TECHNICAL COMMITTEE FOR

MODEL-BASED OPTIMIZATION FOR ROBOTICS

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2022-2023 TC Seminar Series

Zoom: https://columbiauniversity.zoom.us/j/91247893326?pwd=L2JWU21aQzc4cU1ZQklEb0QrWGQvdz09

Time: *April 28, 2023, 9 AM EDT*

Hae-Won Park, KAIST

Model Predictive Control for Legged Robots: From Fast Quadruped Locomotion to Agile Climbing Systems

Abstract:
Model predictive control (MPC) has emerged as a widely-adopted algorithm for controlling legged robots, such as humanoids and quadrupeds, due to its robust performance and flexibility to address various legged robot types and gaits. Numerous control algorithms in the form of MPC, taking into account the unique characteristics and nature of legged robots, have been proposed and successfully validated on real robot hardware. In this presentation, I will presents a model predictive control algorithm implemented in two different robotic platforms developed in our lab: KAIST HOUND, a fast-running quadruped robot, and MARVEL, an agile and versatile climbing legged robot. A single MPC algorithm effectively controls both hardware systems with a small modification of contact force conditions. Furthermore, I will provide an overview of a novel MPC algorithm that does not rely on a fixed foot sequence. This MPC algorithm incorporates contact dynamics and its analytical gradient in its formulation to obtain the control input without a predefined gait sequence.

Biography:
Prof. Hae-Won Park is the director of Humanoid Robot Research Center and an Associate Professor of Mechanical Engineering with the Korea Advanced Institute of Science and Technology (KAIST). He received his B.S. and M.S. degrees from Yonsei University, Seoul, Korea, in 2005 and 2007, respectively, and the Ph.D. degree from the University of Michigan, Ann Arbor, MI, USA, in 2012, all in mechanical engineering. Before joining KAIST, he was an Assistant Professor of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign from 2015 to 2019, and postdoctoral associate and research scientist at the Massachusetts Institute of Technology from 2012 to 2015. His research interests lie at the intersection of control, dynamics, and mechanical design of robotic systems, with special emphasis on legged locomotion robots and bio-inspired robots. Throughout his career, Prof. Park won multiple prestigious academic awards including NSF CAREER Award from National Science Foundation (2018), Early-Career Spotlight Award from Robotics: Science and Systems (RSS) Foundation (2021), and the IROS RoboCup Best Paper Award.

Ioannis Havoutis, University of Oxford

Learning and optimization for locomanipulation with quadrupedal robots

Abstract:
Legged robots have made tremendous progress in the last few years and are now taking their first steps in a range of applications. Their key advantage is the unmatched mobility that legged locomotion provides and the versatility this offers as a platform for both sensing and manipulation. These, however, require control solutions that are able to recover from unexpected perturbations, adapt to variations in system and environment dynamics, and execute tasks safely and reliably. In this talk I will give an overview of my groups' work on optimization- and learning-based approaches to locomotion and manipulation on legged robots. In addition, I will briefly touch on our engagement with industrial partners and the applications we are pursuing.

Biography:
Ioannis Havoutis is a Senior Research Fellow in Robotics at the University of Oxford. His group is part of the Oxford Robotics institute while his research combines dynamic whole-body motion planning and control with machine learning, focusing on robots with arms and legs. He received his Ph.D. (2011) and M.Sc. (2007) from the University of Edinburgh, where he worked on machine learning for motion planning and control of articulated robots. He has authored award-winning publications and has been part of a number of national (UK) and international (EU) projects.