Prosthetic Hand Control Using EMG Sensor

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Abstract - *The idea of this project is to change the perspective of remote controls to manually operated Robotic-Hand. In this project we work on the design and development of a Robotic Hand using an Arduino board, and servo motors. The design of the hand is based on a simple, easy, flexible, and minimal controlling strategy. The Robotic Hand has been assigned independent commands for all the five fingers to open and close, pick and place, and to get back to home position. The Arduino based human hand replication system is a system that can help and avoid the human presence to be put under harmful situations such as radioactive and bio hazardous. Thetechnology can also be helpful in very precise instrumentationworkings like a doctor operating a patient with a robot without its own hands. The technology has its many useful applications in the field of robotics, surgical operations, humanoid robots, etc.*

***Key Words*: Arduino, FFRH, Robotic-Hand, Replication System**

1. INTRODUCTION

The term "prosthetic" comes from a new Latin word from Greek "prostithenai" meaning "to add to, or to put in addition", this describes the addition of an artificial body part, such as a limb, a heart. The human upper limb is an important part of the body, the partial or complete loss of which can have a serious effect on a person's ability on the day to day activities. The human upper limb has three sections the hand, forearm, and arm. For the movement of each section, coordination of the nervous system, musculoskeletal systems, and its surroundings is necessary. To perform various daily activities, coordination of different joints (shoulder, elbow, wrist, and finger joint) is essential, including a broad range of motions with several degrees of freedom. These coordinated movements are notalways redundant and can be beneficial to perform complex tasks. When it comes to an artificial hand, all the control features of the normal hand should extensively match, so that the user can perform their daily needs in a modified and effective way. The coordinated control of the biological hand is quite complex, making it highly difficult to replicate it exactly in any prosthetic hand.

Most of the systems are designed for people who lost their hand or leg in an accident or who are handicapped by birth. With 3D printed prosthetics gaining popularity with the advent of consumer-level 3D printers, practical applications of these prosthetics have also been increasing. Online open- source development has allowed for printable hand models to be downloaded for free within minutes from websites such as Thingiverse, a free, open-source 3D modeling site. Contrary to traditional prosthetics, which often cost tens of thousands of dollars and are usually unaffordable to many, these alternatives provide a relatively inexpensive option to the public. This allows for less expensive, yet effective prosthetics to be available to modern consumers, with increased personalization for the user at a speed unachievable by conventional methods.

Objective

- It is helpful for the people who have lost one of their hands or if it is paralyzed.
- Low cost. The whole hand can be manufactured for 200 USD, which makes it very affordable in comparisons to its present contemporary robotic hand proposal.
- Highly effective
- The Light weight 3D printed modules/parts, makes it very easy for the user to carry it around with them.
- Safe to use
- Easy operate
- It can be further modified. It can be custom made depending upon how the user wants it to function. It can even be controlled through cloud or Wi-Fi.

Need of the Project

In the United States, there are approximately 40,000+ persons who have lost their major upper-limb or have it paralyzed. Activities that a person could routinely perform may no longer be possible or may require additional effort and time due to upper limb amputation. Upper limb prostheses can assist amputees in activities of daily living such as feeding, dressing, and hygiene tasks. These performance capabilities are highly desired by persons with upper-limb amputation, regardless of their amputation level or current prosthesis type. Unfortunately, due to the limitations of clinically available prosthetics technologies, a substantial proportion of persons with upper limb amputation (10–25%) do not use prosthesis. Of those patients that do use prosthesis, only approximately 50% of subjects use an electric prosthesis. Improving prosthetic technology in ways that yield appreciable benefits in tasks that amputees identify as important, such as ADLs, is essential to increase acceptance rates of electric prostheses and, ultimately, improve quality of life post-amputation.

2. METHODOLOGY

The following block diagram of the proposed system, which includes Arduino UNO, regulated power supply, fourservo motors (MG995), and one servo motor (SG90). Arduino boards are broadly used because it has the feature that it can read various types of input like light on a sensor, pressing of a button by finger and turning ON/OFF of a motor/LED, etc. So, this board is very suitable for this project. In this system, the MG995 servo motor is used because it provides low speed with the exact position which is very important for the useful functioning of the hand. Servo motors are present in many sizes and shapes. Servo motors have three wires one is for power supply, one is forground and one more is for angular rotation (0-180 degree) readings and this wire of the servo motor is connected tothe Arduino board.

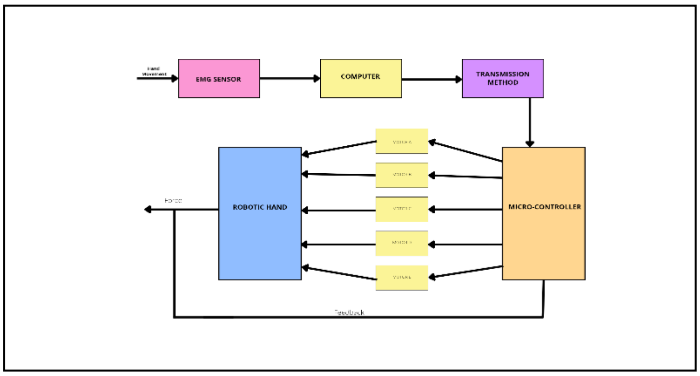


Fig2.1 Experimental Setup

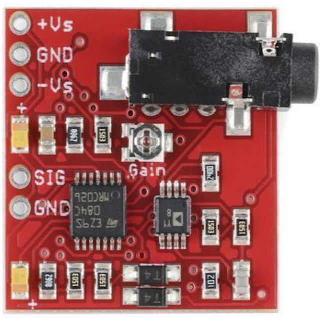
3. SYSTEM DEVELOPMENT

List of Components used in this project:

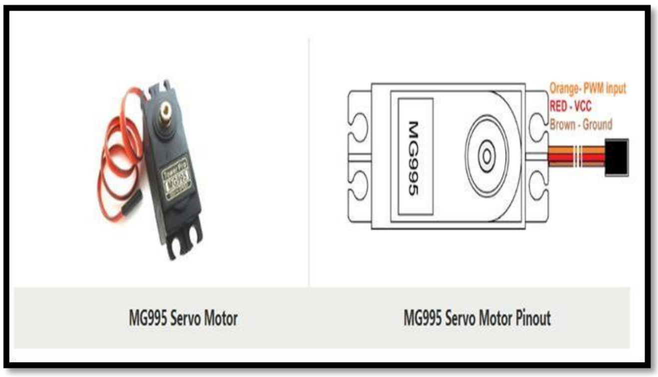
Sr. No	Component	Quantity
1.	3D Printed Prosthetic Hand (20 Parts)	×1
2.	Servo Motors (MG995)	×4
3.	Servo Motor (SG90)	×1
4.	Electromyography Sensor (V3.0 Module)	×1
5.	Electrode Pad	×3
6.	Connecting Cable	×1
7.	Lead Acid Battery (6V-5Ah)	×1
8.	Arduino UNO/Arduino MEGA	×1
9.	5V Adapter	×1
10.	Servo Motor Tester	×2
11.	Elastic Thread	×1
12.	Nylon Thread	×1

3D Printed Prosthetic Hand

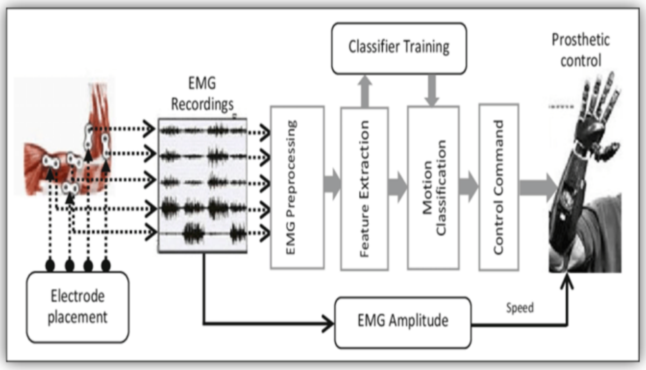
EMG Sensor



Servo Motor (MG995)



4. BLOCK DIAGRAM



5. ASSEMBLY

Step by step procedure to assemble the hand:

Step 1: All fingers except the thumb are assembled from the fingertip, joint, and knuckle. The string is used to join these parts. Thumb is assembled from the thumb joint, thumb tip, and joint.

Step 2: Four Servo motors are placed in the Forearm region and tightened with a screw provided with the servo motor. Threads are connected to the servo on the horns. The infant finger and the ring finger are connected to a similar servo, as they provide the same functionality. Four Gesture Recognition of a Robotic Hand using EMG.

Step 3: Cut ten 20 inches of fishing line. Two fishing lines per finger are used. Crimp them by feeding the fishing line from one side. Feed the fishing line from the fingertips till the fishing line exists from the palm.

Step 4: Now the fishing line is attached to the corresponding servo motor. The fishing line should be tensioned. To check the fishing line is tension's move. The motor is counter-clockwise with the hand and the finger will move inward. By rotating it clockwise the finger should open.

Step 5: Now stick the electrode pads and then connect Arduino with motors and place the forearm cover on the forearm body.

6. PROGRAM

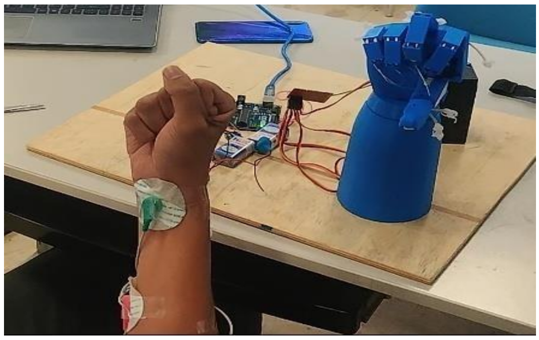
The following code is for the Electromyography Sensor:

```
int EMGPin = A0;
int EMGVal = 0;

void setup() {
Serial.begin(9600);
}

void loop() {
EMGVal = analogRead(EMGPin);
Serial.println(EMGVal);
}
```

The following code is for making a wrist:



```
#include
<Servo.h> int
EMGPin = A1;
int EMGVal = 0;
Servo servo1;
Servo servo2;
Servo servo3;
Servo servo4;
Servo servo5;

const int servoPin1
= 3; const int
servoPin2 = 5; const
int servoPin3 = 6;
const int servoPin4
= 9; const int
servoPin5 = 10;

void setup() {
 Serial.begin(9600);
 servo1.attach(servoP
 in1);
 servo2.attach(servoP
 in2);
 servo3.attach(servoP
 in3);
 servo4.attach(servoP
 in4);
 servo5.attach(servoP
 in5);

 servo1.write(0);//pi
```

```
servo3.write(1
80);
servo2.write(0
)
servo4.write(0
);
servo5.write(0
); delay(2000);
servo1.detach(
);
servo3.detach(
);
servo2.detach(
);
servo4.detach(
);
servo5.detach(
); delay(2000);
 }


nky              delay(1000);
servo1.detach();
servo2.write(180);//midd
le               delay(1000);
servo2.detach();
servo3.write(0);//thumb
delay(1000);
servo3.detach();
servo4.write(180);//4
delay(1000);
servo4.detach();
servo5.write(180);//5
delay(1000);
servo5.detach();
}

void loop() {

 //****************    FOR    READING    OF    EMG
 *********************EMGVal = analogRead(EMGPin);
 Serial.println(EMGVal);
 delay(20);
 //**********************************************************
 **********

 if (EMGVal >= 120 && EMGVal <= 200)
 {    //****************    FOR    CLOSING    OF    FINGERS
  *********************servo1.attach(servoPin1);
  servo2.attach(servoPin2);
  servo3.attach(servoPin3);
  servo4.attach(servoPin4);
  servo5.attach(servoPin5);
  servo1.write(180);

  if (EMGVal >= 50 && EMGVal <= 100)
  {
//****************    FOR    OPNING    OF    FINGERS
*********************

   servo1.attach(s
   ervoPin1);
   servo2.attach(s
   ervoPin2);
   servo3.attach(s
   ervoPin3);
   servo4.attach(s
   ervoPin4);
   servo5.attach(s
   ervoPin5);
   servo1.write(0);
   servo3.write(0);
   servo2.write(18
   0);
   servo4.write(18
   0);
   servo5.write(18
   0); delay(2000);
   servo1.detach();
   servo3.detach();
   servo2.detach();
   servo4.detach();
   servo5.detach();
   delay(2000);
  }

//***** FOR TESTING UNCOMMENT IT AND COMMENT
ALL *****
  //  servo1.attach(servoPin1);
  //  servo2.attach(servoPin2);
  //  servo3.attach(servoPin3);
  //  servo4.attach(servoPin4);
  //  servo5.attach(servoPin5);
  //  servo1.write(130);
  //  servo3.write(0);
  //  servo2.write(0);
  //  servo4.write(0);  //   servo5.write(160);
  //  delay(2000);
  //  servo1.write(0);
  //  servo3.write(180);
  //  servo2.write(200);
  //  servo4.write(180);
  //  servo5.write(0);
  //  delay(2000);
  //  servo1.detach();
  //  servo3.detach();
  //  servo2.detach();
  //  servo4.detach();
  //  servo5.detach();
  //  delay(2000);
```

7. CONCLUSION

In this project, we have designed and developed the lightweight 3D-printedprosthetic robotic hand which works on Arduino UNO, Servo motor, and EMG sensor. The Arduino board is programmed in such a way that the whole system is controlled to perform the daily life activities. This system helps the disabled person to overcome their obstacles in daily life and it also have many applications in manufacturing industries, the medical field, and many more.The proposed model is of low cost and the hardware components of the system are easily available.

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