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

Thesis Project Form

Title (tentative): IMU-based mirror control for the FloatEVO upper limb exoskeleton

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Description

Motivation and application domain

Many activities of daily living require coordinated motion of both arms, posing significant challenges for individuals with orthopedic or neurological conditions that impair motor control in one arm. Robot-mediated rehabilitation offers potential solutions for restoring lost motor control. Techniques like mirroring leverage the residual functionality of the intact limb to guide the movement of the impaired one - for instance, through an exoskeleton.

General objectives and main activities

The general objective is to develop and implement a mirror controller for an upper limb exoskeleton. The student will be responsible for acquiring a dataset that includes IMU and exoskeleton data recorded during experimental sessions with healthy subjects wearing the exoskeleton. This dataset will be exploited to analyse and describe the correlation between IMU data and the corresponding robotic configurations. The student will integrate Inertial Measurement Units (IMUs) into a unified sensor platform (Unity & MuJoCo) to estimate the movements of one upper limb. This information will then be used to control the FloatEVO Exoskeleton to assist the movements of the impaired arm.
The control scheme will first be tested in simulation and, if feasible, directly on the exoskeleton. The goal is to extract the control signals that enable the exoskeleton to replicate the movements of the subject's healthy arm.

Training Objectives (technical/analytical tools, experimental methodologies)

IMU-based motion capture
Control of exoskeletons
Simulation and control of musculoskeletal systems
Sensors integration
Communication protocols
Machine Learning models

Place(s) where the thesis work will be carried out: Rehab Technologies - INAIL-IIT lab, Fondazione Istituto Italiano di Tecnologia Via Morego 30, 16163 Genova

Additional information

Pre-requisite abilities/skills: Previous experience or knowledge in the following topics would be highly appreciated: 1) Programming skills, Python, C, C++, MATLAB for scripting, development of control algorithms and sensor interfacing. 2) Basic knowledge in robotics, in particular: DH convention, direct and inverse kinematics. 3) Sensor Integration: knowledge of integrating sensors using platforms like ROS or direct

APIs and knowledge of different communication protocols. 4) Some knowledge of C# could be useful for Unity environment (platform where the IMUs sensors will be integrated); experience with XML configuration

Maximum number of students: 1