ABSTRACTS

Plenary Speech 1

January 21 (Thursday), 18:00-18:50

Chair: Fumitoshi Matsuno (Kyoto University, Japan)

Soft Robotics – the route to true robotic organisms?

Prof. Jonathan Rossiter

University of Bristol, UK

Soft robotics has come to the fore in the last decade as a new way of conceptualising, designing and fabricating robots. Soft materials empower robots with locomotion, manipulation, and adaptability capabilities beyond those possible with conventional rigid robots. Soft robots can also be made from biological, biocompatible and biodegradable materials. This offers the tantalising possibility of bridging the gap between robots and organisms. We will discuss the properties of soft materials and soft systems that make them so attractive for future robots. In doing so we consider how future robots can behave like, and have abilities akin to, biological organisms. These include huge numbers, finite lifetime, homeostasis and minimal environmental impact. This paves the way for future robots, not as machines, but as robotic organisms.

Biography:

Jonathan Rossiter is Professor of Robotics at Bristol Robotics Laboratory and the University of Bristol. His is founder and head of the SoftLab research group, and leader in the field of Soft Robotics - the development of soft materials, mechanisms and machines that will have a huge impact on almost all aspect of our lives, from healthcare and virtual reality to environmental protection and space systems. In 2018 he was awarded the Royal Academy of Engineering Chair in Emerging Technologies, one of the most prestigious UK research awards. He is concurrently EPSRC Research Fellow and was previously Royal Society Research Fellow. He has published over 200 peer reviewed publications, patents and commercial licenses. He has generated research firsts which lay the foundations for ubiquitous soft robotics, including biodegradable and edible robotics, stretchable and pocketable electroskin robots, models of soft robot and microorganism deformation, soft matter computers, and scalable artificial muscles with largest ever contractile strain. His TED talk on biodegradable and pollution eating robots has been viewed 1.4M times, and his research has been broadcast through major media (incl. BBC, Sky, CBS, Reuters) reaching audiences of over 1 billion.

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Plenary Speech 2

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

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

AI Empowered Social Robots for Human-Centric Society

Dr. Li-Chen Fu

Center for AI and Advanced Robotics
Dept. of Computer Science & Information Engineering
National Taiwan University, Taiwan

Given the rapid advance in various robot technology development, increasing research attentions have been paid to the field of social robotics lately, where a social robot is an autonomous robot that interacts and communicates with humans or other autonomous physical agents by following social behaviors and rules attached to its role. On the other hand, human-centric society tries to provide an environment which is enriched by intelligent machines and software agents designed to unobtrusively or proactively serve human needs while staying mostly in backend. Naturally, social robots have been considered as advanced means to establish such kind of society, which may eventually lead to the state where human lives would become easier, healthier, and more productive. However, so far there remains a great challenge for the currently developed social robots to be able to get along with humans long and well enough in order for them to address real needs in human's life due to failure to hold contextual intelligence as well as essential autonomy. In other words, robots are not able to adapt what they are capable of to the real world scenarios and situations. Fortunately, enlightened by the recent breakthrough in artificial intelligence (AI), a variety of powerful perceptional and reasoning abilities have been developed such that, after leveraging versatile big data from open sources, the social robots are enabled to comprehend the underlying contexts and to make autonomous decision much better than before. Under such circumstance, these AI empowered social robots can interact with humans more naturally and versatilely, and thus may provide services more centered on humans, which attains the goal of the society we strive to establish.

Biography:

Li-Chen Fu received the B.S. degree from National Taiwan University in 1981, and the Ph.D. degree from the University of California, Berkeley, in 1987. Since 1987, he joined National Taiwan University, and was awarded Lifetime Distinguished Professorship and Irving T. Ho Chair-professorship in 2007. He has also served as the university Secretary General from 2005 to 2008. Currently, he serves as Director of NTU Center for Artificial Intelligence (AI) and Advanced Robotics as well as Co-director of MOST (Ministry of Science and Technology)/NTU Joint Research Center for AI Technology and All Vista Healthcare. His areas of research interest include Social Robotics, Smart Home/Healthcare, VR/AR, Visual Detection/Tracking, and Control Theory & Applications.

Dr. Fu has been extremely active and highly regarded in his technical field. He has served as the Program Chairs of 「2003 IEEE International Conference on Robotics & Automation」 and 「2004 IEEE Conference on Control

Applications (CCA)」. For recognition, he was later invited to serve as Program Director of Control Program under Engineering Department, Ministry of Science & Technology (MOST), Taiwan, during 2010~2012. In terms of the editorial work, he has served as Associate Editor of the prestigious control journal, called Automatica from 1996 to 1999. Starting from 1999, he started a new international control journal, called Asian Journal of Control, and became an Editor-in-Chief of the journal till now. Due to his profound academic reputation, he was appointed as Vice-President for Publication of Asian Control Association (ACA) since 2006, and then was elected as President of ACA during 2012–2013. Due to his active role in international control community, he was elected as BoG member of IEEE Control Systems Society (CSS) from 2014 to 2016, and later served as the Vice President for Membership of IEEE CSS from 2017~2018.

Dr. Fu has received numerous recognitions for his outstanding performance in research and education during his technical career over three decades. Domestically, he has received multiple Distinguished Research Awards from MOST before 2000, Outstanding Youth Medal in 1991, Ten Outstanding Young Persons Award in 1999, Outstanding Control Engineering Award from Chinese Automatic Control Society (CACS) in 2000, Industry-Academia Collaboration Award from Ministry of Education (MOE) in 2004, TECO Technology Award in 2005, Outstanding Research Award from Pan Wen Yuan Foundation in 2012, Y.Z. Hsu Science Award from Y.Z. Hsu Science and Technology Memorial Foundation in 2017, Academic Award as well as National Chair Professorship both from MOE respectively in 2015 and 2019, and Life Achievement Award from CACS in 2019. Internationally, he was awarded IEEE Fellow in 2004, has been elected as a Distinguished Lecturer for IEEE Control Systems Society from 2013~2015, was awarded「Wook Hyun Kwon Education Prize」from Asian Control Association in 2015, was elevated to IFAC Fellow in 2016, and was awarded「Outstanding Service Award」from Asian Control Association in 2017.

Plenary Speech 3

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

Chair: Takaya Arita (Nagoya University, Japan)

Lenia and the Rise of Agency in Artificial Life

Mr. Bert Wang-Chak CHAN

Independent researcher, Hong Kong

In robotics and artificial intelligence, agency is a basic given concept. Agents are being designed, trained, rolled out and tested in real or virtual environments to perform certain tasks. In artificial life and biology, there are more fundamental discussions of “what is agency” and “what can be considered an agent”, usually in the context of biological hierarchy and information theory. To add to the discussion, we present a possible case of agents arising from scratch inside a grid-based system.

By generalizing Conway’s Game of Life, a system of continuous cellular automata called Lenia was discovered. It is capable of producing a huge variety of lifelike moving patterns inside computer simulation. As the system was further generalized, resilient cell-like structures started to emerge. These structures could maintain self boundaries; they attract, repel, and interact with each other; they self-reproduce and self-destruct. They seem to be able to sense the virtual world around them and act accordingly to fulfill the goal of survival. This means we may be witnessing the emergence of “agency” out of a distributed model with simple local rules, without explicitly designing for it.

If these abstract patterns can be considered agents, one possible research direction is to train or evolve them using techniques from robotics and reinforcement learning, by giving a suitable set of goals or reward functions (e.g. survival, locomotion, reproduction).

Biography:

Bert Chan is a big data and software team lead in Hong Kong, and an independent researcher on artificial life. He received a B.Sc. degree in computer science from the Chinese University of Hong Kong (1999), and a M.Sc. degree in cognitive science from Lund University, Sweden (2008). His personal project since 2015, a continuous cellular automata system called Lenia, has attracted some attention on the internet and academia. The project sparks international collaborations with universities and research labs (e.g. Google Brain, Inria, the University of Tokyo, Nagoya University, the Czech Technical University in Prague, Tufts University), using Lenia as a new platform for frontier research in deep learning, information theory, parallel computing, and complex systems. His research paper “Lenia - Biology of Artificial Life” was awarded the Outstanding Paper of 2019 by the International Society for Artificial Life (ISAL).

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January 21 (Thursday), 11:00–12:00

Room A

GS1 Agent-based modelling

Chair: Hiroyuki Iizuka (Hokkaido University, Japan)

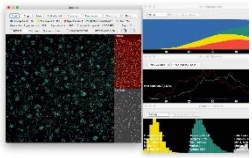
GS1-1 A hybrid dynamical modelling of sheep flocking and sheepdog guiding

Tatsuki Mizui, Tohru Kawabe, and Ikkyu Aihara
(University of Tsukuba, Japan)

Sheep are known as animals that make a flock. They can be herded and guided to a destination by a trained dog called a sheepdog. In this study, we propose a mathematical model of a sheep and a sheepdog and then numerically investigate the process of sheep flocking and sheepdog guiding. Based on our observation, we assume that both sheep and sheepdogs change their behaviour between multiple modes during the guidance. Therefore, we model their behaviour as a hybrid model. In addition, we assume that sheep recognize a sheepdog as a predator, and sheep feel fear of it. We describe these characteristics using fear value and model that sheep change their behaviour depending on it. Numerical simulation demonstrates that three sheep were successfully guided to a destination keeping one flock by a sheepdog. However, simulation with four sheep seldom succeeded.

GS1-2 An individual-based epidemic simulator

Tatsuo Unemi, Saki Nawata, Masaaki Miyashita, and Norihiko Shinomiya
(Soka University, Japan)



From a view point of Artificial Life researches, a multi-agent based ecological simulation will be helpful to understand the dynamics of epidemic. The authors developed an individual-based simulator in which the user is allowed to set the parameter values and to examine what would go on in a virtual population of tens or more thousands of individuals. The parameters include the metrics for environment, mobility, pathogenesis, countermeasures, and tests. We conducted some cases of simulation experiments based on the parameter settings targeting SARS-CoV-2. The dynamics shows almost same figures to those known from SIR model when the population size is large. However, under some conditions of strong restriction in relatively small population, the end of epidemic comes early. This fact also means it takes long period until the cessation in big cities, even when similar scale of restrictions to the country side are applied.

GS1-3 Mobility can promote the evolution of extortion strategies in iterated prisoner's dilemma games

Koki Kawaguchi, Reiji Suzuki, and Takaya Arita
(Nagoya University, Japan)

Iterated prisoner's dilemma game has been widely used to study the emergence of cooperation in social interaction and conflict situations. Recently, Press & Dyson (2012) proposed groundbreaking strategies, called zero-determinant (ZD) strategies. They can unilaterally enforce a linear relationship between the payoff expectations of the two players. For example, Extort-2 strategy, a subset of ZD strategies, can have about twice as much payoff as the opponents. On the other hand, they cannot spread out in the population, meaning a lack of evolutionary stability, because they have a small payoff when playing with themselves. We built the following hypothesis as part of the elucidation of unexplored properties of ZD. In an environment where agents move around and play, Extort-2 can continue to play with other strategies. Because of this, they can get higher as their unique property and thus increase their existence ratio by being imitated by other strategies. We conducted evolutionary experiments and analyses for the purpose of investigating the hypotheses for unexplored properties of ZD. These experiments support the hypothesis that Extort-2, a subset of ZD strategies, can increase their presence by exhibiting ZD-specific properties when they are provided with spatial locality and mobility.

January 21 (Thursday), 11:00–12:00

GS1-4 Simulation for labor market using a multi-agent model towards the validation of the Amended Labor Contract Act

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

In 2012, the Labor Contract Act has been amended in Japan to correct the employment conditions for fixed-term workers. The amended law still has a problem known as refusal of renewal of contracts. Our purpose in this paper is to show the amendment of the law does not necessarily reflect the initial motivation by finding a gap between the predicted and actual effects. We em-ploy a multi-agent system, in which agents autonomously behave as employers and employees. We simulated the effect of the amendment with the multi-agent system which consists of company agents with Q-learning and worker agents. Our experi-mental results showed that the company agents behaved similarly to the actual company managers in the real situation, that is, they did not employ permanent workers but fixed-term ones as possible. Our study will support legislation for amendment of laws.

January 21 (Thursday), 11:00–12:15

Room B

GS5 Control techniques

Chair: Yuichiro Taira (Sojo University, Japan)

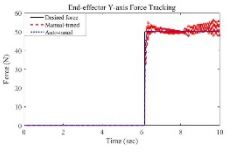
GS5-1 4-leg Balancing System for Takeoff of Quad-copter on Swaying Surface

Seonghyeon Hwang, Yeongkeun Kwon, Hosun Kang, and Jangmyung Lee
(Pusan National University, Republic of Korea)

This paper proposes the 4-legs balancing system for the takeoff of quad-copter on swaying surfaces such as ships. It is more difficult and unpredictable than flat ground due to the waves. Therefore, this system was created to provide a stable environment for the quad-copter during takeoff. By controlling the position of the legs, the multi-copter is able to maintain its stability on the ship and lower its center of mass to avert the multi-copter from flipping over. In order to maintain the attitude of the multi-copter, the PID control was applied for the error of angle to track the angle change of the surface, and the height of the center of mass was controlled in proportion to the angular velocity. The stability and tracking performance for angle change was confirmed through experiments comparing the IMU sensor value of the platform and the testbed.

GS5-2 SMC-Based Impedance Control Tuned by Particle Swarm Optimization for Robot Arm End-Effector Force Tracking

Muhammad Hamza Khan, Saad Jamshed Abbasi, Jin Won Lee, Hyun Hee Kim, and Min Cheol Lee
(Pusan National University, Republic of Korea)

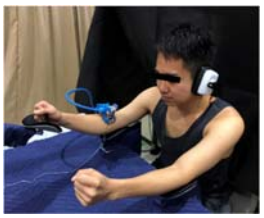


In this paper, a sliding mode control (SMC)-based force tracking impedance control is designed and auto-tuned for robot end-effector. SMC-based impedance control reduces the force overshoot and the force tracking error as compared to conventional impedance control. However, the overall performance is also/mainly depending on the choice of impedance parameters, i.e., inertia, damping, and stiffness. Generally, these parameters are selected based on the trial-and-error method to achieve the desired response, but they usually fail to provide satisfactory performance. Therefore, impedance parameters are self-tuned by the particle swarm optimization (PSO) technique. The parameters regulation is achieved based on the desired force, current interaction force, and PSO cost-function. The performance of manual and auto-tuned SMC-based impedance control is compared. The comparison shows that the PSO-SMC-based impedance control provides enhanced performance than the manually tuned impedance control.

January 21 (Thursday), 11:00–12:15

GS5-3 Investigation of main factors causing kinesthetic illusion in elbow joints towards rehabilitation robotics

Hiraku Komura[1], Takeshi Nozawa[2], Masakazu Honda[3], and Masahiro Ohka[2]
([1]Kyushu Institute of Technology, Japan)
([2]Nagoya University, Japan)
([3]Industrial Research Institute of Shizuoka Prefecture, Japan)



Researchers pay attention to kinesthetic illusion (KI) as a rehabilitation technology for stroke patients and as cognitive assistance for dementia patients. To achieve this goal, the researcher investigated the best stimulus condition of the KI that causes strong proprioception. We assumed that the optimum frequency of the vibration stimulus that causes the KI is derived from the natural frequency of the muscle tendon. However, our previous research clarified that the only natural frequency is insufficient to explain the optimal frequency for KI, since the correlation coefficient between them is R = 0.5. Therefore, in this study, we proposed a new model that predicts the optimum vibration frequency condition with the parameters of body composition as new explanatory variables. As the result of our experiment, the body weight and the upper arm circumference is chosen as the explanatory variables to predict the optimal condition for KI, and this prediction accuracy is greatly improved (R2 = 0.713).

GS5-4 Digital notch filter for reducing resonance in robot control system

JinHyeok Lee, Hyeonjae Ryu, and MinCheol Lee
(Pusan National University, Republic of Korea)

Resonance gives the controlled robots the impact due to the sharply rising output and damages a robot. The damping ratio is directly related to the magnitude of resonance. To minimize resonance that damages the robot, the damping ratio of the control system should be improved. Using the property of the modified notch filter that reduces its response magnitude in the specific frequency band and keep it up in the other frequency, it can be possible to cancel resonance by matching the frequencies. The proposed resonance reduction algorithm was simulated in MATLAB. The simulation compared existing PD control and P control with the proposed approach. Although this filter doesn't have a direct control performance, it can be applied with other controllers. The magnitude of resonance can be reduced in advance before other control algorithm apply to the system. Accordingly, engineers can freely decide which control algorithm to apply.

GS5-5 Development of autonomous control system for automatic search and transportation of an object by a mobile manipulator based on image processing

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

In this research, an autonomous control system of a mobile manipulator for automatic search and transportation of an object is developed. The control system is constructed by improving an existing system using image processing and distance measurement. The system has two functions of automatic search and transportation. The targets are detected by HSV color recognition using camera image. The autonomous control is realized based on proportional integral control law to determine the angular velocity, where the control error is calculated by using the image information and the angle-pixel characteristics. The effectiveness of the control system considered in this research was confirmed through experimental results.

January 21 (Thursday), 11:00–12:15

Room C

GS7 Human-machine interaction and collaboration

Chair: Hideo Miyachi (Tokyo City University, Japan)

GS7-1 Threshold selection methods for anomaly detection of facial skin temperature using variational autoencoder

Ayaka Masaki[1], Kent Nagumo[1], Bikash Lamsal[2], Kosuke Oiwa[1], and Akio Nozawa[1]
([1]Aoyama Gakuin University, Japan)
([2]Kajima Corporation, Japan)

A completely new approach to incorporate the concept of anomaly detection into the analysis of physiological and psychological states by facial skin temperature was proposed. The previous study suggests that a method using Variational Autoencoder, a deep generative model, can separate normal and abnormal facial skin temperature conditions. However, a method for automatically determining the boundary between normal and anomaly had not been established. In this study, Threshold selection methods for anomaly detection of facial skin temperature using variational autoencoder were proposed.

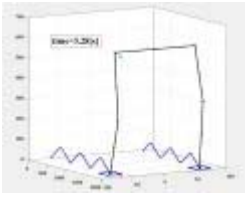
GS7-2 An evaluation of time delay tolerance in steer-by-wire - Research on stationary steering -

Yusuke MAENO, Hirokazu MATSUI, and Norihiko KATO
(Mie University, Japan)

We research the human tolerance corresponding to movement of the vehicle on the actual vehicle (customized COMS), and we propose the steering method with considering the tolerance. The rudder angle should be steered according to the moving distance. We propose a method to prevent steering without driving by permitting the obtained steerable angle, reduce tire wear and energy consumption within the range of human tolerance. We investigate whether a subject notice the difference between the rudder angles. The proposed method is considered to be effective if a subject steers stationary without the method or if he does not steer stationary with the method.

GS7-3 Evaluation of the stability limit of static walking in the elderly by considering the relationship between a projected point of a centroid and the base of support

Atsuki Tsuboi, Taku Itami, and Jun Yoneyama
(Aoyama Gakuin University, Japan)



Walking ability deteriorates due to aging-related muscle weakness and deterioration of balance ability, which makes it difficult to walk freely using gravity and leads to a static rather than dynamic walking pattern. In this study, we applied a biped walking robot simulation to static walking in the elderly and calculated the stability limit of static walking by changing the stride length. The lower limb parameters, walking speed, and ankle trajectory of the robot were applied to the average parameters of the elderly, and the stability limit of static walking was evaluated on the basis of the relationship between a projected point of a centroid and the base of support during walking. We were able to use a biped robot simulation to obtain static gait stride limits using the average physical parameters of elderly men.

January 21 (Thursday), 11:00–12:15

GS7-4 Development of a forearm-supported walker with walking support and autonomous driving functions

Yuto Mori[1], Soichiro Yokoyama[1], Tomohisa Yamashita[1], Hidenori Kawamura[1], Masato Mori[2], and Norio Kato[3]
([1]Hokkaido University, Japan)
([2]SUNCREER Co., Ltd., Japan)
([3]Hokkaido University of Science, Japan)

Owing to technological advancements in medicine and nursing, an aging population. Consequently, the elderly need more care and support from their caregivers. This study develops an autonomous forearm support walker for people who can use the walker alone. Its three main functions include moving with the user's weight supported, assisting the user in walking, and autonomous driving. These functions are expected to assist the patient in walking while reducing the burden on nursing staff. In this study, participants used the walker to walk a prescribed course. The stability of the walker's functions is verified by measuring its acceleration and the path it travels based on the self-position estimation from the sensors. From the results, the stability of the walking support function was shown using acceleration. As for the autonomous driving function, it was possible to drive without deviating significantly from the route.

GS7-5 An attempt at spatial normalization of facial thermal images using facial feature points

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

A human-machine interface (HMI) is an interface for humans and machines to communicate with each other. HMIs need to recognize the human state quantitatively and in real-time. Although it is possible to quantitatively evaluate the human condition by measuring biological signals, the challenge is that it often requires physical constraints. There is an increasing interest in non-contact evaluation methods for physiological and psychological states by measuring facial skin temperature using a thermography camera. However, there have been cases where the physiological state evaluation using facial thermal images did not work well due to individual differences in facial shape. In this study, we attempted at spatial normalization of facial thermal images to reduce individual differences in face shape. Next, to evaluate the effect of spatially normalized facial thermal images, we estimated one of the physiological state, drowsiness.

January 21 (Thursday), 11:00–11:45

Room D

OS4 Biomimetic Machines and Robots 1

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

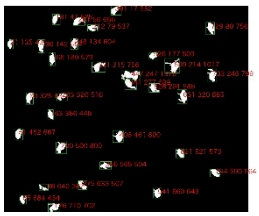
OS4-1 Detection of Defective Wrap Film Product Using Convolution Neural Network

Kento Nakashima[1], Fusaomi Nagata[1], Akimasa Otsuka[1], Keigo Watanabe[2], and Maki K. Habib[3]
([1]Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)
([3]The American University in Cairo, Egypt)

Although automation of some inspection processes for various kinds of industrial products has progressed, the situation seems to be largely depending on visual inspection ability of inspectors who are familiar with the quality control of each product. Recently, many attempts have been tried to apply CNNs specialized in deep learning technology to image recognition for product defect detection. In this paper, the authors try to detect defects occurring in the manufacturing process of wrap film products. Firstly, a template matching is applied to the entire images of the wrap film products to extract only the film part. Then, a CNN consisting of 15 layers is designed and trained using many augmented images of good products and defective ones to perform generalization ability. Finally, the generalization ability of CNN is evaluated through classification experiments. The usefulness of the developed CNN design application is also accessed through the test trial.

OS4-3 Visual Feedback Control and Object Count Function for a Quadrotor Using Image Processing Techniques

Lu Shao[1], Fusaomi Nagata[1], Keigo Watanabe[2], and Maki K. Habib[3]
([1]Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)
([3]The American University in Cairo, Egypt)



jpg

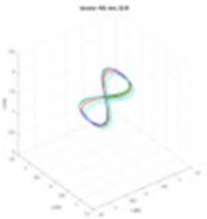
In the previous report, a target object in image frames composing a movie was successfully searched and identified based on the template image prepared in color or shape. The center of gravity (COG) could be consecutively calculated by detecting the object every sampling period, so that visual feedback (VF) control of a quadrotor became possible by referring the change of the COG as the relative velocity with respect to the target object. In this paper, another useful function to count the number of target objects is considered. This allows the quadrotor to monitor the number of individuals such as cars, animals and other objects contained in image frames. Not only it is difficult for human eyes to conduct high-speed counting of such objects, but also counting errors may occur due to overlapping of objects. This work contributes to cope with these problems using the quadrotor.

January 21 (Thursday), 11:00–11:45

OS4-4 Control for a tandem rotor UAV robot under wind disturbances

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

This paper presents the flight control of coupling both the position and attitude for a tandem rotor UAV robot that has two 2-DOF tiltable coaxial rotors in the presence of wind field disturbances. The performance of the computed torque control strategy already showed some limitations with the considering of the wind field disturbances in the previous study, in which the dynamical models of the proposed tandem rotor UAV robot and the model of the wind field disturbances have been discussed. In order to improve the flight performance of the UAV robot, a classical backstepping controller is designed and the system using this controller is proved to be asymptotically stabilized by the Lyapunov stability theory when unconsidering the external disturbance. Also, a robust backstepping controller for the UAV robot with the considering of the wind field disturbances is proposed, in which the integral of error is included in the Lyapunov function, together with using a saturation function in the controller. Finally, some numerical simulations are demonstrated to verify the performance of the proposed control strategies for the UAV robot.



January 21 (Thursday), 13:00–14:30

Room A

GS2 Artificial intelligence

Chair: Masatoshi Hatano (Nihon University, Japan)

GS2-1 Recognition of Road Conditions for Driving Support Using Deep Learning

Ashish Adhikari and Hironori Hiraishi
(Ashikaga University, Japan)

In this research, we propose an image analysis-based smartphone application model and the dataset to train. We used the Caffe implementation of the MobileNet-SSD detection network, with pre-trained weights on Visual Object Classes Challenge 2012 (VOC2012) with the dataset we prepared. Counting depthwise and pointwise convolutions as separate layers, MobileNet has 28 layers. Android terminals were used to demonstrate the model efficiency and the experiment was conducted in the daytime on the public roads as well as by showing the screen. Although, the system was not fully efficient. Analysis and detection tasks validation was performed manually as well to avoid mechanical errors. While validating misrecognized and undiscovered objects, images are manually taken for re-train.

GS2-2 Natural Intelligence：A Complement to Artificial Intelligence

Shuichi Fukuda
(Keio University, Japan)

Recently, changes occur frequently, extensively, and unpredictably. And materials are getting softer and softer. To cope with these difficulties, humans and machines need to work together, as IoT indicates. What we hare with machines is movement. It is a nonverbal communication tool. But to move adaptively and flexibly, we need another approach other than Euclidean Space approach, which requires orthonormality and interval scale distance. It makes mathematical approaches easy, so that most research on movement are based on the idea of control, But the number of dimensions of the real world is tremendously large. So, we cannot solve the real problem due to the curse of dimensionality. This paper introduces Non-Euclidean approach to overcome this difficulty. It is an approach for goal finding, while traditional one is problem solving. The new strategic decision-making tool is developed. Its uniqueness is it makes the most of instinct.

January 21 (Thursday), 13:00–14:30

GS2-3 3D Object Detection Algorithms on Intelligent Driving: A Survey

Zhen Li, Miaomiao Zhu, Shi Zhou, and Lifeng Zhang
(Kyushu Institute of Technology, Japan)

With the rapid development of Artificial Intelligent algorithms on Computer Vision, 2D object detection has greatly succeeded and been applied in various industrial products. In the past several years, the accuracy of 2D object detection has been dramatically improved, even beyond the human eyes' detection ability. However, there is still a limitation of 2D object detection using for the application of Intelligent Driving. A safe and reliable self-driving car needs to detect a 3D model of the around objects so that an intelligent driving car has a perception ability to real driving situations. This paper systematically surveys the development of 3D object detection methods applied to intelligent driving technology. This paper also analyzes the shortcomings of the existing 3D detection algorithms and the future development direction of 3D detection algorithms on intelligent driving.

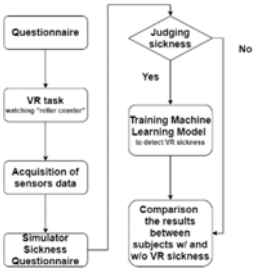
GS2-4 Mental stress level recognition using heart rate variability (HRV) and a deep recurrent neural network

Nan Bu[1], Masanori Fukami[2], and Osamu Fukuda[2]
([1]National Institute of Technology, Kumamoto College, Japan)
([2]Saga University, Japan)

The present study attempts to develop a recognition method for mental stress levels based on heart rate variability (HRV) data. Traditional research studies have utilized a lot of artificial intelligent approaches, and the recognition performance usually relies largely on the choice of HRV evaluation indices and/or their combinations. However, proper feature indices are frequently chosen with trial and error. Alternatively, the research strategy may shift from handcrafting feature indices to a totalized framework of feature extraction and recognition using deep learning techniques. In this study, long short-term memory (LSTM) is applied for deep learning of HRV data. Mental level recognition experiments have been conducted with configurations of level numbers from two to four. Length of data segments for stress recognition is used as 10, 20 and 30 s in the experiments.

GS2-5 VR Sickness Detection based on Electroencephalogram and Heart Rate Data

Atsushi Kakida, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)

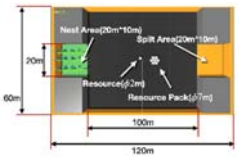


Recently, a variety of Virtual Reality (VR) services and immersive contents have been provided. Unfortunately, VR technology has a substantial disadvantage for some users, i.e., "VR sickness". Similar to the well-known motion sickness, VR sick-ness is a symptom of feeling sick while watching VR videos. Hence, it is one of the main reasons preventing a safe and sustained immersive experience of VR contents. In this study, we propose a method to detect VR sickness by machine learning based on multiple sensors data, e.g., EEG data and heart rate (bpm). We attempt to associate with those types of data to con-struct better indicators of VR sickness. Also, in order to record sensor data with continuous changes of subjects' state of the awareness of VR sickness during the experiment, we developed a recording program that can receive signals from sensor devices and a game controller.

January 21 (Thursday), 13:00–14:30

GS2-6 Hierarchical training method implementation on generating collective foraging behavior for robotic swarm

Boyin Jin, Yupeng Liang, Ziyao Han, and Kazuhiro Ohkura
(Hiroshima University, Japan)



Swarm robotics is a field in which multiple robots coordinate their collective behavior autonomously to accomplish a given task without any form of centralized control. Using sparse rewards to train swarm robotics to complete tasks is a challenge in reinforcement learning (RL). One solution is reward shaping, thus guiding the robot to reach the final goal by distributing additional rewards. But sometimes reward shaping also converge the robots to a local optimum in a long-horizon task. Besides, multi-objective tasks often require an elaborate reward shaping scheme, which prevents robots from learning efficient strategies. This study describes how a hierarchical training method-based RL approach can be applied to train the control policies for swarm robotics in a multi-objective task with a delayed reward. We conduct computer simulation experiments where robotic swarms have to accomplish a complex collective foraging problem.

January 21 (Thursday), 13:00–14:30

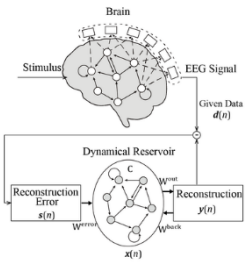
Room B

GS3 Artificial life & Chaos

Chair: Yoshihiko Kayama (BAIKA Women's University, Japan)

GS3-1 Encoding of time series data using reservoir computing

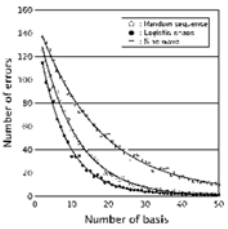
Masumi Kaneko[1], Naoyuki Sato[1], and Yuichi Katori[1,2]
([1]Future University Hakodate, Japan)
([2]The University of Tokyo, Japan)



Biological time-series like electroencephalograms potentially contain much fruitful information, but it is still challenging to fully extract that information. We propose a method for encoding a given time-series using reservoir computing, in which a recurrent neural network called reservoir learns and predicts a given time-series' dynamics. The reservoir extracts the features of the spatiotemporal pattern of the given time-series and reconstructs the data. We evaluate the method using time-series data generated by diffusively coupled spiking neuron models with injected pulses that induce different fluctuation patterns. The proposed model reconstructs the given time-series using extracted features based on the reservoir dynamics driven by the reconstruction error. The random forests classifies the given time-series into types of injected currents based on the extracted features. We show that the reservoir's state reflecting the injected pulse patterns is efficient in the classification of types of injected currents.

GS3-2 Mathematical basis for nonlinear time series

Masanori Shiro
(AIST, Japan)

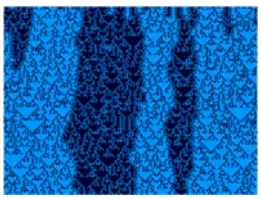


In this report, we propose a concept of mathematical basis for various sequences included nonlinear time series, for which the use of Fourier transform is not appropriate. The proposed method uses the recurrence plot and arithmetic representations. We implemented a prototype of the method and made a basis representation for random sequence, logistic chaos, and linear waves.

January 21 (Thursday), 13:00–14:30

GS3-3 Turing-like structures in outer-totalistic cellular automata and their extended rules

Yoshihiko Kayama
(BAIKA Women's University, Japan)



Cellular automata (CAs) have played a significant role in the study of complex systems. In particular, Conway developed a 2D CA called “Game of Life,” which exhibits complex behaviors reminiscent of biological activities. This study focuses on another attractive CA called “Day & Night,” which shows a different type of complex behavior from Conway’s CA. Its self-organizing pattern formation can be considered as one of the Turing patterns in reaction-diffusion systems. Its CA rule has a symmetry with respect to the one and zero states of cells (self-complementarity). This paper presents some examples of CA that show similar pattern formations to Day & Night. The mean field analysis helps discuss the conditions the candidates must satisfy to exhibit Day & Night-like behaviors. Such candidates were determined by extending outer-totalistic CA rules with a unit radius to rules with larger radius values. The extension of the CA through a modified recursive estimation of neighbor (REN) algorithm was presented at the 25th AROB conference. One of the modified REN algorithms, called REN-oppose, can be considered an inhibitor of a reaction-diffusion system and has been applied to the outer-totalistic rules of 1D elementary CA and 2D CA with a von Neumann neighborhood or a Moore neighborhood. The examples are self-complementary and show Turing patterns and attractive self-organizing processes similar to those of Day & Night.

GS3-4 Complexity Growth by Cooperative Interaction in Adversarial Learning

Taiki Sasaki, Wataru Noguchi, Hiroyuki Iizuka, and Masahito Yamamoto
(Hokkaido University, Japan)

Bird songs in nature are known as complex time series. It is hypothesized these time series appear in the competition where an individual bird tries to imitate the other's songs while trying not to be imitated by others, and the simulation study that models the emergence of complex time series in such adversarial competition has been conducted. Another study showed that the situation consists of not only adversarial but also cooperative interactions strongly promote complexity growth. We perform simulation of the evolution of time series in both adversarial and cooperative interactions by using artificial neural networks with more generality than the simple model as in the previous study, and investigate how complexity emerges. Our experimental results show that individuals in cooperative relations become complex, and this indicates cooperative interactions promote complexity growth even in a more general model of artificial neural networks.

GS3-5 Evolutionary design of soft robots that achieve energy-efficient locomotion based on co-evolution of morphology, materials, and control

Yuya Nakamura, Reiji Suzuki, and Takaya Arita
(Nagoya University, Japan)

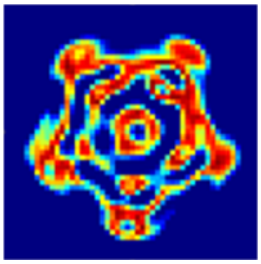
Soft robots are robots made of soft or elastic materials with a continuously deformable structure and muscle-like motions that mimic biological systems. It is important to design robots that are energy efficient in engineering applications. Natural organisms are composed of many different materials, from soft tissues to hard bones, and they have different energy consumption rates to maintain their structures and behaviors. In this study, we aim to gain insights into the evolutionary design of soft robots that achieve energy-efficient locomotion based on co-evolution of morphology, materials, and control. The robot's phenotype is encoded by CPPNs (Compositional Pattern Producing Networks) and is represented as a mass-spring system using the 2D particle and rigid-body physics simulation environment, LiquidFun. We could evolve various locomotion behaviors of soft robots that were composed of different materials when the energy efficiency of materials of their body was incorporated into the fitness evaluation. Among them, crawling-type robots tended to have modular structures and larger traveled distances. This result can contribute to the field of evolutionary biomechanics, suggesting that structural constraints on energy consumption may rather promote the optimization of the function.

January 21 (Thursday), 13:00–14:30

GS3-6 Replacement of the state-updating rule in the continuous cellular automaton model Lenia

Takako Kawaguchi, Reiji Suzuki, and Takaya Arita
(Nagoya University, Japan)

We report an extension that introduces asymptotics to the state-updating rules of Lenia, a family of continuous cellular automata. We conducted experiments to search for organisms in the proposed model and found several new species of organisms. They tend to move more smoothly than the organisms in the original model. Furthermore, we compared the original and our models to see where and what kind of organisms are in the parameter space. We found the cases in which the organisms have more complex internal structure or stable behavior than existing species in Lenia with the same parameter set. These results show that the introduction of asymptotics tends to change the behavior and shape of organisms according to the ease of their presence in the parameter space.



January 21 (Thursday), 13:00–14:15

Room C

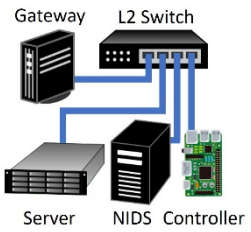
OS2 Bio-inspired Theory and Applications 1

Chair: Kunihito Yamamori (University of Miyazaki, Japan)

OS2-1 Network Design for Session Type NIDS

Ryo Saito, Kunihito Yamamori, Masaru Aikawa, and Kentaro Inoue
(University of Miyazaki, Japan)

In this paper, we propose a network design for session-type Network-based Intrusion Detection System (NIDS). We focus on the network itself, network availability and stream data handling to achieve the practical session type NIDS. NIDS insertion cost depends on the network design, and it tends to increase. When the inserted NIDS fails, communications may be blocked depending on the insertion style. We use the Address Resolution Protocol (ARP) to reduce the cost of inserting NIDS into the network. And, our design prepares an independent controller from NIDS to improve the network availability. After inserting the NIDS into the network, NIDS starts monitoring of the packets. And a large amount of memory is required to build a session from the packets. The proposed NIDS only focuses on the headers of some protocols to reduce memory usage.



OS2-2 Delivery Route Suboptimization Combined by Map Application and Genetic Algorithm

Yoshitaka Matushita, Masaru Aikawa, Kentaro Inoue, and Kunihito Yamamori
(University of Miyazaki, Japan)

In this paper, we aim to propose and evaluate a delivery route optimization method including random redelivery requests. An arrangement of Genetic Algorithm and enumeration method is used to determine the delivery route. Genetic algorithm and enumeration method are one of the popular solution methods to solve Traveling Salesman Problem. During the experiments, a map application will be used to obtain real distances. In the environment for experiments, absent destinations are randomly arranged and redelivery requests also randomly occur. Experiments showed that our method could present the delivery route even if 30% of destinations were absent and 60% of those sent redelivery requests when we set the number of destinations to 20.

January 21 (Thursday), 13:00–14:15

OS2-3 Computer aided arrangements using cadences and melodic regularity

Kosuke Yoshida, Kunihito Yamamori, Masaru Aikawa, and Kentaro Inoue
(University of Miyazaki, Japan)

In this paper, we aim to propose and evaluate music arrangement with computer support. We use cadences and melodic regularity in music arrangement.Cadences are musical heuristics and rules of transition easiness from a chord to the other chord. Since a lot of music has a regularity that includes the repetition of the same melody within a song, we use regularity to add a chord progression. To evaluate our proposed method, we get our information from questionnaires. In this questionnaire, naturalness of the music created by our method compared with the music created by cadence only.

OS2-4 Reinforcement Learning Approach for Imperfect Information Games

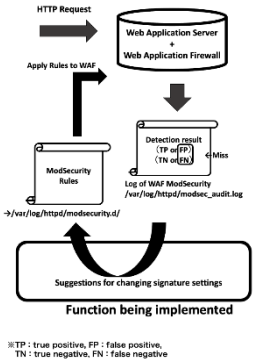
Akinobu Iwai, Kunihito Yamamori, Masaru Aikawa, and Kentaro Inoue
(University of Miyazaki, Japan)

In recent years, the development of game AI has been attracting a lot of attention. Game AI
is prominent in the fields of Go and Shogi. Game AI deal with games which are clearly defined states, restrictions of available actions, and reward settings. In the game theory, games can be classified into the complete information games and the incomplete information games.
A complete information game is defined as a game that all players can observe all decisions by the other player. On the other hands, an incomplete information game cannot know the
decision by a player at least. For a person, most of the real-world problems aim to maximize the person's profit without the others' profits and their decisions. In other words, it can consider the real-world problems to be the incomplete information
games.
Reinforcement learning (RL) is one of the methods to find the best action on the specific situation, and sometimes utilizes to optimize the game AI. RL is a framework to adapt a learning agent to an environment through trial and error. Reinforcement learning differs from supervised learning because there is no teacher which explicitly gives the appropriate action on the current environment to the learning agent. In the environments with the imprecise parameters or too complex environments, the concrete tasks or the solutions to conquer the environments are not clear for the developers. However, to set a goal which should be accomplished in an environment is relatively easier than dealing with many complex parameters. In addition, RL learns through trial and error, and RL has a potential to discover better solutions than those obtained by human experts. When the RL agent takes an action, the environment transits to a different state. The RL agent updates the own value function to select an action under a specific state of environment based on a given reward then, proceeds the learning process. The goal of RL is to obtain the value …

OS2-5 Tuning Support Tool for WAF Mod Security by Log Analysis with Machine Learning

Chihiro Kudo, Kunihito Yamamori, Masaru Aikawa, Kentaro Inoue, and Ryo Saito
(University of Miyazaki, Japan)

In this research, we develop and evaluate a tool that supports tuning work of WAF (Web Application Firewall). The tuning of WAF is very hard because a lot of new vulnerabilities are found in every day, and deep understanding of computer and network securities are required. At the tuning work, attack detection rules are set to reduce misdetections. Misdetection has two attributes, false positive and false negative. In this research, we aim to reduce false positives because WAF operators has to deal with every positive detection for secure operation of their web services. Our tool makes a classifier train by machine learning algorithm with a dataset including true positives and false positives, and the classifier obtains rules how to classify a communication is an attack or not. When a false positive detection will occur, then our tool gives the WAF operators an advice to correct the attack detection rules.



January 21 (Thursday), 13:00–14:00

Room D

OS5 Biomimetic Machines and Robots 2

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

OS5-1 A self-position estimation method by optical flow considering luminance changes

Kaito Miyai, Keigo Watanabe, and Isaku Nagai
(Okayama University, Japan)

Optical flow is a method of estimating the self-position, where the motion of an object at each pixelbetween two consecutive frames in a moving image is represented by a vector. In brief, it is a technique to find outhow a number of points at an image have moved to the other image. By using optical flow, it can detect the motionof objects in the frame and the motion of the camera, and analyze their movements. Optical flow can be appliedto image processing such as image recognition for various objects in applications, which include an on-board unit,robotics, and surveillance, etc. Note however that, since it is difficult to determine the optical flow uniquely, themotion (vector) is generally determined by estimation. The Lucas-Kanade method is known as a typical method forestimating the optical flow. This method assumes that the luminance value of a pixel does not change from frame toframe, which is a property of luminance conservation, but it can be often used to estimate the optical flow in videoimages without any special considerations, such as changes in the photographing environment (e.g., changes in theamount of sunlight) and flickering of fluorescent lights. If the luminance preservation between frames is not held, thenthe accuracy of flow estimation deteriorates significantly. Therefore, it needs an optical flow estimation algorithmthat is robust to luminance changes. In this study, two algorithms are proposed for optical flow estimation: one is anestimation algorithm that weights the least-squares method used in optical flow calculation to improve the accuracy ofthe optical flow, and the other is an algorithm based on the Lucas-Kanade algorithm for optical flow estimation thatis robust to changes in luminance. The effectiveness of these two algorithms is demonstrated by several simulationsthat compare them with the conventional ones.

OS5-2 Development of a Fault-Tolerant Control System for Multicopters Using Nonlinear Model Predictive Control and Deep Reinforcement Learning

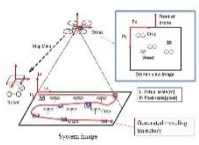
Satoshi Kato, Keigo Watanabe, and Isaku Nagai
(Okayama university, Japan)

In recent years, multicopters have been used for industrial fields. Among them, the realization of electric Vertical Takeoff and Landing (eVTOL) is the best example, and it is expected to significantly shorten the travel time between short and medium distances. But several accidents such as contact and crash are endless. If an eVTOL aircraft operation would be started in the future, the occurrence of those accidents may cause a large-scale disaster, thus any counterplans are essential. Therefore, this research aims to realize a fault-tolerant control system for multiple rotor faults using nonlinear model predictive control (NMPC). In this paper, Sequential Quadratic Programming (SQP) is used to design the performance function, and control simulations are conducted for the occurrence of two or more rotor faults.

OS5-3 Generation of target traveling trajectories for agricultural robots by drones with AI

Daiki Hachiya and Masatoshi Hatano
(Nihon University, Japan)

The purpose of the research is to develop a generation method of target traveling trajectories for an agricultural robot traveling on ground using object detection results by a drone with AI (Artificial Intelligence). Recently, the agricultural population is declining in Japan because of shortage of young farmers. Then, agricultural robots are required to work instead of farmers. Thus, robots on the ground and drones are used in the field of agriculture. In this research, we propose a generation method of target traveling trajectory with an object detection system with AI and the artificial potential method.

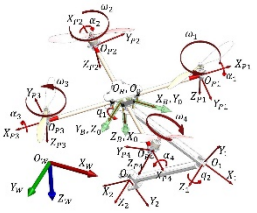


January 21 (Thursday), 13:00–14:00

OS5-4 Trajectory Tracking Control of Quadrotor Manipulator with Tiltable Rotors based on Sliding Mode Control

Shilin Yi, Keigo Watanabe, and Isaku Nagai
(Okayama University, Japan)

A fully-actuated quadrotor manipulator with tiltable rotors is proposed to follow a prescribed trajectory while transporting objects. The interaction between the quadrotor part and the manipulator part introduces a state-dependent nonlinear vector term into the dynamic equations of the proposed quadrotor manipulator. In the practical case, the bound of the nonlinear term is known. Since the integral sliding mode control retains robustness from the initial state in the presence of bounded disturbances and unmodeled uncertainties, a model-based integral sliding mode is designed to assure asymptotical convergence based on the Lyapunov stability analysis when the quadrotor manipulator is used to follow a prescribed 6-DOF trajectory.



January 21 (Thursday), 15:00–16:00

Room A

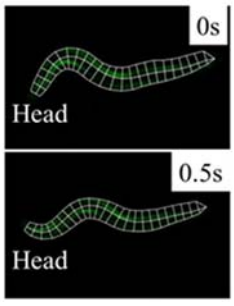
GS4 Bioinformatics & Medical Informatics

Chair: Abhijeet Ravankar (Kitami Institute of Technology, Japan)

GS4-1 Multiple Regression Analysis to Reveal Relationships between Muscle Activities and Body Bends in a Transgenic Caenorhabditis elegans

Kazuma Sakamoto[1], Hiroki Yamashita[1], Zu Soh[1], Michiyo Suzuki[2], and Toshio Tsuji[1]
([1]Hiroshima University, Japan)
([2]Takasaki Advanced Radiation Research Institute, National Institutes for Quantum and Radiological Science and Technology, Japan)

The nematode Caenorhabditis elegans (C. elegans) is a multicellular organism with a length of approximately 1.0 mm, and although they have a very simple structure with approximately 1,000 cells, they can move according to diverse environmental stimuli. Research has been conducted to investigate the mechanism of the C. elegans movement; however, the relationship between muscle activity and local body bends has not been fully clarified. In this study, we employed a transgenic strain of the C. elegans expressing fluorescent proteins on its body wall muscle to measure the fluorescence intensity corresponding to muscle activity and analyze their relation to local body-bending angles. The partial regression coefficients showed that the fluorescence rate was mainly correlated with the local bending angles. This finding indicated that the stiffness effect was dominant in driving the body.



GS4-2 Reinforcement Learning Approach to Design of Simple Stalizing Controllers for Probabilistic Boolean Networks

Michiaki Takizawa, Koichi Kobayashi, and Yuh Yamashita
(Hokkaido University, Japan)

A probabilistic Boolean networks (PBN) is a stochastic logical system in which update functions are randomly selected from a set of candidates of Boolean functions according to a prescribed probability distribution at each time step. A PBN can be regarded as a discrete-time Markov decision process (MDP). Hence, the stabilization problem of PBNs may be reduced to a reinforcement learning (RL) problem. RL provides a model-free framework, and solves a discrete-time optimal control problem for an MDP. In this paper, for a RL based approach of stabilization for PBNs, we propose a method for designing a reward function to reduce the number of states used in the controller. Since it is frequently difficult to realize a complicated controller, it is important to reduce the number of state variables used in the controller as much as possible. We also present a simple example.

January 21 (Thursday), 15:00–16:00

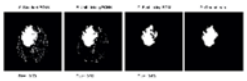
GS4-3 Behavior Recognition of Patients through Computer Vision

Abhijeet Ravankar[1], Ankit A. Ravankar[2], Michiko Watanabe[1], Yohei Hoshino[1], and Arpit Rawankar[3]
([1]Kitami Institute of Technology, Japan)
([2]Hokkaido University, Japan)
([3]Vidyalankar Institute of Technology, India)

Currently, Japan faces the problem of increasing old-age population which has become a serious concern. People in old-age home, and rehabilitation centers are expected to increase in the coming years. In such a scenario, it can be foreseen that it will be increasingly difficult to monitor each patient. This requires an automation of patient's activity detection. To this end, this paper proposes to use computer vision for automatic detection of patient's behavior. The proposed work first detects pose of the patient through a Convolutional Neural Network. Next, the coordinates of the different body parts are detected. These coordinates are input in the decision generation layer which uses the relationship between the coordinates to output the results. This paper focuses on the detection of important activities like: fall detection, and detection of sitting, eating, sleeping, and computer usage. We verify the proposed system thorough experiments in real environment with actual sensors.

GS4-5 Study of pulse-coupled neural networks for glioma segmentation

Brad Niepceron, Ahmed Nait-Sidi-Moh, and Filippo Grassia
(University of Picardie Jules Verne, France)



Glioma tumors are amongst the most aggressive and infiltrative form of cancer. An early stage identification can drastically improve a patient’s survival by anticipating a possible treatment. However, the variety of shape and location they can take as well as their rapid growth exposes healthcare providers to a challenge regarding the segmentation of a tumor and the establishment of a fast diagnosis. Hence, developing faster and lighter computer aided medical image analysis systems for tumor segmentation appears crucial to face the aforementioned problem. In this work, we address this challenge by studying the efficiency of various pulse-coupled neural networks for segmenting glioma. We used samples of the BRaTS 2020 training dataset to prove that pulse-coupled neural networks can be used as a base for the development of fast and lightweight glioma diagnosis applications.

January 21 (Thursday), 15:00–16:00

Room B

GS8 Identification and Estimation

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

GS8-1 Identification of human standing stabilizing dynamics by experiment of disturbance application using swash plate fall

Tsutomu Togoe, Pham Hoang Tung, Yasutaka Nakashima, and Motoji Yamamoto
(Kyushu University, Japan)

This paper firstly proposes a swash plate disturbance application device to measure the COP trajectory when the mechanical disturbance is applied. A linear identification method, where the input is the disturbance and the output is the COP trajectory, is used to get a human standing stability system model. The model is expressed by a transfer function which includes the parameters of poles and zeros. Using the identified parameters, a human standing stability is evaluated. By some swash plate disturbance experiments for human standing and system identification experiments under several experimental conditions based on the proposed method, various parameters of stability system dynamical model are obtained. Then, it is found that the stability index values according to the experimental conditions such as normal standing and tandem standing, are different. Which indicates the identified dynamics of the stabilizing system are different for the experimental conditions including the kinds of disturbances.

GS8-2 Simple Voice Emotion Recognition System for Companion Robot

Zijun YANG and Seiichi SERIKAWA
(Kyushu Institute of Technology, Japan)

With the continuous acceleration of the pace of life, people's pressure in life is increasing, their psychological conditions have been affected to a certain extent. These mental illnesses will not cause any impact in normal times, but once they break out, they will cause trauma that cannot be ignored in life and even society. Therefore, we want to design a companion robot that can chat with us in daily life. Use the most comfortable tone for everyone to accompany, and at the same time, it can feel our emotional changes in the dialogue. When we have negative emotions, it can promptly comfort and enlighten or even issue warnings in time. This paper mainly analyzes the basic characteristics of audio signals to preliminarily judge the user's emotional changes. We use six different emotional voices recorded by four voice performers, each of which contains 50 single sentences for emotion recognition analysis.

GS8-3 Moving-Object Tracking by Scanning LiDAR Mounted on Motorcycle Based on Dynamic Background Subtraction

Shotaro Muro, Masafumi Hashimoto, and Kazuhiko Takahashi
(Doshisha University, Japan)

This paper presents a method for tracking (estimating position, velocity and size of) moving objects in global navigation satellite systems (GNSS)-denied environments using light detection and ranging (LiDAR) mounted on motorcycle. Distortion in scan data from the scanning LiDAR is corrected by estimating the pose (3D positions and attitude angles) of the vehicle in a period shorter than the LiDAR scan period using normal distribution transforms based simultaneous localization and mapping (NDT based SLAM) and the information from inertial measurement unit (IMU) via the extended Kalman filter (EKF). By subtracting the local environment map generated by NDT based SLAM from the LiDAR scan data, the scan data of interest are extracted. Moving objects are detected in the scan data of interest based on an occupancy grid method and are tracked based on a Bayesian filter. The experimental results obtained in road environments demonstrate the effectiveness of the proposed method.

January 21 (Thursday), 15:00–16:00

GS8-4 Research on the automation of Tannkin production

Kazuha Yamamoto and Nobuo Iwasaki
(National Institute of Technology, Wakayama College, Japan)

Kishu Bincho charcoal from Wakayama prefecture is famous throughout Japan. “Tannkin” a Musical instrument using Kishu Bincho charcoal, is made in Akitsugawa. It is made by tuning Bincho charcoal to create a pitch so that it can be played. The tuning work is done by the craftsman by cutting the charcoal with a hatchet, which takes a lot of time because it depends on the intuition and experience of the craftsman. In this study we consider a system that automatically produces Bincho charcoal with an accurate pitch. Firstly we recorded the amplitude spectrum of the blow sound of the charcoal to evaluate pitch. The pitch of charcoal can be seen from the amplitude spectrum. Next, we investigated how the pitch changes with the shape of the charcoal. In particular, the length was found to be inversely proportional to the square root of the frequency.

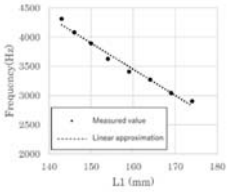


Fig.10. Relationship between the total length of Bincho charcoal and frequency

January 21 (Thursday), 15:00–16:00

Room C

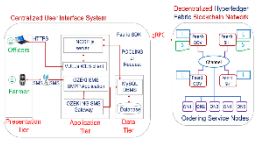
OS3 Bio-inspired Theory and Applications 2

Chair: Kunihito Yamamori (University of Miyazaki, Japan)

OS3-1 Development and evaluation of blockchain based agricultural input voucher system

Isakwisa Gaddy Tende, Kentaro Aburada, Hisaaki Yamaba, Tetsuro Katayama, and Naonobu Okazaki
(University of Miyazaki, Japan)

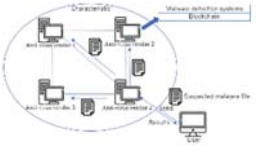
Most of the small-scale farmers in Tanzania can’t afford to buy quality agricultural inputs (fertilizers and seeds), therefore the Tanzanian government issues paper-based subsidy vouchers to farmers for buying the inputs at half price. However, challenges like misuse of the vouchers by some government officials (stealing and favoritism in allocation) and lack of trust (difficulty of verifying vouchers’ authenticity) have caused low crop productivity for the farmers and loss of government funds. To address this, we have developed agricultural input voucher system which stores and allocates digital subsidy vouchers to farmers in the Hyperledger Fabric blockchain network whose features like hashing and digital signature prevent misuse and ensure trust of the vouchers. Farmers access the digital vouchers through Short Message Service (SMS) in their mobile phones. Evaluation reveals that, the developed system is effective and meets performance demands of Tanzanian farmers. Also, Raft has better performance that Kafka consensus protocol.



OS3-2 Blockchain-based vote-type unknown malware detection method using a characteristic of anti-virus vendors' voting

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

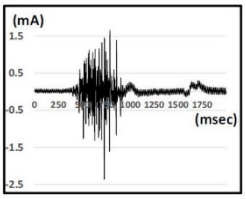
Year by year, the number of new malware observed has been increasing. We need to detect it quickly. However, it takes time for anti-virus vendors to update new malware information of anti-virus software. In this study, we propose a vote-type malware detection method by sharing information of suspected malware file among anti-virus vendors to detect new malware and improve the detection accuracy. The shared information includes votes indicating if the file is malicious or not. This system takes those votes into account to determine if the file is malicious or benign. If this system uses general database, shared malware information could be tampered and there is also the problem of responsibility for managing the database. Therefore, we adopted the blockchain technology for sharing of information among anti-virus vendors.



January 21 (Thursday), 15:00–16:00

OS3-3 An attempt at an introduction of deep learning for a user authentication system using s-EMG

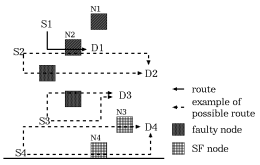
Hisaaki Yamaba[1], Kenya Shiraishi[1], Shotaro Usuzaki[1], Kayoko Takatsuka[1], Kentaro Aburada[1], Tetsuro Katayama[1], Mirang Park[2], and Naonobu Okazaki[1]
([1]University of Miyazaki, Japan)
([2]Kanagawa Institute of Technology, Japan)



Mobile devices such as tablet-type personal computers and smartphones have penetrated into our daily lives. We report on a new user authentication method for mobile devices that uses surface electromyogram (s-EMG) signals rather than screen-touch operations. S-EMG signals, which are generated by the electrical activity of muscle fibers during contraction, can be used to identify who generated the signals and which gestures were made. Our method uses a technique called “pass-gesture”, which refers to a series of hand gestures, to achieve s-EMG-based authentication. In this paper, deep learning is introduced to facilitate the identification of gestures from s-EMG signals. Pictures of s-EMG signals were directly used to differentiate gestures in experiments and the performance was evaluated. The results showed that the performance using deep learning was better than the one using support vector machines that was used in our previous works.

OS3-4 An Adaptive Fault-tolerant Routing Method for 2D Mesh NoCs Based on the Passage of Faulty Nodes

Yota Kurokawa and Masaru Fukushi
(Yamaguchi University, Japan)



Network-on-Chip (NoC) provides high computation performance for wide range of applications such as multimedia, robotics, artificial intelligence, as well as scientific parallel computing. In such highly-integrated parallel systems, fault-tolerant routing plays a key role in communication among nodes. Recently, a fault-tolerant routing method has been proposed based on the novel concept; passage of faulty nodes. Although the passage function is shown to be highly effective in reducing communication latency, this method provides deterministic routing and thus cannot choose alternative paths for avoiding network congestion. To overcome this problem, we propose an adaptive fault-tolerant routing method based on the concept of passage of faulty nodes. We employ well-known two adaptive routing methods, west-last and east-last routing, and allow passage of faulty nodes in both x and y directional movement. Performance evaluation shows that the proposed method reduces average latency of packet transfer by at least about 88% compared with the previous methods.

January 21 (Thursday), 15:00–16:00

Room D

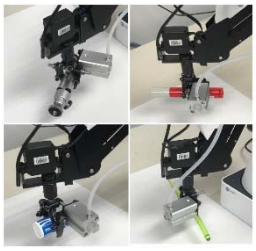
OS1 Bioinspiration and Robotics

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

OS1-1 Defective Molded Article Picking Robot Using Image Processing Technique and Visual Feedback Control

Kohei Miki[1], Fusaomi Nagata[1], Takeshi Ikeda[1], Keigo Watanabe[2], and Maki K. Habib[3]
([1]Sanyo-Onoda City University, Japan)
([2]Okayama University, Japan)
([3]The American University in Cairo, Egypt)

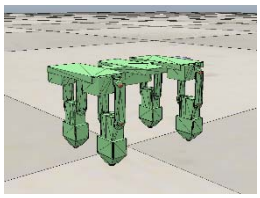
The authors are developing a robot system which will be able to remove defective molded articles in narrow metallic mold space. Currently, the inspection process is being manually done by skilled workers. The robot system can estimate the orientation of articles by using a transfer learning-based convolutional neural network (CNN). The orientation information is essential and indispensable to realize stable robotic picking operation. In addition, a visual feedback (VF) controller is designed by referring the center of gravity (COG) position of articles obtained by an image processing technique, so that the complicated calibration task between camera and robot coordinate systems can be eliminated. As a result, the authors propose a smart pick and place robot system in which the conventional calibration task is not required.



OS1-2 Dynamic simulation of non-programmed gait generation of quadruped robot

Yuki Takei, Riku Tazawa, Takumi Kaimai, Katsuyuki Morishita, and Ken Saito
(Nihon University, Japan)

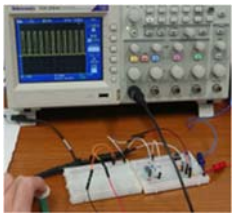
This paper describes a bio-inspired gait generation mechanism for quadruped robots. The authors implemented a leg controlling method to a quadruped robot model built on a dynamic simulator. The leg controlling method separately controls its legs using each toe's normal force. The leg controlling method is quite simple: the robot model drives its toe at a constant speed when the leg does not support its body. On the other hand, it reduces the speed according to the toe's normal force when the leg supports its body. Each toe moves the same semi-oval trajectory. The authors confirmed that the robot model could actively generate animals' gaits due to dynamic simulations. The robot model generated the walk gait and the trot gait according to the toe's speed. These results suggest we may identify the essential elements necessary to generate the gaits in quadrupedal walking by analyzing the proposed robot model's behavior.



OS1-3 Development of receptor cell model converting sensor inputs into pulse waveforms

Katsuyuki Morishita, Shinya Kato, Takuro Sasaki, Yuki Takei, and Ken Saito
(Nihon University, Japan)

The authors are studying to mimic an animal's nervous systems. In this paper, we developed an analog electronic circuit model that mimics biological receptor cells' function. The receptor cell model converts the sensory inputs into pulse waveforms. The output oscillation frequency of the receptor cell model varies according to the magnitude of the pMOS's gate voltage that changes due to the sensory input. As a simulation result, the receptor cell model's oscillation frequency changed from 1000 Hz to 380 Hz by the magnitude of the pMOS's gate voltage. As a measuring result, the receptor cell model's oscillation frequency changed from 670 Hz to 275 Hz by the magnitude of the pMOS's gate voltage. We also experiment with the receptor cell model's response characteristics using an optical sensor and the pressure sensor. The result shows that our developed receptor cell model could convert the sensory inputs into pulse waveforms.



January 21 (Thursday), 15:00–16:00

OS1-4 Robotics for Search, Rescue and Risky Interventions

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

Disasters including pandemics represent a serious disruption of life activities and functions of society, and the disaster hazard that pose threat to people and economy. Hence, they represent unpredictable emergencies that needs first quick response recovery with effective rescue and risky interventions supported by range of effective and reliable technologies and recovery equipment able to deal with harsh and dangerous environments. Robotics can play important roles supporting first response recovery while assisting response teams to accomplish critical and complex tasks collaboratively at the scene, collaboratively with human engaging at distance, or acting independently at the scene and remotely monitored from hazardous situations. Robotics solutions that are well adapted to local conditions of unstructured and unknown environment can greatly improve safety and security of personnel as well as improve work efficiency, productivity flexibility and reducing secondary damage in disaster area. This article discusses the rescue robotics challenge and highlight its role and the required technical specifications and functionalities. In addition, the paper introduces brief descriptions of selected rescue robotics projects associated with ground, air and sea for harsh and risky environment. Finally, the paper introduces an insight for the future of disaster relief and the insight into the future for search, rescue and disaster relief robots that can address real world applications by identifying the necessary requirements and development priorities.

January 22 (Friday), 9:00–10:15

Room A

GS10 Machine learning

Chair: Michiharu Maeda (Fukuoka Institute of Technology, Japan)

GS10-1 Research on improvement of comfortable indoor environment using environmental information

Yuta Kinoshita and Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

In recent years, air-conditioning equipment has become widespread in our lives, and as a result, the number of households that do not ventilate the room is increasing. Due to such lack of ventilation in the room, when we spend a long time in the same room The effect on the body due to the increase in carbon dioxide concentration in the room is regarded as a problem. It is important to prepare the indoor environment such as ventilation in order to prevent the deterioration of physical condition due to air pollution. In this study, Consider a program that alerts you before ventilation is needed, using sensors that measure room temperature, humidity, pressure, and carbon dioxide concentration. In addition, in order to prevent the indoor population density from increasing, we predict the density of people from the carbon dioxide concentration and grasp the fluctuation of the number of people in the room.

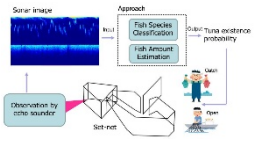
GS10-2 Person Re-identification in the Real-World Application Based on Deep Learning

Miaomiao Zhu[1], Shengrong Gong[2], Zhenjiang Qian[2], Seiichi Serikawa[1], and Lifeng Zhang[1]
([1]Kyushu Institute of Technology, Japan)
([2]Chang Shu Institute of Technology, China)

Person re-identification (ReID), aiming at retrieving a person of interest across multiple non-overlapping cameras. Because of increasing demand for real-world applications in intelligent video surveillance, it has become an important task in computer vision. And achieved high performance in recent years. However, the traditional research is mainly focus on matching cropped pedestrian images between queries and candidates on commonly used datasets, and divided into two steps: pedestrian detection and person re-identification, there is still a big gap with practical applications. Under the premise of model optimization, based on the existing object detection and person re-identification, this paper achieves a one-step search of specific pedestrians in whole images or video sequences in actual application scenario. The experimental results show that our method is effective in commonly used datasets, and has achieved good results in the real-world application, such as finding criminals, cross-camera person tracking and activity analysis.

GS10-3 Detection of fish species in sonar images using CNN

Yudai Hirama[1], Soichiro Yokoyama[1], Tomohisa Yamashita[1], Hidenori Kawamura[1], Keiji Suzuki[2], and Masaaki Wada[2]
([1]Hokkaido University, Japan)
([2]Future University Hakodate, Japan)

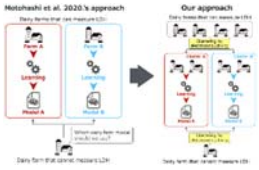


In this research, we applied a deep learning model to detect fish species in sonar images obtained using an echo sounder attached to the set-net. Sonar image presents a visualization of the underwater using the intensity of the reflected pulse and the time difference between reception. It is difficult to link fish species and their characteristics because the fish shadows reflected in sonar images are not constant owing to the changes in the natural environment. It should be noted that there are no technology-based methods that can distinguish between fish species. Therefore, in this paper, we propose a method to detect fish species in the sonar images by implementing a convolutional neural network (CNN), which is a model used in image recognition. Sonar images from an observation in 2015 and the amount of fishes caught daily for each species were the data used in the experiment.

January 22 (Friday), 9:00–10:15

GS10-4 Prediction of Bovine Mastitis Considering Differences among Dairy Farms using Machine Learning

Ginpei Yahagi, Ryo Hatano, and Hiroyuki Nishiyama
(Tokyo University of Science, Japan)



The aim of this study is to provide a method to detect bovine mastitis of dairy cows in dairy farming based on electroconductivity of milk and milk yield. It is known that bovine mastitis is a typical disease of dairy cows in dairy farming which causes serious economic losses to dairy farmers. To achieve our goal, we extend Motohashi et al. 2020's approach for a single farm to handle many farms based on clustering with respect to electroconductivity. The results showed that although there were some differences among dairies, the performance of the models in each cluster was close to the accuracy achieved when they were trained on the same dairy.

GS10-5 An algorithm of particle swarm optimization with subsidiary power

Takuya Muto and Michiharu Maeda
(Fukuoka Institute of Technology, Japan)

Particle swarm optimization is one of metaheuristics, which is inspired by the swarm behavior of bird flocking and fish schooling when searching for a prey. This algorithm explores an optimal solution by particle swarm which has information about velocity and position. Each particle searches the optimal solution while sharing the best solution. In this paper, we present an algorithm of particle swarm optimization with subsidiary power. Our algorithm moves particles to arbitrary positions within a certain range, and tends to avoid local solutions. In order to show the effectiveness of the proposed algorithm, we examine of the best solution to compare with existing algorithms by test functions.

January 22 (Friday), 9:00–10:15

Room B

GS11 Mobile robots

Chair: Yoshitaka Matsuda (Saga University, Japan)

GS11-1 A water-driven robot composed of oat seed with awns

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

In recent years, many researchers have created biomimetic robots inspired by the structure and function of living organisms. In general, the aim of biomimetic robots is to imitate only the movements of living things. As these robots include electronic parts and mechanical parts, they have a high environmental load. In this research, we focus on the behavior of oat seeds under dry and wet conditions, and develop a non-electrically driven robot using oats. The developed robot can move autonomously by controlling the amount of water from the outside. The proposed robot is composed only of organic substances that exist in the natural world, and is a robot with a low environmental load, which is different from conventional robots.

January 22 (Friday), 9:00–10:15

GS11-2 Sim-to-Real Transfer Learning to Close Gaps Between Simulation and Real Environments using Q-learning algorithm

Yuto Ushida, Hafiyanda Razan, Shunta Ishizuya, Takuto Sakuma, and Shohei Kato
(Nagoya Institute of Technology, Japan)

We aim to develop an autonomous mobile robot that supports workers in the warehouse to reduce their burden. The robot acquires a state-action policy to avoid obstacles and reach a destination by reinforcement learning using a LiDAR sensor. In the case of real-world application of reinforcement learning, the policy learned previously under simulation environment are generally diverted to real robots because of uncertainties that are unexpected under simulation environment, for example, friction, sensor noise, and so on. In this paper, we proposed a method to refine the action control of an Omni wheel robot by transfer learning in the real environment to deal with this problem. We conduct the experiment of searching the route for reaching a goal in a real environment using transfer learning's results and verify the effectiveness of the policy acquired.

GS11-3 CNN and LSTM models for acquiring stop and turn motion of self-driving model car

Ryo Fukuoka, Noritaka Shigei, Yoshihiro Nakamura, and Hiromi Miyajima
(Kagoshima University, Japan)

In this paper, we consider having small-scale cars learn the task of proceeding along the walls of a narrow and stopping in front of the target object. To improve the week point of our previous proposed CNN model with input of the previous throttle amount, we propose several models based on LSTM (Long Short-Term Memory), which is suitable for classification with sequential data. Our experiments demonstrate the effectiveness of the proposed models.

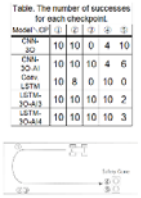


Table. The number of successes for each checkpoint.

Model \ CP	①	②	③	④	⑤
CNN-RG	10	10	0	4	10
CNN-3Q-AI	10	10	10	4	6
Conv-LSTM	10	8	0	10	0
LSTM-3Q-A3	10	10	10	10	2
LSTM-3Q-A4	10	10	10	10	3

GS11-4 Development of robot-assisted acoustic inspection for social infrastructure

Tomoyuki Hashiguchi, Geunho Lee, and Chunhe Li
(University of Miyazaki, Japan)

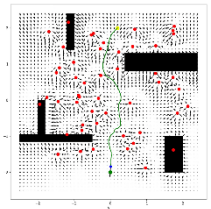
This paper proposes a hammering test method using a robot in order to solve the current labor shortage of structural inspectors. A mobile robot with a tapping unit mounted on the arm was manufactured, and tapping experiments were conducted to show the effectiveness of the device.

January 22 (Friday), 9:00–10:15

GS11-5 Dynamic Motion Planning for Mobile Robots using Improved Artificial Potential Field Method

Ankit A. Ravankar [1], Abhijeet Ravankar [2], Takanori Emaru[1], Yukinori Kobayashi[1]
([1]Hokkaido University, Japan)
([2]Kitami Institute of Technology, Japan)

Robot motion planning is a fundamental and important problem in robotics. Many existing path planning methods for wheeled robots are designed to work in static environment. However, in real environment the robot must tackle both stationary and dynamic moving obstacles such as people and plan its path without colliding with them. Artificial potential field method is classical local navigation method that can tackle both static and dynamic obstacles in the map and is very efficient. By generating a potential field around the obstacles into repulsive and attractive potential the robot can easily follow the vector field force and guide itself towards the goal. However, the artificial potential method suffers from local minima and bug trap scenarios. Moreover, the presence of many obstacles creates a deadlock situation for the moving robot due to cumulative repulsive forces acting on the robot body. To overcome this problem, we present a dynamic motion planning method using an improved artificial potential field method. We present a virtual force directed potential field method that overcomes the local minima problem and guarantees that the robot never gets stuck in the deadlock situation. The virtual force is determined by considering robot heading and goal direction. The magnitude of this force is mathematically modeled to always sway the robot away from the obstacle and towards the goal. We present with simulations and different map configurations the effectiveness of our proposed method in static and dynamic scenes. Moreover, we tested planning algorithm with number of randomly moving obstacles and show the advantage of our proposed method. The proposed method can be easily combined with state of the art global planners for a complete reactive navigation problem for mobile robots operating in dynamic environments.



January 22 (Friday), 9:00–10:00

Room C

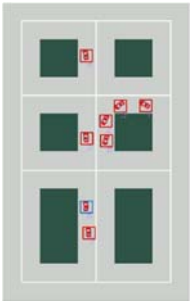
GS13 Multi-agent systems

Chair: Kazuhiro Ohkura (Hiroshima University, Japan)

GS13-1 Deep Reinforcement Learning for Smooth Traffic Flow at An Intersection

Tomoya Oda[1], Soichiro Yokoyama[1], Tomohisa Yamashita[1], Hidenori Kawamura[1], Takayuki Warabino[2], Tomohiko Ogishi[2], and Hideaki Tanaka[2]
([1]Hokkaido University, Japan)
([2]KDDI Research Inc., Japan)

Traffic jams are a major problem in crowded cities. Because vehicles wish to reach their respective destinations quickly, traffic may be concentrated in a specific area. Therefore, in this study, we focused on intersections, which are characterized by heavy traffic flow and interactions with other vehicles, to improve traffic flow within intersections. At intersections, priorities are strictly defined; however, in some cases, temporary changes to these priorities can increase the overall traffic flow. If each vehicle in the traffic environment could change their behavior independently so that overall traffic flow is increased. To consider this, we developed a simulator that can temporarily change the priority and successfully applied reinforcement learning to improve the overall traffic flow.

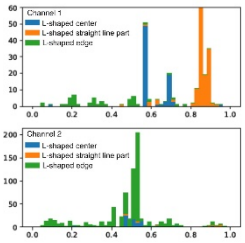


January 22 (Friday), 9:00–10:00

GS13-2 Multi-agent formation by learning communication signals using DIAL in a distributed multi-agent environment

Hironobu Horiuchi, Wataru Noguchi, Hiroyuki Iizuka, and Masahito Yamamoto
(Hokkaido University, Japan)

In multi-agent systems, communication between agents are useful for coordinating each other. Predefining the patterns of the signals limits the performance and robustness against unexpected situations. It is desirable that the agents autonomously learn how to use the signal so that the system properly coordinates to adapt to the various environments or tasks. In this paper, we propose a signal-learning method that can be incorporated into deep reinforcement learning. Our proposed method is evaluated in a multi-agent formation task where it is necessary to communicate with each other because it is impossible to know the overall locations of agents from local information, agents must communicate with each other to achieve the task. Our results showed that the signals are differentiated according to the agent's position in the formation, and the agents constructed and use signals appropriately for achieving the formation task.



GS13-3 An evaluation of fluidics for Tsunami in pedestrian's flood evacuation

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

In recent years, earthquakes have been observed at an increasing rate. A large-scale earthquake may lead to a tsunami, which could cause floods in urban areas. The evacuation of pedestrians in front of an approaching tsunami is difficult due to the speed of the water. Advanced evacuations are important in floods and can be achieved by coupling pedestrian simulation with a multi-agent system (MAS) and flood simulation with the shallow water equation. However, there may be some situations in which evacuators must ensure sufficient time for evacuation. Therefore, the authors of the present study developed fluidics to increase the time available for pedestrian evacuation by reducing the speed of the water to approximately one-third of its original speed. In this paper, the authors evaluate the effectiveness of fluidics for tsunamis in pedestrian flood evacuations. The results of the simulation indicate that fluidics can mitigate the speed of a spreading flood and thus increase the time available for evacuation. Therefore, we can confirm that the presently developed fluidics would effectively improve pedestrian evacuations in tsunamis.

GS13-4 An analysis of expansion and reduction speeds of traffic jams on graph exploration

Yukari Mochizuki and Kenji Sawada
(The University of Electro-Communications, Japan)

One of the representative problems of multi-agent systems is the graph exploration for package delivery. In the package delivery, not only overcrowding but also stopping of agents for loading and unloading package cause traffic jams. This paper motivates to evaluate a relationship between stopping of agents and exploration efficiency. In this paper, we introduce the incident ID which expresses the stopping of an agent and formulate outbreak, entry, and separation condition of traffic jams from model of movement and stopping of agents in ASEP, ASEP network, and two-dimensional grid exploration. We derive expansion and reduction speeds of length and width of traffic jams. Using the expansion speed and the reduction speed of length, we show the cancellation condition of traffic jams. For the verify of the derived cancellation condition, expansion speeds, and reduction speeds, we show the numerical experiments.

January 22 (Friday), 9:00–10:30

Room D

OS6 Design and Control of Robotic System

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

OS6-1 Development of Robot Hands Driven by Myoelectric Signal Input -Thumb Joint Dynamics-

Norihiro Goto[1], Arata Ejiri[1], Hidetaka Ohta[1], Yuichiro Taira[2], and Masahiro Oya[1]
([1]Kyushu Institute of Technology, Japan)
([2]Sojo University, Japan)

Prosthetic hands are used as a substitute for lost hands due to accidents, disease and so on. Development of design schemes for myoelectric prosthetic hands has become an active area of research. We have been developed the wrist joint dynamic model which can describe human wrist joint dynamics from amplitudes of surface electromyogram signals on hands to wrist joint angle. However, the thumb joint dynamics has not been considered when developing the dynamic model even though the thumb plays an important role in grabbing and picking. In this paper we will verify whether the proposed dynamic model can apply to reproduce the behavior of the thumb.

OS6-2 Rollover Prevention Control Scheme for Heavy Vehicles with Varying Mass and Longitudinal Velocity

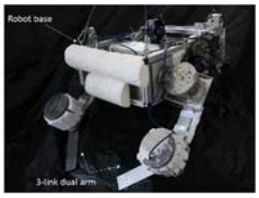
Kouhei Ohtomo, Syogo Miyamoto, Arata Ejiri, and Masahiro Oya
(Kyushu Institute of Technology, Japan)

In this paper, we propose a rollover prevention control method using front and rear wheel steering that takes into account variation of vehicle velocity and vehicle mass. First, we propose a new description for vehicles. The description is suitable for controller design in case when vehicle velocity and vehicle mass vary. Next, based on the description, we develop a new rollover prevention control scheme. Finally, numerical simulations are carried out to demonstrate the usefulness of the proposed controller.

OS6-3 Comparison of position control methods for UVMS using a dual-arm 3-link underwater robot

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

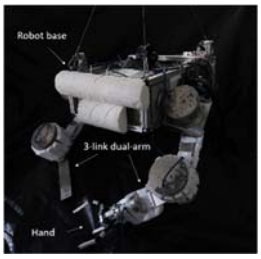
We have proposed a resolved acceleration control method for Underwater Vehicle-Manipulator Systems and have confirmed the usefulness of the proposed method through simulations and experiments using a 3-link dual-arm underwater robot. Furthermore, the proposed control method is compared with other control methods by simulation. Since the influence of modeling errors such as fluid force is large, it is necessary to compare these control methods by experiments as well as simulations. In this paper, we compare our proposed method with the computed torque method through experiments. The experimental results show that the control performance of our proposed method is better than the the computed torque method.



January 22 (Friday), 9:00–10:30

OS6-4 Force control of a floating underwater robot equipped with 3-link manipulator

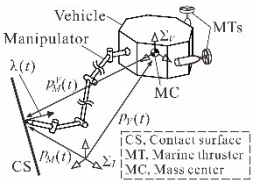
Taiga Yamasaki[1], Ryouma Mizoguchi[1], Yuichiro Taira[2], Radzi Ambar[3], Yuta Hanazawa[1], and Shinichi Sagara[1]
([1]Kyushu Institute of Technology, Japan)
([2]Sojo University, Japan)
([3]Universiti Tun Hussein Onn Malaysia, Malaysia)



Since underwater activities are dangerous to humans, research studies on the development of underwater robotic systems called Underwater Vehicle-Manipulator System (UVMS) are currently being carried out extensively. UVMS are robots equipped with multiple manipulators for the purpose of supporting and substituting humans in underwater activities. We have also proposed a resolved acceleration control method for UVMS and the effectiveness of the control method has been shown by simulations and experiments. In actual robot operations, force control is also necessary. Therefore, the authors have also developed an impedance control system, which consists of a continuous-time position-based impedance control system, and have verified its effectiveness by simulations. Since fluid force models used for control systems are not accurate, not only simulations but also experiments are required to verify the effectiveness of the proposed control method. In this work, the usefulness of the proposed system is verified through experimental results.

OS6-5 Design of an impedance controller for an underwater vehicle-manipulator system with a differently-controlled vehicle

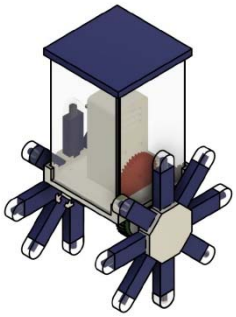
Yuichiro Taira[1], Shinichi Sagara[2], and Masahiro Oya[2]
([1]Sojo University, Japan)
([2]Kyushu Institute of Technology, Japan)



In this paper, we develop a motion and force controller for underwater robots, each of which is equipped with a manipulator. Its features are(1) to be designed for the manipulator under the condition that the robot body is independently controlled by a motion controller with poor performance, (2) to be designed in consideration of the dynamics of the robot body including its actuators (i.e., marine thrusters), and (3) to achieve a desired mechanical impedance which is suitable for a subsea operation that requires a contact between the manipulator tip (e.g., the hand) and an environment with a soft or fragile surface. Furthermore, we conducted numerical simulations for comparing the proposed controller with an existing one designed in disregard of the motion of the vehicle. The simulation results demonstrate the usefulness of the proposed controller.

OS6-6 Design of Rimless Wheel Walking Robots for 3D Printing

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



In this paper, we propose a design of the rimless wheel walking robot using 3D printers. We have studied a rimless walking robot for mobile robots walking on various road conditions. This robot consists of a torso and a rimless wheel. In the future, we must develop the many prototype of the rimless walking robots to evaluate the walking performance of our robot. However, development of the robot consumes a lot of monetary, human and temporal costs. To achieve efficiently developing of the rimless wheel robot, we have developed the robot using 3D printer. We present the design of the rimless wheel robot, outputted parts by the 3D printer, and an assembled robot.

January 22 (Friday), 13:00–14:15

Room A

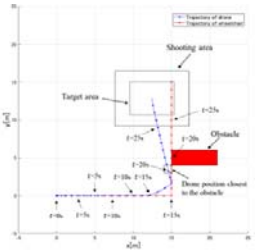
GS9 Intelligent control

Chair: Kazuyuki Ito (Hosei University, Japan)

GS9-1 Optimal trajectory generation of drone for wheelchair tracking by mixed integer programming

Shun Watanabe and Masakazu Mukai
(Kogakuin University, Japan)

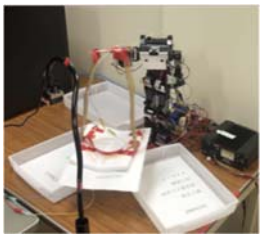
This paper considers the optimal trajectory generation problem in which the drone captures the wheelchair with the onboard camera and avoid collision with obstacles. The optimal trajectory generation problem is formulated as a mixed integer linear programming. The same method can be used to formulate the capture of the wheelchair. The same method can be used to formulate the capture of the wheelchair. The optimal trajectory generation problem is solved at each time step, and the first element of the optimal input are applied. Optimization Toolbox for MATLAB is used to solve the optimal trajectory generation problem. As a result, it was possible to avoid obstacles while capturing the wheelchair in which the drone moves on the target trajectory in the camera image.



GS9-2 Developing a paper sorting robot for physical RPA

Takuya Okamoto, Hideaki Itoh, Hisao Fukumoto, and Hiroshi Wakuya
(Saga University, Japan)

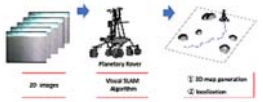
The technology called Robotic Process Automation (RPA) has attracted the attention of many companies, because it can reduce human workload in offices. However, most existing RPA systems do not automate physical office job processes. Therefore, it is highly desirable to develop RPA systems that can automate physical processes. As a first step towards such physical RPA systems, in the present study, we have developed a system in which a robot automatically sorts paper documents. Our system consists of three subsystems. First, a camera subsystem recognizes the number written on each paper document. Second, an electroadhesion subsystem holds each paper. Last, a robot motion subsystem moves the robot hand. Experimental results show that our system successfully sorted given documents automatically.



GS9-3 A preliminary study on visual SLAM for planetary exploration rovers

Rio Kajiura and Satoshi Ono
(Kagoshima University, Japan)

In the past, wheeled planetary probes have been controlled mainly by instructions from Earth in environments with communication delays. Recent self-positioning technologies are expected to be applied to the planetary probles; however, they suffer from the error accumulation and might be unsuitable for environments with fewer feature points. This study attempts to apply a method of Simultaneous Localization And Map buliding (SLAM) to planetary exploration. This study focuses on a Visual SLAM method, which reconstructs the geometric features of the surrounding environment from camera-captured images, and assesses the performance of self-positioning in environments with few feature points. Experimental results have shown that the tested Visual SLAM method could only reconstruct 16.0% of the trajectory of the wheeled planetary probe whereas the method could estimate 99.6% of the trajectory for data taken by a car driving in an urban area on the Earth.



January 22 (Friday), 13:00–14:15

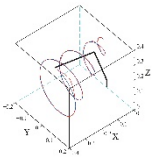
GS9-4 Study on landslide prediction using edge computer

Issei Uohira and Kazuya Okamoto
(National Institute of Technology, Wakayama College, Japan)

In Japan, the condition of the ground changes every year due to the effects of meteorological disasters such as typhoons and the accompanying heavy rains. As the condition of the ground changes, the inclination angle of the slope changes, which may cause a landslide. When a landslide occurs, there is a risk that cars running near the landslide occurrence point, residents living near slopes, installed utility poles and power generation and transformation equipment will be caught in the landslide. Therefore, in order to prevent residents living near the slope and vehicles traveling near the slope from being caught in the landslide, it is necessary to continuously monitor the condition of the ground by dispatching personnel to investigate the condition of the ground.

GS9-5 Comparison of High–Dimensional Neural Networks Using Hypercomplex Numbers in a Robot Manipulator Control

Kazuhiko Takahashi
(Doshisha University, Japan)



This study considers high-dimensional neural networks based on hypercomplex numbers that form four-dimensional algebra over the field of real numbers, such as quaternion, coquaternion, hyperbolic-quaternion, bicomplex and dual-complex numbers. Moreover, the characteristics of the networks in the application of controlling a robot manipulator are explored. In the control system, the output of the high-dimensional neural network is used as the control input for the robot manipulator to ensure that the manipulator's end-effector tracks a desired trajectory in a three-dimensional space. To evaluate the learning and control performance of the high-dimensional neural networks, computational experiments are conducted on controlling a three-link robot manipulator. The simulation results demonstrate that the quaternion-valued neural network affords better performance in learning and control compared to other networks.

January 22 (Friday), 13:00–14:15

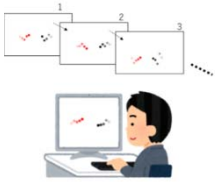
Room B

GS12 Motion planning and navigation

Chair: Ryuhei Yamada (The University of Aizu, Japan)

GS12-1 Animacy perception of a pair of movements under quantitative control of its temporal contingency: a preliminary study

Kenichi Oguma, Takuma Torii, and Shohei Hidaka
(Japan Advanced Institute of Science and Technology, Japan)



People perceive life-likeness from the movements of even geometric shapes. This phenomenon is called animacy perception. In this study, we examine our hypothesis that the degree to which one movement contributes to the predictability of the other movement characterizes the degree of animacy. To quantify temporal contingency in this sense, we define temporal contingency by Granger causality in multivariate animacy. To test our hypothesis, we created various movie clips of the two moving circles and asked human participants to rate the degree of animacy, intention, and contingency in each movie. The result of this experiment showed that the degrees of contingency and intension of one object were correlated to those of animacy, only if there was low Granger causality from the other to the object. This result suggests that perceived autonomy, measurable by Granger causality, would play a major role in deciding factors correlated to animacy perception.

January 22 (Friday), 13:00–14:15

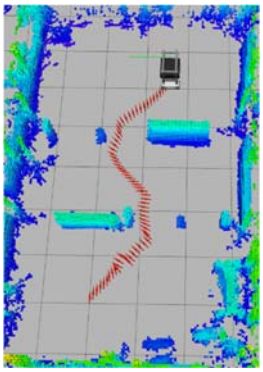
GS12-2 Invention of automatic movement and dynamic positioning control method of unmanned vessel for mud mining

Shun Fujii[1], Tetsu Kato[1], Yamato Kawamura[1], Junichiro Tahara[1], Shoichiro Baba[2], and Yukihisa Sanada[3]
([1]Tokyo University of Marine Science and Technology, Japan)
([2]Japan Agency for Marine-Earth Science and Technology, Japan)
([3]Japan Atomic Energy Agency, Japan)

In recent years, unmanned vessels that navigate autonomously have been actively studied. Many of these vessels are designed to perform unmanned tasks such as observation and transportation. On the other hand, this study uses an unmanned vessel with a moon pool to collect mud on the seafloor, which is difficult to be done by an ordinary vessel. Since the area where the vessel is used has large disturbance by wind, it is necessary to maintain a fixed point and heading during the mud extraction. The vessel is equipped with side thrusters, which enable it to hold a fixed point and heading. In this study, a control method is devised for maintaining the fixed point and heading. The control method is based on the sliding mode control, which is robust against disturbance. The proposed control method was verified by simulations, and it was confirmed that the desired behavior could be achieved.

GS12-3 Real-time Path Planning for Mobile Robots in Large-scale 3-D Environment

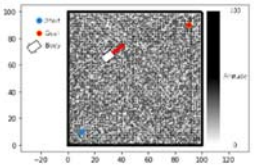
Xixun Wang[1], Kozo Moriyama[2], Lucas Brooks[2], Shin Kameyama[2], and Fumitoshi Matsuno[1]
([1]Kyoto University, Japan)
([2]JOHNAN Corporation, Japan)



Real-time path planning in a large scale dynamic environment for mobile robots is a complex task, especially when the 3-D configurations of mobile robots and obstacles are considered. In this research, a hardware accelerator is used for real-time path planning on a large-scale hierarchical roadmap. Meanwhile, a parallel version of 3-D collision detection is used to enable/disable edges of the hierarchical roadmap in real-time when the environment is dynamically changing. Finally, the physical experiment is carried out to demonstrate that a mobile robot can navigate itself in real-time in a scaled-down environment while the roadmap keeps a large number of nodes for a large-scale environment.

GS12-4 Robust Path Planning Combined Persistent Homology with H2 Augmented Graph in 2.5D Environment

Daichi Yamada, Taku Itami, and Jun Yoneyama
(Aoyama Gakuin University, Japan)

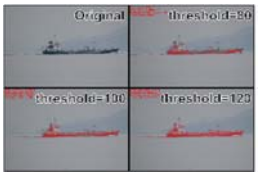


This paper considers a path planning algorithm for vehicle using persistent homology in 2.5D environment. In recent years, the growth of automated driving technology has been remarkably progressed. Even, fully autonomous driving technology is under establishment. There is still an open problem in motion planning that controls not only the vehicle itself but also autonomous mobile vehicle robot from the initial position to the target position. The optimal solution in the motion planning problem is to move from the initial position to the target position with fast, short and safe trajectory without colliding with obstacles. In this study, we propose a trajectory generation algorithm by applying persistent homology and H2 augmented graph taking into account the altitude of the terrain. This approach guarantees robustness in both stability and efficiency.

January 22 (Friday), 13:00–14:15

GS12-5 Development of wake detection system for ship navigation

Katsuya Hakozaki, Etsuro Shimizu, and Ayako Umeda
(Tokyo University of Marine Science and Technology, Japan)



Currently, the development of autonomous ships has been carried out all over the world. It is expected that the functions of course tracking, automatic collision avoidance, and automatic berthing will be developed for autonomous ships. Even if automating these three tasks, it remains a question whether it is possible to realize the system for autonomous ships that can replace seafarers. A method to suppress the rolling and pitching of the ship has been established by changing the direction of the ship in response to the wakes from other ships. On the other hand, a system to detect the wakes using visual acuity is not exist. Therefore, in this research, we developed a wake detection system using images taken by a camera for the purpose of automating ship maneuvering against wakes.

January 22 (Friday), 13:00–14:30

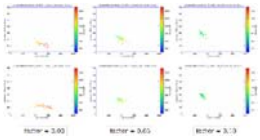
Room C

OS10 Social simulation and HPC

Chair: Nobuyasu Ito (RIKEN Center for Computational Science, Japan)
Co-Chair: Itsuki Noda (AIST, Japan)

OS10-1 Higher-Order Statistics in Simple Pandemic Simulation

Itsuki Noda[1], Shunki Takami[1,2], and Masaki Onishi[1,2]
([1]National Institute of Advanced Industrial Science and Technology, Japan)
([2]University of Tsukuba, Japan)



We propose a method, named ``adjustment of infection ratio by grid histgram (AIRGH)'', to adjust ununiformity effects of population distribution of real data in simple pandemic simulations that use simple random-walks as a agents' movement model that form uniform population distributions. The method is delived from higher-order statistics of population, which correlate with non-linear social phenomena like pandmic.http://isarob.org/symposium/ The method is varidated by a series of twin experiments of a pandemic simulation with various ununiform distributions.

OS10-2 Modeling of a mode choice behavior toward agent-based Mobility as a Service simulation

Ryo Nishida[1,3], Ryo Kanamori[2], and Itsuki Noda[3]
([1]Tohoku University, Japan)
([2]Nagoya University, Japan)
([3]National Institute of Advanced Industrial Science and Technology, Japan)

The concept of Mobility as a Service (MaaS), which means integrating multiple transportation modes, not only fixed transportation but also on-demand service, and providing them as a single service, is attracting attention. For the efficient operation of the MaaS system, appropriate number of on-demand service vehicles and pricing are required. Agent-based simulation is suitable for analyzing the relationship between such transportation setting and user behavior. Therefore, we construct a simulation tool to quantitatively analyze and evaluate a MaaS system that consists of users mode choice model as demand side, on-demand shared service allocation method and railway/bus operational information as supply side, and traffic simulator, SUMO. As a case study, we analyze the impact on an actual MaaS demonstration where on-demand shared services were introduced into public transportation modes such as railways, fixed-route buses.

January 22 (Friday), 13:00–14:30

OS10-3 Covid-19 disease and social simulation with the Fugaku supercomputer

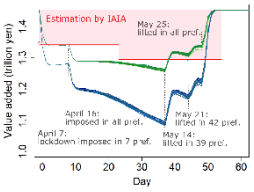
Nobuyasu Ito
(RIKEN Center for Computational Science, Japan)

Application libraries for disease spreading and GPS-data mining were developed mainly for use on the Fugaku supercomputer. The disease-spreading library named “DisSim” uses an agent-based model with Monte-Carlo sampling over distribution of disease periods like incubation, infection and recovery. The GPS-data mining library named “GPSMiner” analyzes GPS records of mobile devices with device identification and visualization. Some examples of these libraries for the Covid-19 pandemic are included.

OS10-4 The impact of supply-chain networks on interactions between the anti-COVID-19 lockdowns in different regions

Hiroyasu Inoue[1], Yohsuke Murase[2], and Yasuyuki Todo[3]
([1]University of Hyogo, Japan)
([2]RIKEN Center for Computational Science, Japan)
([3]Waseda University,)

To prevent the spread of COVID-19, many cities, states, and countries have `locked down', restricting economic activities in non-essential sectors. Such lockdowns have substantially shrunk production in most countries. This study examines how the economic effects of lockdowns in different regions interact through supply chains, a network of firms for production, simulating an agent-based model of production on supply-chain data for 1.6 million firms in Japan. We further investigate how the complex network structure affects the interactions of lockdowns, emphasising the role of upstreamness and loops by decomposing supply-chain flows into potential and circular flow components. We find that a region's upstreamness, intensity of loops, and supplier substitutability in supply chains with other regions largely determine the economic effect of the lockdown in the region. In particular, when a region lifts its lockdown, its economic recovery substantially varies depending on whether it lifts lockdown alone or together with another region closely linked through supply chains.



OS10-5 An effect of a contact trace application when the reproduction number is around 1.0

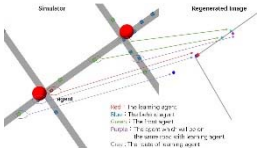
Naohiro Tsuzu[1,2], Naoki Yoshioka[2], and Nobuyasu Ito[2]
([1]Nagoya University, Japan)
([2]RIKEN Center for Computational Science, Japan)

The COVID-19 is spreading like wildfire. In Japan, a moving average of new confirmed cases are almost flat for two months from September to October, which means that the reproduction number is around 1.0. Considering this situation, we investigate how effective a contact trace app is when the reproduction number is around 1.0 by using agent-based model. We see that the peak decreases to nearly one tenth and the reproduction number becomes less than 1.0 by using contact-trace applications. We also see that delays of the app alert and self-isolation affect the peak and the reproduction number.

January 22 (Friday), 13:00–14:30

OS10-6 Generation of Traffic Flows in Multi-Agent Traffic Simulation with Agent Behaviour Model based on Deep Reinforcement Learning

Junjie ZHONG[1,2] and Hiromitsu HATTORI[1]
([1]Ritsumeikan University, Japan)
([2]Dalian University of Technology, China)



In multi-agent based traffic simulation, agents are always supposed to move following existing instructions, and mechanically and unnaturally imitate human behaviour. The human drivers perform acceleration or deceleration irregularly all the time, which seems unnecessary in some conditions. For letting agents in traffic simulation behave more like humans and recognize other agents' behaviour in complex conditions, we propose a unified mechanism for agents learn to decide various accelerations by using deep reinforcement learning based on a combination of regenerated visual images revealing some notable features, and numerical vectors containing some important data such as instantaneous speed. By handling batches of sequential data, agents are enabled to recognize surrounding agents' behaviour and decide their own acceleration. In addition, we can generate a traffic flow behaving diversely to simulate the real traffic flow by using an architecture of fully decentralized training and fully centralized execution without violating Markov assumptions.

January 22 (Friday), 13:00–14:30

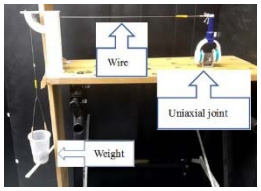
Room D

OS8 Robotics with Intelligence and/or Informatics 1

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

OS8-1 Impact resistance test on the single-shaft joint mechanism imitating a cartilage cushioning

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



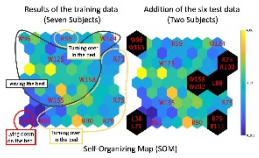
There are high expectations for robots that can work without breaking even in human living spaces in order to ameliorate the labor shortage due to population decline. Robots need to be protected from unpredictable multi-directional disturbances. Therefore, expecting a role like human cartilage, we incorporated a connector made of soft material into the uniaxial joint of the robot. This connector has shown its effectiveness against static external forces. In this paper, we used the CAE function of CAD software to perform a simulation that applies a momentary impact. The results show that the soft connector serves to protect the motor and frame of the uniaxial joint against momentary impacts.

January 22 (Friday), 13:00–14:30

OS8-2 Development of a bed-leaving motion detecting system using Self-Organizing Map

Kazuya Hamaguchi[1], Masanori Sato[1], Takeshi Ikeda[2], and Shinsuke Yasukawa[3]
([1]Nagasaki Institute of Applied Science, Japan)
([2]Sanyo-Onoda City University, Japan)
([3]Kyushu Institute of Technology, Japan)

In this paper, we developed the motion detecting system using the depth image which applied discrete Fourier transform. The depth images of the user are providing the user's posture considering the user's privacy. Two-dimensional discrete Fourier transform applied to the depth image shows the spatial frequency. Therefore, the same motion shows almost results even if the user's positions are difficult on camera images. Our system is designed to determine three postures:(1) lying down on the bed, (2) turning over in the bed, and (3) leaving the bed. To determine the three motions, we obtained the number of lines and their angles using Hough transform to the two-dimensional spatial frequency spectrum. And we applied the Self-Organizing Map (SOM) to classify the three motions. In the experiments, we obtained favorable results. Our proposed method could estimate the three motions with blanket especially turning over in the bed and leaving bed motion.



OS8-3 Stereo-vision-based AUV docking system for resetting the Inertial Navigation System errors

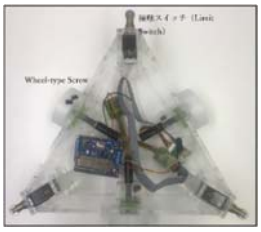
Horng-Yi Hsu, Yuichiro Toda, Kohei Yamashita, Keigo Watanabe, and Mamoru Minami
(Okayama University, Japan)

Autonomous Underwater Vehicles (AUVs) are used for underwater exploration of the sea floor. AUVs use an Inertial Navigation System (INS) and sonar sensors to recognize their positions in the underwater, but recognition errors are possible. Global Positioning System (GPS) that have been useful for all bind of vehicles moving on the ground or in the air could not be utilized in water because radio signals could not penetrate into the water. As the task progresses, the INS accumulates recognition errors. As the accumulated error is increased, the success rate of the task is decreased. In this study, we propose a stereo-vision-based docking system using AUV for resetting the integrated INS errors. The experiment simulates the AUV returning to the docking station by using the INS navigation system. The experimental results show that our proposed method enables to dock the AUV and reset the INS errors.

OS8-4 Development of an autonomous bathtub cleaning robot

Seiji Furuno[1], Nabeel Azhar Bin Rijap[1], Takeshi Ikeda[2], and Masanori Sato[3]
([1]National Institute of Technology, Kitakyushu College, Japan)
([2]Sanyo-Onoda City University, Japan)
([3]Nagasaki Institute of Applied Science, Japan)

Cleaning robot, which is widely used across the world as well as Japan, has been gaining traction amongst various industries and households. Thus, the demand for automation in households is remarkably high. Hence, we propose to develop a cleaning robot that can clean bathtub autonomously. Since it is impractical to install a robot arm in a bathtub, we aim to develop a small-sized cleaning robot. In this paper, we developed an equilateral triangle robot attached with a motor to each side with a limit switch at each vertex. The motor then attached with newly developed screw-type wheel that can provide new mechanism which is propulsion and driving mechanism in one robot.



January 22 (Friday), 13:00–14:30

OS8-5 Development of a semi-submersible autonomous surface vehicle for cooperating with remotely operated vehicle

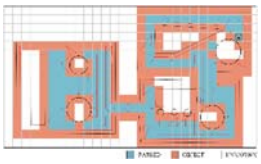
Taiki Shichijo, Kazuya Hamaguchi, and Masanori Sato
(Nagasaki Institute of Applied Science, Japan)

Recent years, remotely operated vehicle (ROV) has been used for observation of a marine structure, bottom of a ship, and education. On the other hand, the ROV is easy to be affected by the tidal current and easy to lost localization. In this paper, we developed a semi-submersible type autonomous surface vehicle (ASV) for support the ROV. The first and second prototypes of ASVs showed well against the ocean waves effect, and it can move omni-direction. The third prototype ASV is designed based on the results of 1st and 2nd ASVs.

OS8-6 Complete coverage algorithm for mobile robot

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

This paper describes a new complete coverage algorithm for mobile robots, such as cleaning robots and exploration robots to cover the unknown environments. The coverage algorithm proposed in this study divides the unknown environment into a square grid, and the mobile robot moves in such a way that it fills all the grids it can enter. We proposed two new coverage algorithms, spiral and along-wall coverage algorithm, and simulated them in two unknown environments. Although the difference in performance was shown depending on the environment, the two proposed algorithms were able to cover the environment with high coverage rate.



January 22 (Friday), 15:00–16:00

Room A

GS6 Data mining

Chair: Takayasu Fuchida (Kagoshima University, Japan)

GS6-1 Mental State Classification by Using Brainwave Sensors

Sukh Sagar Subedi and Hironori Hiraishi
(Ashikaga University, Japan)

Human Brain, a very complex part of the human body which generates various type of signals of different frequency in wakefulness or sleeping period. By using these dissimilar type frequencies brain waves can be distinguished from each other. Brain waves is a generic term used to refer to the electrical impulses generated by the neurons or doing interaction between them. These impulses also known as Neural Oscillation can be observed by measuring technique as Electroencephalogram (EEG). In this research 2 types of Brainwave sensors have been used. Neurosky mindwave mobile sensor is cheap and user-friendly EEG device and Emotiv Epoc+ sensor is little bit expensive but user-friendly EEG device, these two sensors were used for our research. The purpose of this research is to analyze the brainwave data for the best accuracy result and also to compare the accuracy result between both sensors.

January 22 (Friday), 15:00–16:00

GS6-3 Estimation for suggestion method of predicates for Open Data

Bo Chen, Daiki Tomari, Fang Cheng, and Takayasu Fuchida
(Kagoshima University, Japan)

In response of that "G8 Open Data Charter" was presented in 2013, efforts of Open Data has begun in each country, there has been increasing interest in Open Data in recent years. The utilization of Open Data has been promoted, and many organizations including the national government, local governments and other organizations are working on publishing and utilizing Open Data. In this research, we focused on the vocabulary that corresponds to the predicate of RDF form for Open Data, and proposed a method to suggest predicates by the clustering of item names for RDF of Open Data. And we present results of our approach, and show that we can learn to predict predicates using the clustering of item names. At last, we gave the conclusion and future work. The experimental results showed that the effectiveness was 80% with the comparison evaluation.

GS6-4 A recommendation system based on product image and text features

Yichi Lu, Mingtian Gao, and Ryosuke Saga
(Osaka Prefecture University, Japan)

Probabilistic matrix factorization (PMF) is a well-known model of recommender systems. With the development of image recognition technology, some PMF recommender systems that combine images have emerged. Some of these systems use the image shape features of the recommended products to achieve better results compared to those of the traditional PMF. However, in the existing methods, no PMF recommender system can combine the image features of products previously purchased by customers and of recommended products. Thus, this study proposes a novel probabilistic model that integrates double convolutional neural networks (CNNs) into PMF. For apparel goods, two trained CNNs from the image shape features of users and items are combined, and the latent variables of users and items are optimized based on the vectorized features of CNNs and ratings. Extensive experiments show that our model predicts outcome more accurately than do other recommender models.

GS6-5 Regression analysis of COVID-19 regional data in Japan

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

In December 2019, Wuhan in China became the center of an outbreak of pneumonia of unknown cause, which raised intense attention internationally. By January 2020, Chinese scientists isolated a novel coronavirus from patients in Wuhan. Later, this virus was identified as the species Severe acute respiratory syndrome-related coronavirus, and named as SARS-CoV-2. This coronavirus-associated disease (COVID-19) is the third documented spillover of an animal coronavirus to humans in only two decades that has caused a major epidemic. Many human coronaviruses have long been known to cause seasonal and usually mild respiratory tracts infections associated with symptoms of the common cold. In contrast, severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV) and SARS-CoV-2 are highly pathogenic. Infections of these coronaviruses develop into severe, life-threatening respiratory pathologies and lung injuries for which no specific treatment has been approved today.

January 22 (Friday), 15:00–16:30

Room B

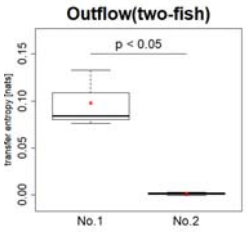
GS19 Swarm robot & Swarm intelligence

Chair: Hiroto Yonenoh (Nagoya University, Japanp)

GS19-1 Information storage and transfer in ayus(Plecoglossus altivelis)

Toshiki Fukushima and Takayuki Niizato
(University of Tsukuba, Japan)

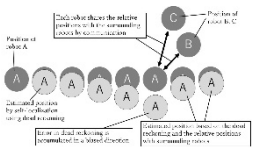
Animal group behavior is widely observed in nature; however, its mechanisms have not been fully elucidated. To deepen our understanding of real swarms, the status of an entire swarm and the relationships between the individuals within a swarm must be analyzed. In this study, we focus on the alignment degree and positional rank of small fish schools (Plecoglossus altivelis). In the analysis, we use two information-theoretic measures: local active information storage and local transfer entropy. Our results reveal the difference between low-and high-level polarizations based on information theory. Furthermore, we suggest that the role of an individual in a particular rank may change depending on the population size.



GS19-2 Dynamic Formation Control reducing Influence of Biased Error using Communication between Robots

Tetsuro Akagawa, Yoshikazu Arai, Shintaro Imai, and Toshimitsu Inomata
(Iwate Prefectural University, Japan)

Recently, robots are used in various environments for any task. In order for these robots to work, various functions are required according to the surrounding environment. Particularly in cases of a heterogeneous swarm robot system, formation control for achieving effective functions by arranging robots at suitable positions is essential technique. In order to carry out this formation control efficiently, a method to reconfigure formation while moving is desirable. In this paper, this method is called "dynamic formation control". Collision avoidance and self-localization are a necessity for this formation. The extended Kalman filter is widely used for self-localization. However, it is difficult to reduce an effect of error that is biased in specific direction. In this paper, methods of collision avoidance and self-localization are shown to solve the problems. And a method that reduces the biased error in robot's position as a premise of them is proposed.



GS19-3 Geometric configuration algorithm adapting to unknown environments for robot swarms

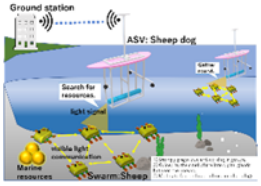
Kouki Ogata and Geunho Lee
(University of Miyazaki, Japan)

In recent years, there have been cases of marine pollution caused by tanker collisions at sea. In this case, there are problems that urgent response is required and the infrastructure of the work environment is not in place. Therefore, in order to respond quickly and efficiently, it is necessary to pay attention to the coordinated movements of many robots and to perform group behaviors that can be adapted to the environment. Therefore, in this paper, we propose a geometric placement method for the placement problem in the siege work. This is a method to make the distance between robots equal and the distance to the boundary of the object constant. In this study, we propose a geometric arrangement method between an unknown boundary and an adjacent robot, and then show the effectiveness of the proposed method by simulation at various boundaries.

January 22 (Friday), 15:00–16:30

GS19-4 Investigation on behavioral control of underwater swarms using nonlinear synchronization

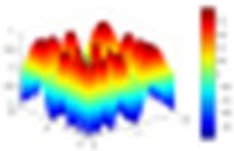
Tetsu Kato[1], Sotaro Ono[1], Makoto Morito[1], Shun Fujii[1], Yamato Kawamura[1], Hidekazu Kajiwara[2], Junichiro Tahara[1], and Masakazu Koike[1]
([1]Tokyo University of Marine Science and Technology, Japan)
([2]Muroran Institute of Technology, Japan)



In this paper, we describe group formation by pheromones and the control of swarm behavior using nonlinear synchronization of underwater swarm for the resource exploration. In nature, there are many organisms that form group by using pheromones. On the other hand, fireflies emit periodic light in synchrony with the entire group by nonlinear synchronization. We considered the use of these phenomena to control the behavior of swarm. First, we confirmed that swarm form group using pheromone by simulation. Next, we made nonlinear synchronization circuits using visible light, and confirmed that the two units synchronized by two coupled van der Pol equation. In addition, we confirmed swarm movement by two-dimensional simulations and actual system move one-dimension.

GS19-5 Finding many good solutions by multi-swarm optimization for multiple robots: the niching migratory multi-swarm optimiser with limited movement

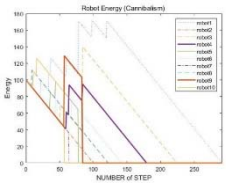
Yusuke Maekawa, Kodai Kawano, Sho Kajihara, Yukiko Fukumoto, Hiroyuki Sato, and Keiki Takadama
(The University of Electro-Communications, Japan)



This paper proposes multi-swarm optimization for real robots to find many optimal solutions and investigate their effectiveness. The Niching Migratory Multi-Swarm Optimiser(NMMSO) has high search performance. However, this method has impractical mechanisms for applying to real robots. Towards adaptation to real robots, this paper modifies NMMSO by imposing constraints;(1)the number of robots is fixed (2) the movement to random locations is deleted. Also, (3) simultaneous movement of particles to improve the search performance is added to the algorithm, and (4) limit the distance of the particle's movement is added for applying real robots. These modifications made the proposed method compared to NMMSO. The experiment has revealed the following implications:(1) the proposed method with constraints obtains the comparable performance to NMMSO, and (2) the simultaneous movement of particles enables the proposed method to find optima in earlier generations than NMMSO.

GS19-6 Cannibalism, altruism and trophallaxis strategies among self-sustainable swarm robots

Zhonghao Zhao and Jonathan Rossiter
(University of Bristol, United Kingdom)



Energy sourcing and usage is a critical component in environmental swarm robotics. Populations of autonomous agents must gather energy from the environment and decide how to distribute it amongst themselves. Determining the optimum strategy for energy management across the swarm, with respect to the high-level goal of the population, remains a challenge. In this paper we explore three bio-inspired energy transfer strategies for self-sustainable swarm robots: Trophallaxis, Altruism and Cannibalism and build a simulation to evaluate the optimal strategy. Decentralised robot agents traverse a bounded environment and undertake terrain detection and food exploration tasks and the total rating of each simulation is recorded as a measure of mission success. Statistical results indicate that dynamic energy transfer can affect the performance of swarm robots significantly, with cannibalism and altruism being suitable for terrain coverage and trophallaxis being best for urgent tasks. This work shows the importance of implementing energy sharing strategies for a wide range of swarm applications, and the suggests that the optimal collaboration strategy is heavily influenced by the specific task goal.

January 22 (Friday), 15:00–16:45

Room C

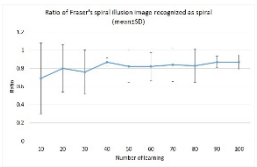
GS14 Neural networks

Chair: Noritaka Shigei (Kagoshima University, Japan)

GS14-1 Recognition of the spiral illusion using a convolutional neural network

Kenji Aoki, Takumi Nakayama, and Makoto Sakamoto
(University of Miyazaki, Japan)

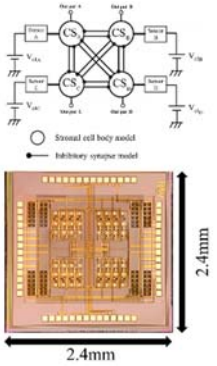
We investigated whether a convolutional neural network (CNN) recognizes the Fraser's spiral illusion image as a spiral image. The Fraser's spiral illusion is an image that humans recognize as a spiral at first glance, but it is actually a concentric circle. We constructed a CNN that can distinguish between concentric images and spiral images. The Fraser's spiral illusion image was given to the trained CNN as an input. As a result, it was found that the ratio of the Fraser's spiral illusion image recognized as a spiral image is as high as about 80%. It was suggested that a visual illusion occurs in CNN. In addition, Grad-CAM, which is a visualization method, was used to investigate which part of the image the CNN was focusing on when identifying it. It was found that the pattern for identifying the Fraser's spiral illusion image is similar to the pattern for identifying the spiral image.



GS14-2 Hardware neural networks that change the gait of quadrupedal walking according to sensor input

Mikihito Hayakawa, Kenji Takeda, Motokuni Ishibashi, Kaito Tanami, Megumi Aibara, Minami Kaneko, and Fumio Uchikoba
(Nihon University, Japan)

The application of artificial neural networks as a control method for robots has been extensively studied in order to achieve bio-like movements. Previously, we modeled a central pattern generator (CPG) using a pulse hardware neural network. How-ever, there was no element in this model that took. Therefore, this model was limited to changing the order of pulses generated with a fixed pulse width and pulse frequency. Hence, the objective of this research in external information as input. In this paper, we developed a sensor-input-capable CPG model and studied its IC implementation in order to realize a motion closer to that of a living organism. As a result, we succeeded in developing an IC that can perform processing similar to that of a living spinal cord. We found that this IC can change the order of pulses, pulse width, and pulse frequency according to the sensor input.

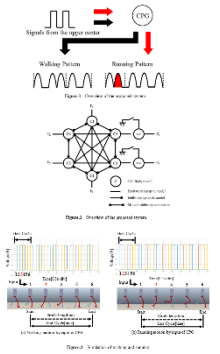


January 22 (Friday), 15:00–16:45

GS14-3 The control of bipedal gait transitions by pulse-type hardware neural networks that mimic the CPG model based on muscle synergy

Kenji Takeda, Mikihito Hayakawa, Motokuni Ishibashi, Kaito Tanami, Megumi Aibara, Minami Kaneko, and Fumio Uchikoba
(Nihon University, Japan)

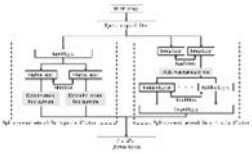
Physiological findings show that control a signal to muscle that generate a human walking-running by a repetition of five time-series pulses which are extremely fewer than a number of muscles. Five time-series pulses generate a walking-running pattern. A difference between the walking-running pattern is a position of a second time-series pulse. It is known that timing slows down while the walking and speeds up while the running. In this paper, a pulse-type hardware neuron model (P-HNM) is used to construct a CPG model based on muscle synergy which is investigated the control of a walking-running in a bipedal gait. Consequently, generation of the walking-running patterns confirmed from the CPG model constructed with the P-HNM. From the walking-running patterns of the CPG model showed the switching between the walking-running was possible using a bipedal gait model.



GS14-4 Motion and shape classification using spiking neural network

Akito Morita, Toshiki Yamada, and Hirotsugu Okuno
(Osaka Institute of Technology, Japan)

Biological visual nervous systems, which have hierarchical architecture that handles multiple features in parallel, are good models for image recognition. Building such a hierarchical framework that handles multiple features in parallel is a promising way for a wide range of applications in image recognition. In the present study, we developed a hierarchical algorithm composed of neuro-inspired spatio-temporal filters and spiking neural networks (SNNs). The algorithm handles shape and motion features in parallel. We evaluated the algorithm by classifying three types of human action. The results showed that the SNNs for motion and shape classification generated signals that would be useful for action classification.



GS14-5 Impression Estimation of Clothing Images by Semi-Supervised Learning Using CNN

Mizuki Kambe, Soichiro Yokoyama, Tomohisa Yamashita, and Hidenori Kawamura
(Hokkaido University, Japan)

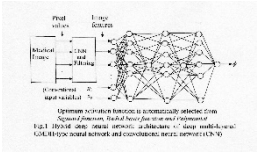
With the development of natural language processing and image recognition, robots can understand what people say and see to some extent. However, they still cannot easily understand abstract human aspects such as common sense and sensibility. Here, we consider how robots learn human sensibility using impressions of clothing as an example. We create a dataset that can vary the number of clothing images and the number of annotators labeling a single image, while keeping the number of labels constant, to investigate the better balance and obtain a high-quality dataset. Moreover, we also introduce semi-supervised learning and investigate its effectiveness for learning human sensibility.

January 22 (Friday), 15:00–16:45

GS14-6 Hybrid deep neural network of deep multi-layered GMDH-type neural network and convolutional neural network and its application to medical image recognition of chest regions

Shoichiro Takao[1], Sayaka Kondo[2], Junji Ueno[1], and Tadashi Kondo[3]
([1]Tokushima University, Japan)
([2]Tokushima Medical Informatics Laboratory, Japan)
([3]The Kyoto College of Graduate Studies for Informatics, Japan)

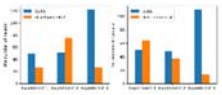
In this study, the hybrid deep neural network of the deep multi-layered Group Method of Data Handling (GMDH)-type neural network and the Convolutional Neural Network (CNN), is applied to medical image recognition of the chest regions. In CNN, many image features are automatically generated from the medical images and these image features are used as the input variables of the deep GMDH-type neural network. In the deep GMDH-type neural network, the deep neural network is automatically generated using the heuristic self-organization method. The conventional image features can be used as the input variables of the deep GMDH-type neural network. The deep GMDH-type neural network selects only useful input variables and generates all combinations of these useful input variables and automatically organizes the deep neural network architectures. The recognition results are compared with those of the conventional three-layered sigmoid function neural networks.



GS14-7 Evolving a neural network with development during learning that solves several problems

Asuka Shikina, Reiji Suzuki, and Takaya Arita
(Nagoya University, Japan)

A variety of neural network models (e.g., deep neural networks) have been proposed in recent years. Very few models assume that the topology of the networks changes dynamically during training although it has been reported that structural aspects of the brains are strongly influenced by the electrical activity within the brain. We propose an evolutionary model that the structure of neural networks changes during learning based on the states of its neural components. Using this architecture, we conduct evolutionary experiments, and show that it works as we expected. Our analysis also shows that the dynamic change of the structure contributes to minimizing the size of the network.



January 22 (Friday), 15:00–16:30

Room D

OS9 Robotics with Intelligence and/or Informatics 2

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

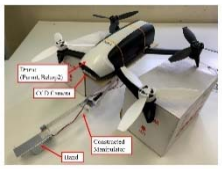
OS9-1 A New Concept of Pose Estimation of Arbitrary 3D Object without Prerequisite Knowledge: Projection-based 3D Perception

Yejun Kou, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

Generally speaking, the tasks that utilize robot vision such as visual servoing or pose estimation towards a solid object require a prerequisite condition. Because the system can only check out objects with predefined features or models, the requirement of a priori knowledge of the target object seems to have been a hindrance for tasks applied for the arbitrary target. For this reason, a new approach named: Pb3DP (Projection-based 3D perception) is proposed in this paper. The concept of Pb3DP employs stereo-vision effectively, that is(1) use the 2D image of the target object in the left camera as the 2D model, then (2) inversely project the model into 3D space with an assumed pose, and then (3) the projected 2D model in space onto right camera's image again. The projection (2) and (3) are calculated by computer. Here, (4) if the 2D model reprojected by the computer coincides with the real 3D target object projected naturally by camera's function, then the assumed pose could be thought to present the real target's pose. In this paper, we apply Pb3DP to estimate a solid target object's pose in real-time, by showing the experimental result, the effectiveness of the proposed method will be discussed.

OS9-2 Aerial mobile operations performed by drones with manipulators using AI

Makoto Yamashita and Masatoshi Hatano
(Nihon University, Japan)



In this research, we set that our final goal is to construct a system in order to transport and set the target blue sheet on the target roof of the house by some drones having manipulators. In the system, AI with the TensorFlow was employed in order to detect a target object from a complex environmental information. In addition, a drone having a manipulator was constructed with the drone (DJI ltd, Matrice 600 Pro) and our constructed original manipulator. However, its experimental environment is limited in a special filed because of large size. Thus, we also constructed a smaller drone having manipulator with the drone (Parrot ltd, Bebop Drone2) and small RC servos. Experimental results that this smaller drone detected a target object and transported it to a destination are shown.

OS9-3 Effectiveness of swing arm for walking/skating efficiencies

Yachen Zhang, Ying Wang, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

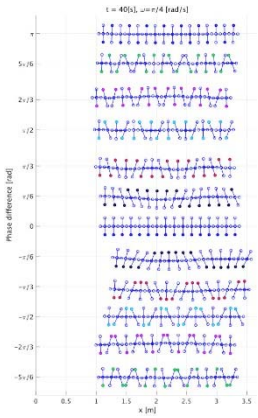
Humans tend to swing their arms when they walk or skate. In the control of biped robot, the arm and leg swing synchronously to imitate human. But the merit of arm swing has not been discussed yet. In this research, a model of the humanoid robot, including slipping, bumping, surface-contacting and point-contacting of the foot has been established, and its dynamical equation is derived by the Newton-Euler method. It must be good for people to swing their arms when they walk or ice skate, otherwise this behavior will be abandoned. There may be two benefits with arm swing, one is to improve efficiency, the other is to increase speed. We will analyze these two variable quantities. Therefore, we put forward the appropriate formula to control the swing arm and analyze the influence of the arm swing. The conclusion of the experiment is that although the swing arm reduces the efficiency, it can effectively speed up the walking speed.

January 22 (Friday), 15:00–16:30

OS9-4 Influence of passive undulation, leg assignment, and trunk stiffness for centipede locomotion

Tetsuya Kinugasa[1], Masaki Yamanaka[1], Shiori Miyamoto[1], Naoki Miyamoto[1], Ryota Hayashi[1], Koji Yoshida[1], and Koichi Osuka[2]
([1]Okayama University of Science, Japan)
([2]Osaka University and JST CREST, Japan)

Centipedes can move fast not only with a wave of lots of limbs but with a lateral undulation of a trunk. It has been reported that passive axial undulation enhances walking in centipedes and centipede-like robots. However, no study has comprehensively investigated the wave propagation direction of the legs and trunk with various leg assignments, not only for myriapods but also for species that do not exist in nature. In this paper, we focus on the influence of passive undulation, leg assignment, and joints stiffness for locomotion in the Chilopoda. For the analysis, a dynamic model is introduced to simulate the locomotion of the centipede. The progressive velocity increased/decreased for the retrograde/direct wave because the stride was enlarged/reduced by the passive undulation. Moreover, the trunk stiffness has an optimal condition for the progressive velocity with passive undulation.



OS9-5 Fitness Calculation with a FPGA Implementation

Shiqian Luo, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

Due to the increasing stress of labor deficiency, robots that could handle heavy load of work automatically are in need. Visual servoing system is widely used in target's pose recognition for it's adaption in all kinds of complex situations. However, conventional visual servoing system requires prerequisite information of targets like size color or apex that can specify an object, which limits their usability in recognition when target changes. Consequently, we want to propose a new method named Projection-based Method, It can recognize arbitrary target in real time with no prior knowledge, besides no preparation is needed when targets change. But the recognition system has been implemented on personal computer in the previous research, which limits their on-the-move application where portability is desired. The portability of the system will ensure the ease of use in movable robots. For instance, the AUV (Autonomous Underwater Vehicle) with FPGA (Field Programmable Gate Array) could be employed in some extreme environment such as deep sea where human operator has difficulties in conducting tasks while AUV with FPGA could achieve a 3D perception just like human. In this paper, we describe our approach for arbitrary objects pose recognition system with FPGA technology, the proposed system is implemented on Zynq UltraScale+ MPSoC ZCU104. Two static photos were used as models in experiment to verify the effectiveness of this system.

OS9-6 Expanding the recognition distance using the Model-based Matching method and the 2D model by zoom cameras

Siyu Pan, Renya Takahashi, Jincheng Li, Yuichiro Toda, and Mamoru Minami
(Okayama University, Japan)

In recent years, Autonomous Underwater Vehicles (AUVs) are essential to explore the ocean that humans are unable to go directly. AUVs could be operated automatically and required to be recharged after the long-term work. In our previous research, we have conducted the docking experiments with the distance of 600 [mm] from docking station to Remotely Operated Vehicle (ROV) in real sea using dual-eye cameras. However, it can be difficult to recognize the 3D marker from further distance owing to the target getting smaller on the screen and the turbid water. In the next step, we need an approaching ability that can guide AUV to reach the docking range from a greater distance. For this purpose, we proposed a system using 2D model and zoom cameras in the approaching step. In this paper, the effectiveness of pose estimation that using 2D model with zoom cameras is confirmed by experiments.

January 23 (Saturday), 9:00–10:00

Room A

ISBC OS1 AI in Medicine

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

ISBC OS1-1 The third revolution in Medicine brought by big data and AI

Hiroshi Tanaka
(Tokyo Medical and Dental University, Japan)

Recent trends in application of big data analytics and artificial intelligence to medical and healthcare fields are beginning to bring about the revolutionary change in both medical science and healthcare practice. As for medical science, data-driven methods are prevailing as a new paradigm of medical research in contrast to traditional hypothesis-driven medical method which made the knowledge system of medicine full of holes like Swiss cheese. Data-driven methods collect comprehensive (genome-wide) data with homogeneous depth and cross-disciplinary way and automatically discover a new knowledge by using unsupervised AI, where the validity of the new knowledge is checked up by the fact whether the knowledge can generate real data again. The data driven method can make medical science holistically defect-free whole.
As for healthcare practice, it changes the current medical practice which is mostly dedicated to therapy of disease, into precognitive control medicine which predicts the future trend of disease dynamics and control it by the power of system molecular medicine. Mobile healthcare by using personal omics profile would become main stream of healthcare.

ISBC OS1-2 A multi-agent-based dimensionality reduction

Shingo Tsuji and Hiroyuki Aburatani
(Research Center for Advanced Science and Technology, The University of Tokyo, Japan)

Recently, biomedical research has been producing high-dimensional data such as single-cell RNA sequencing. It is impossible to understand the high-dimensional data as it is, the dimensionality reduction techniques are essential to utilize the data and push on biomedical research. There are many types of dimensionality reduction methods. PCA is one of the most fundamental linear method. t-SNE and UMAP are relatively new and state of the art non-linear methods. Each method has its own characteristics, we might obtain different visualization images in 2D or 3D spaces. We developed a new dimensionality reduction method based on a multi-agent-based architecture. The method regards a sample as an agent and makes agents communicate each other to optimize the position in the low-dimension space. We will present the quantitative comparison between our method and commonly used methods and introduce an application for AI medicine research field.

ISBC OS1-3 AI and network analysis based computational framework for drug-target repositioning

Takeshi Hase
(The Systems Biology Institute, Tokyo,
Medical Data Sciences Office, Tokyo Medical Dental University, Tokyo, Japan)

Drug-target repositioning is to find novel indications of established therapeutic targets of FDA-approved drugs and a key tool for successful drug development. However, cost and time to experimentally investigate repositionable targets are extremely large. Therefore, we here propose computational framework based on AI and network analysis techniques to prioritize potential repositioning targets for given diseases.
The procedure of our computational framework is composed of four steps:
(i) By using a representative unsupervised machine learning technique, we extracted feature vectors from chemical structures of FDA-approved drugs.
(ii) By using the feature vectors, we calculated similarity between drug-targets to generate target-similarity network, in which nodes and links represents drug-targets and similarity between them.
(iii) By using target information of a given disease, we labeled nodes in the network. Then, we propagated the label through links in the network to calculate scores for all the nodes in the network.
(iv) Based on the scores for nodes from (iii), we prioritized potential repositioning target for the given disease.
By using the computational framework, we prioritized potential repositionable targets for several diseases including Alzheimer's disease and Rheumatoid. We are planning to report the results in our presentation.

January 23 (Saturday), 9:00–10:00

ISBC OS1-4 Person trip survey and simulation analysis of outpatient visit.

Kazuro Shimokawa and Hiroshi Tanaka
(Tokyo Medical and Dental University, Japan)

We have examined the outpatient's flow to the medical institution changed due to the Great East Japan earthquake by using the person trip investigation, held in Miyagi prefecture, and discussed the arrangement of transportation, appropriate for this area by using a simulation.
A lot of traffic channel were damaged due to the Great East Japan earthquake.
However, many of them have been restored as time passes, and some of transportation routes including the railway and the road advanced greatly.
Moreover, the substantial change happened to dynamic trends in population in various places around this prefecture.
We investigated the outpatient's transportation to the hospital, focusing on the change in the age structure of population in this prefecture.
We also discussed the optimization of geographic arrangement of the medical institution by the simulation, based on these results.

January 23 (Saturday), 9:00–10:15

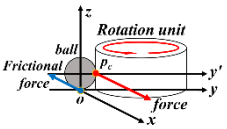
Room B

GS15 Robotic Mechanism

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

GS15-1 Rotational motion-based ball induction model for collection robot

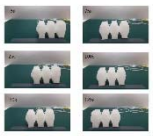
Kazuma Takemoto and Geunho Lee
(University of Miyazaki, Japan)



In recent years, sports for people with disabilities have been actively performed. A ball collecting device can be mentioned as a support method for the competition. This paper focuses on the rotation mechanism as a method of collecting for equipment. The rotating mechanism has the advantage that many balls can be collected at one time. Therefore, we propose a ball trajectory guidance model using a rotation mechanism. Next, an experimental machine using the model was manufactured and a verification experiment was conducted. In the experiment, the effectiveness of the model was shown by changing the conditions such as the shape of the rotating body and the inclination of the ground on which the ball moves.

GS15-2 Crawling soft robot without explicit controllers

Yusei Sakuhara and Kazuyuki Ito
(Hosei University, Japan)

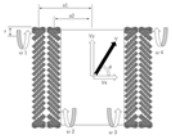


Generally, we consider that intelligence comes from our brains, and various approaches have been proposed to realize the functions of a brain using computers. However, it is still extremely difficult to operate an autonomous robot in the real world. We aim to develop a soft robot that has no explicit controllers. In this robot, all the adaptive behaviors are produced by utilizing the physical and dynamical properties of the soft body. The most important aspect is that the robot does not include sensors or controllers. By simply injecting air at constant pressure, cyclic expanding and shrinking motions are generated. We built an actual robot and conducted experiments. As a result, we realized the desired crawling motion, and the robot moved forward.

January 23 (Saturday), 9:00–10:15

GS15-3 Motion formula for multi-directional movement crawler robot with bilateral two pairs of subcrawlers

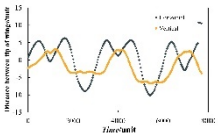
Hiroaki Yamamoto, Geunho Lee, and Kazuma Takemoto[3]
(University of Miyazaki, Japan)



In this paper, we propose a new moving mechanism based on passive sub-crawlers. In recent years, the movement of objects using multi-directional moving mechanisms has been used for inventory control in large-scale warehouses. However, all of the previous directional moving mechanisms with the ability to handle rough terrain had complicated vehicle designs and were not portable to chassis with simple platforms such as multi-directional wheels. Therefore, the proposed mechanism is a new mechanism that aims to achieve both crossing performance on uneven terrain and portability to current platforms. In this paper, we describe this moving mechanism and its control in detail. The mechanism is mathematically analyzed and verified by experiments using a prototype.

GS15-4 Elytra model for flapping of beetles during hovering

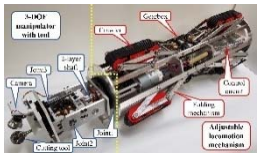
Haruka Noritake and Geunho Lee
(University of Miyazaki, Japan)



Recently, the flight performance of existing flight methods such as drones has improved and the place flight devices use is expanding. Along with this, the flapping of insects, which are familiar flying objects, has attracted attention. Among them, beetles fly by flapping both hindwings that are thin and flexible and elytra that are hard. However, few clearly describe the role of the elytron in flight. Therefore, in order to clarify how the wings of the ladybug that is a kind of beetles move, the motion of the elytra and the hind wings during hovering flight was analyzed by using slow-motion videos. Furthermore, the flapping motion was modeled from this video analysis. Based on the analyzed data, this work generates the model of flapping motions. By employing the flapping motion, an artificial flapping mechanism is developed as our future direction.

GS15-5 Development of a Compact In-Pipe Robot with Multi-DOF Drilling Tool

Thaelasutt Tugeumwolachot, Hiroaki Seki, Tokuo Tsuji, and Tatsuhiro Hiramitsu
(Kanazawa University, Japan)



This research is about the in-pipe robot for maintenance in a sewerage system. It is expected to use for repairing old sewer. Most conventional robots in the past were mainly designed for survey and inspection. While some robots for maintenance, but their manipulator have a few DOF. Then, we propose a compact in-pipe robot with multi-DOF drilling tool (CIPbot-1) for 150-300mm pipe to enhance the ability of these kind of robot. The difficulties of development this robot is a space limitation of the small pipe and the rigidity of its mechanisms. The proposed robot consists of a locomotion section (adjustable folding mechanism and six-crawlers, each of them is driven by only one motor) and a 3-DOF manipulator with a drilling tool and a camera. The prototype of CIPbot-1 was made and confirmed the mobility, the ability, and the usefulness by the experimentations.

January 23 (Saturday), 9:00–10:15

Room C

GS16 Robot vision and image processing 1

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

GS16-1 High-level synthesis-oriented program description method considering display output in embedded video image processing system

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

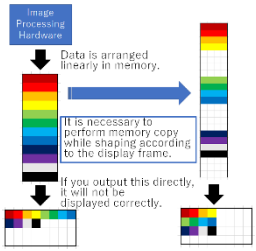
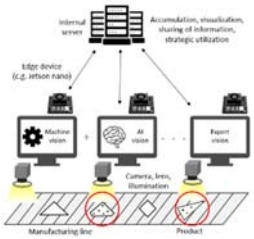


Image processing methods can be roughly divided into hardware processing and software processing. Generally, hardware processing is more suitable for embedded image processing systems because hardware has higher performance and lower power consumption than CPU. For the shorter development time, it is desirable to use high-level synthesis, which is automatic hardware conversion technology for software. However, if we use high-level synthesis for the software that doesn't consider the hardware configuration, problems will occur. A typical embedded video processing system is a combination of various devices. Usually, the data from the hardware for the display output should be shaped to display frame area, but that is useless memory copy. In this paper, we focused on the display output system to make it more efficient and faster. The background subtraction method was used for verification. Finally, we found the performance was about 15 times better than the conventional method.

GS16-2 Defect Detection on Transparent Industrial Parts using Edge AI.

Victorien PASTEUR[1], Yannis BERROCAL[1], Osamu FUKUDA[2], Yunan HE[2], Daisuke SAKAGUCHI[2], and Valentin GRAVE[1]
([1]ESIREM: Burgundy University, France)
([2]Saga University, Japan)

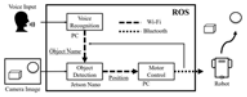


Considering the current challenges many industrial companies have to confront, such as economic instabilities, natural disasters or even health hazards, there is an emerging need for better control of production costs, management of the data produced and their processing. The paper focuses on the detection of defects on transparent industrial parts through the use of Edge AI system. This system would be implemented directly on the production line and affect it through a feedback loop to potentially re-configure a machine, control energy consumption and, more generally, manage the interconnections of different processes. The question lies in the optimization of detection methods, as well as the centralized and secured management of the data produced. We have selected the NVIDIA Jetson Nano board for the development of a low-cost, low-power Edge AI system. This small computer is equipped with a Linux-based operating system with numerous libraries and APIs for Deep Learning. Thus, a neural network based on YOLOv4 trained using the neural network framework Darknet has been selected. The developed system was trained, validated, and tested on a sample of four different car optics parts. These samples represent a significant range of headlight optics types, from alveolar structures to fully transparent ones. A dataset, made from these samples, was fed into the neural network as training data. The results showed attractive reliability and adaptability capabilities. Overall, the results demonstrated an encouraging predictability and reproducibility. They proved significant manufacture control possibilities with a single developed device, that could be enhanced to an autonomous system, if a network supervision system was added. Finally, the outcome suggests that the proposed inspection systems could replace the existing ones, enhancing reliability and efficiency of production lines. The objective of Edge AI is to associate and interconnect machine detection processes through various AI methods. The combination of these methods, whether they be traditional or more complex, would allow in a future development to obtain higher true detection rates and avoid false detection.

January 23 (Saturday), 9:00–10:15

GS16-3 Vision-based object search for autonomous mobile robot

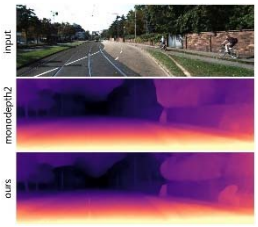
Ryosuke MIYATA, Osamu FUKUDA, Nobuhiko YAMAGUCHI, and Hiroshi OKUMURA
(Saga University, Japan)



In recent years, robots have been used in various environments thanks to the development of artificial intelligence. Humans and robots will be coexist and everyone will have more opportunities to interact with robots in near future. In this research, we develop an AI autonomous mobile robot using open-source software. We use ROS: Robot Operating System, which is a software platform for robot development. The proposed system has an object detection function and a voice recognition function. The robot searches for a target object instructed with the operator's voice and approaches it based on its position information. Since instructions are given with the operator's voice, anyone can easily instructs the robot what he/she wants to search for. This system is supposed to be used as a life support robot, so we aim to realize the robot operation intuitively in real time.

GS16-4 Self-supervised monocular depth estimation with occlusion mask and edge awareness

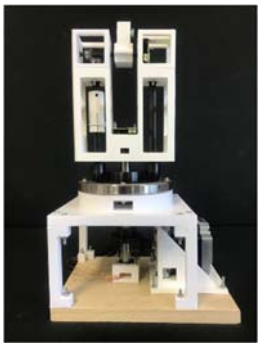
Shi Zhou, Miaomiao Zhu, Zhen Li, Mitsunori Mizumachi, and Lifeng Zhang
(Kyushu Institute of Technology, Japan)



Depth estimation is one of the basic and important tasks in 3D vision. Recently, many works have been done in self-supervised depth estimation based on geometric consistency between frames. However, these research works still have difficulties in ill-posed regions, such as occlusion areas and texture-less areas. This work proposes a novel self-supervised monocular depth estimation method based on occlusion mask and edge awareness to overcome these difficulties. The occlusion mask divides the image into two classes, making the training of the network more reasonable. The edge awareness loss function is designed based on the edge obtained by the traditional method, so that the method has strong robustness to various lighting conditions. Furthermore, we evaluated our proposed method on the KITTI dataset. The occlusion mask and edge awareness are both beneficial to find corresponding points in ill-posed regions.

GS16-6 A single motor driven 3D sensing mechanism

Takeshi MIZUGUCHI and Geunho LEE
(University of Miyazaki, Japan)



Many sensor devices for three-dimensional measurement, such as laser scanners, are equipped with a plurality of motors for the purpose of measuring a wide range. This will lead to an increase in the size of the sensor device, and it is considered that it will be a burden for mounting the sensor device, especially in a drone. Therefore, in this paper, we propose a single motor driven 3D sensing mechanism. This mechanism is driven by a single power source and generates rotation in two directions, vertical and horizontal. Due to these rotations, a part of the mechanism draws a continuous spherical orbit. In this research, the goal is to expand the measurement range of the sensor in three dimensions by the mechanism. This mechanism is considered to lead to reduction of system size, weight, and cost, especially in 3D measurement.

January 23 (Saturday), 9:00–10:30

Room D

OS11 System Sensing and Its Applications

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

OS11-1 The effects of the jellied nutritional supplement intake on physiological and psychological states and behaviour: An exploratory study

Nanako Kurogi[1], Kanako Sakiyama[2], Shigeru Tominaga[2], Yoshio Toyama[2], Kent Nagumo[1], Kosuke Oiwa[1], and Akio Nozawa[1]
([1]Aoyama Gakuin University, Japan)
([2]Meiji Holdings Co., Ltd., Japan)

This study evaluates the effects of the act of intake on the performance and psychophysiological state between repeated tasks. The experiment was conducted under two conditions: taking a break with his eyes opened between the repeated tasks (Control) and taking a break with jellied nutritional supplement intake (Intake). We found the rate of deterioration of the distance between target pointer and the mouse cursor, a performance index, showed significant differences between the two conditions. Significant differences were also found between the two conditions in all assessment items of subjective feelings. Considering the hemodynamic parameters and nasal skin temperature responses, it was found that the approach to the second task was different in the two conditions. We conclude that the psychological responses of "Awareness" and "Refreshing" were maintained through jellied nutritional supplement intake between repeated tasks. The intake also helped maintain a positive attitude toward the task as well as performance.

OS11-2 Separation of circadian and acute-stress blood pressure variations on facial skin temperature distribution

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

The objective of this study was to estimate resting blood pressure (BP) using non-contact measurements. Resting Blood Pressure varies throughout the day according to the circadian rhythm. In our study, the effects of the circadian rhythm and acute-stress blood pressure variations on facial skin temperature distribution were separated using independent component analysis, and multiple regression analysis was performed to estimate the resting blood pressure. As a result, we identified the short-term components of acute stress blood pressure variation in facial skin temperature, and these could be separated from the circadian rhythm and acute stress blood pressure variations. The results of multiple regression analysis considering acute stress blood pressure the independent component related to acute stress blood pressure variations, it was suggested that resting blood pressure can be estimated from facial skin temperature. In addition, circadian rhythm and acute-stress blood pressure variations in blood pressure were expressed in the same area on the face.

OS11-3 A Virtual Hand Manipulation System using EEG and its Sense of Agency

Yuki Shimizu and Hisaya Tanaka
(Kogakuin University, Japan)

We have developed a Brain Computer Interface–a virtual reality system. This creates an event-related desynchronization (ERD) in the electroencephalogram by imagining movement and provides the user with virtual hand animation feedback. The purpose is to enhance the movement of the image by providing visual feedback with regard to the imaging movement. Subjects used Hand animation and Bar graph animation to conduct experiments to evaluate ΔERD strength, Accuracy (percentage of tasks that can be performed), and sense of agency (SOA, whether they can manipulate by their own will). As a result, and it cannot be said that Hands animation had significantly higher ΔERD strength and Accuracy than Bar graph animation (N = 10). However, Hands animation can more correctly provide feedback with regard to the state of motor imagery and may promote learning than Bar graph animation from relationship of the correlation between ERD and SOA, Accuracy and SOA.

January 23 (Saturday), 9:00–10:30

OS11-4 Monitoring mental stress using photoplethysmographic amplitudes obtained from a smartwatch

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

Monitoring daily mental stress has become necessary to prevent mental illness. We estimated the extent of mental stress using photoplethysmographic amplitudes (PPGAs) obtained from a smartwatch capable of lifelogging. Since PPGAs can be used to estimate mental stress from fragmented data, PPGAs can be obtained from smartwatches wherein data collection may be interrupted due to physical movement. In contrast, the accuracy of acquiring PPGA from a smartwatch might be low due to various factors such as changes in blood flow or skin temperature. Hence, in this study, we propose a new method for obtaining highly accurate PPGAs from a smartwatch.

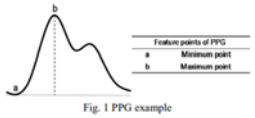
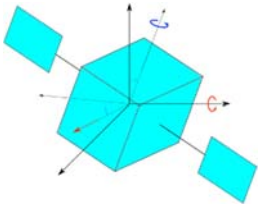


Fig. 1 PPG example

OS11-5 Trajectory Generation for Balloon Robot by Using Time-State Control Form Extended to Three Dimensions Space

Yusuke Kataoka and Masafumi Uchida
(The University of Electro-Communications, Japan)

The balloon robot is made up of balloons and has airship-like functions by filling it with helium. Due to the lower risk of accidents compared to other flying robots, balloon robot is better suited for use in densely populated environments. The control characteristics of the balloon robot are that it does not skid and has non-holonomic constraint in the direction perpendicular to the propulsion direction. This makes the balloon robot difficult to control from Brockett's theorem. One of the methods for controlling a robot with non-holonomic constraints is the time-axis state control. In the previous study, predecessor developed a control law for the motion of the balloon robot in two dimensions space. In this study, we extend this control law to three dimensions space by analyzing the relationship between the pitch angle of the balloon robot and the propulsive characteristics of the pectoral fin motion. We analyze the relationship between the pitch angle of the balloon robot and the propulsive characteristics of the pectoral fins and derive the output of translational velocity and turning angular velocity by changing the motion of the pectoral fins in various ways. Based on the results, we simulate the trajectory of the aircraft.



OS11-6 An attempt to generate pseudo-thermal images using an adversary generation network

Takuto Umemoto[1], Kenichi Fujimoto[1], and Hirotoshi Asano[2]
([1]Kagawa University, Japan)
([2]Kogakuin University, Japan)

Temporary loss of alertness due to lack of sleep can cause illness and traffic accidents. One of the researches to prevent them is a technique to detect wakefulness using nasal skin temperature. Non-invasive devices that measure skin temperature include infrared cameras, which need to detect specific areas from thermal images. We have developed a model for detecting nose positions from thermal images using machine learning, but a large amount of training data is needed to create a more accurate model. In addition, collecting thermal images is more difficult compared to visible images. In this report, we have tried to generate pseudo-thermal images using an adversary generated network in order to prepare a large number of thermal images as a teacher data to improve the accuracy of the detection model. The results confirmed the possibility of generating pseudo-thermal images with the generative adversarial network.

January 23 (Saturday), 13:00–14:15

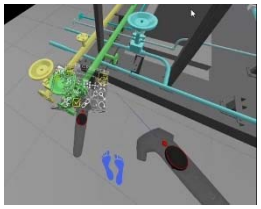
Room A

ISBC OS2 Complexity and Information

Chair: Ken Naitoh (Waseda University, Japan)

ISBC OS2-1 Research on the usability of controllers and gloves in VR maintenance training system

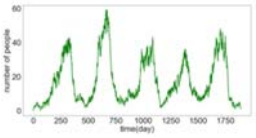
Kodai Tsushima[1] and Hideo Miyachi[2]
([1]Ebara.co.ltd, Japan)
([2]Tokyo City University, Japan)



We have been developing a VR system for maintenance training of semiconductor manufacturing equipment. In a training system using VR, the most important point is to experience the real feeling similar to the actual experience. Therefore, using the VR training system we have developed, we examined the usability of the two types of user interfaces, the controller and the VR gloves. As a result of a questionnaire survey of experimental collaborators who experienced both, We conclude that the VR glove is easier to use than the controller. However, by keep showing the selected part in the user's view, we learned that the usability of a controller that is cheaper than VR gloves can be improved.

ISBC OS2-2 Epidemic waves in susceptible-exposed-infectious-removed model and multi-agent simulations

Masaki Nieda, Yuhi Hara, Takayuki Sukegawa, Yuta Amanuma, and Tomohiro Yanao
(Waseda University, Japan)



This study investigates infection dynamics using two complementary models: A macroscopic model based on ordinary differential equations and a microscopic model based on multi-agent simulations. While these two models can produce a single wave of infections, they generally do not produce the secondary and further waves by themselves. However, as evidenced by actual data in different countries, many infectious diseases show multiple waves, i.e., multimodality. This study shows that the following two conditions are responsible for the multimodality in the infection dynamics.(1) The immune function does not last forever. (2) There is an external influx of population. This study also shows that the recurrence of infection occurs when the susceptible population crosses the threshold determined by the total population, infection rate, and infection period.

ISBC OS2-3 A model of transporter

Yuhei OKUBO[1], Takashi SHIMADA[2], and Toru OHIRA[2]
([1]Nagoya University, Japan)
([2]The University of Tokyo, Japan)

We considered a theoretical model of a "transporter" in two-dimensions. We defined “town" by square 2-D grids. In the town, we placed multiple “parcels" with randomly chosen specified pick-up and delivery addresses. The transporter goes around these addresses to deliver parcels. First, we observed the transporter's total traveling distance for the delivery of all the parcels. We found that it can be approximately obtained by the number of parcels and the size of the town. Also, we observed the transporter's maximum numbers of holding parcels during delivery. It converges to a certain ratio of the number of the parcels regardless of the size of the town.

January 23 (Saturday), 13:00–14:15

ISBC OS2-4 Development of reaction system with constant temperature water flow system for fundamental experiments measuring anomalous heat effect quantitatively

Junsuke Shigemura[1], Tomotaka Kobayashi[1], Ken Naitoh[1], Yoshinari Wake[1], Akito Takahashi[2], Reiko Seto[2], Hiroyuki Ido[2], and Joji Hachisuka[2]
([1]Waseda University, Japan)
([2]Technova Inc., Japan)

Anomalous heat is generated when hydrogen or deuterium is absorbed by nickel or palladium. In the previous report, we developed a small reaction chamber system and conducted fundamental experiment in order to validate the anomalous heat. In the experiment, hydrogen gas is loaded into the chamber and absorbed by the metal powder made by nickel, palladium and zirconium to confirm the temperature increase. As a result, temperature rise of about 3K is observed when the hydrogen gas is loaded into the chamber. In the present study, we improved a reaction system used in the experiments conducted by Hioki T et al. to measure the anomalous heat quantitatively.

ISBC OS2-5 A study on gait analysis utilizing OpenPose

Cheng Zhou[1], Kayo Hirose[2], and Shinjiro Umezu[1]
([1]Waseda University, Japan)
([2]The University of Tokyo, Japan)

As developed countries, including Japan, have become super-aging societies, it is important to develop technologies for the elderly, and various researchers are working on them. The development of AI systems has been remarkable in recent years. Therefore, the authors wondered if it would be possible to apply AI to the captured images for inexpensive gait analysis. Most of the gait parameter measurement systems currently used in the rehabilitation of the elderly are a combination of force plates and motion tracking systems. However, the environment required for the measurement of gait parameters is generally limited to specific locations such as hospitals. On the other hand, the proportion of the elderly population is increasing significantly, which calls for the development of home systems that can analyze gait and are low-cost. Recently, it has been reported that the human posture change can be accurately monitored using openPose. We therefore used oponPose to analyze the gait of a partic-ipant walking on a treadmill. We conducted experiments to develop a clinical gait analysis system that combines the treadmill with the OpenPose system, and the results we have obtained so far show that OpenPose can accurately display the range of motion and angular changes in the knee joint. We believe that these results have potential applications in clinical science and could lead to the development of a home system that encourages self-training and improved mobility.

January 23 (Saturday), 13:00–14:15

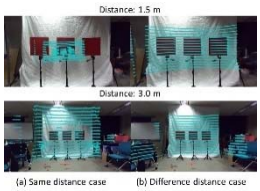
Room B

GS18 Sensor and multi-sensor data fusion

Chair: Reiji Suzuki (Nagoya University, Japan)

GS18-1 Evaluation method of calibration for data fusion of the camera images and laser point cloud and appropriate deployment of the calibration boards

Ryuhei Yamada, Nobuyuki Nakajima, and Yuichi Yaguchi
(The University of Aizu, Japan)



The data fusion of LIDAR point cloud and camera image is useful to construct a more useful 3-D map compared to that using the single sensor data. For the data fusion, the calibration to determine the relative position between the LIDAR and the camera is required and identical calibration objects should be measured by both sensors simultaneously in the calibration. In this study, we have designed a new criterion to evaluate qualification of a method of the LIDAR and the camera calibration. Then, we have investigated appropriate deployment of the calibration objects using the criterion. The investigation has indicated that usage of multiple calibration objects set at various distances in the calibration is effective to achieve good data fusion.

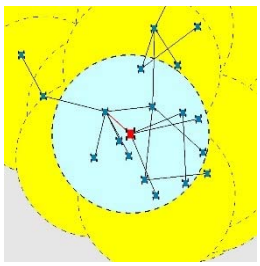
GS18-2 Development of low-cost and highly sensitive formaldehyde detection device

Kengo Maegaki and Kazuya Okamoto
([1]National Institute of Technology, Wakayama College, Japan)

In recent years, from the viewpoint of energy saving, the airtightness and heat insulation of houses have been improved. On the other hand, the air permeability in the room has deteriorated, and the environment is easily filled with polluted air. In addition, the number of patients with "sick house syndrome" is increasing due to toxic gases such as formaldehyde volatilized from building materials such as heat insulating materials and interior materials such as wallpaper and paints. Many of the methods used as the conventional simple formaldehyde measurement method are manual and analog measurement, which causes measurement errors centered on reading errors. In addition, some formaldehyde reactions took time, which inevitably took time. In this research, in order to make formaldehyde measurement easier, we aim to develop an IoT device equipped with a formaldehyde gas sensor and enable digital measurement and telemetry.

GS18-4 Self-organization algorithm of a sensor network for monitoring herds of cattle

Takeshi Okuno[1], Geunho Lee[1], Atsushi Ishimoto[1], and Fumiaki Sugino[2]
([1]University of Miyazaki, Japan)
([2]Miyazaki Livestock Research Institute, Japan)



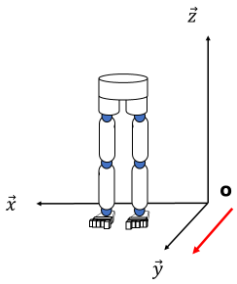
In recent years, with the development of communication equipment, wearable devices have been installed for monitoring cattle. In cattle monitoring, estrus and health management are mainly monitored. Many of the existing devices that have been introduced perform individual management of cattle with restricted movement such as barns. In a grazing environment, cows form a small herd in free movement, especially cows that approach frequently are considered to be in estrus, and isolated cows are considered to have some abnormal condition. If the interaction of cattle can be visualized, an index of behavior analysis of cattle at the Time of monitoring can be obtained. In this paper, we focus on the occurrence of such interactions between cattle and work on the proposal of observation methods. The purpose is to make such interactions observable by communicating sensor devices attached to cows and constructing a network.

January 23 (Saturday), 13:00–14:15

GS18-5 Estimation scheme for forward movements by using proximity sensors

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

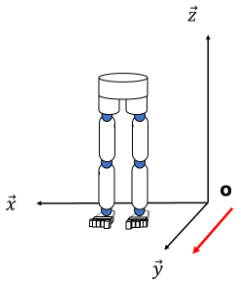
Currently, various robots and methods for providing nursing care and support are being developed. In these research, we focus on supporting lower limb movements using robot technology. When assisting lower limb movements for the elderly and people with disabilities, An interface for estimating and discriminating the user's intention is required. Therefore, in this research, we estimate and discriminate walking movements that do not need to be worn on the human body, using only the distance data obtained from the proximity sensor. We propose a three-dimensional observation method using possible geometrical figures. We also conduct experiments using the method proposed in this study, and discuss the method and future prospects from the data obtained from the experiment.



GS18-6 Evaluation of communication performance between sensor nodes in a flexible and scalable sensor array

Ryota Nakamura and Akira Yamawaki
(Kyushu Institute of Technology, Japan)

we have proposed a flexible and scalable method realizing sensor array, which can connect any number of sensors with two wires in a daisy-chain fashion through very simple communication protocol. This allows us to realize a sensor array with any size by a fixed number of cables independent of the number of sensors without the complexity handling network. The proposed sensor array can be applied with any shape and size by the user to suit the application. However, our sensor array requires the control signals to go through all sensor nodes sequentially from the top to the tail. Therefore, the communication time over sensors may significantly affect affects the performance of the sensor array. To evaluate the communication time over our sensor array, we develop a prototype system with sensor nodes, which are realized by FPGAs including our serial communication mechanism and evaluated the communication performance between sensor nodes.



January 23 (Saturday), 13:00–14:30

Room C

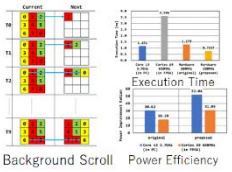
GS17 Robot vision and image processing 2

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

GS17-1 Background Scrolling in High-level Synthesis Oriented Game Programing Library

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

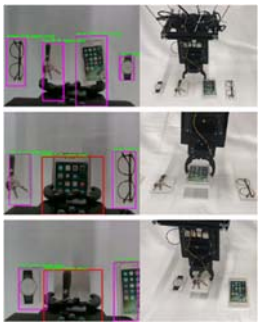
We are developing a game programing library which can be converted to hardware modules by high-level synthesis, HLS, technology to realize high-performance and low-power mobile terminals executing game applications. High level synthesis, HLS, is a technology that converts software into hardware automatically. The game software is executed by high-speed and low-power hardware on the reconfigurable devices in the mobile terminals instead of power-hungry software execution. To make an HLS tool generate a desirable hardware module, we must describe software program well considering the hardware organization. In this paper, we develop a background scrolling processing as one of functions in HLS oriented game software library. The pure software to realize the background scrolling has two nested loops accessing to the same array in the main loop. The former loop must finish all read and write accesses to the arrays before starting the operations of the latter loop. This prevents the latter loop starting in parallel to the former loop even if they have some parallelism. As a result, it disturbs making hardware high-speeded and well-pipelined by HLS tool and may lead to a significant latency. In this paper, we show a program description method to avoid this problem. With this method, HLS tool may convert background scrolling processing efficiently. In addition, we also evaluate the execution time, resource usage and power consumption of the hardware module that HLS generated through the experiment.



GS17-2 Control of smart aerial hand for dementia patients based on object recognition

Ryusuke KUBOZONO[1], Osamu FUKUDA[1], Yunan HE[2], Koichi NAKAYAMA[1], Chika OSHIMA[1], and Yoshiaki HAYASHI[1]
([1]Saga University, Japan)
([2]Chongqing University of Technology, China)

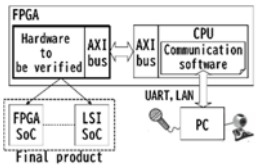
This research develops a smart aerial hand for supporting dementia patients at home. The hand can move freely in the space using the parallel wire system and deliver a target object to the user. The proposed method controls the grasping motion of the hand using the 3D depth camera and object detection technology. The 2D position of the object in the caputured image is calculated based on the position of the bounding box which indicates the detected object. The distance information from the camera to the object is also estimated based on the depth information obtained from the 3D depth camera. The closing motion of the hand is triggered once the position of the target object comes within the range where the hand can grasp the object.



January 23 (Saturday), 13:00–14:30

GS17-3 Development of a simple verification environment using FPGA of image processing hardware created by High-Level-Synthesis

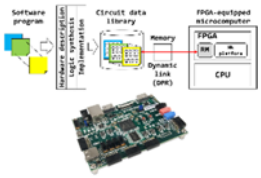
Atsushi Shojima and Akira Yamawaki
(Kyushu Institute of Technology, Japan)



Development of image processing hardware on FPGA requires various peripheral devices like memory, display, and so on for verification. We propose a generic verification environment that need not any real peripheral and can be imported to a commercial board with FPGA including CPU. The key features of our environment are software and hardware frameworks providing peripheral devices virtually on a personal computer. In addition, our verification environment can mount the high-level synthesized hardware module, which is converted from software program automatically, without taking care of how to embed HLS hardware. Finally, development of the interface circuits for peripherals can be omitted. The developer can concentrate to make good image processing hardware at software programming level. This paper develops a prototype system with same functionality of proposed verification environment. We demonstrate a case study for a simple image processing and evaluate a communication performance between PC and FPGA board used.

GS17-4 Development and Evaluation of Hardware Dynamic Link Library on FPGA running Linux

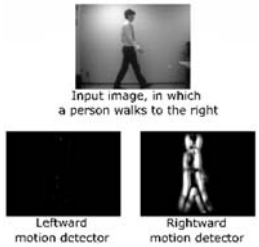
Takuma Sono and Akira Yamawaki
(Kyushu Institute of Technology, Japan)



Hardware implementation of image processing is important to make embedded systems high performance and low-power. Even if a unified hardware that can handle all image processing is designed, device resource volume, cost, and power consumption are issues. If we can introduce the concept of DLL (Dynamic Link Library) to hardware, it is possible to design unified hardware without worrying about these issues. We developed a hardware DLL that contains the hardware circuit data in a library and dynamically reconfigures the required hardware module in a library on demand by Dynamic Partial Reconfiguration on FPGA. However, embedded devices are becoming more and more complex, and detailed development isn't possible without the help of OS for embedded devices, so Hardware DLL should be realized on the OS. For this purpose, this paper develops a hardware and software organization for hardware DLL on Linux launched on an FPGA containing the CPU.

GS17-5 A spatio-temporal feature extraction algorithm that simulates a physiological model of a neuron in the early visual cortex

Eisaku Horiguchi and Hirotsugu Okuno
(Osaka Institute of Technology, Japan)

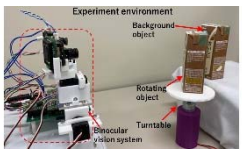


In the visual nervous system of mammals, visual features related to shape and motion are extracted by spatio-temporal processing at an early stage. Simulating such visual feature extraction is a promising way to improve the performance of classifiers in motion recognition. In the present study, we developed an algorithm for visual feature extraction based on a physiological model of the visual nervous system and evaluated this physiological model in terms of practical applications to visual processing systems. For quantitative and qualitative evaluation, we used two types of movies as input data: one is a computer simulated movie, and another is a real-world movie, in which a person walks. The results showed that the algorithm has high selectivity to motion direction, and little dependence on contrast. The algorithm also detected the motion direction of a walking person appropriately.

January 23 (Saturday), 13:00–14:30

GS17-6 A binocular disparity detection algorithm inspired by the spatio-temporal properties of binocular cells

Shintaro Hayashi, Hiroto Kajihara, and Hirotsugu Okuno
(Osaka Institute of Technology, Japan)



We have developed a binocular disparity detection algorithm inspired by the spatio-temporal properties of binocular cells in the visual cortex. The spatio-temporal properties implement motion direction selectivity into the binocular energy model, and can reduce the number of binocular matching candidates. The algorithm was programmed by using C language and Python. We evaluated the algorithm by presenting an object rotating at a constant angular velocity on a motor-controlled turntable to a binocular vision system, which consists of two image sensors, three field-programmable gate arrays (FPGAs), and a USB microcomputer. While the original binocular energy model estimated a wrong disparity due to mismatching when the rotating object moved near a background object that has similar spatial features, the proposed method estimated the correct disparity in the same situation because the spatio-temporal filter prevented the mismatching.

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Room D

OS7 Learning and Control

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

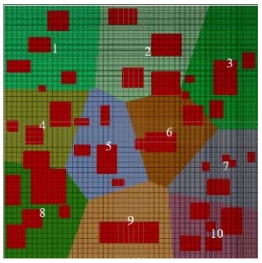
OS7-1 Dynamic Weighted Splitting D* lite for Rescue Robot Path Planning in Large Fire Areas.

Shin-nyeong Heo, Jiaheng Chen, Youngdal Oh, Ji-sun Shin, and Hee-hyol Lee
(Waseda University, Japan)

Rescue robots and Unmanned aerial vehicles(UAVs) are applied in dangerous areas search and obstacle avoidance to assist the first responder. In this research, we focused on a less calculation amount of path planning algorithm for rescue robots in the wide fire area with a dynamic partially known environment. A splitting D* lite is proposed and analyzed for the less calculation amount. The splitting D* lite doesn't need to re-plan the path in all areas and it shows less calculation amount compare with a traditional D* lite. Also, a dynamic weighted procedure is combined with the splitting D*. The dynamic weighted procedure reduces expanded nodes in splitting D* lite. Also, the calculation amount reduces the algorithm running speed.

OS7-2 Auto-Splitting using k-means with Voronoi Diagram to Divide Large Map for Splitting D* Lite.

Jiaheng Chen, Shin-nyeong Heo, and Hee-hyol Lee
(Waseda University, Japan)



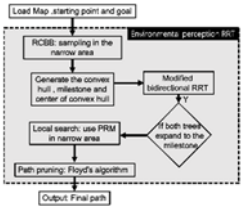
Path planning has been applied to rescue robots with UAVs for navigating and avoiding obstacles. A total execution time of path planning algorithms affects the arrival time of rescue robots. Traditional node-based path planning algorithms such as an A* and a D* lite have a long execution time on a large map. Thus, some modified path planning methods were developed using a split map for shorter execution time on the large map. However, the split map requires a pre-processing procedure for a large map. The pre-processing procedure is possible to make faster by using an auto-splitting method, so making the auto-splitting method for faster pre-processing on the large map is researched in this paper.

January 23 (Saturday), 13:00–14:00

OS7-3 Environmental Perception RRT Algorithm for Path Planning in Narrow Environments

Yuan Huang and Hee-Hyol Lee
(Waseda University, Japan)

Although sampling-based algorithms are popular in many practical applications, finding a feasible path within little time in narrow environments remains a problem. In this paper, an environmental perception Rapidly-exploring Random Tree (epRRT) algorithm is proposed to reduce the calculation time and solve the “zigzag” problem. Based on bidirectional RRT, epRRT is a two-stage algorithm: sampling and environmental perception. We utilize an efficient hybrid sampling approach to identify the critical narrow passages. Also, the uniform sampling and a new nonuniform sampling method are combined, and they perform in different regions. Moreover, in the second stage, milestones are marked to identify whether the search has entered a narrow area. Finally, the PRM as a local planner is used to search in the narrow passages. The experimental results show the priority of environmental perception RRT algorithm compared with bidirectional RRT.



OS7-4 Real-time Learning Detection of Drowsy Driving using Bus Driver

Youngdal Oh[1,2], Shin-nyeong Heo[2], Sunhong Park[1], Jinhae Yae[1], Sujin Baek[1], and Hee-hyol Lee[2]
([1]Korea Automotive Technology Institute, Republic of Korea)
([2]Waseda University, Japan)

Among the causes of traffic accidents, human errors occupy a large proportion. In particular, bus drivers are more likely to have human error accidents than passenger car drivers due to the type of work that requires long driving. Also, human errors of the bus drivers can lead to a high fatality rate because a major accident occurs in one accident. For this reason, a lot of research and commercialization are being conducted to determine a driver's condition using a single sensor (vision, bio-signal, vehicle driving information, etc.). However, in the driving environment of the bus, the vibration of the vehicle body and the amount of light coming from the front windshield are larger than that of passenger cars. Also, the driver's movement has a large radius to control the large steering wheel. In case of using alone the vision sensor to detect the driver's drowsy driving, phenomena such as infrared saturation or departure of the driver's face may occur due to the driving environment of the bus. In addition, in case of using alone the bio-signal sensor, it can be useless due to noise caused by strong vibration of the bus body. In this study, we propose a method to classify the driver's drowsiness into 1-3 stages based on multiple sensors in a bus driving environment. In order to compensate for the weakness of each sensor, the vision and bio-signal sensor measure the quality value of the sensor's output value through vehicle body behavior data and driver's operation data. In addition, for supervised learning based on the acquired driver's face image, the level of driver's drowsiness is divided into 1 to 3 levels through multiple monitors. This value and all data are used as inputs for ensemble learning of drowsy a classification model. As a result, we develop a drowsy detection model that compensates the weaknesses of each sensor according to the situation. This model is developed and evaluated in real bus and embedded environments, and the result of low false alarm rate and fast processing speed is shown.