ROBO-ANATOMY

CREATING A DIY GLOVE CONTROLLED ROBOTIC HAND

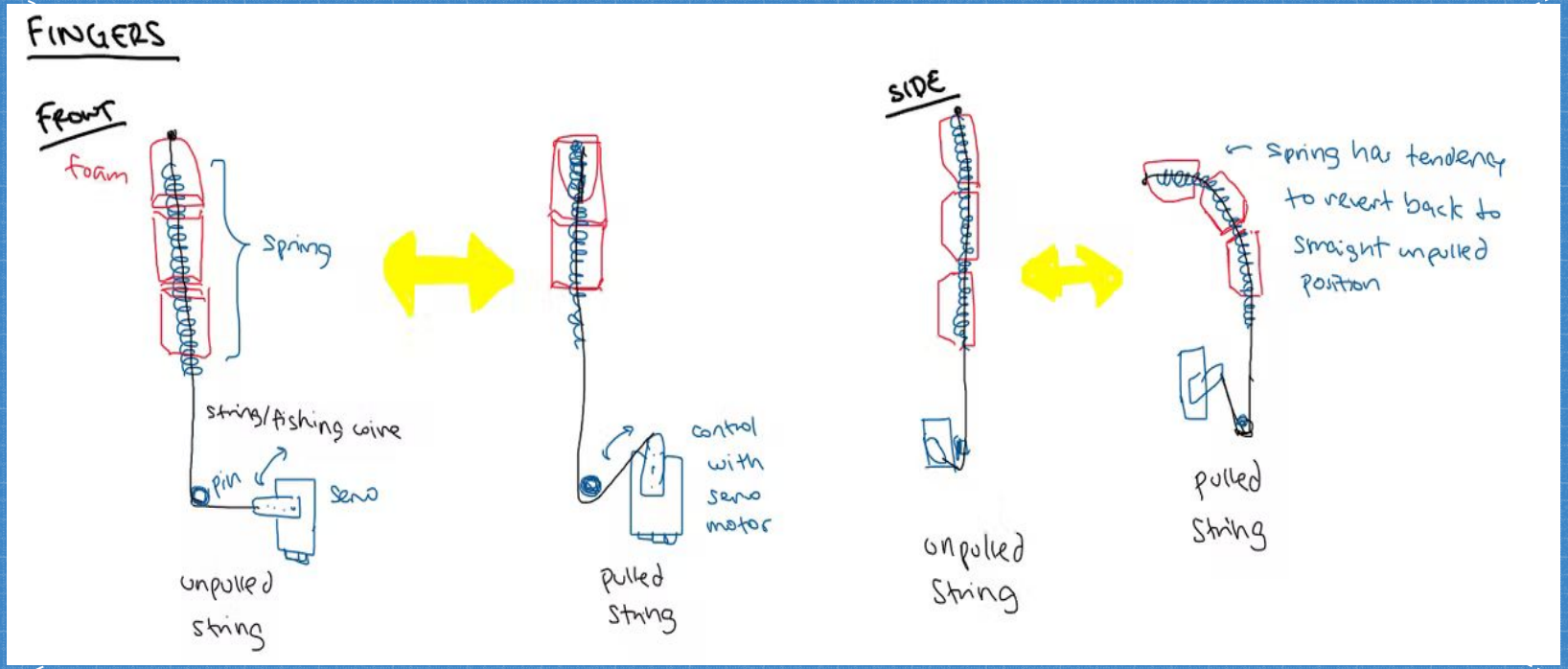
BY: LAURENCE LAI

1

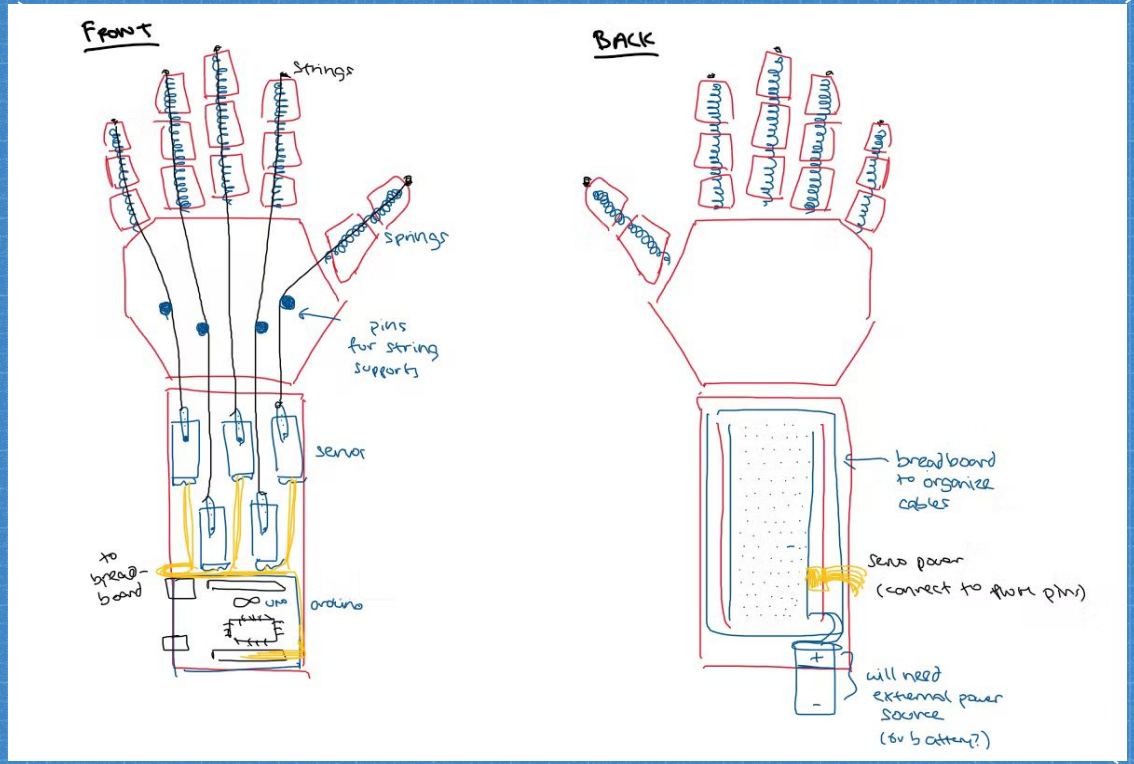
DESIGN

Let’s start with the first set of slides

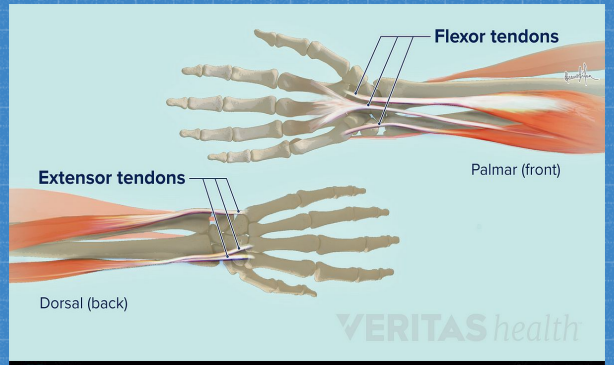
FINGER DESIGN



FULL HAND DESIGN

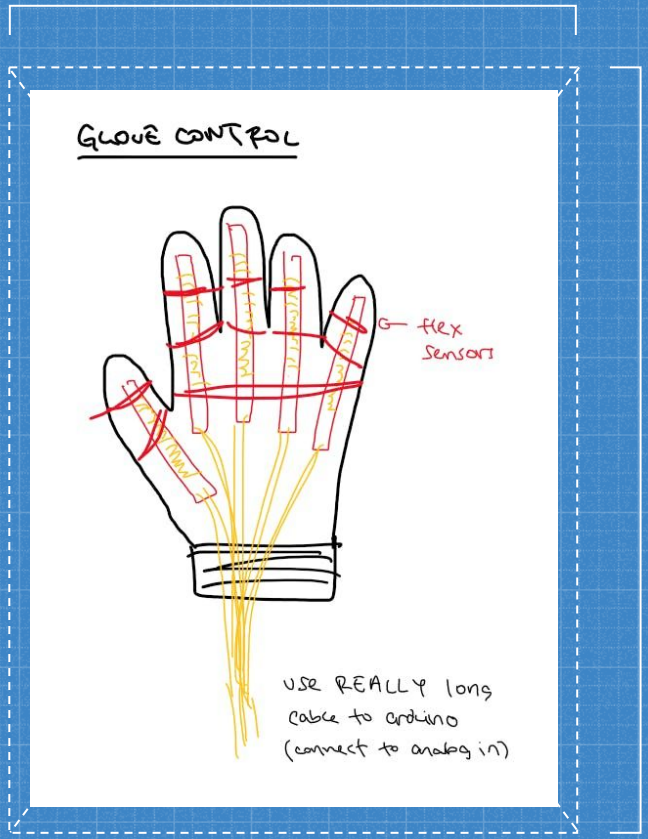


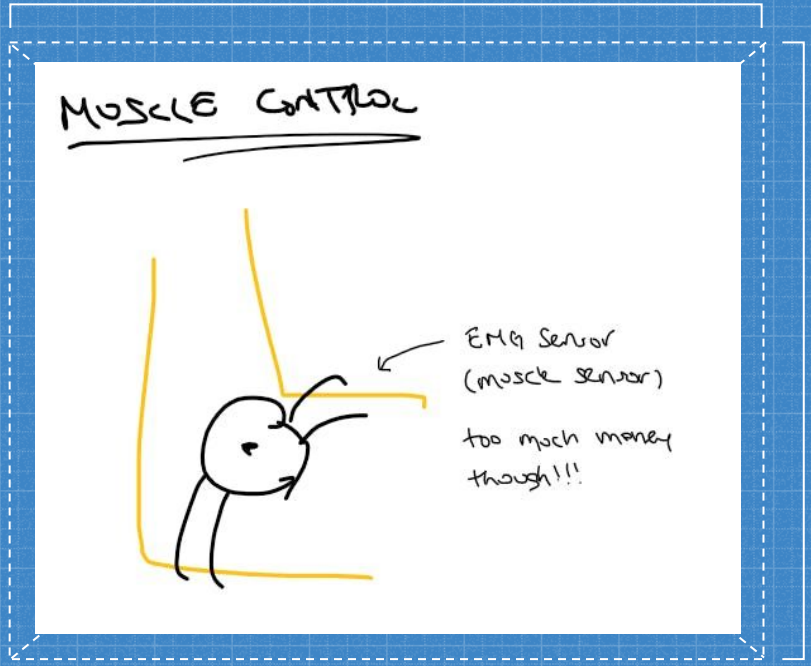
PARALLELS TO HUMAN ANATOMY



- **Foam** represents bones of the hand and wrist
- **Strings** represent tendons connecting the bones to muscles
- **Pulling the strings** represents flexion of the muscles
- **Releasing the strings** - fingers return to position when the flexor muscles are relaxed
- **Servo motors** used to control the tendons
- No extensor muscles or extensor tendons demonstrated in the model (back of the hand)

CONTROLLER DESIGN





2
CONSTRUCTION

Physically implementing
the design in real life

MATERIALS

COMPONENTS AND SUPPLIES

Arduino UNO × 1

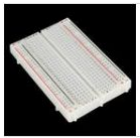
Project Foam
This can be replaced by any other material that is solid and can be molded into place × 1

Tape
Optional layer to protect the foam/Holds flex sensors in place × 1

String/Fishing Wire × 1

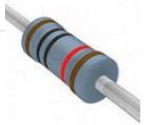
Metal Springs
Thin spring around the length of a finger. Can combine shorter springs together with solder if necessary. × 1

SG90 Micro-servo motor × 5



Breadboard (generic) × 1

Jumper wires (generic) × 1



Resistor 10k ohm × 5

4xAA battery holder
Alternative power supplies possible too × 1

Glove
Glove to control the robotic hand × 1

Paper and Pencil
DIY flex sensor parts × 1

Flexible Plastic Sheet
Allows flex sensor to flex × 1

Zipties or Rubber Bands
Cable organization × 1

NECESSARY TOOLS AND MACHINES

Hot glue gun (generic)

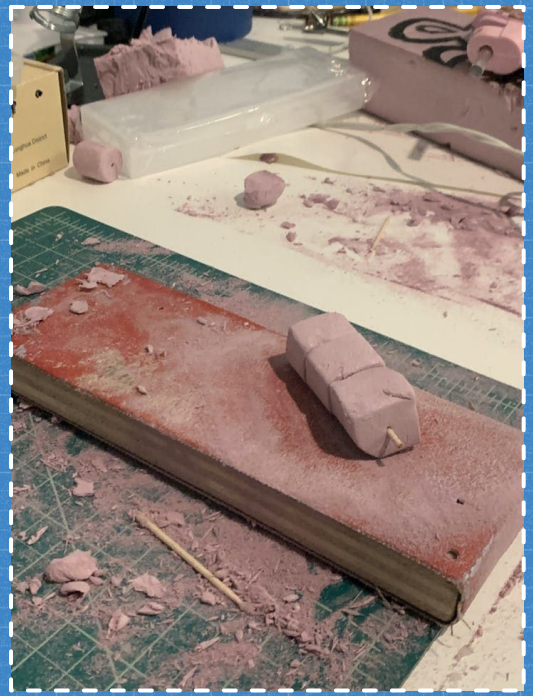
Wire Stripper & Cutter, 18-10 AWG / 0.75-4mm² Capacity Wires

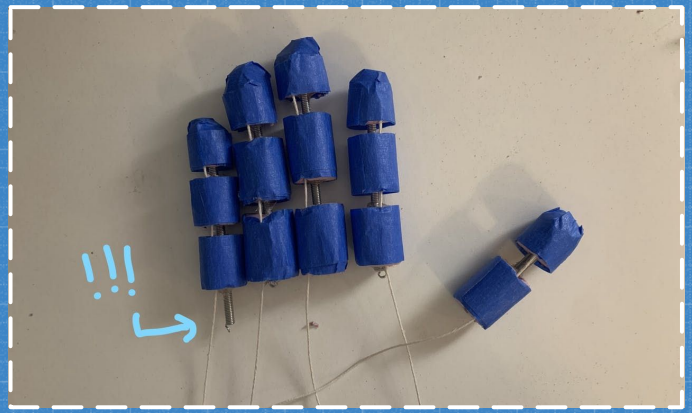
Soldering iron (generic)

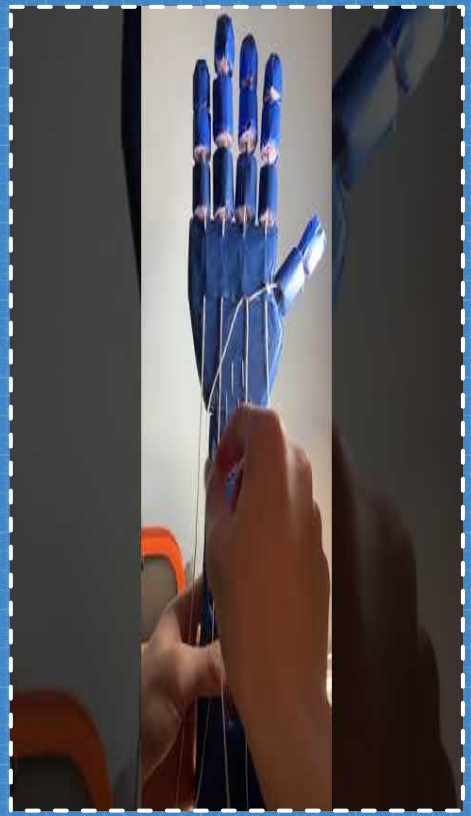
APPS AND ONLINE SERVICES

Arduino IDE

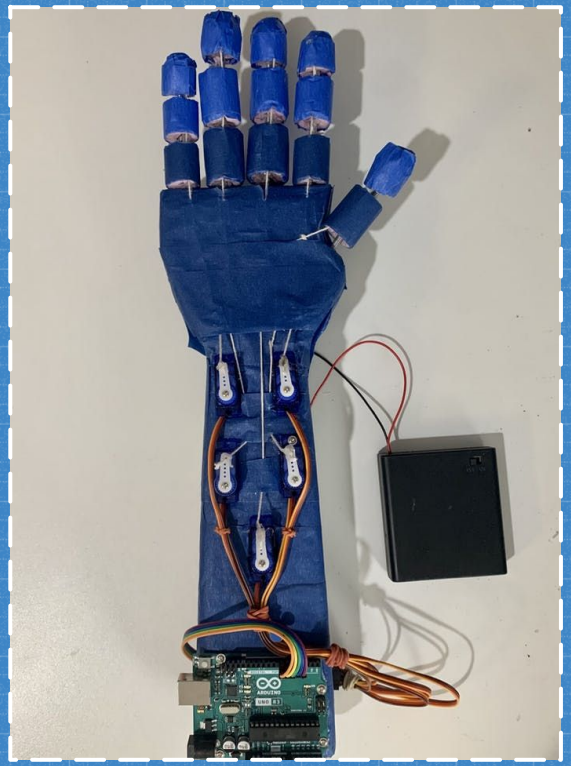
HAND CONSTRUCTION

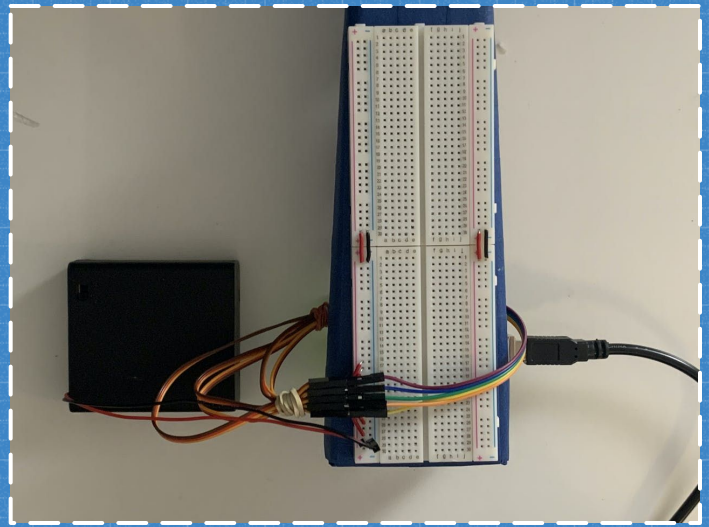


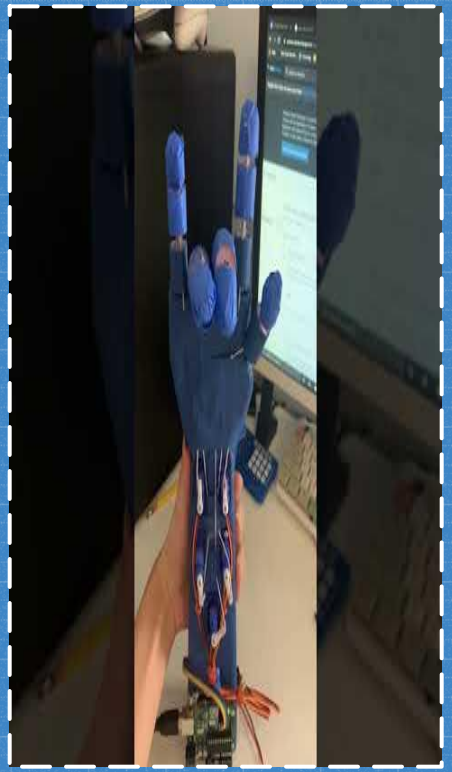




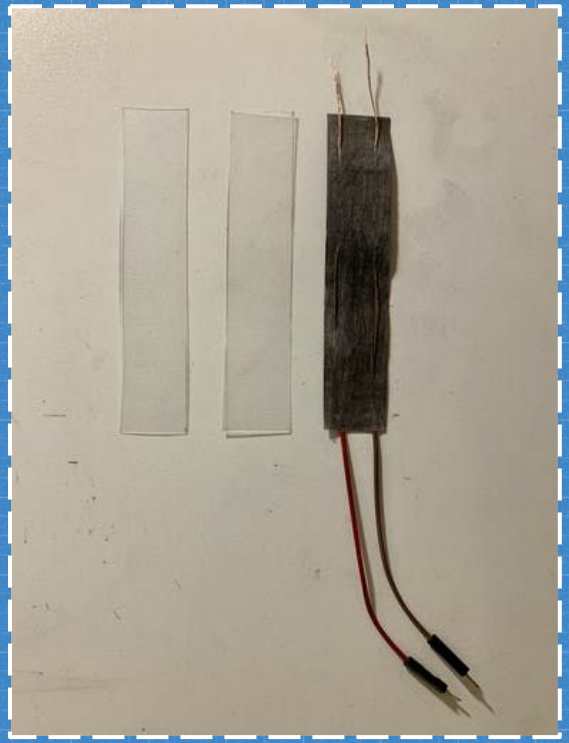
HAND CONSTRUCTION

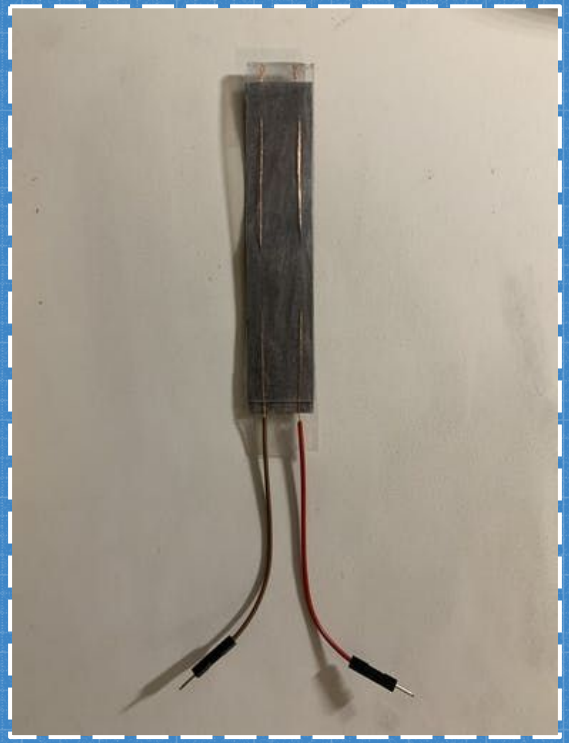






GLOVE CONSTRUCTION

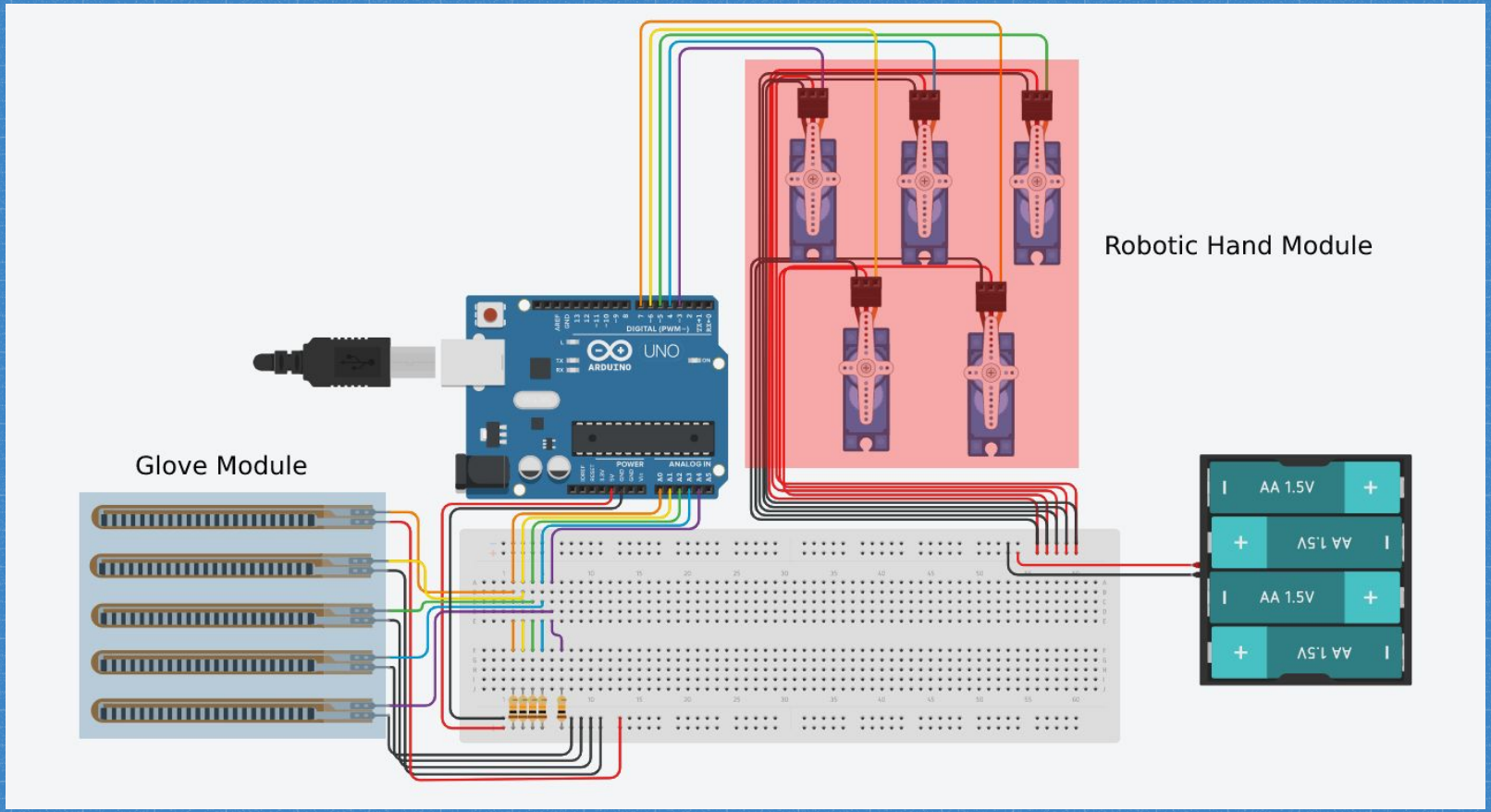




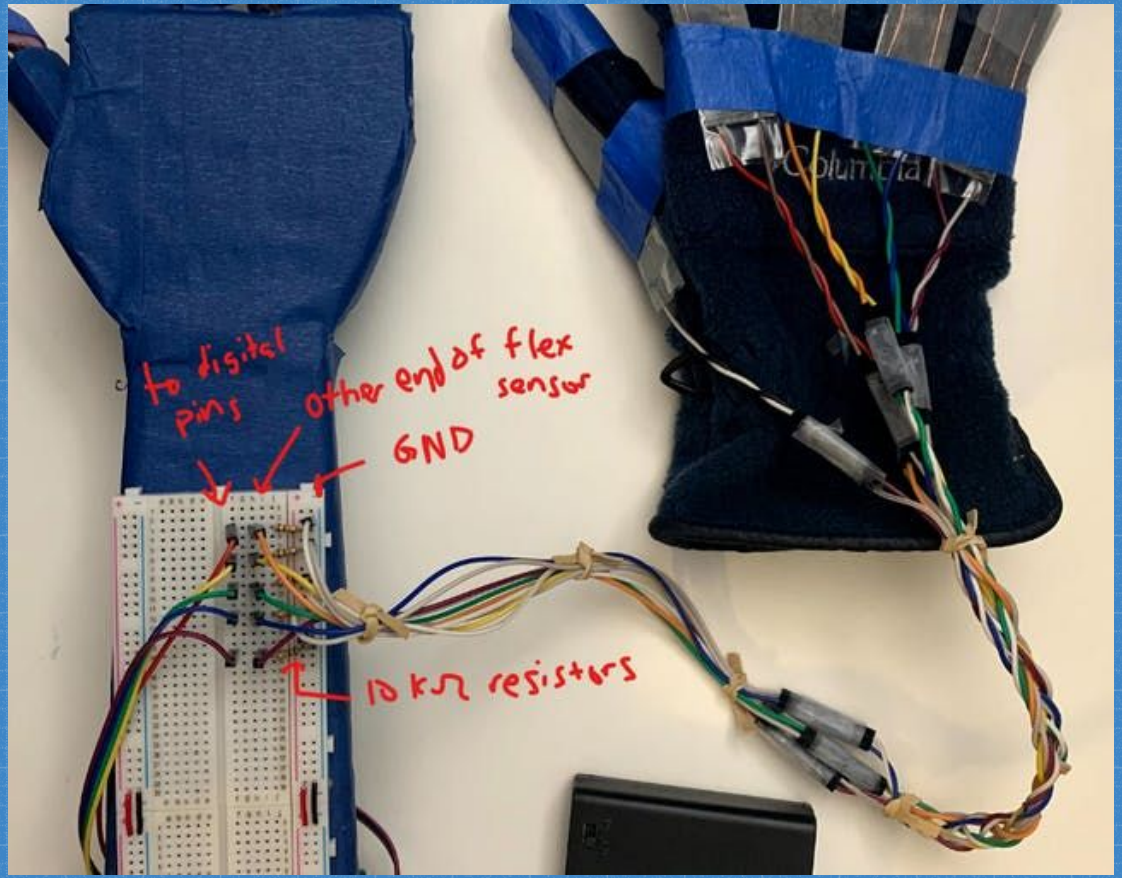
3
CODING

Programming the project
to come to life!

CIRCUIT DIAGRAM



CIRCUIT DIAGRAM IN REAL LIFE



CODE

```
#include <Servo.h>
//define servo motors
Servo pinkie, ring, middle, index, thumb;
```

defines the servo motors (makes the computer “see” the motors)

```
//define flex sensors on glove (F1 = flex sensor 1)
(values vary depending on your own flex sensors
const int pinkieFlex = A0; //bent - 710, flat - 900
const int ringFlex = A1; //bent - 920, flat - 965
const int middleFlex = A2; //bent - 966, flat - 993
const int indexFlex = A3; //bent - 808, flat - 870
const int thumbFlex = A4; //bent - 490, flat - 525
```

defines flex sensors (makes the computer “see”the glove)

```
void setup(){
  //attach servo motors to digital pins
  pinkie.attach(13);
  ring.attach(12);
  middle.attach(11);
  index.attach(9);
  thumb.attach(10);
  //starting position for all fingers
  pinkie.write(180);
  ring.write(180);
  middle.write(180);
  index.write(180);
  thumb.write(180);
 Serial.begin(9600);
}
```

tells the computer where the servo motors are attached to (what does each wire mean?)

```
void loop(){
  //testFlex(); //use testFlex to debug Flex sensor values
  //assign fingercontrol function for each finger
  fingerControl(pinkie, pinkieFlex, 30, 180, 710, 900);
  fingerControl(ring, ringFlex, 0, 180, 935, 965);
  fingerControl(middle, middleFlex, 0, 180, 976, 985);
  fingerControl(index, indexFlex, 30, 180, 850, 920);
  fingerControl(thumb, thumbFlex, 0, 180, 487, 500);
}
```

main program loop, assigns each finger to the sensor on the glove

```
void fingerControl(Servo servo, int flex, int s_bent, int s_flat, int f_bent, int f_flat) {
  //use parameters to customize for each servo/flex sensor
   //servo - name of servo (ex. pinkie), flex - name of flex sensor (ex. pinkieFlex)
   //s_bent - servo motor value when finger bent, s_flat - servo motor value when finger flat
   //f_bent - flex sensor value when finger bent, f_flat - flex sensor value when finger flat
  //define flex sesnor and servo position
  int servo_pos;
  int flex_pos;
  flex_pos = analogRead(flex); //read flex sensor value
  //Serial.println(flex_pos); //debug line
  servo_pos = map(flex_pos, f_bent, f_flat, s_bent, s_flat); //map flex sensor values to servo motors
  servo.write(servo_pos); //write mapped servo value to servo
  delay(100); //delay for efficiency
}
```

connects the servo motor to the sensor on the gloves

```
void testFlex(){
  //use serial monitor to calcultate flex sensor
bounds - reacts in live time to glove
  int val0 = analogRead(A0);
  Serial.println("");
  Serial.print(" A0: ");
  Serial.print(val0);

  int val1 = analogRead(A1);
  Serial.print(" A1: ");
  Serial.print(val1);

  int val2 = analogRead(A2);
  Serial.print(" A2: ");
  Serial.print(val2);

  int val3 = analogRead(A3);
  Serial.print(" A3: ");
  Serial.print(val3);

  int val4 = analogRead(A4);
  Serial.print(" A4: ");
  Serial.print(val4);

  delay(500); //delay for efficiency
}
```

Code used to test each finger/sensor on the glove controller

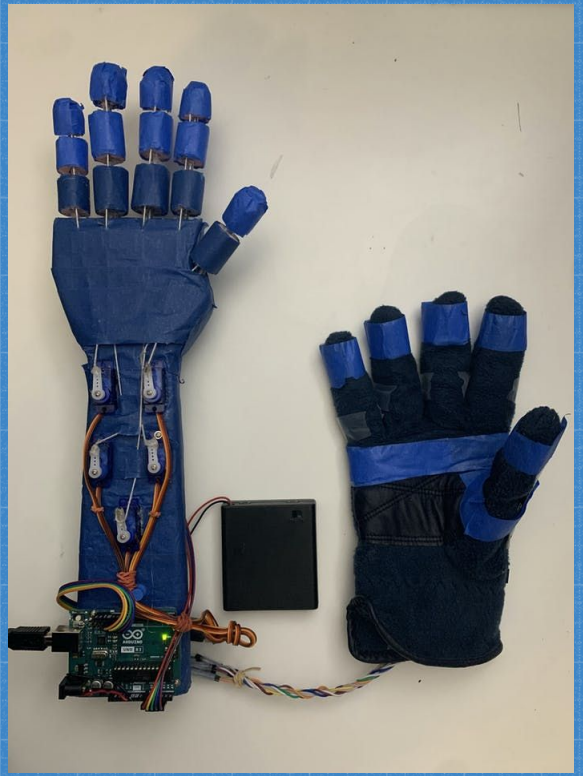
4

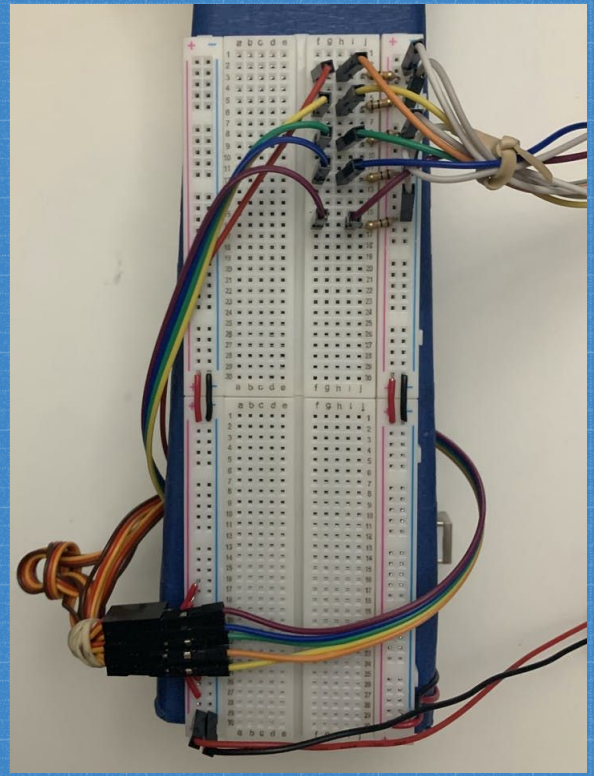
FINAL PRODUCT

Demonstration of the finished project

VIDEO DEMONSTRATION

IMAGES





IMAGES