Optimal Design of a Sit-to-Stand Assistance Device using Optimal Control

K.-L. Ho Hoang[1] **and K. D. Mombaur**[1]

Abstract: Regaining basic life skills and maintaining an independent life is an important goal in the rehabilitation of elderly patients suffering from mobility disablities e. g. due to Parkinson's disease, dementia or strokes. The MOBOT project aims on developing an assistive device that supports such patients during gait and sit-to-stand (STS) transfer. This work presents a part of the project in which optimal control methods, and specifically multiple shooting algorithms, were applied to find the optimal states and controls as well as the optimal mechanical design parameters of an STS assistive device that provide optimal STS assistance to subjects from a range of body heights and weights representing the MOBOT target group.

A three-dimensional rigid-body model of a mechanical concept of the MOBOT device was established and included into the optimal control problem. Previously computed optimal assistance trajectories were used as desired trajectories and the optimal assistance forces as external forces for the MOBOT device. The device's main mechanical design parameters were included into the optimal control problem as free parameters. A solution for the optimal control problem was found such that the states, controls and mechanical design parameters were found that cover all desired trajectories of the whole range of the MOBOT target group and minimizes the joint torques of the device.

[1] Research Group Optimization in Robotics and Biomechanics,
Interdisciplinary Center for Scientific Computing, University of Heidelberg
Speyerer Str. 6, 69115 Heidelberg, Germany
khailong.hohoang@iwr.uni-heidelberg.de, katja.mombaur@iwr.uni-heidelberg.de