Stony Brook University
Electrical and Computer Engineering

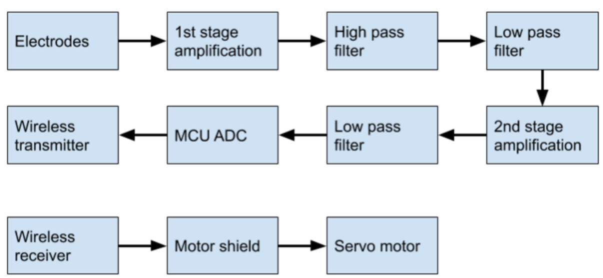
Design and implementation of a bionic prosthetic hand

Mentor: Professor David Westerfeld
Alexander Volkov, Jaesung Song

Introduction

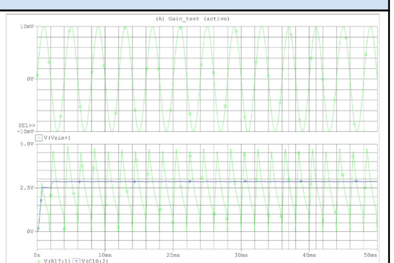
The idea behind this project is to further the development of affordable bionic prosthetic limbs. The bionic hand is controlled by user's forearm muscles. Reading of the muscle contractions is be done by electrode sensors on the skin and utilizing electromyography (EMG) technology.The design is comprised of 3-D printed parts and a pulley system using servos to actuate the fingers and wrist.

Block diagram

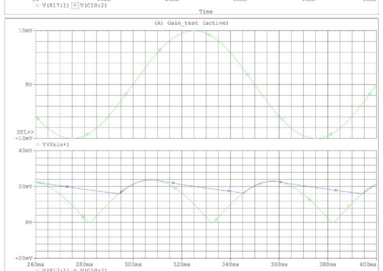


Simulation

Simulation results for a 10mV input at 250 Hz frequency show the output voltage clipped at 3V as per the design specification.



Simulating the curcuit for input of 10mV at the frequency of 10 Hz has a significantly low output indicating a successful filtering out of an unwanted signal.

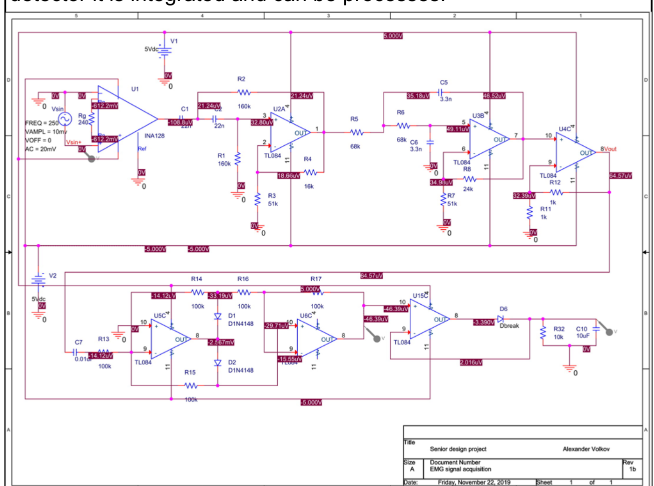


Engineering specifications

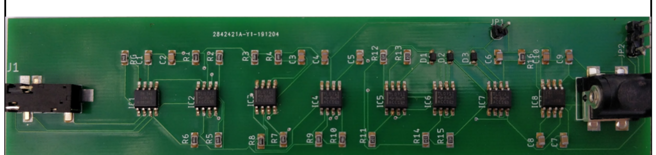
Hand gestures: 1
Freedom of movement (Finger Joints): 90 Degrees
Signal Delay 0.5 seconds
Cost Range $200-$300
Weight: Under 2 lbs
Grip strength: 1 lbs
Battery Life: 3 Days
4 AA Batteries
MCU: TI MSP Ultra-Low-Power

EMG signal processing circuit

We've designed our own circuit for signal processing with an emphasis on noise treatment. It used an instrumentation amplifier to get initial reading from the muscle. Then the signal is filtered by a second order bandpass filters with bandwidth of 50-700 Hz, which is the dominating range of frequencies in human muscles. In the final stage the signal is rectified and with the help of the peak detector it is integrated and can be processes.



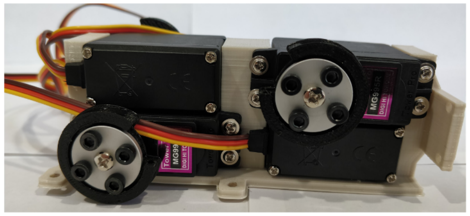
Circuit schematic for EMG processing



PCB board design

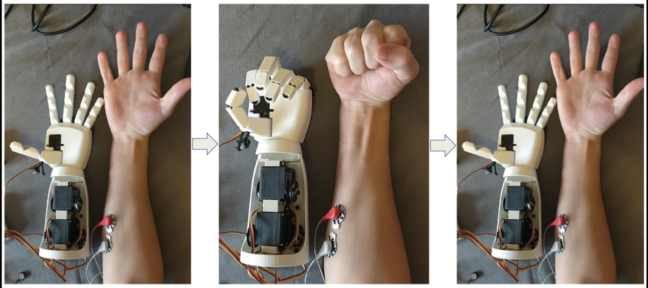
Final prototype

The following is the current version of the project. The EMG sensor reads and amplifies the voltage from the muscle contraction. The MCU then determines whether the servo motors should move to an open or closed position depending on the threshold voltage (1V). There are 4 servo motors driving 5 fingers (One for thumb, index and middle fingers; one for ring and pinky).



Servomotor block

The following images demonstrate the operation of the bionic arm. Flexing the wrist causes the robotic hand to follow.



Glossary

EMG - electromyography; MCU - microcontroller unit;

PCB - printed circuit board;

mV - milivolt, a unit of measurement;

Hz - hertz, unit of measurement.

Acknowlegements

We would like to thank Professor Westerfeld for his expert advice and encouragement throughout the year, as well as Anthony Olivo for invaluable lab assistance.

Cybernetic Solutions