Development and Testing of 3D Printed Prostheses, Orthoses, and Assistive Devices for Children and Adults

Walker Arce, UNO, Electrical Engineering; Dr. Zuniga, UNO, Biomechanics; James Pierce III, UNO, Biomechanics; Jean Peck, External, Hand Therapist

ABSTRACT

User controllable interfaces for exoskeletons have consisted of either switch controlled interfaces, for 'on' or 'off', or elastic powered schemes that allow the user's wrist flexion to provide the resistance for their therapy. This project aims to develop a hands-free mode of control for the exoskeleton, that uses more advanced electronic components to achieve a more natural user interface. Our approach to this project is the prototyping of a control system that uses the MyoBand Gesture Control Armband (MyoBand), and a simple Arduino based electronic design. The three modes of operation possible for this design is measuring the electrical signals of the user's arm, or to use the built-in 'pose' sensing which consists of: fist, fingers spread, double tap, wave in, and wave out. The software we are using to communicate with the MyoBand is MyoBridge, and open source library written by Valentine Roland, and it allows for a reliable stream of information from the MyoBand to our Bluetooth Low Energy device. We intend on developing this prototype system and verifying the use of one of these control schemes. The user will be able to use the control scheme to actuate the motors when their fingers are either fully extended, or when they are gripping.

BACKGROUND

There are multiple integral parts of our prototype system:

- The software connecting the whole system will be the MyoBridge library, which allows for Bluetooth based communications of the readings of the MyoBand.
- The Arduino is a development platform that allows for prototyping of embedded software and we will use it in our prototype.
- The exoskeleton used is intended to assist stroke patients regain the dexterity of their digits by using the motor to pull their fingers back, allowing for use of their hand.

OBJECTIVES

- Develop a breadboard based prototype.
- Integrate onto a protoboard and verify operation.
- Using exoskeleton test both pose and 'raw' readings from the MyoBand.
- Finalize software implementation.

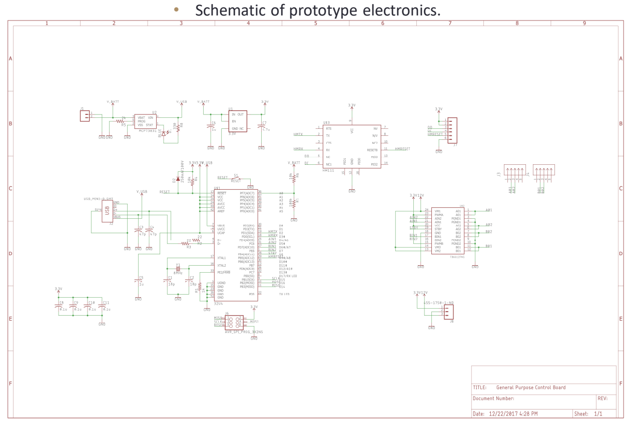
METHODS

- Prototype the system
  - Using a breadboard and Arduino, we interfaced the Bluetooth module, MyoBand, and Arduino.
- Develop the software
  - Test the MyoBridge and be able to control motors using readings.
- Integrate onto a protoboard for a portable form factor
  - This method allows us to put all of the parts onto a single board and integrate a lithium polymer battery to power the system.
- Test both 'raw' and pose sensing
  - There are eight sensors on the MyoBand, each one reading the muscle activity, we can use that to tell which muscles are being activated and then control motors based on that. We can also use the poses, which are fist, fan out, fan in, fingers spread, and double tap.
- Finalize software
  - Determine which method of control is most reliable and tailor the software to use that in particular.

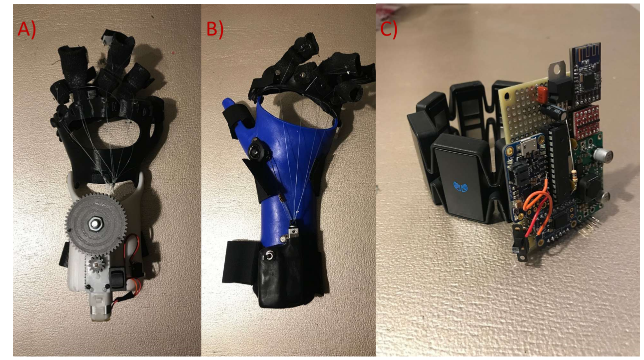
RESULTS

- The 'raw' readings were less reliable and harder to control than the pose based readings.
- Using the pose readings we were able to have reliable control over 'on' and 'off' of the motor.
- The system is too large to use in its current iteration and will need a dedicated printed circuit board to miniaturize the footprint of the system.

- Schematic of prototype electronics.



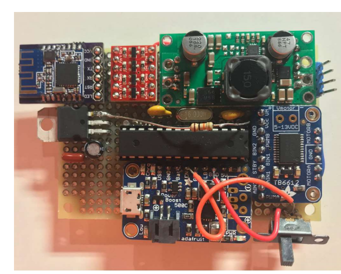
RESULTS



- A – DC motor driven exoskeleton prototype.
- B – Linear actuator driven exoskeleton prototype.
- C – Prototype Electronics with MyoBand for scale.

CONCLUSIONS

- The pose control variation of the control scheme is more reliable than any other current scheme at this point. It also fits well with the intended use of the system and how the user will interact with the device.
- Due to the size of the current system, we will need to develop a custom printed circuit board for the control system that enables the same functionality. This would reduce the size, cost, and the amount of time needed to manufacture these devices.
- We have two current options for the exoskeleton actuation, either a DC motor based tensioning system, or a linear actuator based tensioning system. Both are awaiting testing on patients.



- Prototype MyoBand control system.