

The IECON 2022 Organizing Committee invites proposals for Tutorials to be held during the conference in Brussels, Belgium from 18 October till 21 October 2022.

Tutorials offer participants from different technical backgrounds the chance to explore innovative trends and learn new techniques from experts in the field. One or more of the following elements are strongly encouraged for the proposal: a) Industry-led or co-hosted lectures; b) Cross-disciplinary topics; c) Interactive and engaging approach.

Suitable tutorial topics range from emerging research areas to established techniques of practical and industrial relevance. Tutorials in all areas of Industrial Electronics disciplines are welcomed and IECON2022 is particularly interested in tutorial topics related to the conference themes.

IECON 2022 Tutorial Proposal Form

- **Title of the Proposal:**

Motion-based Machine Learning and Its Application to Motion Control

- **Presenter(s):** Title, name, affiliation

Professor Toshiaki Tsuji, Saitama University, Japan

Professor Sho Sakaino, Tsukuba University, Japan

One more presenter (TBA)

- **Brief description:** No more than 600 words

The application of machine learning with image information has been expected as one of the methods to improve the motion control performance of robots, and there have been many reports in the literature. However, in order for robots to reproduce skilled motion, such as high-precision metal polishing, it is important to reproduce motion including force information.

These days, applications of motion-based machine learning which uses motion information as well as image information have been making great achievements.

In this tutorial, we introduce state-of-the-art research topics on the application of motion-based machine learning to motion control of robots.

This tutorial is supported by the Technical Committee on Motion Control.

- **Duration:** Presentation duration

4 hours (2 hours x 2 slots)

- **Outline:** Outline shall define the topics and subtopics. No detail description (No more than 600 words)

Motion Control

Robotics

Machine Learning

Imitation Learning

Acquisition of tacit knowledge

- **Motivation and Focus:** Briefly explain why this topic is important for IES community and outline the learning outcome (No more than 600 words)

These days, applications of motion-based machine learning including motion information as well as image information have been making great achievements. As AI-based motion control would be one of the important topics related to Industry 4.0, the IES members would be able to learn knowledge related to this topic.

- **Brief CV:** Photo, name, email, and short CV (relevant to the proposal).

Professor Toshiaki Tsuji, tsuji@ees.saitama-u.ac.jp



Toshiaki Tsuji received the B.E. degree in system design engineering and the M.E. and Ph.D. degrees in integrated design engineering from Keio University, Yokohama, Japan, in 2001, 2003, and 2006, respectively. He was a Research Associate with the Department of Mechanical Engineering, Tokyo University of Science, from 2006 to 2007. He is currently an Associate Professor with the Department of Electrical and Electronic Systems, Saitama University, Saitama, Japan. His research interests include motion control, haptics and rehabilitation robots.

Dr. Tsuji received the FANUC FA and Robot Foundation Original Paper Award, in 2007 and 2008, respectively.

Professor Sho Sakaino, sakaino@iit.tsukuba.ac.jp

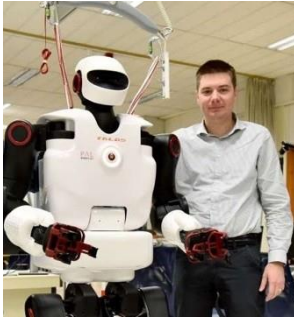


Sho Sakaino received the B.E. degree in system design engineering and the M.E. and Ph.D. degrees in integrated design engineering from Keio University, Yokohama, Japan, in 2006, 2008, and 2011, respectively. He was an assistant professor at Saitama University from 2011 to 2019. Since 2019, he has been an associate professor at University of Tsukuba.

His current research interests include haptics and AI-based motion control. In this research, motions include human skills are collected, and AI is trained to imitate the motions. Then, robots realizes human-like skillful motions.

Dr. Sakaino received the IEEJ Industry Application Society Distinguished Transaction Paper Award in 2011 and 2020. He also received the RSJ Advanced Robotics Excellent Paper Award in 2020.

Doctor Tadej Petric, tadej.petric@ijs.si



Tadej Petrič is currently a senior research associate at the Department for Automation, Biocybernetics and Robotics at the Jožef Stefan Institute and an assistant professor at Jožef Stefan International Postgraduate School, Slovenia. He is also the head of Laboratory for advancing collaborative robot behaviours in physical human-robot interaction (CoBoTaT).

In 2015 he was a Postdoctoral Fellow with the Biorob (prof. Auke Ijspeert lab), at the École polytechnique fédérale de Lausanne (EPFL).

In 2013 he received the D.Sc. degree in robotics from the Faculty of Electrical Engineering at the University of Ljubljana. He performed a part of his doctoral research at the Department of Robotic Systems for Dynamic Control of Legged Humanoid Robots at German Aerospace Center (DLR) in Germany. In 2013 he was a visiting researcher at ATR Computational Neuroscience Laboratories in Japan. Tadej Petrič attended the Faculty of Electrical Engineering and Computer Science at the University of Maribor, Slovenia, where he obtained the B.Sc degree in Electrical Engineering in 2008. His B.Sc. covered modeling and robotic control of underactuated dynamic system. For his work, he received the prof. dr. Vratislav Bedjanič award in 2008.

His current research is concerned with the design of biologically plausible robot controllers that achieve robustness and adaptation to changing environments comparable to that found in humans.

- **Relevant publications:** Maximally 5 publications including edited books
- 1. Ayumu Sasagawa, Sho Sakaino, Toshiaki Tsuji: "Motion Generation Using Bilateral Control-based Imitation Learning with Autoregressive Learning," IEEE Access, Vol. 9, pp. 20508-20520, 2021.
- 2. Ayumu Sasagawa, Kazuki Fujimoto, Sho Sakaino, Toshiaki Tsuji: "Imitation Learning Based on Bilateral Control for Human-Robot Cooperation," IEEE Robotics and Automation Letters, Vol. 5, No. 4, pp. 6169-6176, 2020.
- 3. Petrič, T; Gams, A; Colasanto, L; Ijspeert, A J; Ude, A: "Accelerated Sensorimotor Learning of Compliant Movement Primitives," IEEE Transactions on Robotics, 34 (6), pp. 1636-1642, 2018, ISSN: 1552-3098.
- 4. Peternel, L; Petrič, T; Babič, J: "Robotic assembly solution by human-in-the-loop teaching method based on real-time stiffness modulation," Autonomous Robots, 42 (1), pp. 1-17, 2018, ISSN: 1573-7527.
- 5. Petrič, Tadej: "Phase-Synchronized Learning of Periodic Compliant Movement Primitives (P-CMPs)," Frontiers in Neurorobotics (2020): 90.