2015

Improved Lower-Arm Prosthesis

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IMPROVED LOWER-ARM PROSTHESIS

PURPOSE

Upper limb amputees face a challenging decision when choosing a prosthesis option. Approximately 35% of these amputees choose not to use a prosthesis due to complaints of difficult operation, comfort, and cost. In order to bridge the gap that exists between functionality and usability in such solutions, we have developed a user-friendly low-cost lower arm prosthesis. This prosthesis is intended to encourage patient adoption and retention by emphasizing ease-of-access and cohesion over technical precision.

DESIGN APPROACH

The improved lower arm prosthesis is a robotic prosthetic solution designed to provide the user with:

- Simplified Usage
- Minimized Cost
- Consistent comfort

As shown in Figure 2, this device has the capability to emulate three common hand grips: a pinch, a full fist, and an index point. This prosthesis is designed to be operated in combination with a signal processor unit. This signal processor should take in myoelectric signals from the user’s muscles, and use them to issue commands to the prosthesis controller.

Mechanical Hardware

The structure of the prosthesis is composed of 3D printed ABS plastic that attaches to the body with the use of an elbow brace to distribute weight off of the insertion point. The joints and dog bone linkages are crafted from steel and aluminum, respectively. Actuation of the prosthesis’ digits are performed by three hybrid linear actuator stepper motors that are connected to a four-bar mechanical linkage shown in Figure 3. The wrist rotation is performed by a DC bi-directional motor with an encoder attached to measure movement distance.

Electrical Hardware

Power for the prosthesis is provided by a 2200 mAh lithium polymer battery and distributed to the various system components through a specially designed power distribution circuit. The prosthesis controller is implemented on a Zynq-7000 development board. Figure 4 shows an overview of the prosthesis’ electrical system.

CONCLUSION

Overall the primary principles of our design were preserved throughout the completion of the project. However, a number of adjustments and alternatives were considered to address a few unexpected issues. After our initial design phase, we determined that a linkage-based movement scheme may be preferable to a string/spring-based concept. This strategy provides increased structural integrity, which should result in less maintenance and cost. While evaluating the structure of our software, we chose to include hardware interrupt signals to manage the parallelization of the sensor interfacing and motor control. This strategy was chosen due to the more precise timing capabilities available, as well as the advantage of not being required to implement a full operating system on the computing platform.

Acknowledgements: We would like to thank Dr. Peter Pidcoe for their help in acquiring EMG sensing data. We would also like to thank our advisors for their assistance during the completion of the project.