Final Presentation of Group Project of Design Project on

"Muscle Controlled Prosthetic Hand"

Presented by

GROUP NUMBER 13

Roll No. 24, JASIRA T. P

Roll No. 46, SHRAVAN SREEDEEP

Roll No. 48, SOORYA P

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

GOVT COLLEGE OF ENGINEERING KANNUR- 670563

December 2020

OVERVEIW

INTRODUCTION

- Motivation
  - According to NCBI there are about 6 million amputees in India alone.
  - Most of the amputees in India use mechanical and cosmetic hands that serve no purpose.
  - Now a days people have been moving to myoelectric hands that just open and close.
  - With more control on these myoelectric hands , amputees could make their lives more easier.

○ Aim :

The aim of this mini project is to develop a low cost muscle controlled artificial hand that need to perform the following functions.

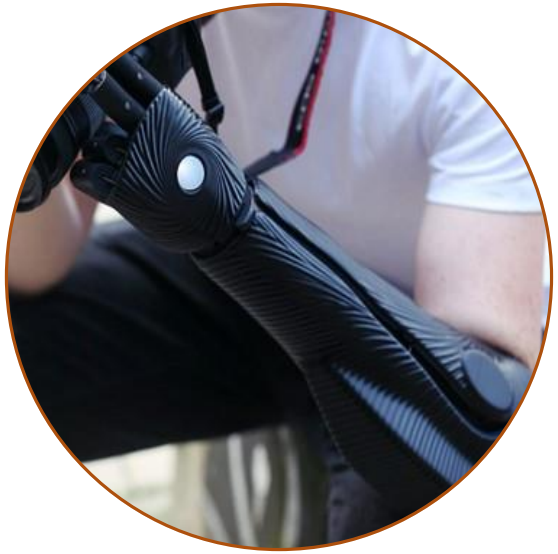
- To identify EMG signals and work according to its value.
- To have different modes for doing different purposes.

PROJECT STUDY

- Selected Area : Prosthetic Hands
- Literature review

1. Author Michele Folgheraiter et al. development of a low cost three finger robotic hand with six degrees of freedom. The hand has three actuators and it can grasp different shapes such as oval, cuboid, circular and cylindrical.
2. Author G.E.Clement et al. research has been done to evaluate recognition of various patterns, and to study real-time implantation. A surface EMG signal is used to allow for the prosthetic hand the ability to evaluate six different hand motions.

Existing Products:



Open Bionics

- Five finger access
- Rotating motion at wrists
- Cost : 9 lakhs

Be Bionic

- All fingers open and close
- Blend with the skin
- Cost : 30 lakhs

Touch Bionic

- Surgically implanted myoware sensor.
- Fast response
- Cost : 32 lakhs

Disadvantages of Existing Products:

- The main advantage of the existing product is high cost. The poor sections of the developing and under developed countries wont have access to such costly hands.
- Some of the hands have surgically implanted sensors and connectors attached to the bone of the hand.

BASIC OPERATION OF MUSCLE CONTROLLED PROSTHETIC HAND

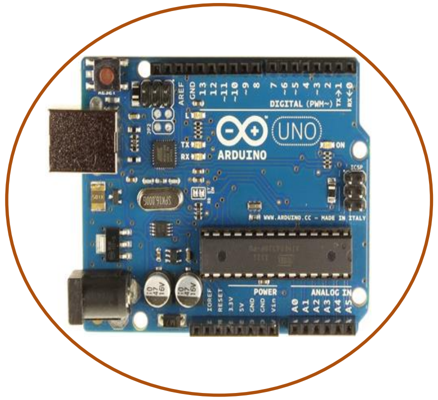
- Muscle controlled prosthetic hand is basically a hand that is controlled according to the EMG signals produced in our muscles.
- The device have one muscle sensor that reads the EMG signals of a particular muscle group and provide it to the micro controller.
- Different modes of hand gestures are added to the hand which can be cycled with the help of a push button.
- The modes can be identified with the help of an RGB LED light.

MUSCLE CONTROLLED ARTIFICIAL HAND

Work Done:

- Analyzed the working principle of each components used.
- Studied the working of Arduino UNO, EMG sensor and servo motor.
- Learned the basics of Arduino coding.
- Analyzed circuit diagram.
- Hardware setup is done.

Components Used :



Arduino UNO

EMG Muscle sensor with electrodes

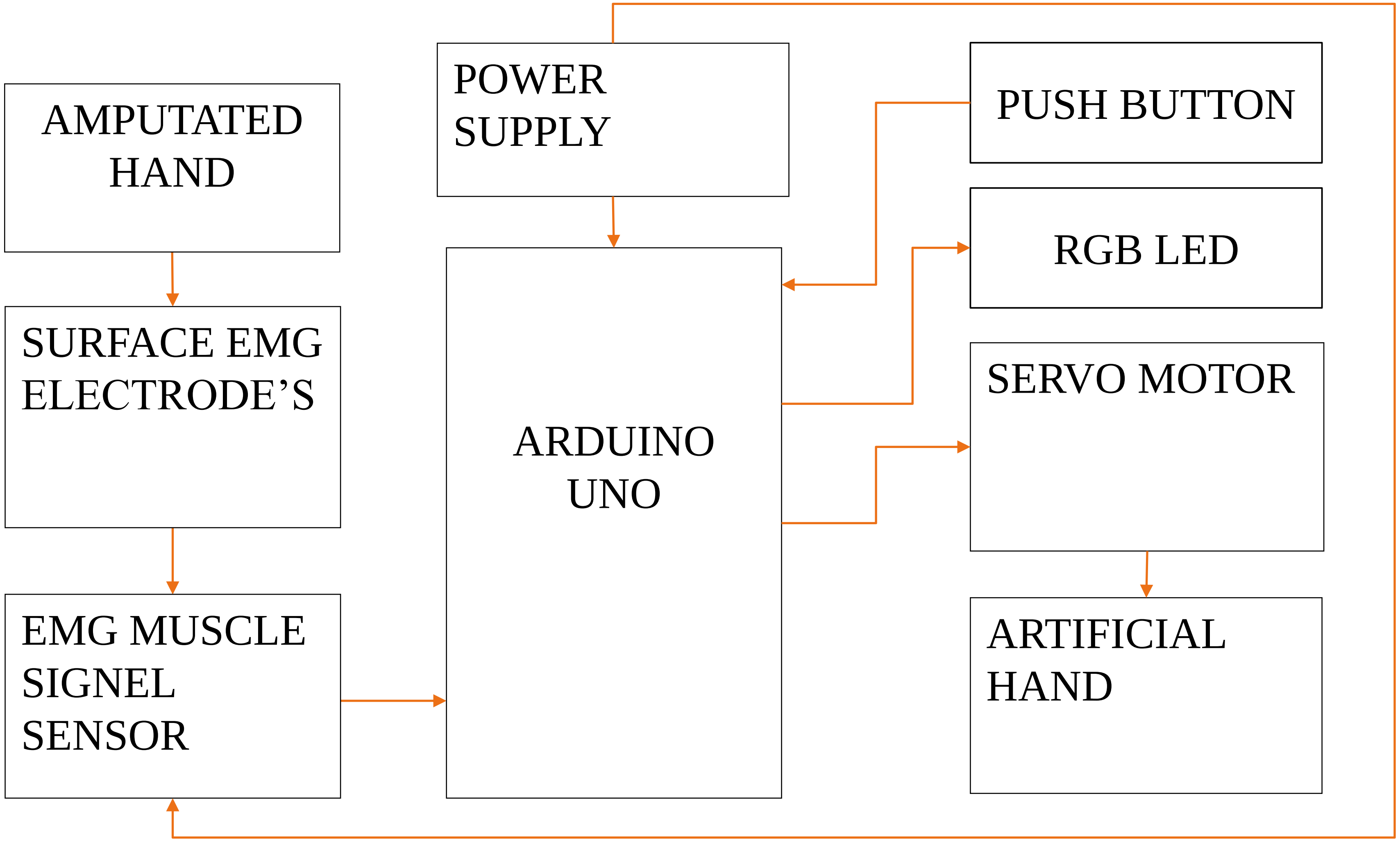
Micro Servo Motor × 5

Push Button

RGB LED

9V DC Battery × 2

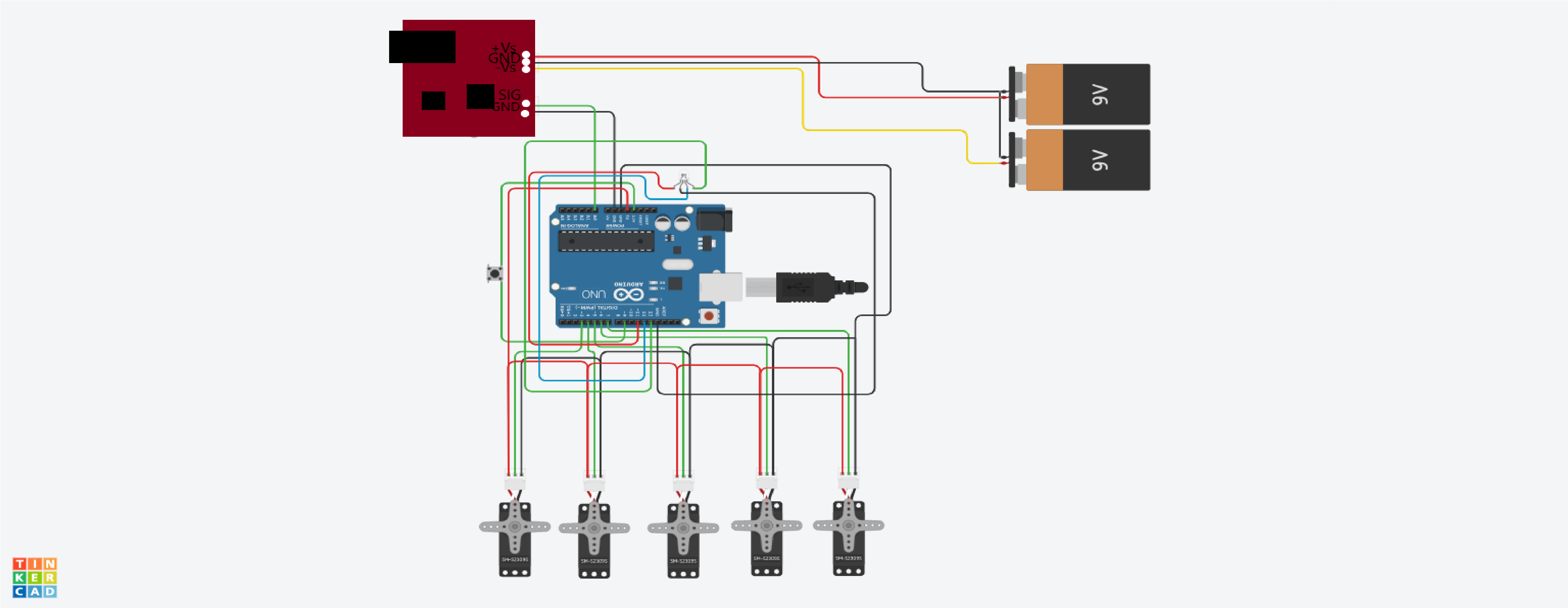
Block Diagram :



ELECTROMYOGRAPHY SIGNAL (EMG SIGNAL)

- EMG signals are generated by the body depending upon the desire to do something which in turn produce current impulses by the muscular movements or activation.
- EMG signals can be acquired from the amputated limb through the placement of surface electrodes.
- The sensor amplifies , rectify and filter this signal and pass it to the micro controller.
- Based on the impulse of the electromyography signal the microcontroller generates the control signal for the servomotor interfaced to the finger arrangements.
- The power supply to the components of the system can be provided with the battery.
- An RGB led and push button is used to toggle between the modes of the hand.

○ Circuit Diagram :



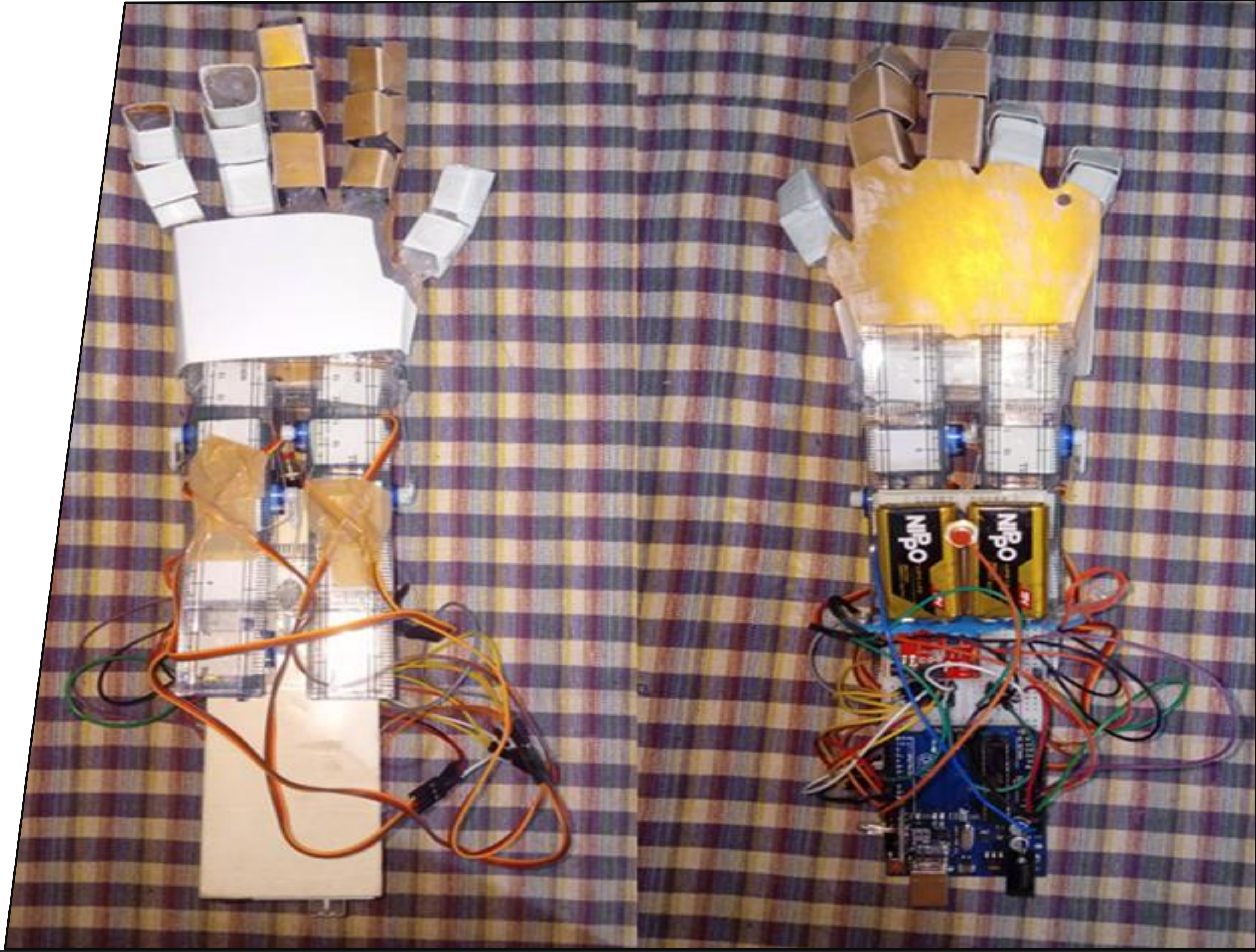
Input Conditions :

- When Muscle is flexed, the value (frequency) from the sensor goes above 240 Hz to 400 Hz peak.
- When Muscle is relaxed , the value (frequency) from the sensor stays between 160 Hz and 170 Hz

Output Conditions :

- There are 3 different modes in this hand. A push button is used to cycle between these modes.
- On mode 0 when muscles are flexed , all the servos rotate 180 degrees and when the muscle is relaxed it rotate to 0 degree.
- On mode 1 the servos connected to small ,ring and middle finger rotate and stays at 180 degree. When muscles are flexed servos connected to index finger and thumb rotate 180 degree and when muscles are relaxed they rotate 0 degree.
- On mode 2 the servos connected to small and ring finger rotate and stays at 180 degree. When muscles are flexed servos connected to index finger , middle finger and thumb rotate 180 degree and when muscles are relaxed they rotate 0 degree.

HARDWARE SETUP



Algorithm :

Step 1 : Start
Step 2 : Set count = 0 for mode selection
Step 3 : Set thresholdvalue = 240
Step 4 : Put Step 5 to Step 17 inside a loop
Step 5 : Read buttonstate and store its value to button
Step 6 : If button is HIGH , increment the value of count by 1
Step 7 : Read the EMG sensor value
Step 8 : If count = 0 , turn on red colour of LED and execute Step 9 and Step 10
Step 9 : If EMG sensor value is greater than thresholdvalue then close all fingers
Step 10 : If EMG sensor value is less than threshold value then open all fingers
Step 11 : If count = 1 ,turn on green colour of LED and execute Step 12 and Step 13

Step 12 : If EMG sensor value is greater than thresholdvalue then close all fingers
Step 13 : If EMG sensor value is less than threshold value then open thumb and index fingers while the rest stay closed
Step 14 : If count = 2 , turn on blue colour of LED and execute Step 15 and Step 16
Step 15 : If EMG sensor value is greater than thresholdvalue then close all fingers
Step 16 : If EMG sensor value is less than threshold value then open thumb, index and middle fingers while the rest stay closed
Step 17 : If count = 3 , set count = 0
Step 18 : Stop

Arduino Program :

```
#include <Servo.h>

//define servo motors

Servo servo_3; Servo servo_4; Servo servo_5; Servo servo_6; Servo servo_7;

//set red, blue, green and button pin

const int r = 11; const int g = 12; const int b = 13;

const int buttonstate = 9;

//initialise count for mode selection

int count = 0;  int button = 0;

int thresholdvalue = 240;

void setup()

{

  Serial.begin(11500);

servo_3.attach(3); servo_4.attach(4); servo_5.attach(5); servo_6.attach(6); servo_7.attach(7);

  pinMode(r, OUTPUT); pinMode(g, OUTPUT); pinMode(b, OUTPUT);

  pinMode(buttonstate, INPUT);

}

void loop() {

  button=digitalRead(buttonstate);

  if (button == HIGH)

    {

     count = count + 1;

//increase the counter once the button is released

}

int emgsensor= analogRead(A0);

//to read analog value from emg sensor

  Serial.println(emgsensor);

//to print value of sensor in serial monitor
```

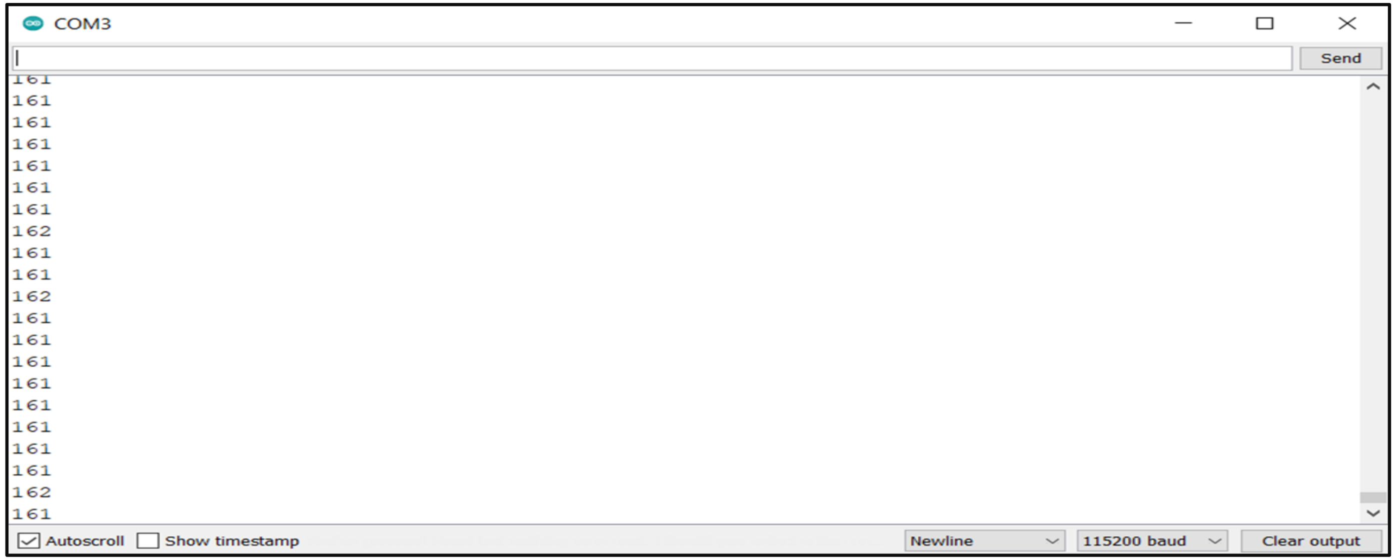
```
//for mode selection

  if (count == 0)

//mode 0 in which the function of the hand is just opening and closing all fingers

{

   digitalWrite(g, LOW);

 digitalWrite(b, LOW); digitalWrite(r, HIGH);

 // for mode 0 red light

   if(emgsensor < thresholdvalue){ servo_3.write(0);delay(100);servo_4.write(0);delay(100);servo_5.write(0);delay(100);servo_6.write(0);delay(100);servo_7.write(0);delay(100);

   }

   else { servo_3.write(180);delay(100);servo_4.write(180);delay(100);servo_5.write(180);delay(100);servo_6.write(180);delay(100);servo_7.write(180);delay(100); }  }

 if (count == 1)

//mode 1 for thumb and index finger while others remain close

{

   digitalWrite(r, LOW);digitalWrite(b, LOW);digitalWrite(g, HIGH);

// for mode 1 green light

   if(emgsensor < thresholdvalue){ servo_3.write(180);delay(100);servo_4.write(180);delay(100);servo_5.write(180);delay(100);servo_6.write(0);delay(100);servo_7.write(0);delay(100); }

   else {

 servo_3.write(180);delay(100);servo_4.write(180);delay(100);servo_5.write(180);delay(100);servo_6.write(180);delay(100);servo_7.write(180);delay(100); }

}

  if (count == 2)

//mode 2 for thumb, index and middle finger while others remain close{

   digitalWrite(b, HIGH);digitalWrite(r, LOW);digitalWrite(g, LOW);

// for mode 2 blue light

   if(emgsensor < thresholdvalue) {

servo_3.write(180);delay(100);servo_4.write(180);delay(100);servo_5.write(0);delay(100);servo_6.write(0);delay(100);servo_7.write(0);delay(100); }

   else {

servo_3.write(180);delay(100);servo_4.write(180);delay(100);servo_5.write(180);delay(100);servo_6.write(180);delay(100);servo_7.write(180);delay(100); } }

  if (count == 3)//mode 3 takes back to mode 0

{

   count = 0;}

}
```

RESULTS

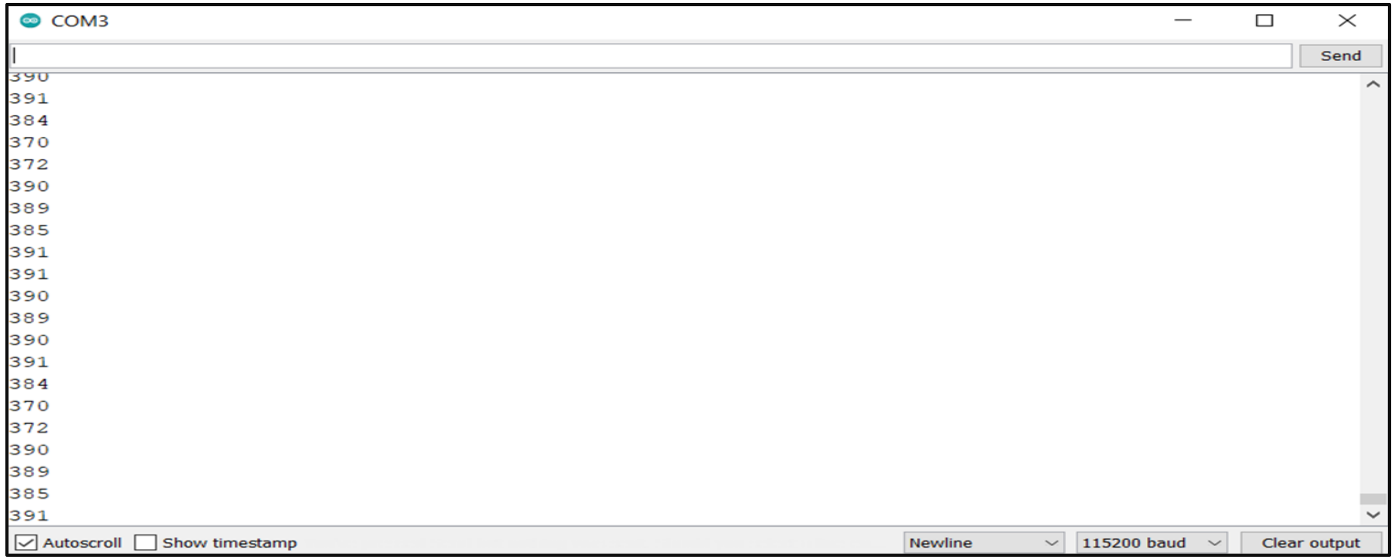
- The muscle controlled prosthetic hand is developed and different modes are tested. The results of the test are given

Serial Monitor Outputs :

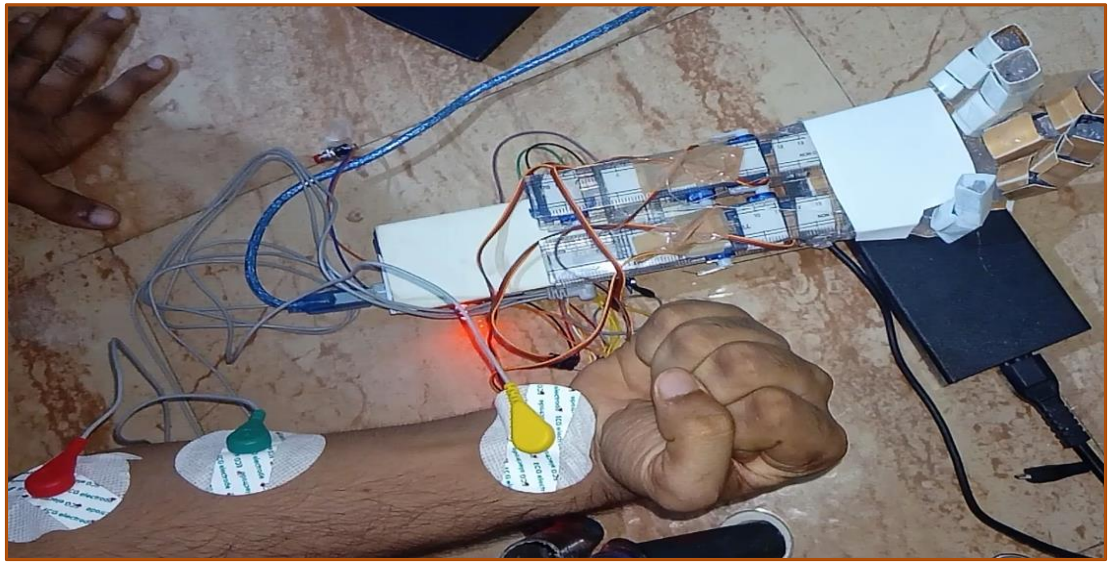
- The value from the muscle sensor varies between 160 to 170 when the muscles are relaxed.



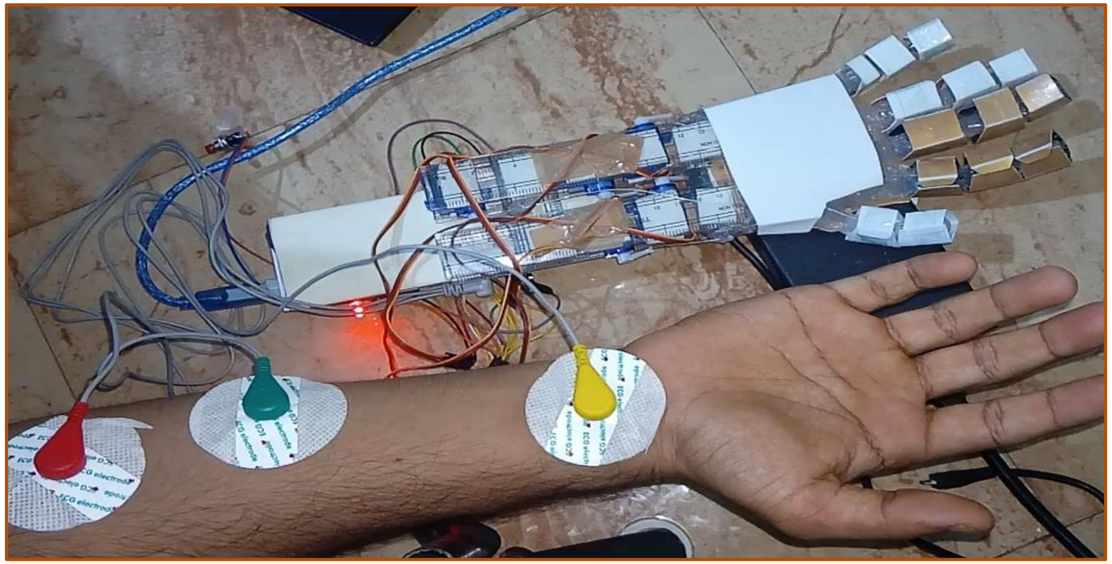
- The value from the muscle sensor varies between 360 to 400 when the muscles are flexed.



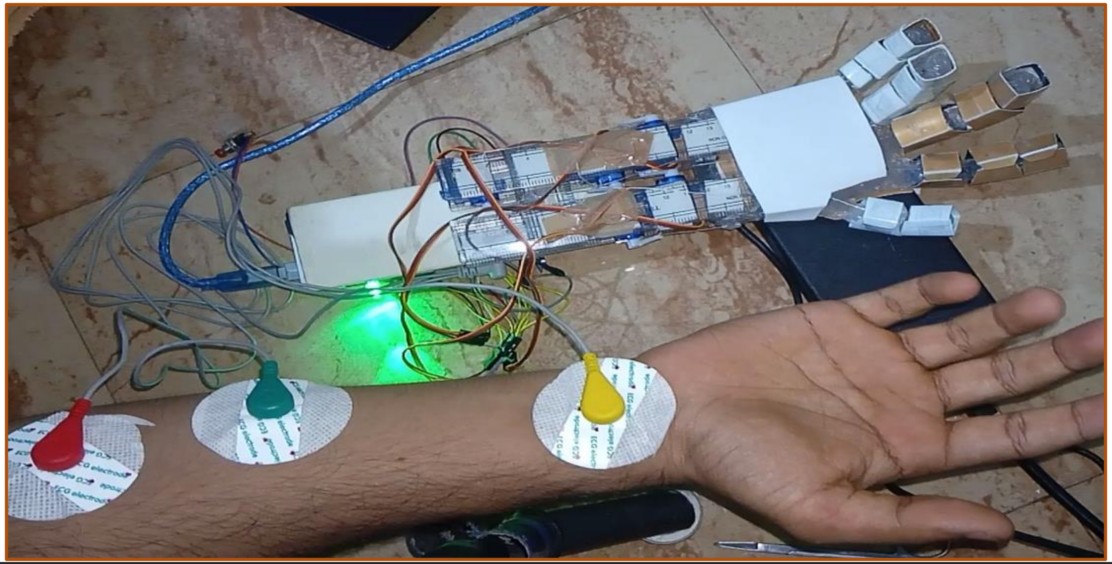
On all modes when muscle is flexed



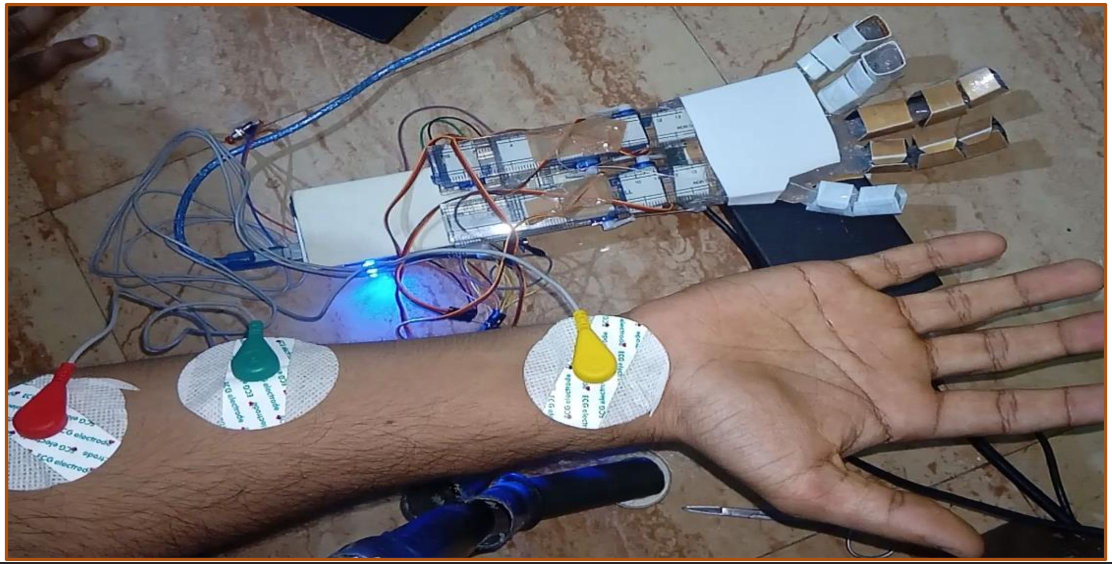
On mode 0 when muscle is relaxed



On mode 1 when muscle is relaxed



On mode 2 when muscle is relaxed



ADVANTAGES :

- It makes the day to day life of an amputee easier.
- It gives confidence to the wearer.
- No additional surgery or life-long medication is needed to fit an upper limb amputee with a prosthetic device.
- No need to train the user for months to learn functioning.
- Even a child of about 18 months can use.

DISADVANTAGES :

- Fingers don't close completely and evenly due to the non availability of 3D printed parts.
- Not suitable for heavy use.
- When used on children , we need to replace the parts yearly according to the child's growth.
- Since the pads of electrode are one time use pads, we need to change the pads each time we use it.

APPLICATIONS :

- It is used to help disabled persons who lost their hand.
- The same technology can be used to help partial paralyzed persons.
- It can be implemented for simulations of real world or in games.
- Exo skeletons for factory workers, soldiers etc can be made which will in turn increase their productivity.

SUGGESTIONS

- Use of 3D printed parts will change the look and efficiency of the hand by a lot.
- 3D printed links can be used that allow easy customization for children of different sizes, or device modifications as the child grows.
- Improved skill is achieved via the addition of sensors and motorized controls.
- Sensor that is wearable just like a band instead of sticky one time pads.

CONCLUSION

- The study of EMG sensor based prosthetic hand is successfully validated through the help of Arduino micro controller.
- The hand identifies the EMG signals and work according to it.
- Modes are successfully added which will give more control to the hand for the disabled person.
- Though the product doesn't support rough use and provide a lot of functionality , it can help a lot of amputees to do their basic daily things like a normal person.

REFERENCES

- https://www.sciencedirect.com/topics/engineering/prosthetic-hand
- https://www.frontiersin.org/articles/10.3389/fnsys.2015.00162/full
- https://www.science.org.au/curious/people-medicine/bionic-limbs
- https://www.semanticscholar.org/paper/EMG-based-prosthetic-hand-control-system-inspired-Seo-Yoon/6c8e910143e891f843336147b8849361cba6dcc7
- Sundara Mahalingam, Study of EMG sensor based servo motor position control, International Research Journal of Engineering and Technology (IRJET), 2019
- Lubna Majid Hamid, Controlling of robotic hand using EMG signals, University of Baghdad, 2016
- Suresh Natarajan, Servo motor based finger movement of myoelectric hand for human, International Journal of Pharmacy and Technology, 2017

THANK YOU