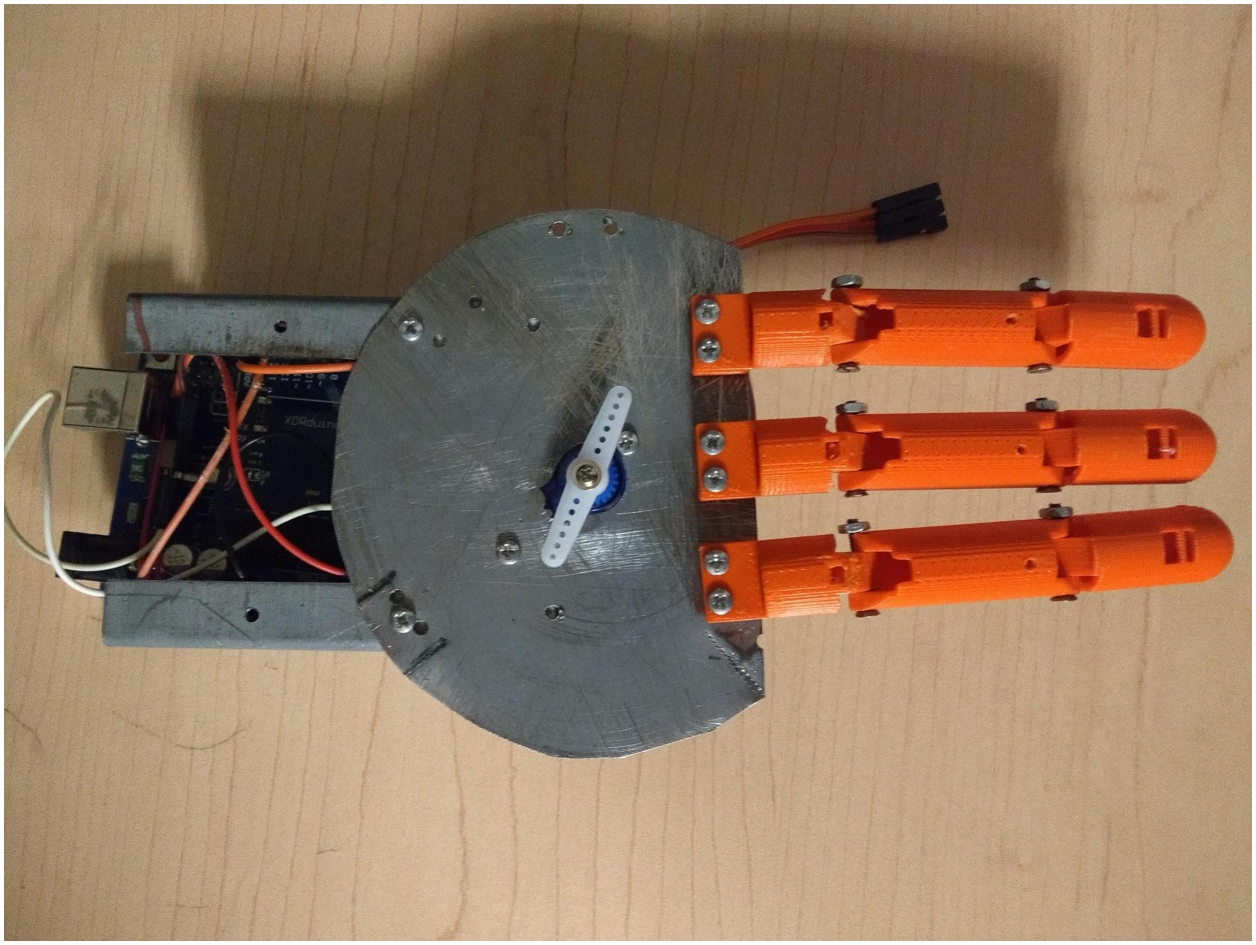
Arduino Hand

How it works

The hand is powered by a servo motor in the center of the palm. When the servo spins, it retracts the strings, pulling the fingers towards the center. This makes the fingers go through a grabbing motion. The string passes through the fingers attaching to the tip of the finger. This forces the finger to bend sequentially. First the tip will completely fold, then the center part will follow. The palm is half circle shaped to allow for the fingers to be mounted straight in reference to the servo center. This is to allow all of the strings to be pulled in the same direction. A touch sensor is encased in a case to prevent it from shorting out. The arduino board is located behind the palm of the hand to hide it from view. The usb port is located at the bottom of the case to allow for easy access.



Previous ideas

The initial idea was to have the strings replaced by stainless steel wires in order to allow the servo to push the fingers back into place, but the wires were found to have too much friction and could not be pushed by the servo. Now, instead, gravity does the work instead and strings are only used to pull the fingers up and together.

Previously, the palm of the hand was a complete circle, but due to the shape, all of the fingers were angled, meaning they had to all be pulled in different directions to grab anything. The servo is not able to do this as it can only rotate one way at a time, so the fingers were straightened out and it now works a lot better.

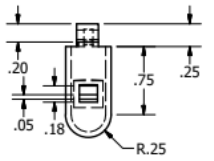
The wires were supposed to pass inside the fingers and come out where the screws currently are, but it was soon realized that the holes were too awkwardly placed to allow for anything to go through. To compensate for this, the screws were put to force the strings a certain direction to allow them to pull the fingers in the right direction.

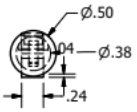
The sensor to be used was supposed to be a shock sensor, but it was triggered by the movement of the servo and would end up causing a feedback loop where the sensor senses the servo which causes it to spin the servo forever.

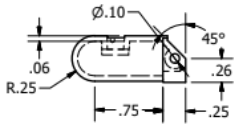
Finally, there was supposed to be a thumb, but it was quickly replaced by a mounting point as the servo could not pull it in the right direction no matter how many guides were placed.

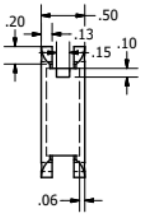
How it was made

All of the fingers were made in the 3d printer. All of the fingers consist of the same three parts, a tip, a middle section and a base. The base is the part which is attached to the palm and does not move. The tip is the part to which the string attaches to, and the middle section is the one which connects the two together. The sensor case was also made using the 3d printer. The drawing used to make these are displayed below.


.20
.05
.18
.75
.25
R.25


Ø.50
.04
Ø.38
.24


Ø.10
45°
.06
R.25
.26
.75
.25


.20
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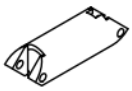
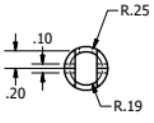
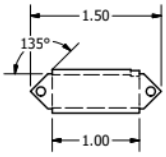
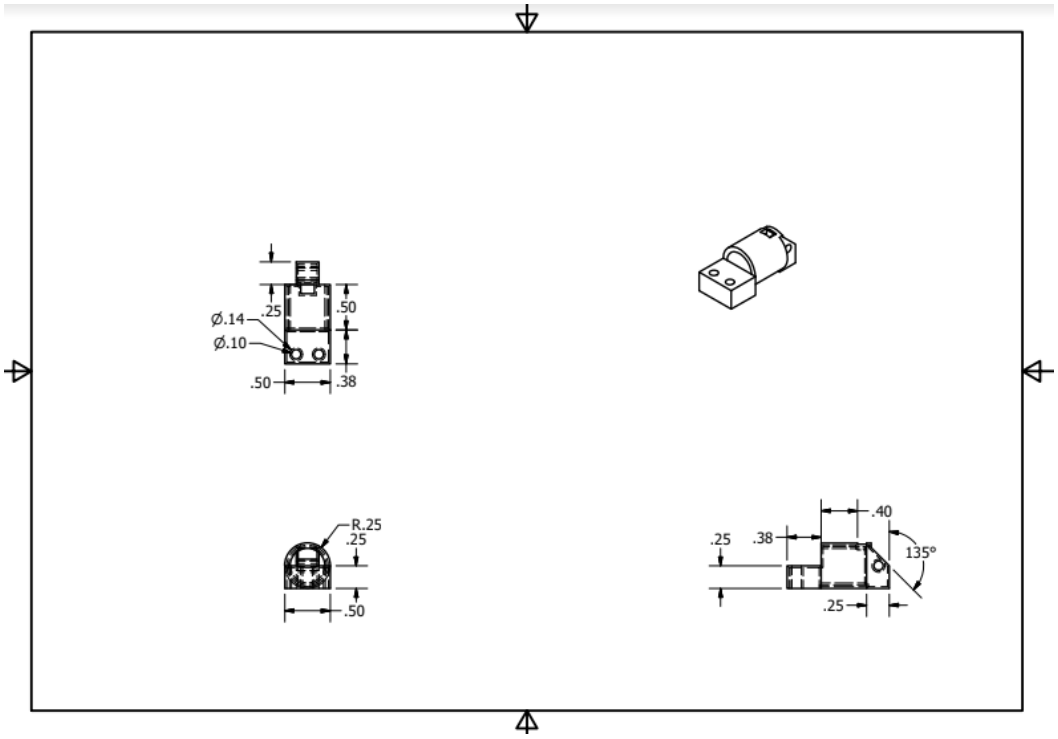
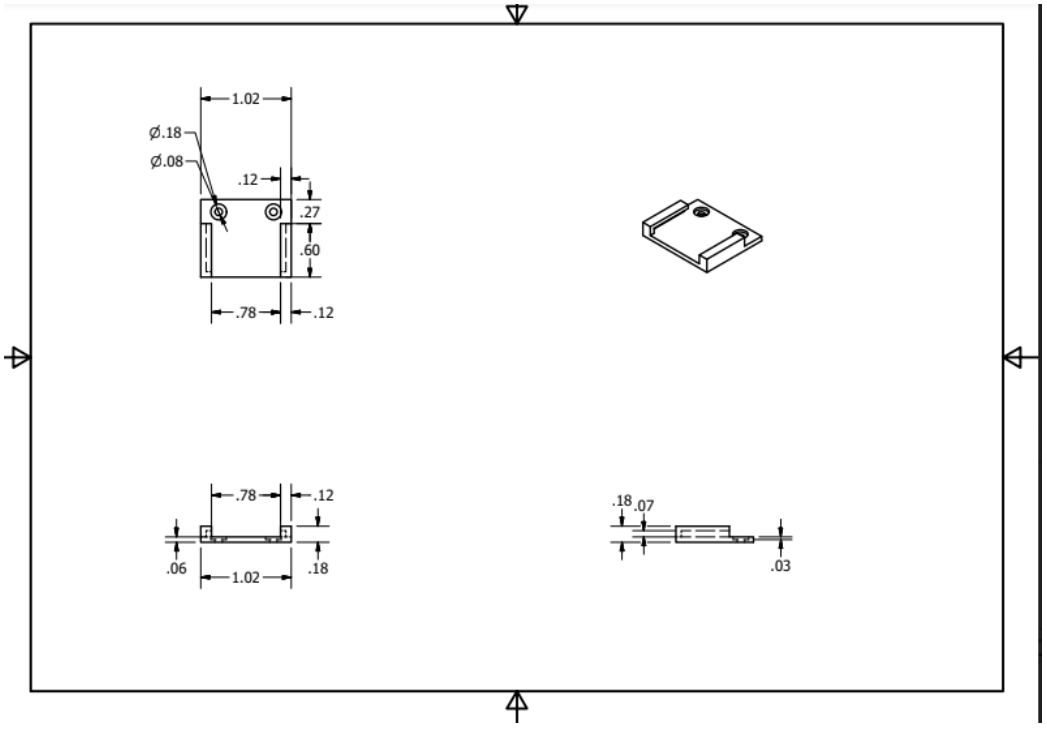
.15
.10
.06



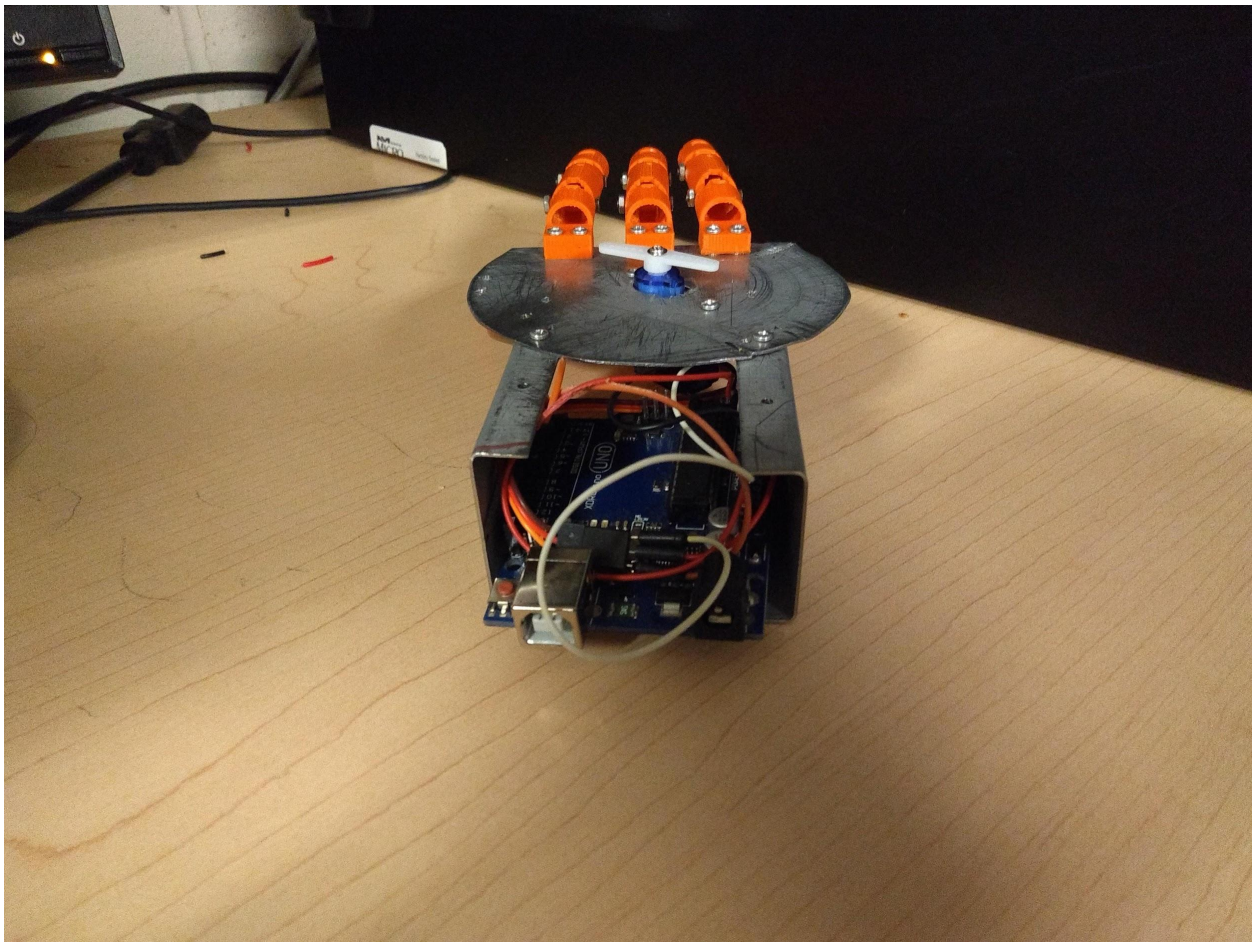

.10
.20
R.25
R.19


1.50
135°
1.00


Ø.14
Ø.10
.25
.50
.50
.38
R.25
.25
.50
.25
.38
.40
135°
.25


1.02
Ø.18
Ø.08
.12
.27
.60
.78
.12
.78
.12
.06
1.02
.18
.18
.07
.03

All of the other pieces were made using the guillotine, the corner cutter, the metal bender, and the drill press with some small screws. The case was made of one sheet of bent metal. The palm was made using a square and cutting down the corners until they looked round using the corner cutter. Once the corners were pretty smooth, a file was used to finish the job.



The code

```
#include <Servo.h>

//Name pins used in the program
#define shock 11
#define servo 10

//Define variables
Servo fingerServo; //Construct servo object
bool shocked = false; //Determine whether sensor has been triggered
int shockState; //Raw value of servo state
byte toggle = 0; //Value used to keep track of when and where to turn the servo
```

```
//Setup all pins and objects
void setup() {
  pinMode(shock, INPUT);
  fingerServo.attach(servo);
  fingerServo.write(0); //Default servo position
}

//Continuous code, runs forever
void loop() {
  shockState = digitalRead(shock); //Get sensor raw value

  //Toggle if statements to switch between different degrees while only checking for 1's
  if (shockState == LOW && toggle == 0){

    toggle = 1;
  }else if(shockState == HIGH && toggle == 1){
    shocked = true;
    toggle = 2;
  }else if(shockState == LOW && toggle == 2){
    toggle = 3;

  }else if(shockState == HIGH && toggle == 3){
    shocked = false;
    toggle = 0;
  }


  //Take values given from toggle if statements and moves the servo
  if (shocked){
    fingerServo.write(10);
  }else if(!shocked){
    fingerServo.write(120);
  }

  //Delay to keep the code running at a constant speed
  delay(40);
}
```