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Ms. Graham

The Amazing MYO

Research Paper

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Reasoning

The name of this project originally, was called the “Infinity Glove” and its purpose was to design a media remote with the ability to control all devices in a person's home with the controls being physical hand gestures. The plan was to create a glove with flex sensors what could process hand and finger movements. I planned for this device to allow for a more natural interface with the media devices in our homes, by allowing for physical hand gestures rather than a bunch or plastic buttons. However, while trying to accomplish this I was hindered by the cost of these sensors. Unwilling to pay these costs I explored more creative ways to accomplish the same feat. Some of the ideas I considered were a pulley system, camera, but all those ideas were outshined by another. In the medical field there is a device that allows for doctors to detect the minute electrical signals within active muscles called electromyography. Fascinated I did research to find out how such a device worked and ended up creating the device with components I already had, bringing the total cost to $0. I then began doing research on muscle anatomy and found it possible to create a device that could decrypt the electrical signals in both your arms and hands from a bracelet and use that data to control living room devices. Instead of a glove, imagine a bracelet that could allow for telekinetic-like control of your media devices.

After exploring and creating this device I found that this device had many more applications other than just aiding in people's inherent laziness and desire for entertainment. This device can be calibrated to detect the tiniest of muscle activity, and can shrink substantially. This would allow for stickers that would enable the measuring of one's muscle activity including the heart, which could be used in devices that could alert in the event of irregular heartbeats of the sick or could detect the progression in muscle recovery of the weak, or even the progression in muscle strength in the strong. But perhaps even more exciting than all that is the ability for those who are mildly or critically paralized, this device can be calibrated to allow people to operate televisions, computers and any other gadget in any way they see fit. For example a person that has severe arthritis in the hands could make this device into a bracelet and detect the muffled muscle activity and allow them to operate their T.V with literally the twitch of a finger! This device could make technologies with an inherent inaccessibility for some, allow equal access for all.

After stumbling onto such a promising technology I pivoted the entire project into creating this bracelet with electromyographic sensory capabilities, this new and possibly medical device I created, was dubbed the MYO after the latin word for muscle. The biggest question for the MYO was, could such a device work, and if so could it allow for the basic operation of a T.V using a twitch of a finger? My hypothesis was that it could! In this project I sought to create a single MYO module. This MYO module will consist of a chip capable of reading the minute electrical signals present in muscles and use that signal to communicate with a media device wirelessly.

Background Research

Electromyography is a medical technique that can detect the health of muscles and the associated nerve cells. Electromyography is commonly referred as EMG. (Mayo Clinic) EMG can determine nerve dysfunction, muscle dysfunction and nerve transmission within the body. Usually medical experts insert a needle beneath the skin directly into the muscle, however this is also done with EKG (ECG) electrodes which sit above the skin. (Imotions) EMG is a low risk procedure but doctors recommend clean surfaces where the electrodes are placed and needles are inserted, for oils can interfere with the EMG signal. (Mayo Clinic)

EMG works by accessing the lower motor neurons of the muscle for they initiate the muscles movement. (Imotions) Once an impulse from the brain reaches the lower motor neurons of the muscle, calcium ions travel into the muscle. This movement of electrical charge (ion) creates an electrical field which has a magnitude in direct correlation with the amount of calcium ions and the strength of the initial electrical signal. If you could detect the change in the electrical field between 2 points you could determine the direction of the charge and the magnitude of the muscle “flex”.

In electrical engineering, circuits involving the comparison between 2 electrical signals, utilize an integrated circuit called the operational amplifier. (Basic Electronics Tutorials) While there are many variations of this device, most contain 5 main pins, VCC, VDD, inverting input, non-inverting input and the output. The VCC and VDD pins connect to power, but because the op-amp can be configured in many different ways, it requires outside components, with needed calculations to determine the gain, and frequency filters. (Basic Electronics Tutorials) And depending on the type of amplifier you want the formula changes. These filtering calculations can be determined using Kirchhoff's current law. (The Art of Electronics)

Most T.V remotes utilize a type of invisible electromagnetic radiation directly below the visible spectrum called infrared radiation. This form of light can be emitted by an infrared light emitting diode called an IR L.E.D. The exact wavelength of the light slightly varies between devices, however the majority use 940nm. (Geneva) This 940nm emitting LED carries a code that informs the target device to perform some function, and the code sent is encoded in a variety of different ways. Some of these ways include RC-5, RC-6, Sony and NEC and understanding the encoding type makes the code interpretation a lot easier. (Remote Control)

In the forearm there are 12 muscles that are responsible for moving your hand, fingers and forearm. (TeachMeAnatomy) These muscles are separated into 3 main layers, the Superficial layer, the Intermediate layer and the Deep compartment. These muscles can also be separated into 2 more groups including intrinsic and extrinsic muscles. These 2 groups categorize the muscles in the hand and forearm. (Jill)

Specifications

In this project I seek to develop the base technology for the MYO, the MYO module. And in order to do this I need to reach these specifications.

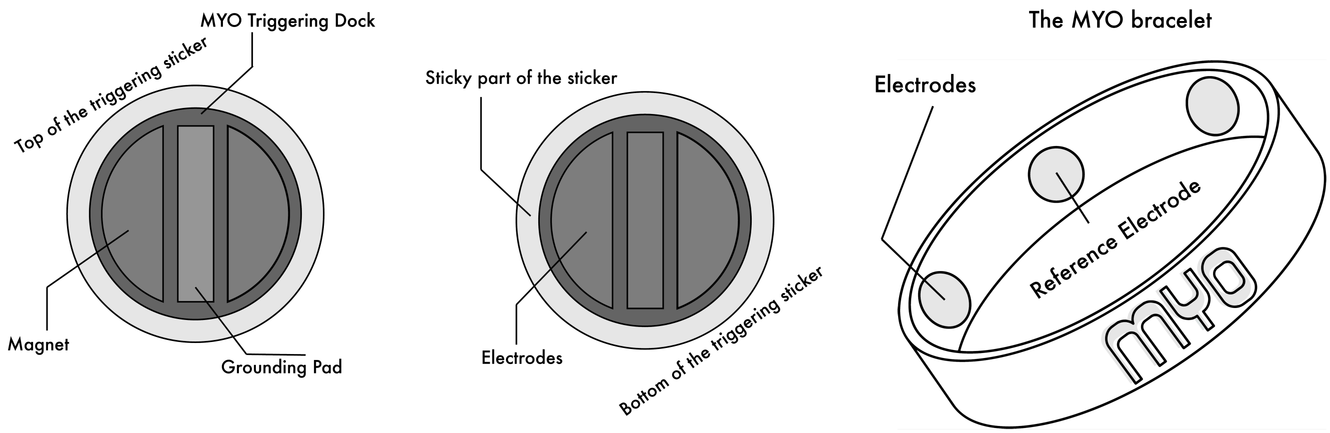
1. The MYO must be sensitive enough to detect a finger twitch but still able to detect a flex of a big muscle like the biceps brachii.
2. The device must be able to turn on and off the target device at will
3. The device must be able to work at a distance from the target device
4. The base-level MYO must be cheap and small

These 4 specifications will be measured and documented by answering these 5 questions and their associated variables. Please note that some of these variables are qualitative and do not have an associated number to represent them.

1. Can detect a finger twitch and a biceps brachii flex? (sensitivity)
2. Can it operate the target device at will? (useability)
3. How far can it work from the target device? (distance)
4. How big the the device? (size)
5. How much does the device cost? (cost)

Final Design

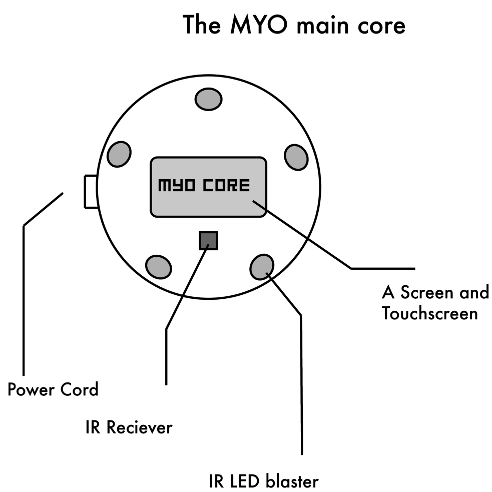
The target design was a system with 3 associated parts, including the MYO bracelet, the Triggering Sticker and the Main Core.



The MYO bracelet, in concept, would have 4 or more operating MYO modules, each with their own electrodes including one more reference electrode. The MYO bracelet needs to be tight and mold into the shape of the users forearm and must be aligned when first put on. The myo will have an onboard processor that can digitize the incoming MYO data from the modules. This data will be sent to an onboard bluetooth module. The Bracelet would be charged using wireless charging with the coil wrapping around the entire bracelets.

There will also be a second MYO bracelet on the users non-dominant hand. This bracelet will tell the dominant signal what device they want to operate. If they have 2 devices programmed into the MYO the second MYO bracelet will determine which one you want using hand gestures as well.

The triggering sticker will contain on the stickside 3 electrodes, 2 for the myo and one to act as a ground for the wireless transmission. On the other side it will have 2 magnets connecting to the electrodes on the other side of the sticker. The top side of the sicker will act as a dock for the triggering MYO module which will be applied after charging. The magnets will align the MYO module and the electrodes will be its input. The triggering MYO Module will have an onboard wireless transmitter which will communicate with the bracelet telling it when the user wants to use the MYO. Because the Signal is grounded with your body the signal can only be received by circuits grounded by your body as well, meaning other people with the sicker cannot interfere with your device.



Once the trigger sticker is activated, the user makes a valid gesture and the second MYO bracelet send the correct device number, the main MYO bracelet will send the necessary data onto the Central Core through bluetooth. The Central core stores and collects all the remote data. When you make a gesture the “On-Body” components it translates the signal into a number and the main core determines what to do with it. The user will also program the MYO through the main core, navigating through the UI on the screen. The main core will have a WIFI module connecting it to a server with a neural network capable of categorizing the users gestures. The user will have the ability to choose if they want the general settings or tailored settings. If the user picks general settings, a setup wizard will be initiated telling the user to pick want kind of device it is (Light, TV, AV system, ect) and tell the user to click the main functions on the remote. This will program the device and give you the gestures necessary to operate the device, from the web server. The gestures you use will go into the neural network teaching it to better recognise your individual gestures. However, it the user picks tailored settings each gesture will have to be manually done repetitively for the neural network to accurately detect your gesture. This will allow for those with muscle problems to operate any device in anyway they see fit. This server will be configured in a categorization framework and when programming in a device, the user will have to provide the training data. And before the user can begin programming the MYO the user must log into their WIFI on the screen.

This is the end goal of the entire MYO project, however the goal of this science fair is to determine if I can build a single MYO module and can I control a single media using only a finger twitch.

Limitations of this Project

The end product of the MYO is exciting, but is not the object of this project. The wireless triggering (triggering sticker) will not be made and the MYO bracelet and the main core will not be fully developed. In the MYO bracelet, I will only attempt to create a single MYO module and transmit that data in some way. The main core in this project will not have a screen, neural network capabilities, or advanced IR data storage. The version of the main core I am attempting will only contain a processor, IR transceiver and some other wireless receiver.

Design Development and Procedure

Firstly construct a MYO module capable of accessing the minute electrical activities of your body and amplify it enough to control a microcontroller. Test its capabilities by observing if the MYO module can detect a finger flex after placing electrodes onto your forearm and inserting an LED into the output. If all works well and the LED lights correctly, program the microcontroller to turn the MYO signal into a number that you can be transmitted over a fairly large distance - bluetooth is most suitable for this part. Test this part of the device by creating a seperate bluetooth receiver and convert the serial output into USB and log the data using a Serial Monitor. If all that works, refine the MYO module into a device compact enough to fit in your pocket. Next construct a main core capable of receiving and decoding the digitized MYO data, storing IR data, and re-transmitting the stored IR data when it receives the correct MYO data. If you programmed all the individual parts correctly you should be able to program the main core with IR signals and retransmit those signals wirelessly using the MYO module by flexing a single finger.

Parts List

Here is a list of all the materials I used while trying to develop the MYO

- DIY Oscilloscope: $20.00
- 3x AA Batteries: < $5.00
- 3x Solderless Breadboards: < $7.00
- AA battery pack: < $2.00
- ATmega328p-pu bootloader: ~ $10 (I made it a long time ago)
- Atmega328p-pu programmer ~ $5 (I made it a long time ago)
- FTDI converter chip: $3.00
- USB type B cord: $2.00
- A computer: It Varies

Here is a list of all the material I used to make the final product of the MYO

- Breadboard: < $1.00
- HC-06 module: $8.00

- HC-05: $8.00
- 2x 16MHz crystal oscillator: $0.50
- 4x 15pF capacitor: < $0.50
- 4x transistors: < $0.50
- 2x bootloader ATMega328P-pu chips: $4.00
- 1x IR receiver and transmitter: < $0.50
- 3.7v 500mAh Lithium Polymer battery - $7.00
- LIPO battery charger module - $5.00
- Resistors: < $0.10
- 2x LM358 (Op-Amp): < $0.50
- 2x Electrodes: < $1.00

Final Product

The goal of this project was to create a device that would be the first step in creating the MYO. I had to create a small MYO module capable of turning movements as faint as a finger twitch to as big as a bicep curl, into data I could use to turn on and off a target device. The MYO module has to be able to communicate with the target device over a simi-large distance wirelessly. The cost cannot be too high and it cannot be too big. My hypothesis was that I could accomplish all this.

The final product was able to complete all the goals. Simply attaching the MYO module to any muscle allows for complete control over the target device. That muscle can be your pecs, jaw, heart, forearm or any other muscle you can think of! The main core is programmed by simply pointing the desired remote at the main core and pressing a button. The MYO module communicates with the main core through bluetooth so its range is 10 - 100m and the range of the IR LED is about 5 - 15m. The MYO module size is 3” x 3” x 0.5” while the main core is 6” x 2” x 0.25”, however if I were to design and print a PCB, the size could be over 5x less! The total cost of both modules is $35 with each independent MYO module being only about $2.50. This means if I were to make a bracelet with 5 MYO modules with a battery, and a bluetooth transmitter it would only cost around $33. In Fact, if I were to buy the items in bulk the cost could be substantially less. In all areas this project was a complete success.

Collected Data

Total Cost	$35
Total Volume	38.1cm^3
Maximum Operating Distance	115 meters

To test the Operation functionality I first attached the MYO module onto my relaxed central forearm. Then I programmed the main core by pressing the power button of my T.V while pointing at the main core. Once I lifted my index finger the MYO responded to the movement, sending the data to the main core turning on the T.V. I did it once more and it turned off.

Next I tested my chest. I placed the MYO module onto my chestal area. The MYO module responded by outputting my heartbeat. After triggering the device - same as last-time - the T.V turned back on.

For a final test I placed the device onto my jaw, then bit down hard, triggering the device. And just like the others, the T.V turned back off.

Conclusion and Future Steps

This project was a complete success. I was able to create a device capable of detecting faint electrical activity inside a person's body and taking that signal and operating an IR device. In this project, the MYO module, paved the way for creating the real project, the MYO. Using this project the MYO should be able to work in the way I described earlier allowing for media devices to be controlled in telekinetic ways.

The future of this device is quite crystal clear. The next step is to make the MYO modules much smaller allowing for a greater density for more intricate detections. The triggering sticker will consist of one of these miniature MYOs and a bracelet will be constructed to contain at least 4 or these modules. Using this dense system of MYO modules I will use machine learning to tailor each gesture to each individual, allowing for the user to control any device in anyway they see fit. The main core will have wifi capabilities allowing it to connect to smart devices. In theory, a person would have the ability to control their entire house with a flick of the wrist. I will continue to make these advances in the MYO long after the science fair is completed. This device has a lot of potential to help a lot of people and I hope one day it will come to fruition!

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