SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Programming, Apps & Robotics

Year 7-8

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Programming, apps, and robotics

IQRA College / Year Level: 7-8

Arduino Powered Prosthetic Hand

Notes:

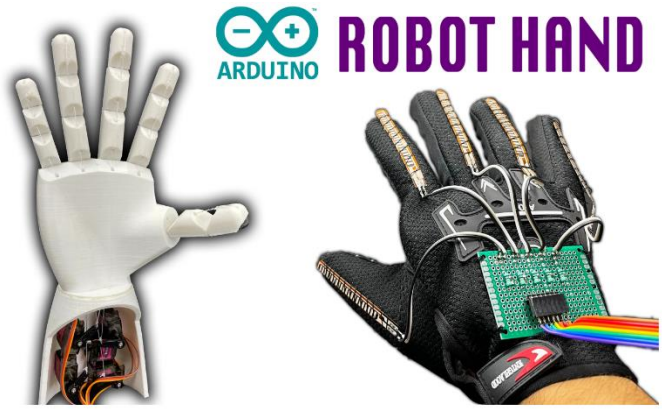
- We have watched online YouTube tutorials to learn the Arduino IDE code and used Arduino UNO R3 Starter kit to practice the physical part of the training.
- For any inquiries regarding this project please email Mahreen Bukhari at mahreen.bukhari@iqracollege.sa.edu.au
- The link to the YouTube video: https://www.youtube.com/watch?v=vTxKlRqzZ74

Aim and Scientific Purpose

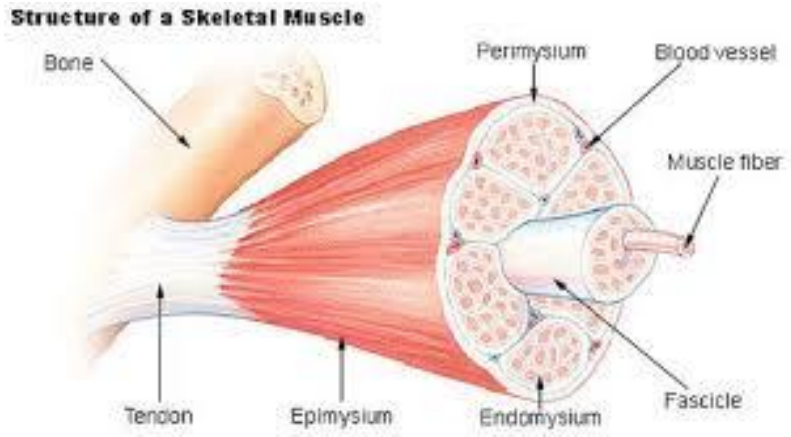
We use our hands for so many things such as doing daily tasks, communicating and expressing our feelings. Losing our hands or part of its functionality could mean losing independence.

Our project aims to help in the hand rehabilitation of children recovering from an incident that affected the full/partial ability of hand movement. Loss of fingers strength can be caused by conditions such as carpal tunnel syndrome, arthritis, peripheral neuropathy, tendinitis, injuries, nerve damage, and systemic diseases.

This 3D-printed hand can significantly aid individuals with weak fingers by facilitating movement. This innovative device is designed with a glove to be worn over the affected hand, with the 3D-printed hand mimicking natural finger movements. Using the flex sensors (variable resistor) attached to the gloves, as shown in the image below, will control the motors and hence the movement of the 3D printed hand. As the flex sensor resistance changes by bending or stretching the gloves fingers, the Arduino board, using the voltage divider, will read it as a change in voltage and send a command to start moving the motors which will bend or stretch the fingers on the 3D printed hand.



Children committing to their assigned rehabilitation practices may prove to be hassle for many, as their attention spans and interest in these exercise decrease. Our idea aims to make rehabilitation more engaging for them and promote function or mobility in a hand that needs to develop strength. For example, weak muscles. As muscle tissue/fiber is damaged, this causes weakness in the muscle in general.

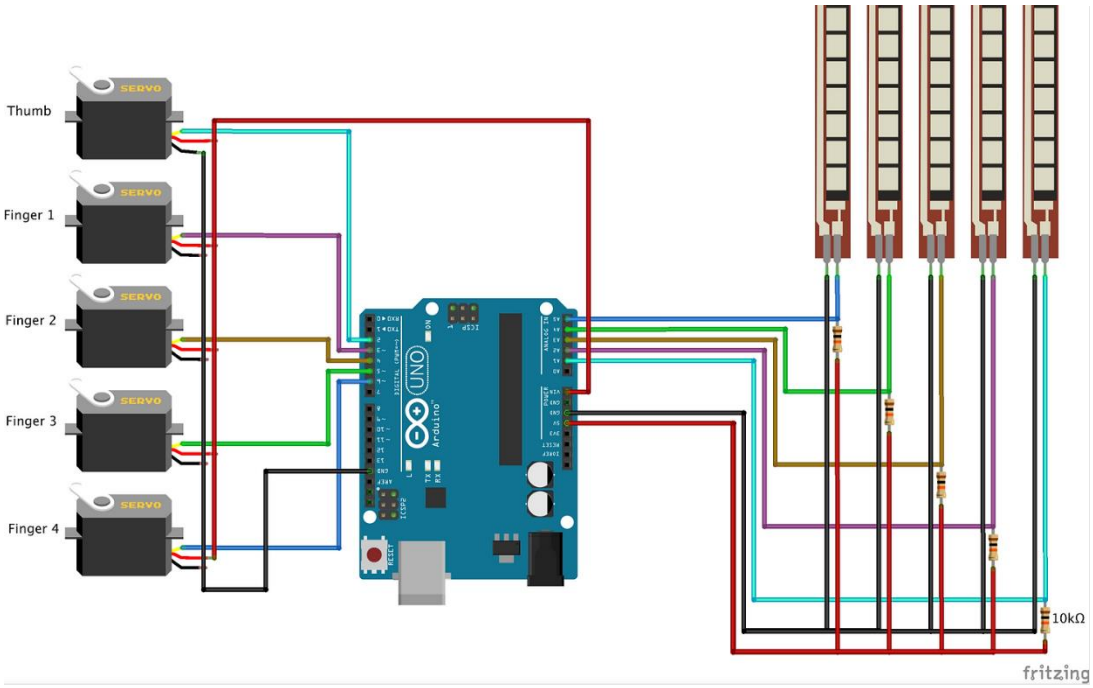


Materials:
3D Printer hand
Arduino UNO
5 Flex Sensor 2.2 inch
5 Servo Motor
5 Resistor 10k ohm
Transparent String / Fishing String
2/3mm Elastic Rope
Adhesive Glue
Gloves
Breadboard
Jumper Wires

Requirements to Run the Program

The program that we used is Arduino IDE. Arduino IDE is software that can be used to receive information as an input from different sensors and transfer it to an output to control LED, bulbs, motors, etc. For this specific project, we have used 5 flex sensors as an input device and 5 motors as an output device. To run the program, we just need to connect the Arduino Uno board to any laptop using USP adaptor or using wall adapter that provides a voltage range from 7 – 12 volts.

Circuit:



Instructions for Use

This project can be used by firstly plugging and connecting the circuit to the computer or power supply. Then after we wear the gloves, as we move each of our fingers, the prosthetic ones on the hands move following our fingers in the gloves.

Full code explanation

- The numbers are the readings on the serial monitor for when the hand is open or closed; transferred reading to Arduino, ranges from minimum to maximum.

```
//Open 735--712--741--757--755--
//Close 813--758--793--864--811--
```

- In this part of the code, we have included the servo library because we are using servo motors.

```
#include <Servo.h>
```

- Here we created servo objects.

```
Servo servo1;
Servo servo2;
Servo servo3;
Servo servo4;
Servo servo5;
```

- Here we have declared the Analog pin numbers for the flex sensors. [Analog pins, from A1 to A5; flex sensor 1 to pinhole A1 and so on.]

```
int flex1 = A1;
int flex2 = A2;
int flex3 = A3;
int flex4 = A4;
int flex5 = A5;
```

- Now we have declared the pin numbers for the servomotors. [servo motors are connected to which digital pinhole, etc.]

```
servo1.attach(2);
servo2.attach(3);
servo3.attach(4);
servo4.attach(5);
servo5.attach(6);
```

- This is the Setup Function of this code.
  This part of the code runs ones when we turn on the Arduino UNO board.
  In the Setup, we have declared the servo variables. As seen, the numbers are vital as they help the program identify the fingers.
  [For example, *Servo servo1* equals the thumb, *Servo servo2* finger number 2 and so on.]

```
void setup ()
{
  Serial. Begin(9600);
  servo1.attach(2);
  servo2.attach(3);
  servo3.attach(4);
  servo4.attach(5);
  servo5.attach(6);
```

- This is the Loop Function of this code.
  This part of the code runs continuously after the Setup function.

```
  void loop()
{
  int flex1_pos;
  int servo1_pos;
  flex1_pos = analogRead(flex1);
  servo1_pos = map(flex1_pos, 740, 805, 0, 180);
  servo1_pos = constrain(servo1_pos, 0, 180);
  servo1.write(servo1_pos);

  int flex2_pos;
  int servo2_pos;
  flex2_pos = analogRead(flex2);
  servo2_pos = map(flex2_pos, 720, 750, 0, 180);
  servo2_pos = constrain(servo2_pos, 0, 180);
  servo2.write(servo2_pos);



  int flex3_pos;
  int servo3_pos;
  flex3_pos = analogRead(flex3);
  servo3_pos = map(flex3_pos, 745, 785, 180, 0);
  servo3_pos = constrain(servo3_pos, 0, 180);
  servo3.write(servo3_pos);

  int flex4_pos;
  int servo4_pos;
  flex4_pos = analogRead(flex4);
  servo4_pos = map(flex4_pos, 760, 860, 180, 0);
  servo4_pos = constrain(servo4_pos, 0, 180);
  servo4.write(servo4_pos);

  int flex5_pos;
  int servo5_pos;
  flex5_pos = analogRead(flex5);
  servo5_pos = map (flex5_pos, 760, 805, 0, 180);
  servo5_pos = constrain (servo5_pos, 0, 180);
  servo5.write(servo5_pos);
```

- Detailed explanation of the loop function:
  Note: This process will be done to all flex sensors and their servo motors.

[flex1_pos = analog Read(flex1);]

Here we are reading the value from the flex sensor and storing the information into here.

[servo1_pos = map (flex1_pos, 740, 805, 0, 180);]

Here we used the map function. The map function maps the reading values of the flex sensors to the corresponding angles for the five motors. [for example: if the value of Flex sensor 1 is in the middle of the sensor range (772) then the corresponding value of the servo motor 1 will be (90).

```
servo1.write(servo1_pos);
```

Here we send the position command to the servo, making it move to the specified angle.

- Here is the code to print the readings of the servomotors in the serial monitor:

```
Serial.print(servo1_pos);
Serial.print("--");
Serial.print(servo2_pos);
Serial.print("--");
Serial.print(servo3_pos);
Serial.print("--");
Serial.print(servo4_pos);
Serial.print("--");
Serial.print(servo5_pos);
Serial.println("--");
```

- Here is the code to print the readings of the flex sensors in the serial monitor:

```
Serial.print(flex1_pos);
Serial.print("--");
Serial.print(flex2_pos);
Serial.print("--");
```

```
Serial.print(flex3_pos);
Serial.print("--");
Serial.print(flex4_pos);
Serial.print("--");
Serial.print(flex5_pos);
Serial.println("--");
```

- This delay can be set to anywhere from 100 to 500.

```
delay300);
}
```


Acknowledgments

We would like to acknowledge our STREAM lab technician helped us to a great degree in the making of this hand. Her support is what motivated us to reach our potential goal. Our STEM teacher also provided us with external support and helped us when we were unsure.
We also would like to acknowledge: (viralsciencecreativity.com) for providing all the explanation of the project, hand 3D design and the code. We would also like to acknowledge the two others behind the scenes, Elizabeth Jennings who helped us with the scientific purpose of this project and the school Marketing Manager who prepared the YouTube video.

A bibliography

- https://www.youtube.com/watch?v=Fvg-v8FPcjg
- https://www.viralsciencecreativity.com
- For the educational Arduino IDE coding tutorials:

  https://www.youtube.com/watch?v=cd04o5yqSAU&list=PLlBVuTSjOrclb0iCMSRpS_H1lSrlSVeEm&t=2s

#1: SETUP