Optimizing Motions in Biomechanics and Robotics by Means of the Direct Boundary Value Problem Approach

K. Mombaur

LAAS-CNRS, kmombaur@laas.fr

Gaining insight into the fundamental principles of human walking and running motions is crucial for researchers in robotics, biomechanics, rehabilitation and sports science. In this talk, we show that mathematical models and numerical optimization are very helpful tools to gain that knowledge. We show in particular the usefulness of the direct boundary value problem approach developed by Bock to solve this class of problems. Motions in biomechanics and robotics result in multi-phase models of highly nonlinear ODEs or DAEs with state variable discontinuities and complex constraints. Relevant objective functions such as the stability, robustness or energy consumption may give rise to additional discontinuities. We present walking, running and artistic motions for complex human-like configurations in the sagittal plane and in three dimensions which have been generated by optimization. We give results for different objective functions some of which lead to remarkably natural motions.