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Robotic Hand Proposal

Introduction

In this senior design project, we will look to use engineering and biological principles to address the market of inexpensive, but functional prosthetics. This design group will seek to consider some of the drawbacks of current technology in the prosthetic market, such as price and limited controllability, and propose a solution to deliver a prosthetic that enhances the user's life and is still quite affordable.

Problem Description

People without the use of an arm or leg can be quite limited in trying to accomplish daily tasks that people with their full anatomy take for granted. While there have been tremendous strides in creating hi-tech prosthetics that enhance a disabled person's life, high costs prevent underprivileged people to obtain such technology. However, currently Notre Dame's E-Nable team is providing prosthetic hands for underprivileged children in the South Bend community. So far, they have been able to provide a young girl named Tori a mechanically actuated prosthetic hand. Tori was born without a hand but one of her dreams in life has been to be able to play catch with her dad. While it was a good attempt to help Tori realize her dream, the hand that was provided had the problems that it could be complicated and uncomfortable to control because it was mechanically actuated by the bending of the wrist. After a feedback meeting with her and her father, the E-Nable team was told that Tori did not like to use the hand because it was not very helpful and too difficult to use.

Proposed Solution

The solution to this problem is an EMG enabled prosthetic hand, where Tori can actuate different grips or releases depending on what muscles she is using. This would help her be able to grab, shake hands, point, etc. more efficiently; hopefully making her day a little simpler, and make her actually want to use her hand everyday

Demonstrated Features

What we expect to demonstrate in May is a hand with the possibility of at least 3 different grips, though we are hoping to make it up to 5 different grips, those grips being:

1. Rest
2. Open
3. Power
4. Three-finger grip
5. Fine pinch

Tori should be able to reliably activate these different grips by simply thinking about the movement, which will cause her brain to send signals to her muscles in her arm to contract or relax. By measuring these states of her muscles with the EMG, we will be able to distinguish what grip she is using and then send that grip to actuate the motors controlling the fingers.

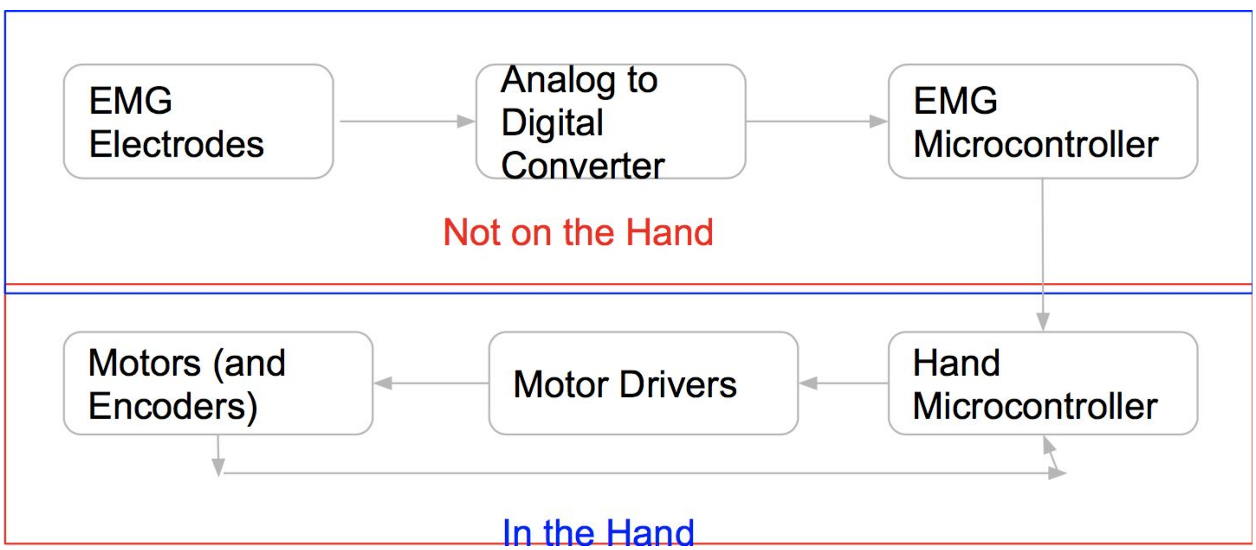
Available Technologies

1. **ADS1298IPAG:** multichannel, simultaneous sampling, 24-bit, delta-sigma (ΔΣ) analog-to-digital converters (ADCs) with built-in programmable gain amplifiers (PGAs), internal reference, and an onboard oscillator. Incorporates all of the features that are commonly required in medical electrocardiogram (ECG) and electroencephalogram (EEG) applications. With high levels of integration and exceptional performance, enables the development of scalable medical instrumentation systems at significantly reduced size, power, and overall cost.
2. **3D Printing:** printing materials makes the design more economic and makes the production faster and easier to modify than conventional technologies. The E-Nable team has their own machine.
3. **Teensy 3.X:** This allows easy programing using the onboard USB connection without the requirement for an external programmer. The Teensy can be programmed in C or via the Arduino IDE by installing the Teensyduino add-on. The ADS1298UPAG can be programmed using it as well. It also works as a good I/O signal management which is really helpful because we are going to be using a lot of inputs from the leads that go on the patient's skin. We are currently using this as our microcontroller.
4. **Leads(1m Snap Electrode Leads (5/Pkg.) Audiology Systems):** Get the information from the patient into the system.
5. **DRV8833PWPR:** IC motor driver PAR 16HTSSSOP. These will control the gearmotors and there will be one for each motor.
6. **100:1 Micro Metal Gearmotor HP 6V with Extended Motor Shaft:** These powerful motors are the ones currently in stock by the E-Nable team which would actuate the fingers. There will be six motors, one for each finger and two for the thumb in order to make it opposable.
7. **Voltage Regulators (L7805CV):** Control the voltage into the microcontrollers and motors. Obviously the voltage into the motor can't be the same as the one into the microcontroller.
8. **TCA9534PWR:** I/O Expander 8 I²C 400kHz 16-TSSOP. For communication between EMG, motor controllers, and the Teensy microcontrollers.
9. **Turnigy 2200mAh 1S 20C Lipo (Single Cell):** Turnigy batteries are known all over the world for performance, reliability, and price. Turnigy batteries deliver the full capacity and performance at a price everyone can afford. If possible, these batteries should be removable from the hand for charging and to allow the user to never have to wait for the battery to charge.

10. **LEDs**: To indicate remaining charge of battery. Battery life will be indicated by an external button found on the prosthetic limb which will turn on the LEDs when the user wants to check.

Engineering Content

Our team will be closely involved with the E-Nable team and the design of the major pieces of this project to make sure that we will able to create an EMG version of the hand with new electrical components. First, we will help to design the physical frame of the hand. We can look to use the previous work of the E-Nable team as a starting point, but we will need to make sure that the hand is designed to contain the additional electrical components while managing weight and structural strength. We will also need to design the electrical system, namely the circuit consisting of the microcontrollers and motor drivers, so that the data from the EMG can be translated correctly and sent to the motors that control the fingers. This will require a good deal of programming of the microcontroller as well in order to coordinate movements of the fingers based on the input signals. Additionally, we need to design a way to fasten the EMGs in the proper places on the arm without prominent negative effects on the body. If we are able to achieve these design marks successfully, we would seek to add additional features such as a feedback system using sensors in the fingers that allows the hand to respond dynamically to whatever the user is trying to interact with. For example, we would like to be able to have the hand grip a piece of paper with the right strength but then also be able to pick up a pencil without trying to crush it.



Conclusion

We are very excited about going forward with this project as it involves a variety of fields in order to deliver a working product and offers a wide variety of design choices and customizability. The added reward of helping underprivileged people as well is a goal that we would like to pursue in our senior design product. While this project does require work into categories beyond programming and utilizing electronic components, we believe it is a very doable project that will be a good test of our abilities.