INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT

IJARnD

(Volume2, Issue4)
Available online at www.ijarnd.com

Bionic Arm

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ABSTRACT

Functional prosthetics are the most sought after solutions to any physical trauma which leads to amputation of the limbs. In this technology, we aim to combine leading sensing techniques to use the user's residual limb to power the prosthesis and advanced processing techniques to ensure optimum operation. The already present prosthesis either serve aesthetic purposes or are dependent on invasive surgery which complicates the integration of the system. The two main points to note in functional prosthetics is choosing the best sensing technique among the many present today and also arriving at the best possible way to process these signals to power the prosthetic i.e. the bionic arm. The main objective of this project is to design a low-cost Bionic Arm using myoelectric signal sensing and advanced signal processing. The main aim of this project is to provide an advanced model of the Bionic arm that can restore natural movement to all those who have undergone upper limb amputations, at an effective cost. The proposed model senses the muscle movement of the user and powers the artificial hand in real time, thus blurring the lines between physical ability and disability.

Keywords: Myoelectric Signals, Signal Processing, Muscle Powered, Human-Robot Interface, Hand Prosthesis, EMG-Based Control, Logical Programs.

I.INTRODUCTION

The replication of the sensory-motor capabilities of the human hand is still an open challenge for scientists and engineers. The results, in fact, are quite far from the original, either in terms of dimension, sensors and so on. Two of the most critical aspects in current hand prostheses:

- Poor functionality
- Poor control capabilities

Surveys on using such artificial hands, in fact, reveal that, due to the above limitations, 30 to 50% of the upper extremity amputees users prefer to use simpler cosmetic or kinematic prosthesis instead of the myoelectric ones.

A possible solution to the first problem is the enhancement of the current design of prosthetic hand, for example by the introduction of advanced underactuated mechanism, biologically-inspired sensors, and so on.

A possible solution to overcome this limitation is the use of soft-computing techniques for the construction of the classifier. In particular, a novel evolutionary approach for the generation of a compact neural classification scheme directly from EMG data, based on is implemented and tested.

This new generation of hands could provide the user with much more functionality and capabilities. As for the poor control interface, instead, among several different possibilities, more or less invasive, the EMG signals recorded using surface electrodes are considered as an interesting source of information to allow human beings to control robotic artifacts. In fact, these signals are very easy to record in a non-invasive way and provide an important access to the neuro-muscular system of the user.

I. BIONIC ARM

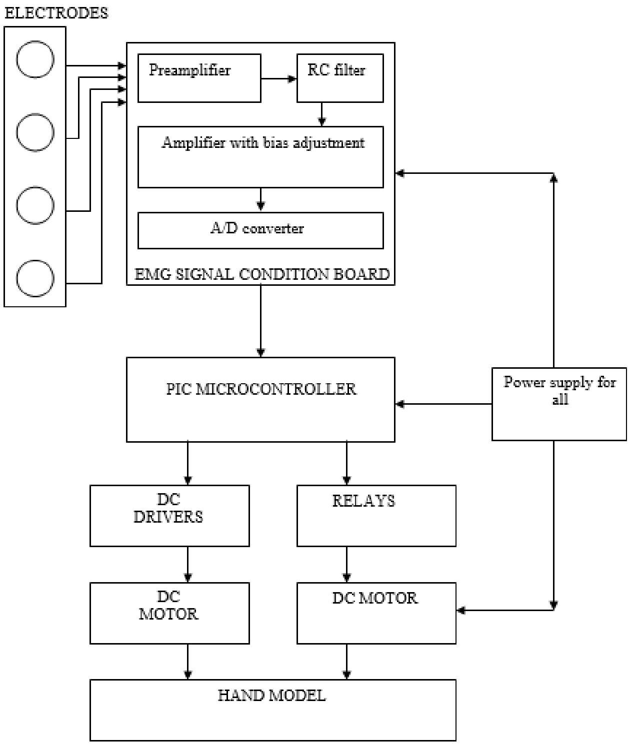
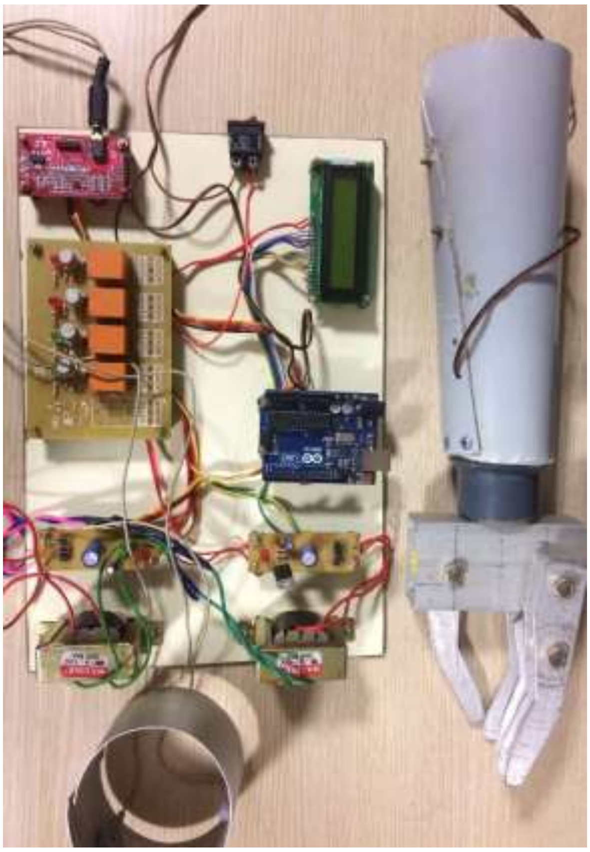


FIGURE.1 Block Diagram of Bionic Arm

II.

A. HARDWARE IMPLEMENTATION



POWER SUPPLY

The power supply output is given to microcontroller and another circuit also; the design of the power supply is mainly because of the microcontroller, the microcontroller work in Dc source with a voltage of +5v. As we are getting the line voltage VL has 230v in ac source, so it is not possible. This power supply designs an output of +5v Dc to activate the microcontroller.

MICROPROCESSOR

Here we are using an Arduino Uno. We use the analog pins as input since the output of the EMG sensors is analog. We convert them into digital signals using basic A/D converters. This is integrated with an Atmega microcontroller. This to ensure that we can integrate the Arduino board with an LCD display and the motors.

RELAY

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered, in a broad sense, to be a form of an electrical amplifier.

DC MOTOR

In any electric motor, the operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

LCD DISPLAY

We use an LCD display to visually flash the voltages as they are being sensed by the system when the user moves their muscle.

EMG SENSORS

Electromyography sensors are used to sense the movement in the muscles. The EMG sensors have three electrodes. One for reference, one for noting the change in the muscle and one is the ground. The signals from the sensors are sent to an amplification stage to allow for voltages in the range which can be processed.

SKELETAL ARM STRUCTURE

The artificial arm structure is made out of aluminum and replicates the movements of a human arm very closely. It is carefully designed and integrated with the DC motor to allow for natural reflexes in real time.

II.

B. SOFTWARE IMPLEMENTATION SOURCE CODE

```
#include <LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);//RS,EN,D4,D5,D6,D7
int a,b,c;

void setup()
{
 for(int k=8;k<14;k++)
 {
  pinMode(k,OUTPUT);//pins 8-14 are enabled as output
 }
 pinMode(A0,INPUT);
 pinMode(A1,INPUT);
 pinMode(A2,INPUT);
 lcd.begin(16, 2);//initializing LCD
 lcd.print("EMG READINGS");
 delay(2000);
 lcd.clear();
```



```
}
void loop() {
  // put your main code here, to run repeatedly:

  a = analogRead(A0);
  b = analogRead(A1);
  c = analogRead(A2);

  lcd.setCursor(0,0);
  lcd.print("S1:");
  lcd.print(a);

  lcd.setCursor(8,0);
  lcd.print("S2:");
  lcd.print(b);

  lcd.setCursor(0,1);
  lcd.print("S3:");
  lcd.print(c);

  delay(1000);


}

#include <LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(2,3,4,5,6,7);//RS,EN,D4,D5,D6,D7
int a,set;
void setup()
{
  // put your setup code here, to run once:
pinMode(A0,INPUT);
pinMode(8,OUTPUT);
pinMode(9,OUTPUT);
digitalWrite(8,LOW);
digitalWrite(9,LOW);
for(int k=2;k<8;k++)
  {
    pinMode(k,OUTPUT);//pins 8-14 are enabled as output
  }
  lcd.begin(16, 2);//initializing LCD
  lcd.print("HAND");
  delay(2000);
  lcd.clear();
  Serial.begin(9600);
}

void loop()
{
  // put your main code here, to run repeatedly:

 a = analogRead(A0);
 Serial.println(a);

 lcd.setCursor(0,0);
 lcd.print("Vol:");
 lcd.print(a);
 delay(1000);
```



```
if(((a > 250) && (a < 700))&&(set==0))
{
 digitalWrite(8,HIGH);
 digitalWrite(9,LOW);
 delay(3000);
 digitalWrite(8,LOW);
 digitalWrite(9,LOW);
 set=1;
}
else if((a < 250)&&(set == 1))
{
 digitalWrite(8,LOW);
 digitalWrite(9,HIGH);
 delay(3000);
 digitalWrite(8,LOW);
 digitalWrite(9,LOW);
 set=0;
}
else if((a > 700)&&(set == 0))
{
 digitalWrite(8,LOW);
 digitalWrite(9,LOW);
 set=0;
}

}
```

II. RESULTS

The myoelectric sensors pick up the movement of the residual muscle in the user's arm and it is sent to the instrument amplifier which adds enough gain to be able to be processed by the Arduino Uno. The source code defines the threshold voltages for the various positions of the artificial arm to be moved. Based on this the microprocessor and microcontroller integrate to show the current voltage detected and also accordingly move the skeletal arm structure fitted with motors. Relays are used to control the motion of the arm.

PARAMETERS

Table 1

VOLTAGE mV	ACTION
0-250	FIST OinPEN
250-650	FIST CLOSED
OTHER CONDITIONS	NORMAL BODY NOISE (NO CHANGE)

IV. CONCLUSION

With the proposed idea the easy integration of upper limb prosthetics can be carried out to the user irrespective of age, gender, medical conditions etc. The model requires no invasive surgery and thus is easy to maintain and highly durable. Once worn by the user, it can start to detect their muscle movements. When the user wants to close their fists and moves the residual muscle, the EMG sensors acknowledge this and the processing unit powers the artificial arm. When the user relaxes the muscle, the voltage requirements are checked and the arm is opened. Thus a cost effective, low maintenance, highly sensitive real-time Bionic Arm proposed by the idea was able to carry out the necessary requirements to be implemented in real life situations.

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