Assistive Robotics Final Project Proposal

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Introduction

Group 7 will construct a fully user-controlled assistive robot in the form of a prosthetic arm and hand to complete complex upper-body tasks like grasping household objects and controlling movement across three dimensions. The device will measure EMG signals from the user's upper body muscle inputs to control its continuous movements and discrete actions. The robot will be housed on an accompanying tabletop training course where users can practice a variety of movement training exercises; the course also serves as a proof-of-concept for the device's viability in everyday household activities.

Project Background

Prosthetic hands provide a greater amount of fine control than the grippers often seen in industrial settings. By providing adaptive force when grasping and moving objects, everyday tasks that would otherwise require a level of motor control too precise for a robotic device can be accomplished. To do so, this device will process a number of complex control signals spanning the user's forearm to control a high-degree-of-freedom robot. Additionally, developing the robot's training course will challenge the group to present a rehabilitative framework for users with upper-limb impairments.

An obvious aspect that will be considered in this project is the SPA(Sense-Plan-Act) paradigm. Due to the open-ended nature of this particular venture, the relationship between the 3 will broadly remain the same, but could vary individually. A large chunk of this project will be directly related to the upper-limb prostheses topic that was discussed, due to the fact that an upper-limb prostheses is exactly what is being designed. The fact that the arm is housed on a platform and could also be used as a proof of concept means that the product can serve multiple functions, which diversifies the functionality of what is being developed. Assistive robotic manipulation is also something that is important for the scope of this project, since the end goal is to be able to provide assistance to people who are otherwise incapable of said functionalities. Each task that the arm is required to accomplish should be broken down into subtasks, from which we can proceed.

Related Prior Work

The majority of the project's work will be built off a previous IoT-connected Upper Prosthetic Limb project (Goswami, 2022). In the prosthetic limb project, EMG sensors were used to capture muscle signals and translate them into precise hand movements. This experience directly applies to the current project, where EMG signals will control a robotic arm for gripping and moving household objects.

One key aspect of the previous work was the use of force sensors and haptic motors to provide a partial sense of touch, enhancing the user's ability to control the prosthetic limb with greater precision. Additionally, the prosthetic could actuate individual fingers and even offer an extra thumb motion, mimicking a human hand and enabling better grip by overlapping fingers around objects.

Overall, this background in sensor integration, signal processing, and mechanical design provides a strong foundation for developing the current project and achieving its goal of creating a versatile, EMG-controlled robotic arm.

Timeline of Work

We will present our initial design and background to this project to the class on October 18th. The team will aim to have 3D printed and assembled the original arm design by October 25th. With the arm assembled, we will continue with installing and configuring the electrical hardware components in the arm by November 1st, by this point the arm should be controllable through explicit commands. By November 15th the team should have a sensor array assembled and programmed to control the arm. By November 22nd we will have created the table-top testing environment to install the arm to. The team will have created a demonstration of the arm working in the testing environment and be prepared to present the final project before Thanksgiving Break (November 27th). There is approximately a one week buffer between this and a theoretical presentation date for any unforeseen delays and/or the addition of features.

References

1. Goswami, J. (2022). *Smart Upper Prosthetic Limb*. Prosthetic Limb | Jay Goswami. https://goswamijaykumar.github.io/pages/pros.html