday), 10:45-11:45

OS23-2 Consideration of a Security Training Program for Industrial Control Systems based on the TCP/IP Communication Model

Masatoshi Enomoto[1], Shu Hosokawa[2], Kenji Sawada[3]
([1]Yokohama College of Commerce, Japan)
([2]Seisho PWB Design Office, Japan)
([3]The University of Electro-Communications, Japan)

The educational program proposed in this paper provides basic training for initial security measures for industrial control systems. To implement this basic training, the proposed educational program provides basic security training for control users focusing on control communication. This program consists of three parts: an educational scenario, a control communication load program, and an educational kit. The educational kit is provided using open devices such as the Raspberry Pi and OpenPLC, and aims to be developed at a low cost so that individuals can perform hands-on training. By focusing the scope of the training on the TCP/IP communication model, we aim to lower the threshold for understanding cyber security issues in industrial control systems. In this paper, we examine the requirements definition and design of the training program, and report on the content of the training program, which has been partially implemented. In the future, we plan to complete the training program and verify its effectiveness.

OS23-3 On generalized intelligent PID control for a class of non-minimum phase systems

Tomoki Takeda, Osamu Kaneko
(The University of Electro-Communications, Japan)

This paper addresses the stability problem of intelligent Proportional-Integral-Derivative (i-PID) control in non-minimum phase systems. The i-PID control system features a simple structure that retains the advantages of PID controllers in the sense that it is easy to understand the effects of tuning parameters. Moreover, the closed-loop system can be stabilized by designing control parameters without information of the plant except the relative degrees. Following the introduction of i-PID controllers, there have been significant research in this area, resulting in various successful applications. However, for linear non-minimum phase systems, there are few studies, and thus the plants to be applied that can be stabilized are restricted. To tackle this problem, this paper proposes a generalized intelligent Proportional-Integral-Derivative control system as a model-free approach for non-minimum phase systems. Theoretical analysis demonstrates that the proposed method can stabilize the closed-loop system for a wider range of controlled plants compared to i-PID systems. A simulation study is provided to verify the effectiveness of the proposed method.

OS23-4 Data informative approach for integral typed servo system with state feedback

Takeyuki Sueyoshi, Osamu Kaneko
(The University of Electro-Communications, Japan)

The data-driven control approach, which focuses on controller tuning and design using data, has been gaining significant attention. Data-driven control does not rely on explicit models, making it particularly appealing in situations where system identification is challenging or where real-world data collected during system operation can be directly used for controller design and updates. Moreover, it addresses the motivation to leverage the information in data, which might otherwise be lost during model identification, and directly incorporate it into control system design. Among these approaches, the framework of data informativity has been proposed. This framework utilizes matrices formed directly from the input-output or state data of the control system to establish sufficient or necessary conditions under which a controller exists that achieves a specific control objective for all systems consistent with the data. In this paper, we propose a method for designing an integral-type servo system using data informativity based on data informativity with state feedback.

January 24 (Friday), 10:45-12:00

Room E

GS25 Mobile robots I

Chair: Norimitsu Sakagami (Ryukoku University, Japan)

GS25-1 Mapless Navigation of Mobile Robots Based on Enhanced Soft Actor-Critic Model

Shanshan Wang, Xiaohan Du, Kenji Hashimoto
(Waseda University, Japan)

This study proposes an enhanced soft actor-critic(SAC) algorithm RSAC for LiDAR-based mapless navigation in complex environments. Mapless navigation is crucial for autonomous robots, which require effective exploration and obstacle avoidance. RSAC combines residual network connection(ResNet) and gradient clipping to solve the problem of instability and inefficient feature extraction in deep reinforcement learning. In this study, training is performed in a simulation environment and compared with other methods. By balanced exploration and utilization, RSAC overcomes the local optimum problem and achieves efficient environment exploration and optimal path planning, which is well suited for navigation in uncertain environments.

GS25-2 Quantification of abstract features and environment map generation using multimodal language models

Kyoya Furukawa, Kenta Tabata, Renato Miyagusuku, Koichi Ozaki
(Utsunomiya University, Japan)

In this study, we introduce a method for constructing environmental maps by utilizing a multimodal language model (MLLM) to quantify abstract features such as congestion levels and indoor/outdoor conditions from images captured by a robot equipped with cameras and sensors. These quantified features are combined with self-positioning data and processed using Gaussian process regression, with a radial basis function kernel and optimized hyperparameters, to create continuous grid maps that represent detailed environmental contexts. The results demonstrate that robots can effectively interpret and represent abstract features, enabling more advanced scene understanding and human-like decision-making in autonomous navigation tasks. Future research will explore real-time processing, integration of additional features such as noise levels and human activity, and the application of these maps in practical navigation scenarios, such as route optimization and congestion avoidance.

GS25-3 Design of a new jumping rescue robot and experimental evaluation

Ayako Katayama[1], Jehun Seo[2], Yoshiaki Yamazaki[3]
([1]Graduate School of Science and Engineering, Meisei University, Japan)
([2]Meisei University, Japan)

Search and rescue operations during an earthquake disaster must find victims at the site of collapsed buildings and debris. Crawler-type traveling robots, which have been actively developed for rescue robots, have high performance in running over rough terrain, but have difficulty entering narrow spaces. Therefore, this study attempted to develop a small jumping robot that could be useful for entering narrow areas with uneven terrain and scattered obstacles. The jumping robots in the previous literature examined were primarily studied to improve jumping height. We thought that by adding a function to check the surrounding environment with a camera and adjust the direction of flight, it would be possible to perform rescue activities with a jumping robot by remote control. This paper describes the results of designing and evaluating a new jumping robot that can be adapted to rescue robots with reference to previous studies.

January 24 (Friday), 10:45-12:00

GS25-4 Development of a Four-Legged Soft Robot with Wave-Like Locomotion

Tomoya Inagaki, Kazuyuki Ito
(Hosei University, Japan)

In recent years, soft robots made of flexible materials, such as silicone rubber have attracted significant attention because of their ability to interact with and adapt to their environment by mimicking the behavior of living organisms. The wave-like locomotion of caterpillars is one such example, providing a simple and effective locomotion strategy that requires minimal control while adapting to diverse terrains through wave propagation. This study focused on wave-like motion to develop a mobility system that utilizes the flexibility of soft robots. This study aims to verify the potential of soft robots and demonstrate the effectiveness of using the wavy motion of the legs as a mobility mechanism. The robot was developed and tested to move on flat surfaces, small stones, and obstacles. It was found to move at a speed of 0.9 cm/s on flat surfaces and was able to overcome steps.

GS25-5 Experiments on obstacle avoidance of AMR with Control Barrier Function using quasi-saturation function

Takeru Ishihara[1], Satoshi Ueki[2], Takahiro Ikeda[2], Hironao Yamada[2]
([1]Graduate School of Natural Science and Technology, Gifu University, Japan)
([2]Department of Mechanical Engineering, Gifu University, Japan)

The paper discusses the need for robotics in changing factory layouts and the development of autonomous mobile robots (AMRs) that can work safely with humans in complex environments. Unlike traditional Automated Guided Vehicles (AGVs), AMRs offer greater flexibility in dynamic factory layouts but require robust control mechanisms to navigate safely in human-robot collaborative environments. Our previous paper proposed a “Safety controller based on control barrier functions using Quasi saturation function". This CBF does not reduce the degree of freedom of movement while ensuring safety and has been verified by simulation. This paper verifies the application of Control Barrier Functions (CBFs) as a safety-critical control strategy for AMRs to prevent collisions and maintain operational safety through experiments.

January 24 (Friday), 13:00-14:45

Room A

OS24 ISBC: Collective Intelligence and Individual Emergence in Biological and Artificial Systems

Chair: Michael Crosscombe (The University of Tokyo, Japan)
Co-Chair: Norihiro Maruyama (The University of Tokyo, Japan)

OS24-1 scRNA-seq reveals subpopulations responsible for distinct carbohydrate metabolic pathways in Tetrahymena thermophila population

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

We have previously cultured Tetrahymena from a single cell and analyzed their motility and division time, finding that these characteristics vary significantly between individual cells. To investigate the underlying differences in gene expression, we conducted single-cell RNA sequencing (scRNA-seq). This study revealed the presence of distinct subpopulations, particularly differing in carbohydrate metabolism. The differences in carbohydrate metabolism may explain the variation in growth rates. Furthermore, extracellular metabolite analysis demonstrated that malate and/or succinate were secreted, suggesting the potential contribution of these metabolites to intercellular interactions.

OS24-2 Quantifying Ant Colony Dynamics and Role Transmission Using Information Theory and Gromov-Wasserstein Optimal Transport

Ilya Horiguchi, Michael Crosscombe, Shigeto Dobata, Takashi Ikegami
(The University of Tokyo, Japan)

Ant colonies exemplify complex systems where collective behaviors emerge from simple interactions among individuals. This study extends prior research on autonomy in ant colonies by incorporating Gromov-Wasserstein Optimal Transport (GWOT) to analyze role transitions. GWOT provides a mathematical framework to compare structural and probabilistic properties of role configurations, allowing a detailed exploration of role evolution over time. Using Non-Trivial Information Closure (NTIC), we quantify individual ants' autonomy by measuring how much their behavior is determined by internal states versus environmental influences. Integrating NTIC with GWOT, we capture the dynamics of role changes, treating ant roles as metric measure spaces and computing optimal transport plans to model transitions. Our results reveal that ants with higher autonomy—indicated by elevated NTIC values—may be critical to colony adaptability, as they facilitate efficient role transitions and resilience. This approach not only offers insights into ant colony dynamics but also provides a framework applicable to broader complex adaptive systems, where individual autonomy and role dynamics drive collective behavior.

OS24-3 Reward Shaping for the Neuroevolution of Collective Behaviours in Ants

Michael Crosscombe, Ilya Horiguchi, Shigeto Dobata, Takashi Ikegami
(The University of Tokyo, Japan)

This paper presents a novel approach to analysing and reproducing complex ant behaviour by developing compositional reward functions for neuroevolution through dimensionality reduction techniques. We develop a behavioural state extraction framework that captures both individual and colony-level features, from movement patterns of individuals to social behaviours, e.g., clustering. By applying Principal Component Analysis (PCA) to behavioural data extracted from ant trajectory recordings, we identify key behavioural signatures that characterise both individual and emergent collective behaviours. This reduced state space representation enables the development of structured reward functions that can effectively guide the evolution of artificial neural networks towards reproducing authentic ant behaviour. Our approach addresses the fundamental challenge of reward shaping in neuroevolution by providing a systematic method for evaluating behavioural similarity across different temporal scales.

January 24 (Friday), 13:00-14:45

OS24-4 Exploring Cultural Evolution Through Modular Dynamics in Temporal Hashtag Networks

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]University of Tsukuba, Japan)

Social media platforms provide unprecedented opportunities for studying cultural evolution by analyzing digital traces. This study presents a methodological framework for analyzing the temporal dynamics of cultural modules in hashtag co-occurrence networks. We address the inherent challenges of analyzing dense, skewed, and highly variable cultural networks by introducing a bootstrap-based ensemble clustering approach that distinguishes between stable and fluid structural elements. By applying the Leiden algorithm to a perturbed ensemble of hashtag networks, we identify core modules that persist across perturbations and peripheral elements that exhibit more variable associations. Analysis of four years of data from a major photo-sharing platform reveals complex patterns in the evolution of cultural modules, including both stable associations and dynamic reorganizations. Our findings demonstrate how ensemble clustering techniques can effectively capture the interplay between stability and change in evolving cultural systems.

OS24-5 A Community First theory for Understanding Individuality

Takashi Ikegami[1], Hiroki Kojima[1], Acer Yu-Chan Chang[2], Ryosuke Takata[1], Atsushi Masumori[1], Norihiro Maruyama[1], Ilya Horiguchi[1], Michael Crosscombe[1], Yasuhiro Hashimoto[3], Hiroki Sato[1], Akiko Kashiwagi[4], Shigeto Dobata[1]
([1]the University of Tokyo, Japan)
([2]Rikkyo University, Japan)
([3]University of Aizu, Japan)
([4]Hirosaki University, Japan)

Collective phenomena in biological and physical systems exhibit emergent behaviors that are challenging to cohesively interpret. Collective intelligence and individuality arise from the dynamics of the collective. To address this gap, we propose an integrative framework to advance the understanding of collective intelligence and behavior through an interdisciplinary lens combining information theory, experimental biology, and computational modeling. We examine Western honeybees, Tetrahy- mena, Polyergus ants, and web-based datasets, and we gain new insights into collective phenomena by tracking the complete set of agents within a society. We hypothesize that individuality, diversity, and autonomy are emerging from the collective dynamics. We propose that this process can be explained using 'hierarchical mutual information' derived from detailed inter-individual data.

OS24-6 Interplaying Evolution and Collective Dynamics of Human-Hashtag Interactions: Analyzing "Soft" Beings on the Web

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

The evolution of highly collective and communicative entities, for instance human (hard beings, like hardware), is coupled with evolution of their soft contents such as culture, languages and technologies. However, evolution of soft beings lacks clear unit of inheritance and genealogy unlike biological evolution. To connect such soft evolution to well studied hard evolution, this study extended Price equation and applied it to a social media dataset about hashtag usages. Our results demonstrate the Price equation's three terms provide comprehensive description of hashtag dynamics.Through discussion on hard and soft evolution using the same framework of Price equation, the novel discovery in their interplay can be expected.

January 24 (Friday), 13:00-14:45

OS24-7 Impact of Cross-Community Interactions on Digital Regulatory Networks

Juan M. Nadales[1], Hiroki Kojima[2], Liam M. Longo[1,3]
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([2]the University of Tokyo, Japan)
([3]Blue Marble Space Institute of Science, United States)

This work aims at investigating cross-community interactions on digital communities composed of agents modeled as adaptive regulatory networks. Utilizing agent-based models, we will conduct experiments where different external signals are applied to observe how these signals influence the evolution of the networks. Each digital agent is a self-regulating network, with its evolution determined by a fitness function that relates external signals to the expression of molecules in some of the nodes of the network. We aim to observe how interactions among these communities influence their evolutionary trajectories under varying environmental setups. This foundational research enhances our understanding of the mechanisms driving the evolution of regulatory networks in response to inter-community interactions, revealing the emergent behaviors that arise from these dynamics. Future work will extend this investigation by integrating digital regulatory networks with living organisms, allowing us to analyze the implications of hybrid digital-biological interactions. This research has significant potential applications in biotechnology, synthetic biology, and ecosystem management, providing insights into the co-evolution of artificial and natural systems in complex environments.

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

Room B

GS14 Evolutionary computations (Genetic algorithm)

Chair: Kunihiko Nakazono (University of the Ryukyus, Japan)

GS14-1 On-Site Verification of Picking Work Efficiency Improvement by Optimizing Product Placement Using BLPSO

Takahiro Suzuki, Ayaka Sugiura, Koya Ihara, Takuto Sakuma, Shohei Kato
(Nagoya Institute of Technology, Japan)

We proposed a meta-heuristics-based product placement optimization method and a mathematical optimization method to optimize the placement of products on the shelves. We conducted demonstration experiments in a real warehouse to verify the effectiveness of these optimization methods. In the experiment, products were selected under certain conditions to reduce the cost of product replacement. The two conditions were that the optimization of the destination shelves should be completed only by inserting products and that there should be enough space for the products to be inserted. The products that satisfied these conditions were selected with a probability based on the frequency of orders, and an order was created for verification. Picking time for the verification order was measured, and a 13% time reduction was confirmed. The paired T-test also showed a significant difference before and after optimization. This paper reports on the above verification experiment and its results.

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

GS14-2 Evaluation Regarding Partitioning the Objective Space for Parallel distributed MOPSO/D

Mitsuhiko Uchida[1], Mikiko Sato[1], Yuji Sato[2]
([1]Tokai University, Japan)
([2]Hosei University, Japan)

This paper proposes a distributed parallelization method for MOPSO/D algorithm that applies Particle Swarm Optimization to the search for multi-objective optimization problems. In the proposed method, first, the objective function space is divided into multiple subproblems using a weight vector, and each particle of the PSO is assigned to each subproblem. Next, in order to parallel speedup using several cores while minimizing the degradation of search accuracy, this study uses an overlapping zone to share the previous personal best solutions that were searched on adjacent cores. Through computer experiments using several standard benchmark problems, we show that the proposed method is effective in improving the search efficiency near the partition boundary.

GS14-3 Multi-objective optimization of flight schedules to maximize constraint-tolerance by local search and archiving mechanisms

Tomoki Ishizuka[1], Hiroyuki Sato[1], Akinori Murata[2], Keiki Takadama[3]
([1]The University of Electro-Communications, Japan)
([2]Electronic Navigation Research Institute, Japan)
([4]Information Technology Center and Information & Communication Engineering,
The University of Tokyo, Japan)

In this paper, we propose an optimization method that incorporates the concept of constraint tolerance to represent the feasibility of solutions. While conventional methods often add an objective function to maximize constraint tolerance alongside optimizing the original objectives, this can degrade optimization performance due to the increased complexity of the search space. To address this, we propose a robust solution search method with high optimization performance for CMOPs and apply it to aviation-related CMOPs to verify its effectiveness. The proposed method combines local search and an archive mechanism to enhance the performance of feasible solution searches compared to conventional methods. It identifies solutions with high constraint tolerance from the Pareto-optimal solution set. A comparison between the conventional two-objective method and the three-objective method, which adds a new objective function to maximize constraint tolerance, demonstrates the statistical superiority of the proposed approach.

GS14-4 Novelty-based multi-objectivization for unbounded search space optimization

Ryuki Ishizawa[1], Hiroyuki Sato[1], Keiki Takadama[2]
([1]The University of Electro-Communications, Japan)
([2]The University of Tokyo, Japan)

In the many conventional evolutionary computation, especially the single-objective multi-modal optimization the search space is "pre-determined" as bounded space. However, the range of design variables is not always fixed, this paper addresses the optimization for the "unbounded" search space. For this purpose, this paper proposes Novelty-based Multi-objectivization with Local and Rough area Search (NM-LRS), which roughly explore the novelty unexplored location to obtained the area optimal likely located as "potential area", move the area to include optimal by local search, and optimize in the area. To investigate the effectiveness of the proposed method, the experiment is conducted with comparison methods and has revealed the following implications: (i) the peak ratio (i.e., the ratio of the founded peaks of the multi-modal function) of NM-LRS is higher than that of the conventional methods; and (ii) NM-LRS is robust for the location of the initial search area in the most functions.

January 24 (Friday), 13:00-14:30

Room C

GS8 & GS9 Bio-inspired robotics I & II

Chair: Xixun Wang (Osaka Institution of Technology, Japan)
Chair: Jun Ogawa (Yamagata University, Japan)

GS8-1 A Study on Battery Loading Method for Multi-Legged MEMS Microrobot

Misaki Takaku, Yifan Yang, Kyotaro Shibuya, Fumio Uchikoba, Minami Kaneko
(Nihon University, Japan)

This study compares the walking behavior of microrobots with different battery loading methods and discusses the differences from insects with similar characteristics. Three types of micro-robot models were used in the kinematic analysis: one with a battery loaded on a top plate, one with a battery mounted on a cart and towed by the main body, and one with a built-in battery and wheels attached. The dimensions of the robot body of the battery-loaded model and the battery-towed model are unified, while the dimensions of the built-in battery model were designed for practical use. As a result of the analysis, it was confirmed that the battery-loaded model weighs 0.98g, the battery-towed model weighs 4.9g, the battery-embedded model weighs 63g when its wheels are removed, and the built-in battery model walks stably up to 75g when its wheels are attached.

GS8-2 Geometrically-inspired Design of Edible Arm

Shoma Abe, Jun Ogawa, Hidemitsu Furukawa
(Yamagata University, Japan)

This study develops an edible soft robot inspired by octopus tentacles, using kurdlan for the structure and kanpyo as tendons. The robot is fabricated by molding a 12% kurdlan-water gel mixture into a silicone mold, heating it at 90°C for 15 minutes, and threading kanpyo through holes to act as tendons. It achieves life-like motion through tension-driven deformation, with measured maximum deformation angles of 155° in the XY plane and 94° in the Z-axis. The 3D trajectory plots visualize its coiling and bending motions, demonstrating its ability to mimic natural movements. By integrating robotics with gastronomy, this study highlights the potential of edible robots to enhance sensory dining experiences and contribute to sustainable innovations in food technology.

GS8-3 Effect of Eccentric Shaft Design on the Gastropod-Inspired Mechanism

Yoshimune Tayama, Jun Ogawa, Hidemitsu Furukawa
(Yamagata University, Japan)

Gastropods, including snails and slugs, exhibit a distinctive locomotion mechanism characterized by the use of flexible body structures and traveling waves, enabling them to navigate a wide range of environments. Emulating this mode of locomotion is anticipated to significantly enhance the adaptability of robots across diverse terrains. To achieve this objective, we developed a novel mechanism comprising parallel links, a flexible silicone rubber foot, and an eccentric shaft that induces wave-like motions through rotational movement. This mechanism facilitates the continuous conversion of forces to generate soft, undulating movements. The eccentric shaft serves as a critical element in wave generation and is central to the functionality of the mechanism. Nonetheless, the specific effects of the eccentric shaft's design on propulsion force remain inadequately understood. This study aims to elucidate how variations in the design parameters of the eccentric shaft influence propulsion, thereby contributing to the foundational understanding required for the development of more efficient locomotion mechanisms.

January 24 (Friday), 13:00-14:30

GS9-1 Wavy synchronization in entire legs of walking train millipedes revealed by automatic tracking and mathematical modeling

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

We studied the walking mechanism of a train millipede (Parafontaria laminata armigera) both experimentally and mathematically. First, we captured millipedes and recorded the legs movement of the walking millipedes with a video camera. The phase dynamics of respective legs were quantified by automatic tracking due to DeepLabCut, demonstrating nearly in-phase synchronization in adjacent legs. Second, we proposed a mathematical model based on a system of coupled oscillators. Specifically, we extended the mathematical model proposed in our previous study so that it can describe the movement of entire legs. Finally, we performed numerical simulation and demonstrated that the proposed model can quantitatively reproduce the phase difference of adjacent legs estimated from empirical data. Important future directions include the analysis on the synchronization properties by considering the detailed body structure of the millipedes as well as the application of the behavioral mechanism of walking millipedes to the development of bio-inspired robots.

GS9-2 A propulsion mechanism combining the torsional behavior of a plate spring and the manta ray's skeletal structure

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

Among aquatic organisms, manta rays are known for their exceptional swimming efficiency and precise posture control. Building on these characteristics, we developed a propulsion mechanism that emulates the swimming behavior of manta rays. Manta rays achieve self-propulsion through a combination of flapping and feathering motions. To replicate both motions with a single actuator, we leverage the torsional deformation of an embedded plate spring. Based on this principle, we developed pectoral fins with a two-layered structure comprising a PLA skeleton and a silicone skin, emphasizing gradient stiffness and mimicking the manta ray's skeletal structure. This study introduces our design approach and validates the feasibility of the proposed method through a series of swimming experiments.

GS9-3 Development of artificial muscles formed from shape-memory alloys and elastomers and their application to musculoskeletal leg models

Yugo Kokubun, Kentaro Yamazaki, Tatsumi Goto, Ginjiro Takashi, Ontatsu Haku, Fumio Uchikoba, Minami Kaneko
(Nihon University, Japan)

Most humanoid robots use CPUs for high-speed processing of huge numerical calculations and servo motors to control joint angles. Humans, on the other hand, use neural networks to generate signals that cause multiple muscles to contract and relax, resulting in efficient joint movement. We have analyzed human gait kinetically and obtained the generated forces and contractions of 12 muscles necessary for walking. In this paper, based on the values obtained from the gait analysis, we designed artificial muscles using elastomers and shape memory alloys, and fabricated a total of 10 muscles: rectus femoris, long head of biceps femoris, short head of biceps femoris, vastus medialis, vastus lateralis, vastus intermedius, medial head of gastrocnemius, lateral head of gastrocnemius, tibialis anterior, and soleus muscles. Four of the ten muscles (long head of biceps femoris, medial head of gastrocnemius, lateral head of gastrocnemius, and soleus) were driven, and the movements of the hip, knee, and ankle joints were confirmed.

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

Room D

GS18 Human-machine interaction and collaboration IV

Chair: Hironori Hiraishi (Ashikaga University, Japan)

GS18-1 ACRC-LLM: A Framework for Automated Construction Robotics Control Using Large Language Models

Yongdong Wang, Runze Xiao, Jun Younes Louhi Kasahara, Keiji Nagatani, Atsushi Yamashita, Hajime Asama
(The University of Tokyo, Japan)

This study presents ACRC-LLM, a framework that integrates Large Language Models (LLMs) with multi-robot construction systems, enabling natural language-based operation of multiple robots. The framework comprises three key modules: the Sensor Module, the Human Interface Module, and the Semantic Grounding Module. ACRC-LLM translates natural language commands into predefined atomic functions, thereby mitigating the risks associated with generating non-executable code. Experimental results demonstrate that lightweight large language models effectively parse instructions for long-sequence tasks. The feasibility of this framework has been validated through tests across multiple scenarios, offering a scalable, computationally efficient, and robust solution for applications in construction robotics and disaster rescue operations.

GS18-2 Realization of an Auto-Calibrating Squeeze Haptic Feedback Device for Supernumerary Robotic Fingers

Connor McGregor, Jacob Char, Faimul Haque, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Haptic feedback is crucial in supernumerary robotics, particularly for enhancing the functionality and user experience of devices like the Supernumerary Robotic Finger (SRF). This paper introduces an innovative squeeze feedback haptic armband equipped with an automatic calibration system that adjusts to the user's forearm size. The system utilizes a pressure sensor within the armband to measure and adjust tension via a winch mechanism, ensuring optimal engagement. Integrated with an SRF, the armband provides realistic squeeze feedback corresponding to interaction forces with objects, enhancing the usability of SRFs. Preliminary evaluations compare its effectiveness against manual calibration, focusing on adaptability to various forearm sizes. The findings suggest that auto-calibration significantly streamlines setup and increases accuracy, offering potential benefits for broader applications in haptic devices.

GS18-3 Evaluation of Haptic Feedback Modalities for Enhanced Locomotor Stability in Lower Limb Prosthetic Training

Pasut Suriyasomboon, Anas Majumder, Rene Manuel Suarez Flores, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Lower limb prostheses enhance mobility for amputees but often face challenges in achieving stable gait, particularly during initial training. Instability increases fall risks and prolongs rehabilitation. Haptic feedback offers a solution by improving proprioception, enabling users to better perceive limb position and force for enhanced stability and safety. Our previous research showed significant balance improvements during training by simulating ground reaction forces. Building on that, this paper compares force-based and vibrotactile feedback integrated into a prosthetic leg. By evaluating these modalities against a control group, we aim to identify the most effective method for improving gait stability. These findings will inform advancements in prosthetic design and rehabilitation, promoting greater independence and confidence for amputees.

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

GS18-4 Proposal of SSVEP Ratio for Efficient Ear-EEG SSVEP-BCI Development and Evaluation

Sodai Kondo, Hideyuki Harafuji, Hisaya Tanaka
(Kogakuin University, Japan)

Ear electroencephalogram (ear-EEG) records electrical signals around the ear, offering a more casual and user-friendly approach to EEG measurement. Steady-state visual evoked potential (SSVEP) are brain responses elicited by gazing at flickering stimuli. Ear-EEG can enhance comfort in SSVEP-based brain-computer interface (SSVEP-BCI), but its performance is typically low behind traditional SSVEP-BCI. Additionally, predicting the performance of ear-EEG SSVEP-BCIs before experimentation is challenging, often increasing design costs. This study proposes the SSVEP ratio as a supplementary index to traditional metrics such as information transfer rate (ITR) and BCI accuracy. Using the SSVEP ratio and the KNN algorithm, we predicted BCI accuracy and ITR, aiming to lower design costs. The developed four-inputs ear-EEG SSVEP-BCI achieved a maximum BCI accuracy of 89.17±3.62% and an ITR of 10.60±0.36 bits/min. Predicted BCI accuracy was 90.21±3.25% and an ITR was 9.43±0.96 bits/min in ear-EEG SSVEP-BCI. Predicted values matched the actual results, demonstrating that the SSVEP ratio can effectively predict BCI accuracy, thereby streamlining the design process for ear-EEG SSVEP-BCI.

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

Room E

GS26 Mobile robots II

Chair: Kenta Tabata (Utsunomiya University, Japan)

GS26-1 Testing a Portable Underwater Robotic Manipulator with a Structure-Wall Suction Mechanism

Norimitsu Sakagami[1], Masatoshi Fukami[2], Yuki Tanaka[2], Aoi Koshioka[2], Atsushi Kakogawa[3]
([1]Ryukoku University, Japan)
([2]Tokai University, Japan)
([3]Ritsumeikan University, Japan)

We propose a portable underwater robotic manipulator equipped with a suction mechanism which consists of a marine thruster and a disk plate called negative pressure effect plate (NPEP). The marine thruster induces water flow between the NPEP and a structure's surface, and water flow produces negative pressure to maintain stable contact between the manipulator and the structure. We numerically and experimentally investigated the stabilization performance of the manipulator. From the results, we confirmed that the first prototype underwater manipulator could maintain its position even in a water flow of 0.3 m/s. We also evaluated the swimming performance of the manipulator in a water tank, achieving a maximum forward speed of 0.89 m/s and a turning speed of 60 deg/s.

GS26-2 Autonomous Navigation for Agricultural Robots Using GNSS and UWB Devices for Indoor and Outdoor Environments Without SLAM

Junsei Tanaka, Yoshihiro Sato
(Kyoto University of Advanced Science, Japan)

This study develops a system that enables agricultural robots to achieve highly accurate autonomous navigation in both indoor and outdoor environments. Autonomous robots can perform various tasks, and their demand is rapidly increasing in the agricultural field due to labor shortages and the need for efficiency. However, crops have the unique property of growing and changing over time, which presents challenges for SLAM technology that relies on pre-generated maps. As a result, conventional mapping methods often fail to adapt to these dynamic environments. To address this issue, this study proposes an agricultural robot equipped with a novel navigation system that utilizes GNSS and UWB technologies for precise localization. By combining these technologies, the system ensures reliable navigation unaffected by crop growth, whether operating indoors or outdoors, making it a robust solution for modern agricultural practices.

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

GS26-3 Development of Neuromorphic Circuit for Microrobot System with Stopping and Changing Direction Ability Using Light Stimuli

Yamato Muramoto[1], Kosei Sekiyama[1], Shuxin Lyu[1], Ken Saito[2]
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Graduate School of Science and Technology, Nihon University, Japan)
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College of Science and Technology, Nihon University, Japan)

The authors are studying insect-type microrobots that can act autonomously by using analog electronic circuits that mimic the neurons of living organisms for motion control. Previously, we have successfully developed a neuromorphic circuit that mimics the function of the central pattern generator of living organisms. Also, we developed an integrated circuit of the neuromorphic circuit as a driving circuit for an insect-type microrobot to walk in a single gait pattern. However, the insect-type microrobot was not equipped with sensors, could not switch gait according to the environment, or stop or change direction. In this paper, we designed and simulated, using HSPICE, a new neuromorphic circuit capable of stopping and changing direction with light stimuli. The simulation results confirmed the neuromorphic circuit could generate four patterns: straight ahead, stop, turn to the right, and turn to the left, which needs to drive the legs of the microrobot.

GS26-4 Rapid Spiral Stair Descent for a Quadruped-Wheeled Robot Using Model Predictive Control

Hongming Chen, Junyang Zhang, Jixin Yang, Pengju Wang, Kenji Hashimoto
(Waseda University, Japan)

In this study, we propose a rapid spiral stair descent method using Model Predictive Control (MPC) on a leg-wheeled robot. Leg-wheeled robots integrate the terrain adaptability of legged robots with the speed and efficiency advantages of wheeled robots. Our research prototype MELEW-3 (Meiji Leg-Wheeled Robot - No. 3) features an additional Yaw axis joint in each leg, setting it apart from typical leg-wheeled robots. Using an MPC controller, we make the robot track planned trajectories to achieve the primary task of descending stairs while also combining Yaw axis joint utilization and impact reduction objectives. Simulation results demonstrate that the controller successfully enables the robot to achieve rapid and stable spiral stair descent, outperforming conventional quadruped-wheeled robots without the additional Yaw axis in smooth tracking.

GS26-5 Microrobot with built-in MEMS turbine driven by compressed air

Takamichi Funakoshi, Koki Ito, Fumio Uchikoba, Minami Kaneko
(Nihon University, Japan)

In this study, we investigated a microrobot with a parallel-drive MEMS turbine driven by compressed air to reduce the mental and physical burden on physicians and patients. The microrobot consists of a parallel-driven MEMS turbine and a triangular-shaped Reuleaux wheel. The dimensions of the parallel-drive MEMS turbine are 5.38 mm (height)× 5.51 mm (width) × 5.52 mm (thickness), with a mass of 0.38 g. The triangular-shaped wheels of the Reuleaux are used as the main body of the microrobot. The dimensions of the main body of the self-propelled parallel-drive MEMS turbine microrobot with Reuleaux triangular-shaped wheels were 6.48 mm (long) × 16.19 mm (wide) × 6.48 mm (high) (excluding the brass tube part) and 0.44 g in mass. The left direction traveled at 44 mm/s when the pressure was 0.5 MPa and the flow rate was 1.0 L/min, and at 118 mm/s when the pressure was 0.5 MPa and the flow rate was 1.0 L/min. The maximum angle to the right was 50.5 degrees and to the left was 21 degrees.

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

Room F

GS33 Robot vision and image processing II

Chair: Masami Iwase (Tokyo Denki University, Japan)

GS33-1 Integration of MaskNet-Based Posture Estimation into Robot Vision Systems

Yu Iwai, Soma Fumoto, Takeshi Nishida
(The University of Kitakyushu, Japan)

Real-time posture estimation based on incomplete three-dimensional (3D) measurements is crucial in vision systems for industrial robots. A recently proposed posture estimation method using MaskNet and singular value decomposition solves various problems and achieves high-speed 3D posture estimation. However, time-series posture estimation still has the problem of fluctuation owing to sensor and inference errors. To improve the accuracy of posture estimation in realistic task situations, we trained MaskNet on a large dataset of CAD models generated by ray casting, which simulates views from random viewpoints of a sensor model. A Kalman filter was also applied to reduce noise in the inference time series.

GS33-2 Computer Vision for Automated Robotic Device Disassembly: Object Detection, Pose Estimation, and Action Prediction

Sebastian Ruiz[1], Boris Kuster[2], Minija Tamosiunaite[1,3], Ales Ude[2], Florentin Wörgötter[1]
([1]University of Göttingen, Inst. Physics 3, Germany)
([2]Jožef Stefan Institute, Slovenia)
([3]Vytautas Magnus University, Lithuania)

The increasing demand for electronic products has led to a surge in old devices, making efficient recycling crucial. Current recycling processes are often tailored to specific models, making adaptation to varying devices complex and costly. This paper addresses automating electronic device disassembly using computer vision and action prediction methods. The research explores key components of a robotic disassembly system, including pose estimation, device classification, rotation estimation, gap detection, and action prediction. High accuracy is achieved using segmentation models and supervised learning for known devices, while zero-shot classification and data-driven approaches show promise for handling unseen devices. A large language model (LLM) is introduced for action prediction, demonstrating its ability to adapt to diverse disassembly tasks with 91% accuracy. The results indicate that generalization across device models is possible. This study provides a framework for developing flexible and robust robotic systems, leading to more sustainable and scalable recycling solutions.

GS33-3 3D Object Recognition and Plane Detection for Grasping Position Estimation in UVG

Kaito Watanabe[1], Yuta Ohno[2], Toshihiko Shimizu[1], Masayoshi Ozawa[1], Julien Amar[1], Masahiko Sakai[1], Tadahiro Oyama[1]
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Service robot arms often require frequent tool changes depending on the target object, which can limit efficiency and flexibility in multi-object handling. A universal vacuum gripper (UVG), however, offers a solution by enabling the grasping of a variety of objects without tool changes, providing stable and versatile manipulation capabilities. In this research, we developed a system that integrates 3D data from a depth camera and other sensors to perform object recognition, pose estimation, and optimal surface detection for effective gripping. This system processes point cloud data to identify ideal grasping points by recognizing object shapes and detecting planar regions suitable for vacuum adhesion.

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

GS33-4 AI-Powered Autonomous Wheelchair with Zero-Shot Obstacle Detection and Navigation Assistance for Enhanced Mobility

Keshavi Joshi, Pasut Suriyasomboon, Rene Manuel Suarez Flores, Sajid Nisar
(Kyoto University of Advanced Science, Japan)

Mobility challenges significantly impact individuals with disabilities and the elderly, often reducing their quality of life. Traditional manual wheelchairs require substantial physical effort, highlighting the need for innovative solutions to improve independence and accessibility. This study introduces an AI-assisted autopilot power wheelchair system that combines AI-driven detection and depth image technology for autonomous navigation. The system enables the wheelchair to autonomously avoid obstacles and recalculate routes to reach a designated destination. By using a minimal set of sensors, the AI determines optimal paths and adapts to real-time environmental changes. Incorporating a zero-shot system for obstacle detection and depth cameras for visual data analysis, the system can identify and respond to previously unseen obstacles, ensuring safe and efficient navigation. This innovative approach allows users to confidently navigate their environment while prioritizing safety for both the user and their surroundings. The proposed system was successfully integrated into a wheelchair and demonstrated the ability to reach its destination in dynamic environments with varying obstacles.

GS33-5 Target Specific Multi-Dimensional Image Scrambling Algorithm for Security Cameras

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With the proliferation of security cameras, image content protection is a major challenge. Image scrambling has increasingly been used for content protection as it does not degrade the quality of image. However, security cameras pose challenges of real-time implementation and target specific content protection. To this end, this paper presents a target specific, linear transform based multi-dimensional image scrambling algorithm. The algorithm can scramble the image in 2D and 3D. Scrambling in 3D enables inter-image pixel scrambling which prevents brute-force attacks. The algorithm can be implemented using MMA (Matrix-Matrix Multiply Add) operation for parallel computing. A faster algorithm is proposed for serial computation. Both square and rectangular images can be scrambled. Along with complete image, targeted areas of the image can be scrambled in real-time. The quality of scrambling is evaluated using PSNR (peak-signal-to-noise-ratio) parameter. Experiment results with actual security cameras with motion detection feature shows that the proposed algorithm can be used in real time with high pixel irregularity for content protection.

January 24 (Friday), 14:30-15:30

Room B

GS27 Mobile robots and motion planning

Chair: Satoshi Ueki (Gifu University, Japan)

GS27-1 Testing an Autonomous Sediment Sampling Method with a Sealing Mechanism for an Underwater Robot

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We propose a sediment sealing mechanism to enable reliable and autonomous sediment sampling by an underwater robot. The proposed mechanism is mainly composed of three parts: a rotating part, a stationary part, and rubber tubes. In this mechanism, the rigid rotating and stationary parts twist the rubber tubes, and the twist shears and encloses the sediment. In this work, we designed and developed the sealing mechanism for sediment sampling. Then, we conducted a preliminary experiment using commercial powdered clay to test its effectiveness in capturing artificial sediment. Additionally, autonomous sampling tests were carried out in Lake Biwa to assess the performance of the robot and the proposed sealing mechanism. From the experimental results, we confirmed that the developed sealing mechanism allows the underwater robot to successfully collect samples without loss.

GS27-2 Development of a Dynamic Positioning System for unmanned mud sampling vessels using Variable Structure Control

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

We propose a Dynamic-Positioning control method for the Unmanned Surface Vehicle using Variable Structure Control in this study. The DP control is required to maintain position and bow heading as the mud sampling USV performs the mud sampling operation. The USV is designed so that the Surge, Sway, and Yaw axes are controlled by individual Sliding Mode Control. The USV cannot control Sway and Yaw at the same time. The method proposed in this paper controls the USV by switching the VSC appropriately according to the ratio of the distance from the switching surface of the SMC. The proposed method was verified by simulation, and the controllability was confirmed.

GS27-3 State Machine for Dynamic Path Planning on Autonomous Articulated Robots

Soma Fumoto, Tsubasa Watanabe, Takeshi Nishida
(The University of Kitakyushu, Japan)

This paper proposes a novel method for constructing a state machine for autonomous industrial robots to perform variable tasks in high-mix, variable-volume production and logistics. The proposed state machine incorporated a path reuse (PR) method for path planning, enabling fast and safe path generation for arbitrary start and goal postures. This approach addresses the limitations of existing methods such as artificial neural networks, which require large databases and manual expert intervention to redesign state machines. The proposed method autonomously constructs and connects paths, rendering it suitable for rapidly changing environments and diverse tasks. Furthermore, we conducted comparative experiments with state machines using conventional path planning methods and demonstrated that those using the PR method had the best performance.

January 24 (Friday), 14:30-15:30

GS27-4 Development of a Brain Machine Interface based Robot Navigation System for Disabled People

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People with serious physical disabilities (ex. Spinal Muscular Atrophy) find it difficult to control a robot wheelchair. Although gesture based robot control mechanisms have been proposed, making such gestures is not always feasible. To this end, this paper proposes a motor imagery-based brain-machine interface (MI-BMI) for robot control by processing electroencephalograph (EEG) signals captured from non-invasive external device. We systematically process the EEG signals to first estimate the most prominent brain channels. This eliminates the redundant information or noise which adversely influences the recognition accuracy. We then estimate the most prominent EEG waves among the prominent channels. Later, the combination of prominent brain waves among the prominent channels which gives the most accurate robot control are estimated. Convolutional Neural Network (CNN) is used to process the EEG signals. The user can control the robot in four different directions. Experiments with actual external BMI device are performed and robot is controlled.

January 24 (Friday), 14:30-15:30

Room D

OS17 AROB: Robot and Control

Chair: Nobuya Takahashi (University of Miyazaki, Japan)
Co-Chair: Masahiro Yokomichi (University of Miyazaki, Japan)

OS17-1 SGLDOMP-Stochastic Gradient Langevin Dynamics Optimization-based Motion Planning

Masahiro Yokomichi, Nobuya Takahashi
(University of Miyazaki, Japan)

Covariant Hamiltonian Optimization Motion Planning (CHOMP) is a optimization based path planning method. In this method, the initial path is updated by covariant gradient descent iteration with cost functional that consists of the obstacle part and smoothness part. This method works fine for the simple environment, but in the case of the cluttered environment, the path may be trapped to local minima. In this paper, CHOMP is modified in the two parts. The first is to change the obstacle cost term and the second is adopting stochastic gradient Langevin dynamics as the optimization algorithm. The effectiveness of the proposed approach is examined by numerical simulations for two dimensional cluttered environment.

OS17-2 Gradient-based Multiplicative Update Rules for Non-negative Matrix Factorization

Nobuya Takahashi, Masahiro Yokomichi
(University of Miyazaki, Japan)

This paper proposes a generic solution for Non-negative Matrix Factorization (NMF). In the standard way, the solution employs an iterative calculation known as the multiplicative update formulas. One approach to introducing these update rules is the auxiliary function method. The update rules are formulated based on the structure of the NMF problem. However, they must be derived with careful consideration of the problem's structure. For example, the type of NMF, divergence, penalty term, and so on. In this paper, we propose a multiplicative update rule based on the gradient of the objective function. By incorporating a multiplier derived from a combination of sigmoid and linear functions, the feature matrix can maintain positive values throughout the calculation process. This method has the advantage that it can be applied to a wide range of problems regardless of the structure of the target problem. Numerical experiments show that the effectiveness of this method.

January 24 (Friday), 14:30-15:30

OS17-3 Reinforcement learning and LiDAR-SLAM based obstacle avoidance of drone with depth camera

Ren Shigenaga, Masahiro Yokomichi, Nobuya Takahashi
(University of Miyazaki, Japan)

In recent years, interest in the industrial use of drones has been growing worldwide, and they are being put to practical use in a variety of fields. Similarly, in Japan, research and experiments into the industrial use of drones are being conducted. However, due to strict regulations in Japan, most use cases require manual operation. In this study, we focus on the large amount of information that must be handled, which is a challenge when using autonomous drones in industry, and aim to develop a system that can handle large amounts of information by combining multiple elements.

OS17-4 Development of an Actual 4-wheeled Vehicle Type Monorail Track Inspection Robot with Electric Differential Drive

Keisuke Sato, Yasunobu Hitaka
(National Institute of Technology, Kitakyushu College, Japan)

Kitakyushu Monorail workers board a maintenance vehicle and inspect the track. One of the concerns in conducting this inspection work is that it is difficult to ensure the safety of the workers because monorail track is height of 10 meters of more. We proposed to develop a compact and lightweight 4-wheeled robot that can travel unmanned on the monorail track and perform visual inspections with camera on the robot body by remote control from a safe location. In addition, the robot can also be equipped with a “Guide Arm” to prevent it from falling off the track. Therefore, the vehicle has an electric differential deceleration drive to run smoothly on the track and prevent idles the inner wheel. In this paper, we will design and fabricate the body frame and drive unit of the inspection robot, develop an electrical differential drive system, and develop a wireless connection system.