# EMG Hand Design Review 1

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Location: 205 Stinson-Remick

Date: February 5th, 2019

Time: 8:45 am

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## Components:

*ADS1298*

1. Description: It is a multichannel, simultaneous sampling, 24-bit, delta-sigma, analog-to-digital converter. It has built in programmable gain amplifiers, internal reference and onboard oscillator.
2. Why is it important: it incorporates all of the features that are commonly required in EMG, EEG and ECG applications. It has high levels of integration, it enables development of medical instrumentation in a small package. It works from -40C to 85C so even in the next polar vortex the hand will still function correctly.
3. How it works: The ADS1298 will take in the data from the EMG leads and convert the 8 channels into digital data for the Tiva to analyze.
4. Functions: Acquiring and converting signals into useful data, this data is going to be then used by a microcontroller to learn the different hand gestures.

*Tiva TM4C1290NCPDT*

1. Description: It is a microcontroller that integrates a large variety of rich communication features to enable a new class of connected designed, it has the ability to allow critical, real-time control between performance and power.
2. Why it is important: The microcontrollers feature integrated communication peripherals along with other high-performance analog and digital functions to offer a strong foundation for many different target uses, spanning from human machine interface to networked system management controllers.
3. How it works: This part will take in the data from the ADS1298 and use a neural network to decide which grip the user is trying to engage. It then communicates with the PIC32 controller.

4. Functions: MACHINE LEARNING! Tiva™ C Series microcontrollers offer the advantages of ARM's widely available development tools, System-on-Chip (SoC) infrastructure, and a large user community. Additionally, these microcontrollers use ARM's Thumb®-compatible Thumb-2 instruction set to reduce memory requirements.

*PIC32MX270F256D*

1. Description: the pic32 delivers 32-bit performance and has increased memory to solve complex embedded system challenges.  80MHz as well as 32 to 512KB Flash and 4 to 128KB RAM for data and program execution. These high-performance Microchip MCUs give you the processing power, memory, and peripherals. With free software, low-cost development tools, pin/peripheral compatibility from 16-bit product lines.
2. Why is it important: it is important because it is going to be our motor controller, it is supposed to be controlling 6 motors while receiving information at a certain rate.
3. How it works: The PIC32 will take a digital signal from the Tiva and convert this into a signal for the motor drivers to initiate different grips.
4. Functions: Receive a gesture signal from the EMG (EMG is going to say which gesture was activated (0-4)). Depending on the signal receive, perform the hand gesture required by moving the motors to necessary position.

*DRV8833: H Bridge dual motor driver*

1. Description: The DRV8833 device offers a dual bridge motor driver solution. The device has 2 dual bridges, and can drive 2 DC brush motors, a bipolar stepper motor, solenoids, etc. It has internal shutdown functions for overcurrent protection, short circuit protection, undervoltage lockout and overtemperature. Packed in 16 pin WQFN.
2. Why is it important: It is important because we have DC motors, having an H bridge gives us an accurate way of controlling them. It has internal shutdown functions for overcurrent protection, short circuit protection, undervoltage lockout and overtemperature
3. How it works: The H bridge will work by taking a signal from the PIC32 and then control the motors to move either forwards, backwards, or not at all.
4. Functions: Control two different motor movements depending on what the microprocessor is telling it to do.

*100:1 Micro Metal Gearmotor HP 6V with Extended Motor Shaft*

1. Description: This gearmotor is a miniature high-power, 6 V brushed DC motor with a 100.37:1 metal gearbox. It has a cross section of 10 × 12 mm, and the D-shaped gearbox output shaft is 9 mm long and 3 mm in diameter. This version also has a 4.5 × 1 mm extended motor shaft.
2. Why is it important: It is important because it is going to be the one in charge of moving the fingers, thanks to these motors, we are able to perform all movements of the hand

3. How it works: The gearmotor will take in a signal from the H bridge and depending on the signal will physically move the gears.
4. Functions: Turning gears to make the hand move.

*Turnigy 5000mAh 7.2V NiMH High Power Series*

1. Description: This Turnigy battery is best suited for devices that have frequently used battery power and is rechargeable with a Tamiya discharge plug. This model is able to put out up to 15C of discharge which should be more than enough to power our motors. The battery is 7.2 V, has 10C constant discharge, and weighs 436 g, 0.96 lbs, with dimensions of 137x47x24 mm.
2. Why is it important: This battery is important because it will be responsible for powering the entire device. We needed a reliable and powerful battery that will be able to sustain power for our device for several hours while also being relatively lightweight.
3. How it works: The battery will be used to connect to the microcontrollers so that they can process the data from the EMG. There will also be a seperate connection from the battery to the motor driver so that the driver will have enough power to move the motors.
4. Functions: This battery will be used to power both the microcontrollers and the gear movement.

## Essential connections:

*ADS1298:*

Power connection:

Analog Voltage: 3V

Digital Voltage: 1.8V

Current: 10 mA (continuous), 100 mA (momentary)

To electrodes:

Voltage: GND - 0.3V (minimum), DVDD + 0.3V = 3.9V (max)

Current: should be minimal, we don’t look to draw current

*PIC32MX270F256D:*

Power connection:

Voltage: 2.3V to 3.6V

Current: 10mA source / sink on all pins, 5V tolerant

*DRV8833:*

Power connection:

Voltage: 0 to 11.8V (max)

Digital Input: 0 to 5.75V

Current: 1.7mA (typical), 3.0mA max

To Gearmotor:
Voltage: 2.7 to 10.8V
Current: 1.5A (max per bridge) in RTY package

*Gearmotor:*

Power connection: from the DRV8833 driver
Voltage: 6V
Current: 0.07A (no load) to 1.6A (stall)
Max Power In: 1.3W

*5000mAh 7.2V Battery:*

Power connection:
Voltage: 7.2V
Current: up to a 15C (75A) discharge rate

## Possible Problems:

There might be a potential issue in implementing a button that will enable the training mode in the right component of the hand without accidentally activating it by accident. To solve this, we could enable training mode by activating it via a computer. Not sure on what sort of connection we will pursue, e.g. USB or some other jack. As well, we will have to consider how to connect to the Tiva microcontroller to program it.

Perhaps one of the major issues in designing a good, enjoyable hand is available user time, which depends on battery capacity and power consumption. While we are working to minimize power consumption via the components we choose and how we run the motors, a critical design choice will be the battery, for they add a lot of weight and limited in how long they can source the hand. Our current solution is to use rechargeable batteries so that we can reduce the capacity needed on the hand because we can recharge it and not force the user to carry around high capacity batteries or have to deal with constantly batteries.

When the motors stall out, due to fully closing the hand or some other cause that doesn't allow the fingers to close any more, they draw the "stall current." This is a high current, potentially around 1.5A, and our batteries will be drained very quickly sourcing this. As well, a lot of unwanted heat will be introduced into the hand and components. Our first main solution is to turn off the motors completely when a stall is detected, as in the off state the motors are hard to move and would simulate maintain a firm grip around an object.

Another potential issue that we can foresee is that the base 3D printed materials and connections may not withstand the normal, daily usage we would like to be able to provide. If this problem arises, we will look to address it with more durable materials once the hand design has proven to be a success,

On the more cosmetic side of things, we realize that as our hand currently is designed we note that we lack the aesthetic appeal. We can address this in one of two ways. The first is to try to replicate the look of a human hand by acquiring a sleeve that look like a real hand. Some you can are even silicon, giving a more appealing texture to the hand. Alternatively, we could design the hand to be very stylized and more sci-fi like and embrace the nature of the hand as a prosthetic. Currently, we are looking to go with the former option.

## Website:

http://seniordesign.ee.nd.edu/2019/Design%20Teams/emg/index.html

For the website we used HTML5 UP for the basic structure of the website. Our Proposal and High Level Design are at the bottom of the page under ‘Other Important Documents’.