UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Thesis Project Form

Title (tentative): Implementation and Validation of a Musculoskeletal Model of the Upper Limb

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Description

Motivation and application domain

This thesis project originates in Rehab Technologies - INAIL - IIT lab, in the framework of the DexterHand project. Hannes is a multi-joint prosthetic system developed in collaboration with Istituto Italiano di Tecnologia (Genoa) and INAIL Prosthetic Research Center in Vigorso di Budrio (Bologna). At the state of the art, Hannes Prosthetic System comprises a poli-articulated hand, a 2 degrees-of-freedom wrist, an elbow joint and a 3 degrees-of-freedom shoulder. The prosthesis is mainly controlled by the user via electromyographic signals (EMG), extracted from the residual limb. In the future version the prosthesis will be able to perform dexterous movements actuating individual fingers.

General objectives and main activities

This thesis aims to develop and validate a musculoskeletal model of the upper limb, modeling the biomechanical and anatomical aspects that characterize human arm movements.
The general objectives include the implementation of the dynamic relationship of muscles and joints in the upper limb. The ultimate goal is to understand the functional dynamics governing human arm motion. Commencing with an exhaustive literature review, the research will navigate existing musculoskeletal models and biomechanical principles. Through an accurate selection of modeling frameworks and data sources, the project will collect and integrate anatomical and biomechanical data. Rigorous model development, executed through Opensim software or programming languages as Matlab /Python, will be followed by validation experiments. These experiments, involving motion capture and electromyography, aim to analyze the model's accuracy and reliability. Sensitivity analyses will further refine key parameters, and functional simulations will explore the upper limb's dynamic responses in activities like reaching and grasping. Comprehensive documentation will transparently encapsulate the model's implementation, validation methodologies, and findings, contributing to the evolving landscape of upper limb musculoskeletal modeling for diverse applications in biomechanics and rehabilitation.

Training Objectives (technical/analytical tools, experimental methodologies)

1. Programming skills: Matlab/Python, Opensim;
2. Analysis of biomechanical data and electromyography data;
3. Design, implementation, and execution of experiments.
4. Development of a pipeline for a multi-joint upper limb skeleton.

Place(s) where the thesis work will be carried out:

Additional information

Pre-requisite abilities/skills: Department of Rehab Technologies, IIT (Genova-Morego)

Maximum number of students: 1