The 18th IEEE International Conference on Advanced Robotics and its Social Impacts (ARSO2022)

May 28-30, 2022, Long Beach, California, USA

Organized Session 1

13:15-14:15, May 30

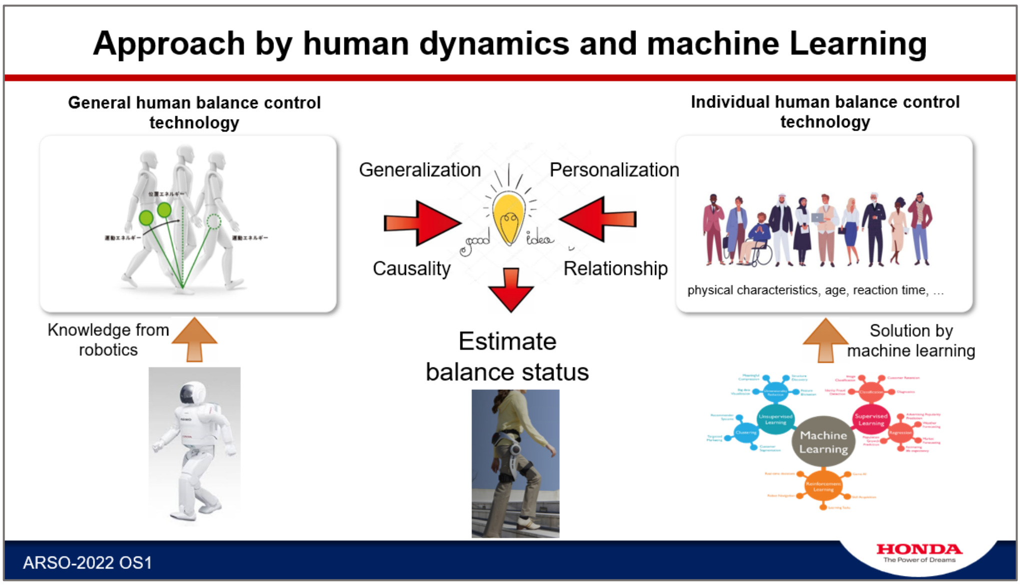
"Human Movement Understanding by Dynamics and Machine Learning"

organized by

Principal Organizer: Taizo Yoshikawa (taizo_yoshikawa@jp.honda)
Honda R&D Co. Ltd., Japan

◆ **Abstract of organized session 1:** Taizo Yoshikawa, Honda R&D Co. Ltd., Japan

Today, the methodologies developed and used in the field of robotics are mature enough to address research agendas in many other areas, from neuroscience to computer animation. If technology in the robot domain is introduced in addition to the conventional human analysis technology, it will be possible to estimate and analyze the internal state during human movement. In addition, by introducing machine learning technology, it will be possible to estimate and analyze the personalized human movement, which can be feedback to the robot system online. In this session, we will first discuss the effect of analyzing human motion by applying humanoid robot technology, and the effect of applying machine learning technology to estimate and predict human motion state. Next, we will introduce the results of applying motion estimation technology to worker ergonomic analysis and the results of applying it to gait analysis.



◆ **Organized session 1-1:** Taizo Yoshikawa, Honda R&D Co. Ltd., Japan (Live)

Title: Identification of human balance controller based on humanoid robot technology

Abstract:

The purpose of this research is to build a technology that enables the wearable robot system that assists human movement to maintain a stable balance. To construct a dynamic model of the human balance state, we focused on the balance control technology of humanoid robots. In the field of humanoid robots, the dynamic model of motion based on the macroscopic relationship between the center of gravity and the center of ground reaction force has been mathematically expressed, a technology for real-time balance control based on internal sensor information has been constructed, and the effectiveness of the balance control model has been confirmed. In

order to build a technology for estimating the balance state of a human based on the balance control technology of humanoid robots, we applied the knowledge of the humanoid robot control to the human stepping and braking motions. In this study, we constructed a system that identifies the phases of walking according to the norms of human gait analysis technology. Next, the human stepping and braking motions constructed were decomposed according to the norms of gait analysis technology and extended to continuous phases of walking. The effectiveness of the constructed balance control model was confirmed by measuring the continuous straight walking and the movement including the change of direction during walking with the motion capture system and the floor reaction force sensor system.

- **Organized session 1-2:** Dr. Viktor Losing, Honda Research Institute Europe GmbH, Germany (Online)

Title: Leveraging Retrospective Self-Training for Personalized Real-Time Motion Classification

Abstract:

Real-time classification of sequential data is becoming essential for an increasing amount of machine learning based applications. For instance, the recognition or prediction of human motion can directly be used to guide the control of assistive devices such as exoskeletons or prostheses. Machine learning models associated with such devices are conventionally static and trained on large amounts of labeled data. However, their performance can be poor when the customer's application environment is not well represented in the training data. This is due to the fact that personal behavior, preferences, and environments can be highly individual. In this talk, I will present an approach that adapts real-time sequence classification models to the specific application environment based on unlabeled data. Precisely, we suggest a semi-supervised learning approach to generate pseudo labels for the unlabeled data. The data is then periodically incorporated into the model using retrospective self-training which leads to continuous improvement over plain supervised learning even for large amounts of labeled data.

- **Organized session 1-3:** Dr. Martina Hasenjäger, Honda Research Institute Europe GmbH, Germany (Online)

Title: Human gait estimation: From catwalk data to walking in the wild

Abstract:

Wearable physical assist robotic devices aim to enhance their user’s performance. In working environments, they aim to reduce physical work load and work-related musculoskeletal disorders. For elderly or physically challenged persons, they aim to improve the quality of life and to extend the activities of daily living. While the field is mature enough to produce a growing number of marketed devices, usability issues become apparent: discomfort and improper alignment with human anatomy and

kinematic. Lacking detection of human intention results in deficiencies in smooth motion support and in an increased risk of stumbling or falling. To avoid such problems, it is not only necessary to develop and employ individual user models for the control of robotic assist devices but also to develop gait models for realistic use cases.

In this presentation, we will discuss the challenge of human walk estimation in natural environments that require smooth transitions between walk modes and early detection of human intention. We present a naturalistic, multi-modal outdoor gait data set from 20 participants that includes whole body IMU motion data, foot pressure data, gaze data and extensive labels for walk mode and orientation classification as well as heel strike prediction. The data set will be made publicly available and may serve as a basis for further research on the modelling of natural human motion.

If you are participating online, please use the chat function to post your question.