**MEGN540 - Project Progress Report**

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**Technical:**

**What problem are you solving?**

The project aims to design, fabricate and control 3 finger animatronic hand mirroring fingers movements made by a human operator. The project addresses a method to capture motion of fingers using flex sensors and fabricating a custom PCB to process, power and control the animatronic hand.

**What is your design concept?**

The **hand design** consists of three fingers viz., thumb, index and middle finger, with 1 DOF. Each finger has three portions viz., proximal, medial and distal portions. The different portions of the fingers are joint together with 1 or 2 springs and hinges on the dorsal side of the hand. 3D printing technique is utilised for printing each portion of the hand. Each finger is driven by a fishing line placed eccentrically on the palmer side of the hand. The finger movements are driven by the servo motors. One end of the fishing line is tied to the distal end of the finger and the other end is tied to the horn of the servo motor. The routing of the fishing line inside each finger is facilitated by having plastic straws enclosed within a hollow section. The entire setup is mounted on a platform having the custom PCB and power supply.

The **glove design** has flex sensors stitched to each finger for the entire length. The flex sensors are connected directly to the custom PCB by extending the wires. Later design may include wireless implementation.

**What Sensors and Actuators will you use?**

Here we are using **flex sensors** ([datasheet](https://www.sparkfun.com/datasheets/Sensors/Flex/flex22.pdf)), which captures the bending movement data.

We are using an **MG995 servo** ([datasheet](https://www.electronicoscaldas.com/datasheet/MG995_Tower-Pro.pdf)), which drives the animatronics hand.

**What will your PCB do?**

The custom PCB has the following components delivering certain processes.

* **ATMega328P** sits on a PCB board for all the required processing and communication purposes like converting flex sensor’s output voltage (digital output - ADC) to PWM timings (range: 0.388 - 2.14ms), in turn it calculates the duty cycle for the servo motor for the desired rotations, which finally replicates the human finger’s position.
* Potentiometer placed in the -ve terminal of the flex sensor would help in adjusting the sensitivity for the input users hand movement.
* Voltage regulator circuit to power the servo motors, sensors and ATMega328 separately.
* ICSP header to connect the external programmer to flash.
* Power jack to connect the external power supply.

All the heavy lifting is done in PCB and finally it sends the PWM commands to the servo motors.

**What is your high-level integration plan?**

**Step 1:** Human hand (uses a glove, where 3 flex sensors are attached to the 3 finger) gives finger movements, which are encoded in terms of resistance. Change of resistance in the three fingers implicitly knows how much it is moved - this is done using flex sensors. Take the analog output from the flex sensor, give it to ADC for conversion.

**Step 2:** Atmega328P receives this signal and converts that into a PWM signal using TIMERS.

**Step 3:** Finally power and PWM signal are sent to the servo motor on the animatronics hand.

**Programmatic:**

**What is your project schedule and key milestones?**

**March 1st - 3rd week:** Purchasing materials. 3D printing fingers and handbase. Building a breadboard prototype of the circuit. Pseudo code for reading the flex sensors data. Key milestone would be to have working finger movements in hand and programmable breadboard circuit.

**March Fourth week(spring break):** Fabricating the glove and writing the embedded C code for calibrating the flex sensor and controlling servo motor position. Implementing a filter to get a smooth response from the sensor. Key milestone would be to calibrate the flex sensor and implement the filter.

**April 1st - 2nd week:** Design and order the PCB. Testing for repeatability of finger actuation. Completing the left out work. Key milestone would be to have a functioning breadboard prototype of the animatronic hand.

**April 3rd week:** Further testing with custom PCB and Demo. Key milestone would be to have the PCB functioning with other components.

**How have you split up the work?**

Mechanical aspects of project: Ramprasad

Electronics aspects of project: Bhuvan Tej

Software aspects of project: both

**What are your critical paths?**

Arrival of sensors, motors and other components.

Getting the correct mapping of PWM values in the desired ranges.

Scaling is also critical - from the resistors value to the PWM signals.

Correct PCB design without shorting any components and arrival of functional PCB.

**What is your current budget estimate?**

Our current budget is around **100-120 USD (20 USD)**

**What is your highest technical risk and how are you mitigating that risk?**

**Hardware standpoint:**

* As there all lots of electronics included on the PCB, make sure there is no shorting wire on PCB connections before giving supply: Using multimeter check all the connections properly for every iteration of testing it- if possible test in simulation software by giving some random test data within the specific range.
* The motor rotation should not exceed the finger movement limits: Start off with some small scaling component (High resistance for the resistor in series with sensor), then gradually increase it to the desired range.
* There is a chance of abduction/adduction finger movement happening instead of purely flexion/extension movement due to clearance in the joints or uneven force distribution along the finger. Having stoppers or adding 2 springs to each joint of the finger on the dorsal side makes sure that it's not moving sideways.

**Software Standpoint:**

* There is a chance sampling of some delay occurring from the user's hand movement to the animatronics hand, which can cause some loss of information in turn making the animatronics hand wobble randomly. Having a robust filter and sampling prevents the loss of information.

**What is your highest programmatic risk and how are you mitigating that risk?**

Higher chance of problem might be only from the hardware design standout point of view, design might change during the testing phase.