Musculoskeletal-based upper limb force feasible set estimation

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Abstract

The goal of this thesis is to develop musculoskeletal-based models of upper limb force capacities that can be personalized to an individual. Such models are needed for physical Robot interaction (phRI) to provide the right assistance given the knowledge of human capacities. Other applications include exoskeleton design and computer aided ergonomics.

For a specific static posture of the upper limb, the force capacities can be represented by a convex polytope called the force feasible set which describes the maximal forces which can be applied to the environment or resisted in any task space direction. This set can be either measured via a force sensor or computed considering a musculoskeletal model (MSK) representative of the subject's upper limb. However, in practice, it is impossible to obtain the true MSK model of a subject due to the wide intra-variability of its parameters, the important number of parameters to tune and inter-variability between subjects.

This thesis focuses on creating personalized musculoskeletal models able to reproduce the experimental force feasible sets of an individual in various postures. Current research on scaling musculoskeletal models allows us to obtain a solid candidate to describe the bone and joint structure, using motion capture. There is still a need to find good candidates for his muscle structure. The current work of this thesis is to use an artificial intelligence approach via evolutionary algorithms to retrieve muscle configurations among which the simulated forces feasible sets fit the measured ones.

Keywords— Force feasible set, musculoskeletal models, evolutionary algorithms