TECHNICAL COMMITTEE FOR

MODEL-BASED OPTIMIZATION FOR ROBOTICS

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Carlos Mastalli

Assistant Professor, Heriot-Watt University

Building athletic intelligence in legged robots: a top-down approach

Building athletic intelligence has been a longstanding challenge in legged robotics. When generating agile motions, we push the robot's motor limit and require tracking angular momentum accurately. Ignoring these aspects is quite restrictive and does not hold for most robots (e.g., ANYmal B). From a top-down perspective, the main considerations when generating an agile manoeuvre are the robot's full dynamics and motor limits, which has implication for the robot's kinetic momenta, control and optimisation. In this talk, I will first share our efforts in developing advanced, efficient and open-sourced algorithms for feedback MPC with forward and inverse dynamics. This feedback MPC is a crucial element in our perceptive locomotion pipeline, which combines mixed-integer and quadratic programs for selecting optimal footstep regions and swing-leg motions that avoid obstacles in real-time. It enables the ANYmal robot to execute jumps, dynamics gaits and climb challenging obstacles. Then, I will also share our recent findings on differentiable optimal control for robotics and how these ideas are enabling simple ways to computationally design robots that can perform agile manurers. It enables us to compose codesign problems (a larger nonlinear program) while exploiting the temporal structure of optimal control. With this, we can interactively design the robot's limbs, motor sizes and distribution of components such as PCs and batteries.

Majid Khadiv

Research Scientist, Max Planck Institute

Optimal Control and Learning for Agile Locomotion

Legged robots have become highly capable in the past few years, thanks to the rapid progress on both hardware and control software sides. However, there is still no consensus among researchers how to combine the strengths of control-theory-driven and data-driven approaches in different stages of the control pipeline. In this talk, I will present our recent efforts on developing algorithms that can benefit from best of both worlds for legged locomotion control.