IAS-16

16TH INTERNATIONAL CONFERENCE ON INTELLIGENT AUTONOMOUS SYSTEMS

22 - 25 JUNE 2021
SINGAPORE

PROGRAMME BOOKLET

WELCOME MESSAGE

Welcome to the 16th International Conference on Intelligent Autonomous System (IAS-16), which is organized in Singapore from 22 to 25 June 2021 and conducted virtually. The 1st and 2nd IAS Conference were held in Amsterdam in 1986 and 1989 respectively, followed by Pittsburgh in 1993 and Karlsruhe in 1995. It has been held once every 2 years since 1998 in Japan, and then to various cities in Europe, North America, and Asia; and more recently in Baden-Baden in Germany in 2018 (IAS-15). It is our pleasure to have you in this first virtual IAS-16 in this conference history.

The rapid spread of Covid-19 in the early months of 2020 has caught all by surprise. Countries, cities and towns were locked down and air travel came to a standstill then. The Committee decided to postpone the conference to 22 to 25 June 2021, optimistic that the global situation will improve, and air travel can resume by then. Covid-19 has proven to be cunning, mutated into many variants and continue to ravage the world. Though vaccines have been introduced to counter the virus, but the pace of vaccination has been slow and uneven. Air travel has opened gradually but at higher costs with quarantine being required for visitors in many countries.

We are proud that we have over 50 papers representing 13 countries, to be presented at IAS-16, despite of the inconvenience caused by the postponement. We thank all the authors for their patience and sticking with us. We acknowledge the contribution and assistance from members of the various committees and paper reviewers.

Covid-19 has also caused considerably challenges to many companies. We are glad that there are still companies out there to support IAS-16 as exhibitors. Please allow us to recognize Sensors, Weston Robot Pte Ltd (Singapore) and TDS Technology (Singapore). We encourage you to support them at the virtual exhibition available online with live persons who are happy to chat with you during the live sessions, typically during the breaks.

We are honored that four internationally renowned robotists have agreed to grace IAS-16 as Plenary Speakers. Thank you, Professor Toshio Fukuda, Professor Robin Murphy, Professor Tamim Asfour and Professor Peter Corke for your support. Last but not least, we are appreciative for the special efforts of the conference secretariat, especially Cheah Kok Keong, Krittin Kawkeeree, Christina Lee, Arjun Agrawal and Beatrix Tung.

I wish all of you a fruitful IAS-16! Let hope that we can all meet face-to-face at IAS-17. Stay healthy and take care.

Prof Marcelo H Ang Jr
General Chair and on behalf of
Board of Governors of IAS

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IAS Society

IAS SOCIETY
intelligent autonomous systems

IAS Conference is a common platform for an exchange and sharing of ideas among the international scientific research and technical community consisting of academics, researchers in institute and industrial leaders. There will be a series of technical programmes consisting of presentations and exhibitions.

Intelligent Autonomous Systems are increasingly applied in areas ranging from industrial applications to professional service and household domains. New technologies and application domains push forward the need for research and development resulting in new challenges to be overcome to apply Intelligent Autonomous Systems in a reliable and user-independent way. Recent advances in the areas of Artificial Intelligence, Machine Learning and Adaptive Control enable autonomous systems with improved robustness and flexibility.

Foundation of the IAS Society
The Intelligent Autonomous Systems (IAS) Society was founded on July 14th 1994 by the organizers of the IAS Conferences on July 14th 1994. As of 1995, the Robotics and Autonomous Systems Journal of Elsevier has been affiliated to IAS Society. In the last thirteen years the ideas have been further developed. It has been decided that the Society membership can be acquired either by participating into a IAS Conference, that allows to apply freely for IAS membership for the two subsequent years, or by subscribing the Robotics and Autonomous Systems Journal, as illustrated in the "Journal and Society" page. This journal is from now onwards also publish a news page from the Society.

The IAS Society has a Governing Board consisting of:
Full Members:

- Marcelo Ang, National University of Singapore
- Hajime Asama, The University of Tokyo
- Weidong Chen, Shanghai Jiao-Tong University
- Angel Del Pobil, University Jaume1
- Ruediger Dillman, FZI

- Gregory Dudek, McGill University
- Maria Gini, University of Minnesota at Minneapolis
- Frans Groen, University of Amsterdam
- Koh Hosoda, Osaka University
- Sukhan Lee, Sungkyunkwan University
- Jangmyung Lee, Pusan National University
- Emanuele Menegatti, University of Padua
- Jun Miura, Toyohashi University of Technology
- Enrico Pagello, University of Padua
- Marcus Strand, Duale Hochschule Baden-Wuertenberg
- Arnoud Visser, The University of Amsterdam

Members of the Honorary board of the Society are:

- Tamio Arai, (formerly The University of Tokyo, Japan)
- Hyung-Suck Cho, (DGIST/KAIST, Korea)
- Louis O. Hertzberger, (formerly University of Amsterdam, The Netherlands)
- Hirochika Inoue, (formerly University of Tokyo, Japan)
- Takeo Kanade, (formerly Carnegie-Mellon University, USA)

IAS-16 Committee

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Registration Information

EARLY BIRD AND STANDARD REGISTRATION FEES

Registration fees are shown below. All prices are quoted in Singapore Dollars (SG$). Please note that the number of paper presentations that can be delivered for each registration category. For instance, standard registration holders can deliver at most 2 presentations. For accepted papers, at least one of the authors of each accepted paper must register for the conference to finalise the submission. The payment of a full registration fee is required to complete the final submission procedure.

STUDENT RATES

Student prices are applicable to anyone with official student status that is effective before 25th June 2021. You will be required to upload a student status letter during registration as a proof.

Early-Bird Registration (Ends 9th Apr 2021)

Standard (Physical) Max 2 Presentation SG$500	**Student (Physical)** Max 1 Presentation SG$300	**Standard/Student (Virtual)** Max 1 Presentation SG$200

Standard Registration Fees (After 9th Apr 2021)

Standard (Physical) Max 2 Presentation SG$600	**Student (Physical)** Max 1 Presentation SG$400	**Standard/Student (Virtual)** Max 1 Presentation SG$300

CLICK TO REGISTER HERE

To register, please click the button below. Google Form will be used for registration while payment will be made through PayPal. After you have successfully registered and made payment, a receipt will be sent to your email.

Instructions for Participants

BASIC PROGRAM STRUCTURE:

All times used will be in (GMT +8).

There are two Zoom links – one for paid registrants and invited guests only (**Restricted**), and one for members of the public (**Public**). The same two links will be used throughout the three days of the conference. The Public link may be found, along with timings of public sessions, on **page 12**. **Our Public Sessions are open to all, no registration required.** Alternatively, you may refer to the Program Schedule or https://www.ias-16.com/.

Registered participants will receive the **Restricted** link via email. The host will begin both Zoom meetings at 8.30 a.m. each day and end the meetings according to the Program Schedule. The Zoom meeting rooms will be open throughout the day. Participants may join the meetings at any time but are advised that content is only available as stated in the Program Schedule.

All Zoom meetings will be recorded automatically from the start of each meeting. Recordings from the previous day will be made available on the IAS-16 website (public content only) and on YouTube (restricted content only, private links to be shared) before the start of the next day's events. All recordings will be available at their respective locations up to a month after the end of the conference (25th July 2021 5 p.m.). Following which, they will be made publicly accessible on the Advanced Robotics Centre's website at https://arc.nus.edu.sg/.

ETIQUETTE FOR PARTICIPANTS

Please always turn off your camera and mute your microphone, except during Q&A sessions. During Q&A sessions, you may ask questions by using Zoom's "Raise Hand" reaction. Please unmute your microphone and turn on your camera to ask your question only when invited to do so.

Please note that due to the limited Q&A duration, you may want to continue your discussion with the author(s) off-line.

ZOOM TIPS

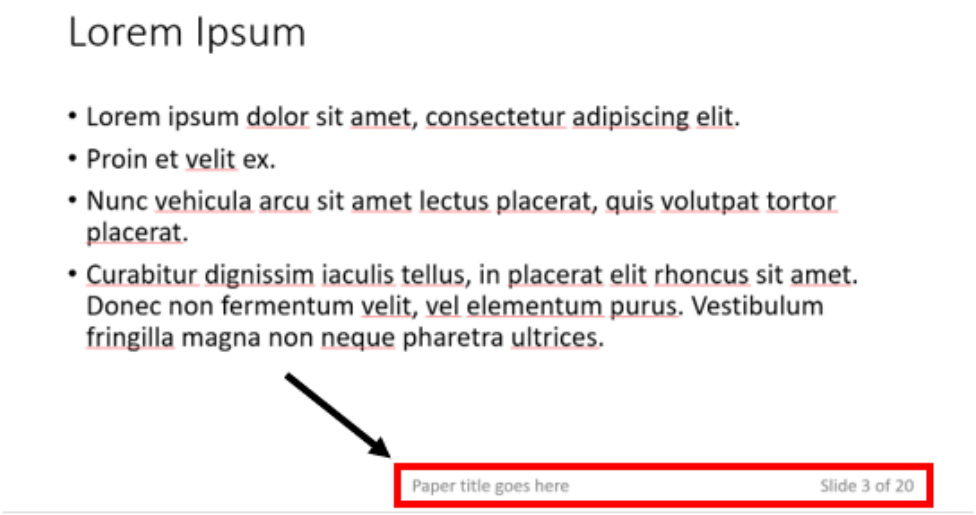
Please install Zoom (https://zoom.us/) in advance.

For a stable connection to the meeting, please check the Zoom Webinar Best Practices and Resources (https://support.zoom.us/hc/en-us/articles/209743263-Meeting-and-Webinar-Best-Practices-and-Resources).

Instructions for Oral Presenters

BEFORE YOUR PRESENTATION

Please include your paper title and slide numbers in the footers if you are using slides, for the benefit of the audience. An example is shown below:



Contact Details: Do consider leaving your contact details in the last slide if you are open to participants engaging in follow-up discussions with you.
Presentation materials: Please send your presentation materials to robotics@nus.edu.sg at least 24 hours before your presentation. This will serve as a backup in case of any technical difficulties you face, so please send only the finalised copy.
Zoom Link (Restricted): It will have been sent to you separately via email. This Restricted Zoom link should be used for accessing the meeting room for your presentation and for all other content for registered participants.
Arrival: Do enter the meeting room approximately **10 minutes before your presentation**. You may test your microphone and camera in Zoom's settings. Do also have your materials open if you intend to share your screen.

DURING YOUR PRESENTATION

The Session Chair will introduce you. Please turn on your camera. When the Session Chair cues you, you may unmute your microphone and start to share your screen.
Each presenter is given **15 minutes** for their presentation. The host will ring a bell once when you have 5 minutes left, and twice when you have 1 minute left. Please adhere strictly to this timing.

AFTER YOUR PRESENTATION

There will be **5 minutes** after each presentation for Q&A.
Participants will indicate that they have a question by using the "Raise Hand" reaction on Zoom. The Session Chair will call on them to unmute themselves to ask their question.
At the end of the Q&A session, please do the following: stop sharing your screen, turn off your camera, and mute your microphone.

Instructions for Session Chairs (Oral Presentations)

BEFORE THE SESSION

The papers and digests of the presenters in the session will have been sent to you for your consideration. Also included are slides for your session which you should use during your introduction of the session and speakers.
Please liaise with your co-chair on the presentations you will be introducing and the session introduction. They have been copied in an email with you. Your co-chair will introduce you during your presentation if you are presenting.
This Restricted Zoom link should be used for accessing the meeting room for your session and for all other content for registered participants. This is in the email we sent to you.
Do enter the meeting room approximately **10 minutes** before your presentation.
You may test your microphone and camera in Zoom's settings.

DURING THE SESSION

You will be introduced by the host. Please turn on your camera, unmute your microphone, and introduce the session.
Please introduce each presenter you are assigned to and cue them to start their presentation.
Each presenter is given **15 minutes** for their presentation. The host will ring a bell once when they have 5 minutes left, and twice when they have 1 minute left.
There will be **5 minutes** after each presentation for Q&A and to change presenters.
Participants will indicate that they have a question by using the "Raise Hand" reaction on Zoom. Please call on them to unmute themselves to ask their question. If there are no questions from the audience, please be sure to ask at least one yourself.
At the end of the Q&A session, please thank the presenter and introduce the next speaker.

AT THE END OF THE SESSION

Thank the speakers and hand over to the host.

Public Sessions

Open to all, No Registration required

JOIN US AT: https://tinyurl.com/IAS16PublicZoom

IAS-16 || Singapore

Day 1 Wednesday, June 23, 2021

Welcome Address | 08:45am - 09:00am (GMT + 8) | Duration: 15 minutes

Marcelo H. Ang Jr, National University of Singapore,
General Chair, IAS - 16

Hajime Asama, The University of Tokyo
President, IAS Society

Plenary Session 1 | Toshio Fukuda, Meijo University
09:00 am - 09:40 am (GMT + 8) | Duration: 40 minutes

AI Robots and Moon-Shot Program

Details: Prof. Fukuda has been working on the multi-scale robotics systems for many years, based on the Cellular Robotics System, which is the basic concept of the emergence of intelligence in the multi-scale way from Organizational Level,

Distributed robotics to Biological Cell engineering and Nanorobotics. It consists of many elements how the system can be structured from the individual to the group/society levels in analogy with the biological system.
Focusing on the coevolution and self-organization capabilities, Prof. Fukuda will show a new initiative on AI and Robot, one of the Moon Shot Programs started by Japanese Government, since 2020 it is a new and challenging program aiming at the AI robotic system in 2050.

Virtual Exhibitions

Virtual Exhibition & Live Chat with TDS Technology
12:40 pm - 01:00 pm (GMT + 8) | Duration: 20 minutes

TDS Technology (S) Pte Ltd

Virtual Exhibition & Live Chat with Sensors by MDPI
01:00 pm - 01:20 pm (GMT + 8) | Duration: 20 minutes

sensors
an Open Access Journal by MDPI

Day 2 Thursday, June 24, 2021

Plenary Session 2 | Robin Murphy, Texas A&M University
09:00 am - 09:40 am (GMT + 8) | Duration: 40 minutes

Robots and COVID-19: Lessons for the Future of Autonomous Systems

Details: This talk will describe how ground, aerial, and marine robots have been used in disasters, most recently the coronavirus pandemic. During the pandemic so far, 338 instances of robots in 48 countries protecting healthcare workers from unnecessary exposure, handling the surge in demand for clinical care, preventing infections, restoring economic activity, and maintaining individual quality of life have been reported. The uses span six sociotechnical work domains and 29 different use cases representing different missions, robot work envelopes, morphologies, styles of autonomy, and human-robot interaction dyads. The dataset also confirms a model of adoption of robotics technology for disasters. Adoption favors robots that maximize the suitability for established use cases while minimizing risk of malfunction, hidden workload costs, or unintended consequences as measured by the NASA Technical Readiness Assessment metrics. Regulations do not present a major barrier but availability, either in terms of

inventory or prohibitively high costs, does. The model suggests that to be prepared for future events, roboticists should partner with responders now, investigate how to rapidly manufacture complex, reliable robots on demand, and conduct fundamental research on predicting and mitigating risk in extreme or novel environments.

Virtual Exhibitions

Virtual Exhibition & Live Chat with Weston Robot (Public)
12:00 pm - 12:20 pm (GMT + 8) | Duration: 20 minutes

Virtual Exhibition & Live Chat with TDS Technology
12:20 pm - 12:40 pm (GMT + 8) | Duration: 20 minutes

Plenary Session 3 | Tamim Asfour, Karlsruhe Institute of Technology
2:20 pm - 03:00 pm (GMT + 8) | Duration: 40 minutes

Towards a Robotics AI - Engineering Humanoid Robots that Empower Humans

Details: The goal of humanoid robotics research is understanding human performance and intelligence to build versatile systems that assist and empower humans in a wide variety of tasks. Research in this area range from building anthropomorphic robots to endowing them with sensorimotor and cognitive abilities to serve humans at home and at work. Such robots must integrate perception and action to generate intelligent behavior for interacting with the real world. The talk will describe recent work aimed at increasing robots' autonomy and creating a symbiotic human-robot interaction to create truly AI robots. In particular, the talk will address affordance-based grasping, learning semantic scene manipulation based on visual perception and natural language instructions, episodic memory as key component of a cognitive robot architecture for encoding and retrieval of experienced events or performed activities occurring at a particular time, place and context. I will showcase experiments with the ARMAR humanoid robots performing tasks in household environments daily and manipulating

contaminated objects in hazardous environments. It concludes with a discussion of challenges and open problems in Robotics AI.

Day 3 Friday, June 25, 2021

Plenary Session 4 | Peter Corke, Queensland University of Technology
1:00 pm - 01:40 pm (GMT + 8) | Duration: 40 minutes

Creating robots that see

Details: This talk will define and motivate the problem of robotic vision, the challenges as well as recent progress at the Australian Centre for Robotic Vision. This includes component technologies such as novel cameras, deep learning for computer vision, transfer learning for manipulation, evaluation methodologies, and also end-to-end systems for applications such as logistics, agriculture, environmental remediation and asset inspection.

Closing Ceremony
05:40 pm - 6:00 pm (GMT + 8) | Duration: 20 minutes

About Singapore

Our city in a garden.

A small island nestled in Southeast Asia – Singapore is home to rich culture and iconic green spaces – a Garden City. Today, many slices of Singapore's multi-cultural, colonial and wartime past are preserved in and around the city. You can visit monuments, museums, and memorials, or for a real trip through time, take a walk along a heritage trail.

Amongst the greens, Singapore is hope to some of the best views around the world – architectural icons that boast an impressive skyline; from the Sands SkyPark® at Marina Bay Sands®, designed by no less than the renowned architect Moshe Safdie, to our latest offering: Jewel @ Changi Airport.

You may not be able to travel to Singapore now, but you can experience our attractions from wherever you are. Enjoy our vibrant culture from the comfort of your living room, or stay close to Singapore from miles away, with a myriad of online experiences from some of our island's top attractions. We hope to see you soon!

PROGRAMME SCHEDULE

Program Schedule (Day 1)

Venue: Zoom

GMT +8 Wednesday, 23 June 2021

8.30 am **Start of Zoom meeting**

8.45 am **Welcome address (Public)**

Marcelo Ang , General Chair IAS-16

Hajime Asama, The University of Tokyo (President of the IAS Society)

Plenary Session 1 (Public)

Session Chair: Hajime Asama

9.00 am **AI Robots and Moon Shot Program**

Toshio Fukuda, Meijo University

Session 1:
Presentation for Best Paper Candidates (I)

Session Chairs: Lin Wei, Jun Miura

9.40 am **Analysis of Exploration in Swarm Robotic Systems**

Maria Gini and Minyoung Jeong, University of Minnesota Twin Cities

10.00 am **TridentNet: A Conditional Generative Model for Dynamic Trajectory Generation**

David Paz Ruiz, University of California San Diego

10.20 am **Online Learning Based Long-Term Feature Existence State Prediction for Visual Topological Localization**

Hongle Xie, Shanghai Jiao Tong University

10.40 am **ALOT: Augmented Localization with Obstacle Tracking**

Zhikai Li, National University of Singapore

11.00 am **Intermission**

Session 2: Localization and SLAM

Session Chair: Yubao Liu , Sun Shuo

11.20 am **RTS-vSLAM: Real-time Visual Semantic Tracking and Mapping under Dynamic Environments**

Yubao Liu, Toyohashi University of Technology

11.40 am **Mobile Robot Localization Considering the Attributes of Objects to Prevent the Kidnapped Robot Problem**

Taiki Harada, Keio University

12.00 pm **Collaborative Mapping of Archaeological Sites using multiple UAVs**

Manthan Patel, Indian Institute of Technology Kharagpur

12.20 pm **3D Nominal Scene Reconstruction for Object Localization and UAS Navigation**

Sutthiphong Srigrarom, National University of Singapore

End of Session 2

12.40 pm **Virtual Exhibition with TDS Technology (Public)**

1.00 pm **Virtual Exhibition with Sensors by MDPI (Public, Pre-Recorded)**

1.20 pm **Intermission**

Session 3: Navigation (I)

Session Chair: Antony Thomas, Alessandro Gabrielli

1.40 pm **Topometric Navigation Considering Movable Objects**
Shunsuke Mochizuki, Keio University

2.00 pm **Harmonious Robot Navigation Strategies for Pedestrians**
Shintaro Nakaoka, Keio University

2.20 pm **Shared autonomy for telepresence robots based on people-aware navigation**
Emanuele Menegatti, University of Padova

2.40 pm **A Framework to Study Autonomous Driving User Acceptance in the Wild**
Alessandro Gabrielli, Politecnico di Milano

3.00 pm **Probabilistic Collision Constraint for Motion Planning in Dynamic Environments**
Antony Thomas, University of Genova

3.20 pm **Intermission**

Session 4: Navigation (II)

Session Chair: Patrick Wolf , Li Zhikai

3.40 pm **Human-following Control in Furrow for Agricultural Support Robot**
Ayanori Yorozu, University of Tsukuba

4.00 pm **Autonomous Off-Road Navigation using Near-Feature-Based World Knowledge Incorporation on the Example of Forest Path Detection**
Patrick Wolf, TU Kaiserslautern, Germany

4.20 pm **Learning to drive fast on a DuckieTown highway**
Thomas Wiggers, University of Amsterdam

4.40 pm **End-to-end learning of autonomous vehicle lateral control via MPC training**
Simone Mentasti, Politecnico di Milano

5.00 pm **End-to-end Imitation Learning for Autonomous Vehicle Steering on a Single Camera Stream**
Thomas van Orden, Universiteit van Amsterdam

5.20 pm **End of Day 1**

Program Schedule (Day 2)

Venue: Zoom

GMT +8 Thursday, 24 June 2021

8.30 am **Start of Zoom meeting**

Plenary Session 2 (Public)

Session Chair: Domenico Campolo

9.00 am **Robots and COVID-19: Lessons for the Future of Autonomous Systems**

Robin Murphy, Texas A&M University

Session 5: Application (I)

Session Chair: Wenwei Yu, Ng Xian Yao

9.40 am **A study on constraint-free vital sign measurement using a millimeter wave sensor in home environment**

Shumpei Nakamura, Chiba University

10.00 am **Development of a Medication-taking Behavior Monitoring System Using Depth Sensor**

Wenwei Yu, Chiba University

10.20 am **Developing a collaborative robotic dishwasher cell system for restaurants**

Wingsum Lo, Tokyo University of Agriculture and Technology & Connected Robotics Inc.

10.40 am **Iterative Improvement for the Heterogeneous Robotic Order Fulfillment Problem Using Simulated Annealing**

Wang Hanfu, Shanghai Jiao Tong University

11.00 am **Intermission**

Session 6: Biomimetic Robots

Session Chair: Khin Phone May, Tiana Monet Miller-Jackson

11.20 am **A simulation study for evaluating the role of pre-tensioned springs in 3 pneumatic artificial muscle driven joint mechanisms with sliding mode controllers**
Zhou Zhongchao, Chiba University

11.40 am **Effect of Tilted Ground on Muscle Activity in Human Sit-to-Stand Motion: Preliminary Result**
Kazunori Yoshida, The University of Tokyo

Session 6 (Break)

12.00 pm **Virtual Exhibition with Weston Robot (Public)**

12.20 pm **Virtual Exhibition with TDS Technology (Public)**

12.40 pm **Intermission**

Session 6 (Resumes)

1.00 pm **In-hand Object Recognition for Sensorized Soft Hand**
Khin Phone May, National University of Singapore

1.20 pm **Scaffolded Gait learning of a Quadruped Robot with Bayesian Optimization**
Keyan Zhai, ShanghaiTech University

1.40 pm **GradNet: A Viscosity Gradient Approach to Achieve Dexterity in Soft Pneumatic Actuators**
Parthsarthi Rawat, Shiv Nadar University

2.00 pm **How to tune Humanoid Walking Parameters for better Performance**
Antonio D'Angelo, University of Udine

Plenary Session 3 (Public)

Session Chair: Yu Haoyong

2.20 pm **Towards a Robotics AI - Engineering Humanoid Robots that Empower Humans**

Tamim Asfour, Karlsruhe Institute of Technology

3.00 pm **Intermission**

Session 7:
Presentation for Best Paper Candidates (II)

Session Chairs: Lin Wei, Ivan Petrović

3.20 pm **Compliant Sensorized Testing Device to Provide a Model Based Estimation of the Cooking Time of Vegetables**

Grzegorz Sochacki, University of Cambridge

Session 8: Application (II)

Session Chair: Pascal Becker , Christina Lee

3.40 pm **Robotic cooking through pose extraction from human natural cooking using OpenPose**

Dylan Danno, University of Cambridge

4.00 pm **Multiple Object Detection and Segmentation for Automated Removal in Additive Manufacturing with Service Robots**

Pascal Becker, FZI Research Center for Information Technology

4.20 pm **Determination of posture comfort zones for robot-human handover tasks**

Oliver Rettig, Baden-Wuerttemberg Cooperative State University Karlsruhe

Session 9: Machine Learning

Session Chair: Taisuke Kobayashi, Tomislav Petkovic

4.40 pm **Adaptive Eligibility Traces for Online Deep Reinforcement Learning**

Taisuke Kobayashi, Nara Institute of Science and Technology

5.00 pm **Ensemble of LSTMs and feature selection for human action prediction**

Tomislav Petkovic, University of Zagreb

5.20 pm **End of Day 2**

Program Schedule (Day 3)

Venue: Zoom

GMT +8 Friday, 25 June 2021

8.30 am **Start of Zoom meeting**

Session 10: Control (I)

Session Chair: Junsu Kang , Chew Chee Meng

9.00 am **Reinforcement Learning at the Cognitive Level in a Belief, Desire, Intention UAS Agent**

Thomas Henderson, University of Utah

9.20 am **Action Feasibility Learning with Cell-based Multi-Object Representation for Task and Motion Planning**

Junsu Kang, POSTECH

9.40 am **Improved Driving Stability of Segway using two Serial Elastic Actuators**

Jinuk Bang, Pusan National University

10.00 am **Optimal Grasping Control System For Performing Precision Indirect Teaching of Robot Hand**

Seongho Jin, Pusan National University

10.20 am **Intermission**

Session 11: Computer Vision (I)

Session Chair: Hiroyasu Akada, Yu Ishihara

10.40 am **Visualization of Dump Truck and Excavator in Bird's-eye View by Fisheye Cameras and 3D Range Sensor**

Yuta Sugasawa, The University of Tokyo

11.00 am **Dynamic Object Removal from Unpaired Images for Agricultural Autonomous Robots**

Hiroyasu Akada, Keio University

11.20 am **Future Image Prediction for Mobile Robot Navigation: Front-facing Camera versus Omni-directional Camera**

Yu Ishihara, Keio University

11.40 am **Intermission**

12.40 pm **Improving embedded convolutional object detectors through low-res training**

Jiahui Zhu, ShanghaiTech University

Plenary Session 4 (Public)

Session Chair: Sutthiphong Srigrarom

1.00 pm **Creating robots that see**

Peter Corke, Queensland University of Technology

Session 12: Computer Vision (II)

Session Chair: Marco Mameli, Chen Chao-Yu

1.40 pm **Fusion Of Radar- And Lidar-Data For Object-Tracking-Applications At Feature Level**

Maximilian Lindinger, SICK AG

2.00 pm **Learning to Segment Human Body Parts with Synthetically Trained Deep Convolutional Networks**

Daniele Evangelista, University of Padova

2.20 pm **Detection and Classification of defects in tyre using a deep learning approach**

Marco Mameli, Università Politecnica delle Marche

Session 13: Control (II)

Session Chair: Alexandre Huart, Eric Price

2.40 pm **Introduction of damping control for obstacle avoidance in direct-contact cobotics operations**

Alexandre Huart, Keio University

3.00 pm **Shape Control of Elastic Objects Based on Implicit Sensorimotor Models and Data-Driven Geometric Features**

Wanyu Ma,The Hong Kong Polytechnic University

3.20 pm **Robotic Arm Control and Task Training through Deep Reinforcement Learning**

Elisa Tosello, University of Padova

3.40 pm **A marker based optical measurement procedure to analyse robot arm movements and its application to improve accuracy of industrial robots**

Oliver Rettig, Baden-Wuerttemberg Cooperative State University Karlsruhe

4.00 pm **Intermission**

4.20 pm **A Planning Domain Definition Language Generator, Interpreter, and Knowledge Base for Efficient Automated Planning**
Luca Tagliapietra, University of Padova

4.40 pm **Weighted Shared-Autonomy with Assistance-to-Target and Collision Avoidance for Intelligent Assistive Robotics**

Stefano Tortora, University of Padova

5.00 pm **Automatic Grasp Pose Generation for Parallel Jaw Grippers**

Kilian Kleeberger, Fraunhofer IPA

5.20 pm **Simulation and Control of Deformable Autonomous Airships in Turbulent Wind**

Eric Price, Max Planck Institute for Intelligent Systems

5.40 pm **Closing Ceremony and Awards Presentation**

6.00 pm **End of Day 3**

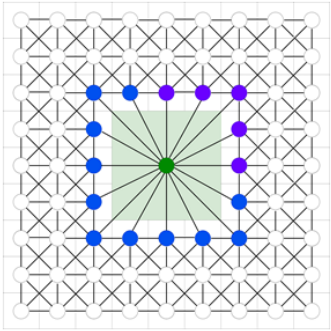
DIGESTS

Session 1: Presentation for Best Paper Candidates (I)

Analysis of Exploration in Swarm Robotic Systems

Minyoung Jeong, John Harwell, and Maria Gini
Computer Science and Engineering, University of Minnesota Minneapolis, USA

- We estimate exploration time, an important performance measure for swarm foraging tasks
- We model the arena and the robots moving randomly using a Markov chain
- We estimate the probability distribution of the time to first reach any given node using Monte Carlo sampling

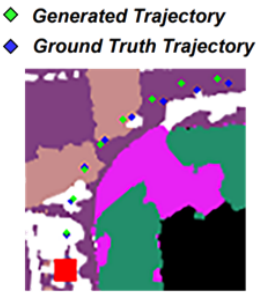


Markov chain model

TridentNet: A Conditional Generative Model for Dynamic Trajectory Generation

David Paz, Hengyuan Zhang, and
Henrik I. Christensen
Contextual Robotics Institute, University of California, USA

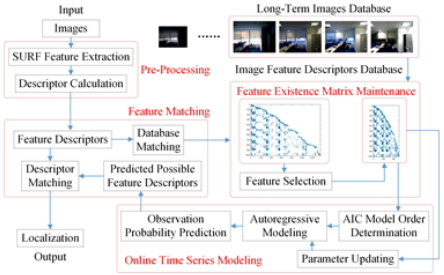
- A dynamic trajectory generation approach for autonomous driving in urban environments is introduced.
- A conditional generative model is introduced to model the distribution of potential trajectories.
- Lightweight global plan and semantic scene representations are leveraged to provide context.



Online Learning Based Long-Term Feature Existence State Prediction for Visual Topological Localization

Hongle Xie, Weidong Chen and Jingchuan Wang
Institute of Medical Robotics, Shanghai Jiao Tong University, China
Department of Automation, Shanghai Jiao Tong University, China
Key Laboratory of System Control and Information Processing,
Ministry of Education of China, China

- A new long-term visual topological localization system in dynamic scene is proposed.
- A new online learning-based time series modeling method is proposed.
- Our system achieves better accuracy and competitive real-time performance.



Framework of the visual topological localization system

ALOT: Augmented Localization with Obstacle Tracking

Zhikai Li, Krittin Kawkeeree, Yue Linn Chong,
Christina Dao Wen Lee and Marcelo H. Ang Jr.
Advanced Robotics Center, National University of Singapore, Singapore

- LiDAR Localization with visual dynamic obstacle tracker to negotiate crowded environments.
- Tracker uses relative position from obstacle to propose ego-poses, filtered with LiDAR readings.
- Low average positional and heading errors of 0.171 m and 1.63° in low/moderate crowd.
- Relatively low average positional and heading errors of 0.467 m and 4.784° in large crowds.

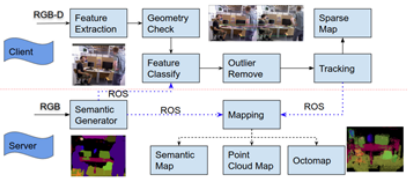
Experimental platform (left) following a line (middle), producing ground truth trajectory (right). Done with and without dynamic obstacles for comparison.

Session 2: Localization and SLAM

RTS-vSLAM: Real-time Visual Semantic Tracking and Mapping under Dynamic Environments

Yubao Liu and Jun Miura
Department of Computer Science and Engineering,
Toyohashi University of Technology, Japan

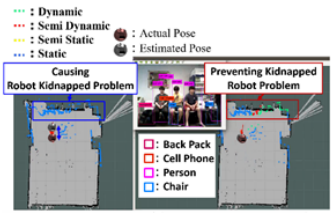
- Scene rigidity assumption limits the wide usage of visual SLAM in populated environments.
- Both semantic segmentation and geometric methods are used to detect dynamic objects.
- Outliers are removed from camera ego-motion estimation using semantic information.
- Tracking accuracy is improved in the dynamic environments and static semantic map is constructed.



Mobile Robot Localization Considering the Attributes of Objects to Prevent the Kidnapped Robot Problem

Taiki Harada and Ayanori Yorozu
School of Science for Open and Environmental Systems, Keio University, Japan
Masaki Takahashi
Department of System Design Engineering, Keio University, Japan

- We propose a localization approach to prevent the occurrence of the kidnapped robot problem.
- This approach associates classified sensor information and prior map embedded objects' classes and movability.
- This approach adapts robots to environmental change by weighting the importance of sensor information.



Simulation Results
Compared Proposed method and conventional method

Collaborative Mapping of Archaeological Sites using Multiple UAVs

Manthan Patel and Aditya Bandopadhyay
Department of Mechanical Engineering,
Indian Institute of Technology Kharagpur, India
Aamir Ahmad
Institute of Flight Mechanics and Controls, University of Stuttgart, Germany

- .A two-step method for faster mapping of archaeological sites using UAVs working collaboratively
- First Step: Online Collaborative Sparse mapping increases map accuracy and reduces mapping time
- Second Step: Offline Dense mapping using Multi-View Stereo
- We Open-source two Novel Datasets for evaluation of Collaborative SLAM approaches

3D Nominal Scene Reconstruction For Object Localization and UAS Navigation

Xuyang Han and Sutthiphong Srigrarom
Mechanical Engineering, National University of Singapore

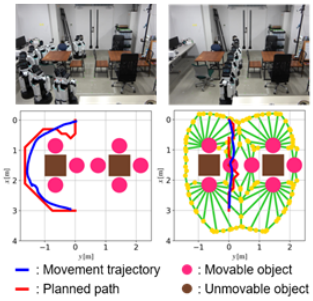
- 'Nominal' scene reconstruction
- Design for UAS navigation in dense & obstacle rich environment.
- Interested in key features, such as tree leaves, cars, houses.
- Real-time & off-board computing.

Session 3: Navigation (I)

Topometric Navigation Considering Movable Objects

Shunsuke Mochizuki and Masaki Takahashi
Department of System Design Engineering, Keio University, Japan
Ayanori Yorozu
Graduate School of Science and Technology, Keio University, Japan

- This study presents navigation framework considering object size, shape, and movability
- Topological map finds discrete path and enables robots to remove movable objects if necessary
- Metric map is used to consider object size and shape when planning continuous path
- Robots reach the goal even when movable objects block the path

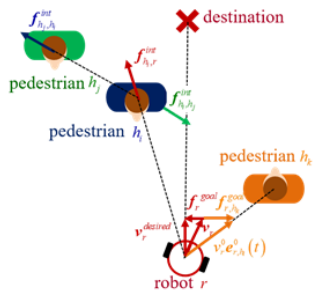


(a) Comparison (b) Proposed
Experimental results

Harmonious Robot Navigation Strategies for Pedestrians

Shintaro Nakaoka and Masaki Takahashi
Department of System Design Engineering, Keio University, Japan
Ayanori Yorozu
Graduate School of Science and Technology, Keio University, Japan

- This study proposes sampling-based motion planner to reduce robot's impact on pedestrians
- Optimal velocity is determined by minimizing evaluation value based on social force model
- Evaluation value includes forces to go toward goal, follow and impact from robot on pedestrians
- Weights of each term are determined based on traveling direction of pedestrians

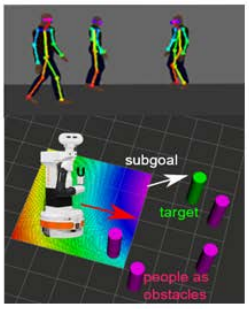


Evaluation value based on social force model

Shared autonomy for telepresence robots based on people-aware navigation

Gloria Beraldo [1,2], Kenji Koide[3], Amedeo Cesta[2], Satoshi Hoshino[4],
Jun Miura[5], Matteo Salvà[1], Emanuele Menegatti[1]
[1] Department of Information Engineering, University of Padua
[2] ISTC, National Research Council of Italy
[3] AIST
[4] Utsunomiya University
[5] Toyohashi University of Technology

- A new telepresence system designed to **facilitate** the **remote teleoperation** in **social** space.
- **Social movements** with **static** and **dynamic** people based on **proxemics** and **user's commands**.
- The system was evaluated by **ten remote users**.
- Results confirm the **effectiveness** of the system with respect to other teleoperation modalities.



A Framework to Study Autonomous Driving User Acceptance in the Wild

Alessandro Gabrielli, Simone Mentasti,
Gabriel Esteban Manzoni and Matteo Matteucci
Department of Electronics Information and Bioengineering,
Politecnico di Milano, Italy
Stefano Arrigoni and Federico Cheli
Department of Mechanical Engineering, Politecnico di Milano, Italy

- We developed a platform to study the interaction between driver and car
- We studied the human driver stress and the autonomous driving factor that impact on stress
- Results show that longitudinal jerk, angular velocity, and lateral acceleration have high correlation with stress.

A driver in the instrumented car wearing physiological sensors

Probabilistic Collision Constraint for Motion Planning in Dynamic Environments

Antony Thomas, Fulvio Mastrogiovanni, and Marco Baglietto
Department of Informatics, Bioengineering, Robotics, and Systems Engineering,
University of Genoa, Italy

- Collision avoidance in dynamic environments, incorporating robot & obstacle state uncertainties
- Tight upper bound for collision probability, formulated as a motion planning constraint and solvable in real time

Methods	Collision probability	Computation time (ms)
Numerical integral	0.1728	9168.9 ± 258.0
Approximate Numerical integral [22]	0.4280	18.30 ± 3.90
Bounding volume [21, 26]	1	0.1480 ± 0.4411
Maximum probability approximation [27]	1	101.6 ± 23.86
Chance constraint [37]	0.5398	0.3917 ± 0.1278
Rectangular bounding box [15]	0.1601	0.067 ± 0.0070
Our approach	0.1772	0.588 ± 0.13

Comparison of collision probability methods

Session 4: Navigation (II)

Human-following Control in Furrow for Agricultural Support Robot

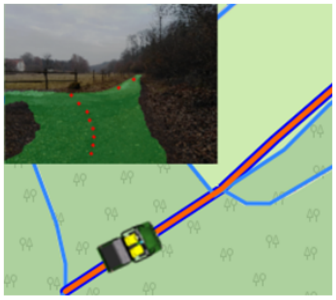
Ayanori Yorozu
Graduate School of Sience and Technology, Keio University, Japan
Department of Information Engineering, University of Tsukuba, Japan
Genya Ishigami
Department of Mechanical Engineering, Keio University, Japan
Masaki Takahashi
Department of System Design Engineering, Keio University, Japan

- For smooth and safe work support, ridge detection and human-following without riding on ridges are required
- Ridge line detection and interpolation during occlusion with an RGB-D camera are proposed
- Human-following control with ridge avoidance using fuzzy potential method is proposed

Autonomous Off-Road Navigation using Near-Feature-Based World Knowledge Incorporation

Patrick Wolf, Axel Vierling, Thorsten Ropertz, Simon Velden, Carlos Guzman, and Karsten Berns
Robotics Research Lab, TU Kaiserslautern, Germany

- Robust pathway segmentation using CNNs
- Global feature extraction using world knowledge (OSM) and local feature matching (shape of trail)
- Multi-feature-grid-based navigation using perception and incorporated database knowledge
- Experimentation in the Rhineland-Palatinate forest with robot GatorX855D

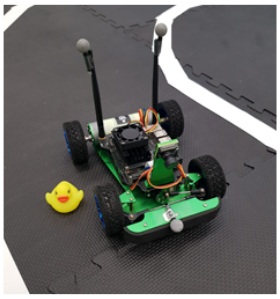


Incorporation of OSM data using local path features.

Learning to drive fast on a DuckieTown highway

Thomas Wiggers and Arnoud Visser
Intelligent Robotics Lab, University of Amsterdam, The Netherlands

- A controller is trained in simulation using PPO to follow the road
- Three different vehicle speeds are investigated
- Real-world evaluation is performed on a DuckieTown highway with the JetRacer
- The presented model is capable of real-world lane following



The JetRacer used for real world evaluation

End-to-end learning of autonomous vehicle lateral control via MPC training

Simone Mentasti and Matteo Matteucci
Department of Electronics Information and Bioengineering, Politecnico di Milano, Italy
Mattia Bersani, Stefano Arrigoni, and Federico Cheli
Department of Mechanical Engineering, Politecnico di Milano, Italy

- Autonomous vehicle trajectory planning via MPC generally requires prior knowledge of the street.
- In this paper, we trained an end-to-end network on the output of an MPC to predict lateral control commands from images.
- Predicted lateral control values are comparable with those from the MPC, without the need for prior information on the street shape.

The testing vehicle driving autonomously through a chicane

End-to-end Imitation Learning for Autonomous Vehicle Steering on a Single-Camera Stream

Thomas van Orden and Arnoud Visser
Intelligent Robotics Lab, Universiteit van Amsterdam, The Netherlands

- End-to-end imitation learning in the **most complex** towns of driving simulator CARLA.
- Comparison of 5 state-of-the-art CNNs.
- Xception best in benchmark: **90%** and **34% success rates** in non- and complex towns.
- To further improve performance in complex situations, a high-level conditional command unit will be necessary.

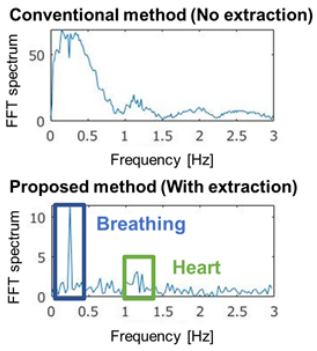
Model inference
in CARLA simulator.

Session 5: Application (I)

A study on constraint-free vital sign measurement using a millimeter wave sensor in home environment

Shumpei Nakamura
Department of Medical System Engineering, Chiba University, Japan
Shao Ying Huang
Engineering Product Development, Singapore University of Technology and Design, Singapore
Wenwei Yu
Center for Frontier Medical Engineering, Chiba University, Japan

- To realize monitoring vital signs in a home environment using millimeter-wave Sensors.
- To estimate the movement of the target person and identify the invalid raw data.
- To extract valid data for accurate estimation of heart rate.

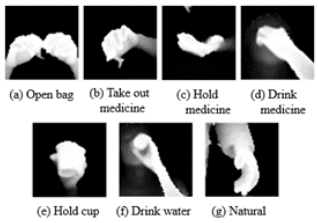


FFT result

Development of a Medication-taking Behavior Monitoring System Using Depth Sensor

Rikuto Osawa and Wenwei Yu
Department of Medical System Engineering, Chiba University, Japan
Shao Ying Huang
Engineering Product Development, Singapore University of Technology and Design, Singapore

- **Purpose:** to improve medication adherence
- **Method 1:** to recognize medication-taking behavior (from open-bag to drink-water) from depth image of each frame
- **Method 2:** to couple recognition results of each frame with state-transition diagram- based probability estimation



Accuracy > 85% (average of seven relevant motions)

Developing a collaborative robotic dishwasher cell system for restaurants

Wing Sum Lo
Dept. Mech. Sys. Engineering, Tokyo University Of Agriculture and Technology and Connected Robotics Inc.
Chihiro Yamamoto, Shizuka Takahashi and Ikuo Mizuuchi
Dept. Mech. Sys. Engineering, Tokyo University Of Agriculture And Technology
Suraj Prakash Pattar, Koichi Tsukamoto and Tetsuya Sawanobori
Connected Robotics Inc.

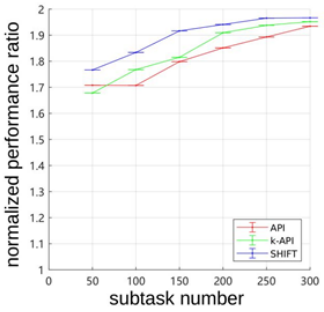
- The first collaborative robot-based dish-washing system for restaurants.
- Insights from observing actual store operation
- User acceptance proposed and verified in this work

The dishwasher system

Iterative Improvement for the Heterogeneous Robotic Order Fulfillment Problem Using Simulated Annealing

Hanfu Wang, Weidong Chen and Jingchuan Wang
Institute of Medical Robotics and Department of Automation, Shanghai Jiao Tong University, and Key Laboratory of System Control and Information Processing, Ministry of Education, China

- Multiple transport robots and pick robots collaborate to achieve complex-schedule order-fulfillment tasks
- The objective is to obtain collective time-extended task schedule with the minimization of makespan
- Simulated annealing algorithms are designed, and several neighborhood structures are introduced
- API neighborhood operator is recommended



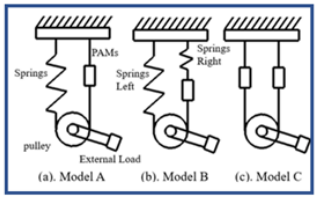
Normalized performance ratio for different problem instance types

Session 6: Biomimetic Robots

A simulation study for evaluating the role of pretensioned springs in 3 PAM driven joint mechanisms with Sliding mode controller

Zhou Zhongchao and Wang Yuanyuan
Department of Medical System Engineering, Chiba University, Japan
Yu Wenwei
Center for Frontier Medical Engineering, Chiba University, Japan

- To compare two novel pretensioned spring - PAM structures with a canonical antagonistic PAM structure.
- To make clear the role of pre-tensioned spring in novel antagonistic structures
- To achieve accurate and fast target tracking with derived SMC.

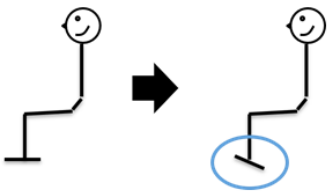


PAM: Pneumatic Artificial Muscles
SMC: Sliding Mode Controller

Effect of Tilted Ground on Muscle Activity in Human Sit-to-Stand Motion: Preliminary Result

Kazunori Yoshida, Hiroshi Yamakawa, Atsushi Yamashita and Hajime Asama
Department of Precision Engineering, The University of Tokyo, Japan
Qi An
Graduate School and Faculty of Information Science and Electrical Engineering, Kyushu University, Japan
Yusuke Tamura
Department of Robotics, Tohoku University, Japan

- The aim is to clarify the relationship between posture and muscle activity in sit-to-stand.
- We analyzed the relationship between the postures and muscle activity using tilted ground.
- The muscle activity contributing towards pushing the body forward was higher.

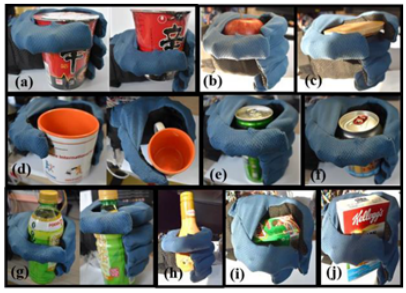


Tilted ground to change the posture

In-hand Object Recognition for Sensorized Soft Hand

Phone May Khin and Marcelo H. Ang Jr.
Department of Mechanical Engineering, NUS, Singapore
Jin Huat Low and Chen-Hua Yeow
Department of Biomedical Engineering, NUS, Singapore

- Anthropomorphic soft robotic hand with embedded flexible sensors
- Transfer learning based recognition of curvature and contact forces of objects that are grasped by the sensorized soft hand
- Classification accuracy of up to 88.20% on unknown objects

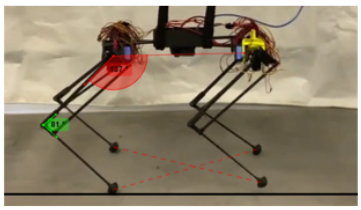


Sensorized soft robotics hand grasping different objects

Scaffolded Learning of In-place Trotting Gait for a Quadruped Robot with Bayesian Optimization

Keyan Zhai, Chu'an Li and Andre Rosendo
School of Information Science and Technology,
ShanghaiTech University, China

- Present the impact of scaffolded support during gait learning of a quadruped robot
- Learning using Bayesian Optimization to conduct a parametric search towards a stable Raibert controller
- Experiments with different support settings are assessed

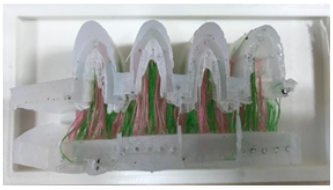


A snapshot of the scaffolded learning process with Bayesian Optimization

GradNet: A Viscosity Gradient Approach to Achieve Dexterity in Soft Pneumatic Actuators

Parthsarthi Rawat and Santanu Mitra
Department of Mechanical Engineering, Shiv Nadar University, India
Tanay Misra
Department of Electronics and Communication Engineering, Shiv Nadar University, India
Khin Phone May and Raye Chen-Hua Yeow
Department of Biomedical Engineering, National University of Singapore, Singapore
Marcelo H Ang Jr
Department of Mechanical Engineering, National University of Singapore, Singapore

- Mixing Ecoflex-20 and DragonSkin-20 in different ratios for a custom Young's Modulus.
- Design and fabrication of a non-parallel surfaced soft actuator with fiber reinforcements.
- Comparison of actuator built with custom material and simply one elastomer.

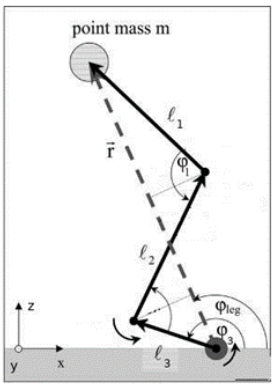


Cross-sectional view of the actuator with custom material

How to tune Humanoid Walking Parameters for better Performance

Antonio D'Angelo
Dept. of Mathematics and Computer Science, University of Udine, Italy
Enrico Pagello
Dept. of Information Engineering, Padua University, Italy

- Three link spring-based leg model:
- Gait parameters follow directly from the elliptic approach to the leg dynamics
- Leg design is the best fit between gait parameters and leg dynamics
- Two different setup are considered as possible candidates to this aim

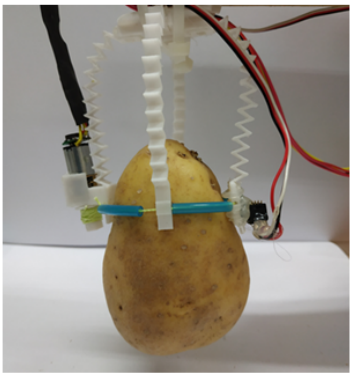


Session 7: Presentation for Best Paper Candidates (II)

Sensorized Compliant Robot Gripper for Estimating the Cooking Time of Boil-Cooked Vegetables

Grzegorz Sochacki, Josephine Hughes and Fumiya Iida
Department of Engineering, University of Cambridge, UK

- Compliant, cheap to produce, 3D-printed gripper with proprioception for object size estimation
- Size estimation combined with soft force sensors allows for spring constant estimation
- Physics model of cooking allows for estimation of 'cookedness' and estimation of needed remaining time

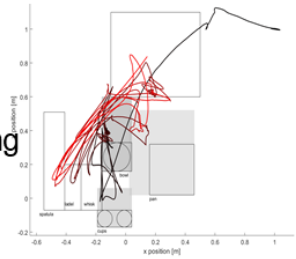


Session 8: Application (II)

Robotic cooking through pose extraction from human natural cooking using OpenPose

Dylan Danno, Simon Hauser
and Fumiya Iida
Bio-Inspired Robotics Lab, University of Cambridge, UK

- Translating recipes into to robotic actions is a challenging task
- Automated recipe technique recognition from recording the pose of demonstrators is a potential solution
- A UR5 arm was made to imitate the pancake recipe techniques of human demonstrators
- Humans scored robot pancakes as only minorly inferior

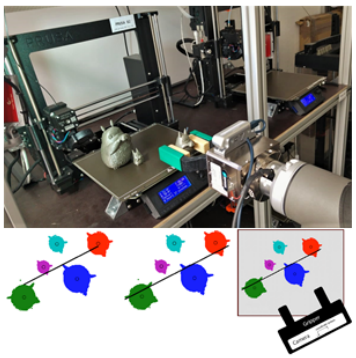


Example Trajectory of Demonstrator's Right Hand

Multiple Object Detection and Segmentation for Automated Removal in AM with Service Robots

Pascal Becker, Anastasiia Maklashevskikh,
Arne Rönnau, and Rüdiger Dillmann
FZI Research Center for Information Technology, Germany

- Automation of additive manufacturing / 3d printers is necessary for industrial use
- This work presents an approach to unload multiple printed objects by a robot autonomously
- Grasping points are calculated based on the CAD / slicing data, validation done with pointclouds
- Successfully unloaded multiple amounts and objects directly from the build plate



Calculation of the best perspective for the validation with the 3d sensor

Determination of posture comfort zones for robot-human handover tasks

Oliver Rettig, Silvan Müller and Marcus Strand
Baden-Wuertemberg Cooperative State University Karlsruhe, Germany

- Determination of posture comfort zones for robot-human takeover tasks depending on individual human postures.
- New criterium found: Compensatory left and right shoulder position translations.
- Marker based optical measurements used to analyse kinematics of the human.

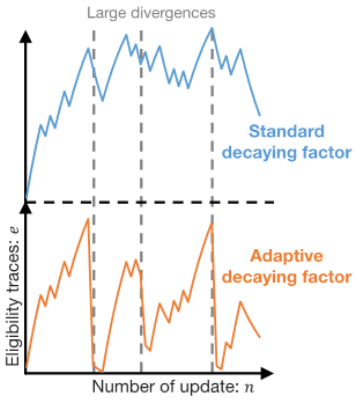
Setup to take a packet for robot-human handover

Session 9: Machine Learning

Adaptive Eligibility Traces for Online Deep Reinforcement Learning

Taisuke Kobayashi
Division of Information Science, Nara Institute of Science and Technology (NAIST), Japan

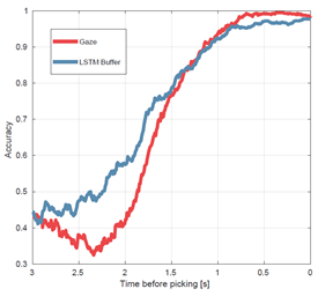
- Deep reinforcement learning makes eligibility traces unsuccessful due to its nonlinearity.
- To mitigate this, the proposed eligibility traces adaptively reset according to output divergences.
- In simulations, the proposed method acquired the larger rewards than the conventional methods.



Ensemble of LSTMs and feature selection for human action prediction

Tomislav Petković, Luka Petrović, Ivan Marković and Ivan Petrović
Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia

- Ensemble of identical LSTMs predicts the next action of a human
- Feature selection based on correlation and individual merit
- Experiments on the MoGaze dataset
- Proposed model works fast and beats baselines



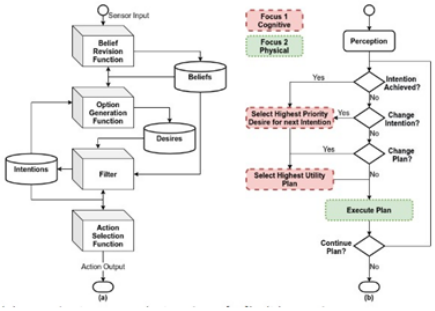
Session 10: Control (I)

Reinforcement Leaning at the Cognitive Level in a Belief, Desire, Intention UAS Agent

David Sacharny, Tom Henderson, Michael Cline, and Ben Russon
School of Computing, University of Utah, USA

- UAS policies learned at cognitive level
- BDI architecture supports independent plans
- Reduces human programming requirement
- Produces human understandable policies

  (e.g., based on nominal flight conditions)

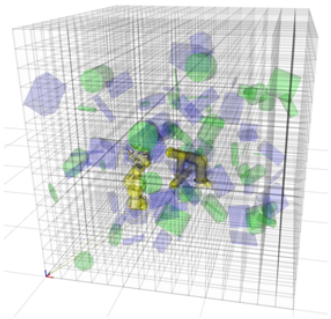


(a) BDI Architecture (b) Reinforcement Learning (adapted [14,15])

Action Feasibility Learning with Cell-based Multi-Object Representation for Task and Motion Planning

Junsu Kang, Wan Kyun Chung, and Keehoon Kim
Department of Mechanical Engineering, POSTECH, Korea

- Quick feasibility determination of subtasks can improve the speed of Task and Motion Planning
- Representing 3D tasks and multiple obstacles is a bottleneck in robotic task learning
- We propose a grid-based approach to represent and learn robot tasks and 3D obstacles



Learning pick & place with 3D obstacles

Improved Driving Stability of Segway using two Serial Elastic Actuators

Jinuk Bang and Jangmyung Lee
Department of Electrical and Electronic Engineering,
Pusan National University, South Korea

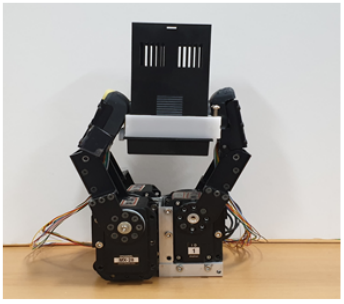
- A research on the Algorithm to Prevent Path Departure Due to the Change of Center of Mass During Turning
- Footplate control using a two Series Elastic Actuator (SEA)
- Use SEA to experiment to see if the Segway can drive along the target route

Segway and footplate system

Optimal Grasping Control System For Performing Precision Indirect Teaching of Robot Hand

Seongho Jin and Jonghak Lee
Electrical and Electronic Engineering, Pusan National University, Korea
Jangmyung Lee
Electronic Engineering, Pusan National University, Korea

- Research on indirect teaching in which robots imitate human movements is actively underway.
- Prevents damage to objects by considering the current value of the motor during teaching work.
- Optimal grasping control by automatically adjusting the torque operating rate(TOR) during teaching



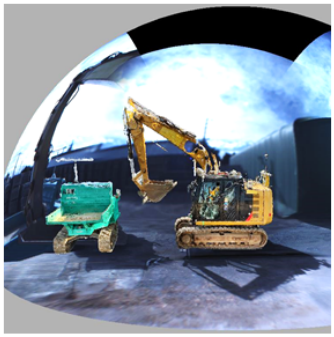
Grasping experiment

Session 11: Computer Vision (I)

Visualization of Dump Truck and Excavator in Bird's-eye View by Fisheye Cameras and 3D Range Sensor

Y. Sugasawa, S. Chikushi, R. Komatsu, J. Y. Louhi Kasahara,
S. Pathak, R. Yajima, S. Hamasaki, K. Nagatani, A. Yamashita and H. Asama
Department of Precision Engineering, The University of Tokyo, Japan
T. Chiba and K. Chayama
Fujita Corporation, Japan

- For remote operation of excavator, display of dump truck in bird's-eye view is needed.
- Bird's-eye view is generated by four fisheye cameras mounted on excavator.
- Dump truck's position and pose are estimated by LiDAR and displayed.
- The relative positions of excavator and dump truck become visible and allow smooth operation.



Bird's-eye view
with 3D models of
excavator and dump truck

Dynamic Object Removal from Unpaired Images for Agricultural Autonomous Robots

Hiroyasu Akada
Graduate School of Science and Technology, Keio University, Japan
Masaki Takahashi
Faculty of Science and Technology, Keio University, Japan

- A novel system to remove humans from images through adversarial training (GANs)
- No need of paired-image datasets for training
- Training and evaluation on datasets collected by an agricultural autonomous robot for practical use
- Experiments to demonstrate the effectiveness of a consistency loss via mask segmentation for GANs

dynamic object removal
via adversarial training

Future Image Prediction for Mobile Robot Navigation: Front-facing Camera vs Omni-directional Camera

Yu Ishihara
Graduate School of Science and Technology, Keio University, Japan
Masaki Takahashi
Department of System Design Engineering, Keio University, Japan

- In mobile robot navigation task, which camera is suitable for predicting image?
- Action-conditioned LSTM based deep learning model is compared among two camera types.
- Front-facing camera is prone to fail predicting image when the robot rotates.
- Omni-directional camera succeeds predicting including cases where front-facing camera fails.

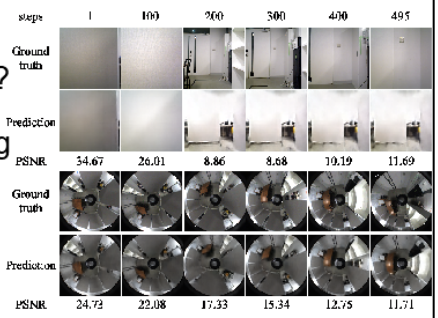
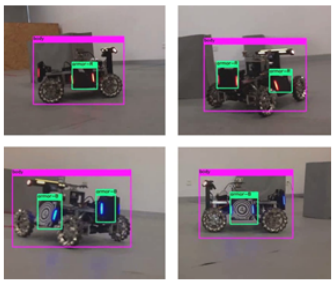


Image prediction result in real robot experiment. Front-facing (top) Omni-directional (bottom)

Improving embedded convolutional object detectors through low-res training

Qian Shi, Jiahui Zhu and Andre Rosendo
School of Information Science and Technology, ShanghaiTech University, China
Zhonglin Nian
University of Pennsylvania, USA

- Both YOLOv3-tiny and MobileNet-SSD are remarkably fast on embedded applications.
- Speed superiority from YOLO on lower-resolutions, while MobileNet-SSD has higher performance in higher-resolutions.
- SSD architectures superior in the absence of strong GPUs, while YOLO architectures are superior otherwise.



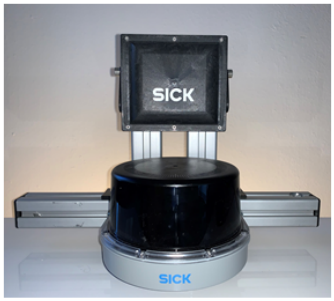
Robot Armor Detections and Recognitions

Session 12: Computer Vision (II)

Fusion Of Radar- And Lidar-Data For Object-Tracking-Applications At Feature Level

Maximilian Lindinger and Marcus Strand
Engineering Department,
Duale Hochschule Baden Württemberg Karlsruhe, Germany
Sebastian Schwarzkopf, Matthias Honal, and Raphael Engesser
SICK AG, Germany

- Combining various measurement properties of Radar and Lidar (such as range and resolution)
- Fusion takes place on level of Kalman filter that is used for realizing object tracking
- Experimental evaluation: especially availability and reliability in tracking can be improved
- Advantage of feature-level over symbol-level



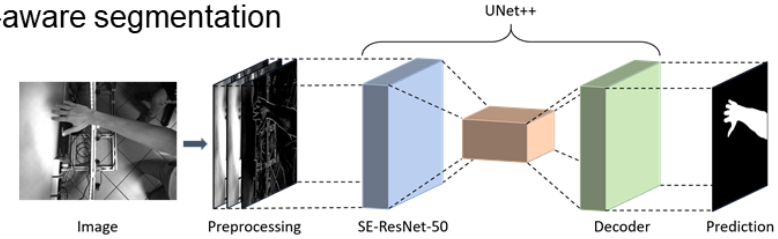
Radar- (top) and Lidar-sensor (bottom)

Learning to Segment Human Body Parts with Synthetically Trained Deep Convolutional Networks

A. Saviolo[2], M. Bonotto[1], D. Evangelista[1], M. Imperoli[2], J. Lazzaro[3], E. Menegatti[1], and A. Pretto[1]

DEI, University of Padova, Italy[1] – FlexSight Srl, Italy[2] – PlayCast Srl, Italy[3]

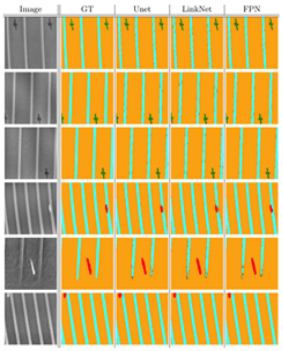
- Accurate foreground segmentation of human body parts
- Synthetic data for training custom UNet++
- Shape-aware segmentation



Detection and Classification of defects in plastic components using a deep learning approach

Marco Mameli , Marina Paolanti, Adriano Mancini , Emanuele Frontoni, and Primo Zingaretti
Dipartimento di Ingegneria dell'Informazione,
Università Politecnica delle Marche, Italy

- A novel dataset of plastic components images is collected, with images manually labelled
- Performance of three deep neural networks UNet, FPN and LinkNet is compared.
- High F1 scores show effectiveness and sustainability of deep learning in automatically identifying tire defects



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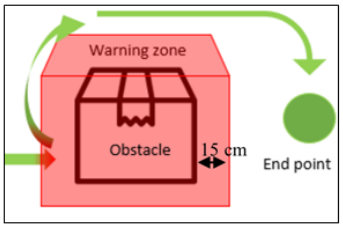
Session 13: Control (II)

Introduction of damping control for obstacle avoidance in direct-contact cobotics operation

Huart Alexandre and Takahashi Masaki
Department of System Design Engineering, Keio University, Japan
Ayanori Yorozu
Faculty of Engineering Information and Systems, Tsukuba University, Japan

- By influencing the oscillations of a robotic system, damping control create an artificial resistance
- Damping control helps the user to notice and to safely avoid obstacle in the workspace
- Experiments demonstrated that damping control is an efficient, comfortable and safe obstacle avoidance method

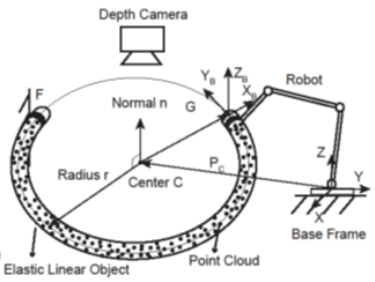


Trajectory realized by the user through damping control

Shape Control of Elastic Objects Based on Implicit Sensorimotor Models and Data-Driven Geometric Features

Wanyu Ma and David Navarro-Alarcon
Department of Mechanical Engineering, The Hong Kong Polytechnic University, HKSAR, China

- This work proposes a 3D continuous geometric model for shape servoing,
- uses implicit function theorem to obtain an analytical Jacobian matrix,
- processes high dimensional data in real-time by dealing with unorganized raw visual feedback.

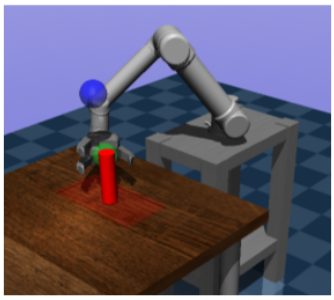


Conceptual illustration of the setup and the shape feature (spatial arc)

Robotic Arm Control and Task Training through Deep Reinforcement Learning

Andrea Franceschetti*, Elisa Tosello*,
Nicola Castaman and Stefano Ghidoni
Department of Information Engineering, University of Padova, Italy
* equal contribution

- Study how reward functions and hyper-parameters affect the quality of DRL policies.
- Compare multiple model-free DRL algorithms when learning continuous torque control policies for manipulation tasks.
- Show how to replicate the approach when selecting the best algorithm according to the assignment.

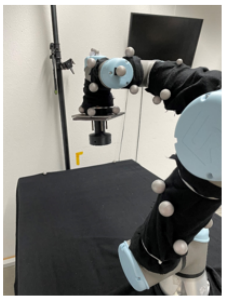


The simulated training setup.

An optical measurement procedure to improve accuracy of industrial robots

Oliver Rettig, Silvan Müller and Marcus Strand
Baden-Wuertemberg Cooperative State University Karlsruhe, Germany

- A marker based optical measurement system can be used as a cost-efficient alternative to laser scanners to determine DH-parameters.
- Accuracy better than 0.1mm was reached with cameras with resolution of only 2.2 Megapixel.
- A robot of type UR5e from Universal Robots was calibrated.



UR5e equipped with spherical retroreflective markers

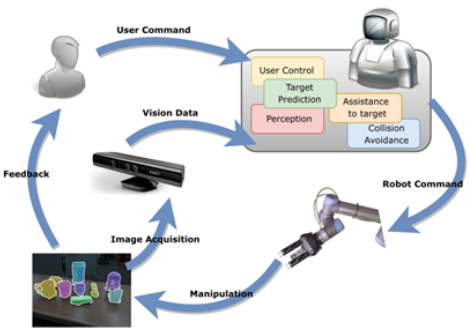
A Planning Domain Definition Language Generator, Interpreter, and Knowledge Base for Efficient Automated Planning

COMING SOON

Weighted shared-autonomy with assistance-to-target and collision avoidance for Intelligent Assistive Robotics

Stefano Tortora, Roberto Sassi, Ruggero Carli and Emanuele Menegatti
Department of Information Engineering, University of Padova, Italy

- We propose a novel shared-autonomy controller integrating the contribution of two semi-autonomous behavioral modules.
- Assistance-to-target, adjusting user's input to simplify the target reaching.
- Collision avoidance, moving the robot away from trajectories leading to possible collisions with obstacles.
- A weighting arbitration function prevents conflicts between the two behaviors and increases the assistance efficacy.

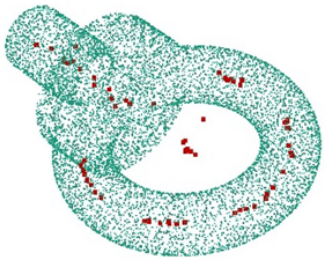


Intelligent assistive robotics (IAR) with shared-autonomy in manipulation tasks

Automatic Grasp Pose Generation for Parallel Jaw Grippers

Kilian Kleeberger, Florian Roth, Richard Bormann
Department Robot and Assistive Systems, Fraunhofer IPA, Germany
Marco F. Huber
IFF, University of Stuttgart, Germany

- Novel approach for automatic grasp pose generation on known rigid objects for parallel jaw grippers
- Clustering is used to reduce the number of grasps while maintaining a high variance
- Grasps can be successfully used in real-world robotic applications



Grasp poses (red) for a ring screw

Simulation and Control of Deformable Autonomous Airships in Turbulent Wind

Eric Price and Yu Tang Liu
Max Planck Institute for Intelligent Systems, Germany and
Institute for Flight Mechanics and Controls, University of Stuttgart, Germany
Michael J. Black
Max Planck Institute for Intelligent Systems, Germany
Aamir Ahmad
Institute for Flight Mechanics and Controls, University of Stuttgart, Germany and
Max Planck Institute for Intelligent Systems, Germany

- Real time physical simulation of non-rigid airship.
- Modeling dynamic shape changes due to gravity, momentum and aerodynamic forces in flight.
- Prediction of effects on vessel control and flight behavior.
- Comparison with Real-world flight experiments.

Airship (Blimp), effects of reduced pressure, simulation and reality.

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