Iterative Learning Control of an Industrial Robot for Neuromuscular Training

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Abstract

Effective training requires high muscle forces potentially leading to training-induced injuries. Thus, continuous monitoring and controlling of the loadings applied to the musculoskeletal system along the motion trajectory is required. In this paper, a norm-optimal iterative learning control algorithm for the robot-assisted training is developed. The algorithm aims at minimizing the external knee joint moment, which is commonly used to quantify the loading of the medial compartment. To estimate the external knee joint moment, a musculoskeletal lower extremity model is implemented in OpenSim and coupled with a model of an industrial robot and a force plate mounted at its end-effector. The algorithm is tested in simulation for patients with varus, normal and valgus alignment of the knee. The results show that the algorithm is able to minimize the external knee joint moment in all three cases and converges after less than seven iterations.