STUDY OF EMG SENSOR BASED SERVO MOTOR POSITION CONTROL

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Abstract - *The word electromyography represent the study of electrical energy polarization signal generated in the skeletal muscles of the human body. This signals from the skeletal muscles are more helpful for Limb lost persons to get rehabilitation from their disabilities. Who lost their limbs due injuries, including from traffic accidents and military combat, Cancer, Birth defects. This study talks about using an electromyography sensor to control the servo motor position for the initiation of prosthetic limb development.*

Key Words: Electromyography, Skeletal Muscles, Rehabilitation, Prosthetic limb.

1. INTRODUCTION

Amputation the word describes the loss of limb from the human body due to trauma, Medical illness or surgery. The amputation in human nowadays slowly removing by a technology called prosthesis. It means replacing the lost part of the human body with artificial limb. The purpose prosthesis is to gain the gait movement of body part after the loss.
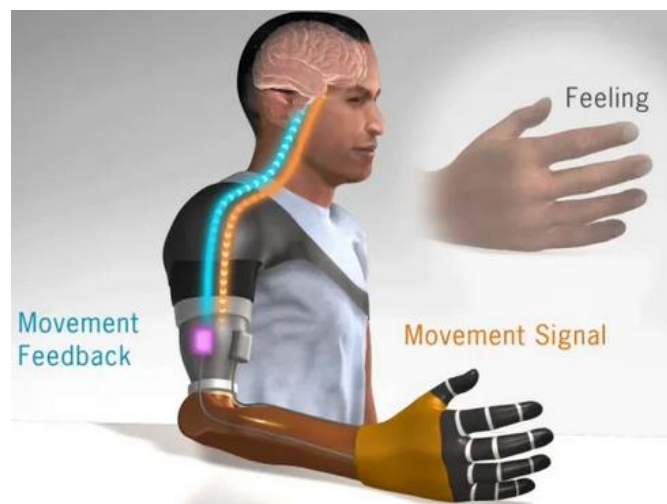

Fig -1: Muscle signal based prosthetic arm

1.1 Electromyography (EMG)

It is technique to collect the information of movement in a muscle. It is based on simple fact that whenever the muscle contracts, a burst of electrical activity is generated which propagates through adjacent tissue and bone and can be recorded from neighboring skin area.

Fig -2: EMG Sensor & Electrodes

1.2 How do muscles move?

The process begins from brain. Prompting muscle movements start in the motor cortex, where series of action potential signals to the spinal cord & the information about the movement is transported to the particular muscle via motor neurons.

The above signal is initiated at upper motor neurons that bring the signal to lower motor neurons. The lower motor neurons are the actual initiators of muscle movement, as they innervate the muscle directly at the neuromuscular junction. This innervation origins the discharge of Calcium ions within the muscle, eventually creating a mechanical change in the tension of the muscle. Muscle tension & contraction involves depolarization (a change in the electrochemical gradient), this difference in voltage potential can be detected by EMG sensor & initiated the actuator movement of prosthetic limb.
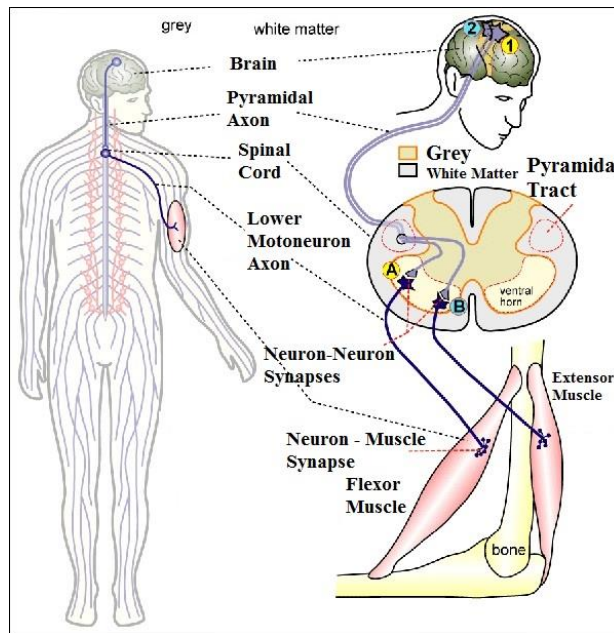

Fig -3: Muscle Tension & Contraction

2. OBJECTIVE OF THE STUDY

The EMG Activity is linearly correlated to the quantity of muscle contraction along with the recorded voltage. By using this voltage signal a servo motor position will controlled.

3. CIRCUIT DIAGRAM

In EMG Sensor required Positive & Negative reference voltage. Therefore two power source are required because the sensor has a maximum operating voltage of ±18V,
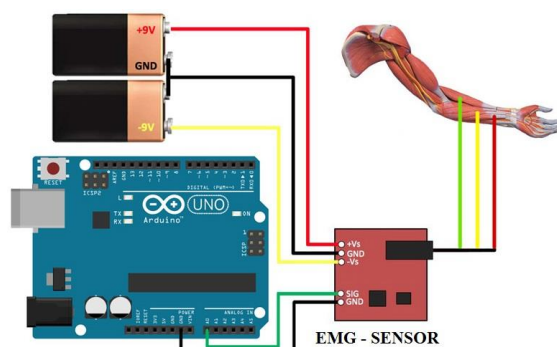

Fig -4: EMG Sensor & Arduino connection

Whenever the arm flexes, the servo motor need to turn 180 & should be indicate by buzzer & LED. Digital Pin 3, 10, and 11 are taken as output for actuating those deices.
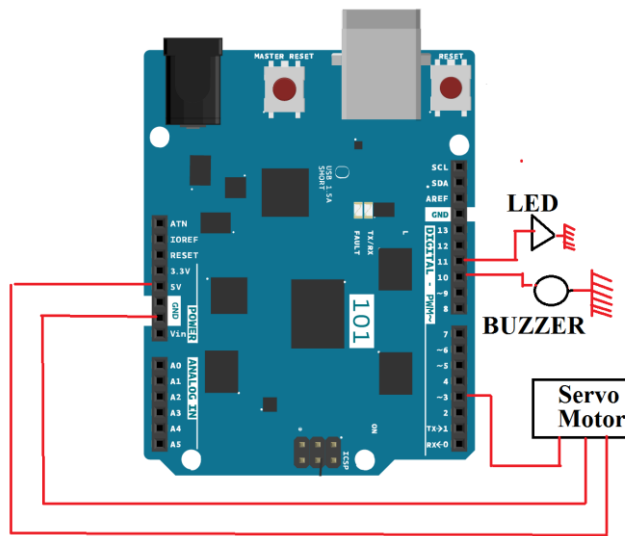
Fig -5: Servo Motor, Buzzer, LED – Arduino Connection

3. ARDUINO PROGRAM

The following program illustrate the position control of servo motor through Arduino atmega controller.

Table -1: Arduino Program

```
#include <Servo.h>

//Threshold for servo motor control with muscle sensor.
//You can set a threshold according to the maximum and minimum values of the muscle sensor.
#define THRESHOLD 250

//Pin number where the sensor is connected. (Analog 0)
#define EMG_PIN 0

//Pin number where the servo motor is connected. (Digital PWM 3)
#define SERVO_PIN 3

//Define Servo motor
Servo SERVO_1;

int ledPin1 = 11;               // Attach led to pin 11.
int Buzzer = 10;                // Attach Buzzer to pin 10.

/*------------------------------ void setup ----------------------------------------------*/

void setup(){

 //BAUDRATE set to 115200, remember it to set monitor serial properly.
 //Used this Baud Rate and "NL&CR" option to visualize the values correctly.
 Serial.begin(115200);

 //Set servo motor to digital pin 3
 SERVO_1.attach(SERVO_PIN);

 pinMode (ledPin1, OUTPUT);        // sets the led pin1 11 up as an output.
 pinMode (Buzzer, OUTPUT);         // Sets the Buzzer pin 10 up as an output.
}
```

```
/*----------------------------- void loop ----------------------------------------*/

void loop(){

 //The "Value" variable reads the value from the analog pin to which the sensor is connected.
 int value = analogRead(EMG_PIN);

 //If the sensor value is GREATER than the THRESHOLD, the servo motor will turn to 170 degrees.
 if(value > THRESHOLD){
   SERVO_1.write(180);
 }

 //If the sensor is LESS than the THRESHOLD, the servo motor will turn to 10 degrees.
 else{
   SERVO_1.write(0);
 }
 //If the sensor value is greater than the THRESHOLD, the LED & Buzzer turns on.
 if (value > THRESHOLD)              // creates bool expression for analyzation. if it evaluates to true,
  {
    digitalWrite (ledPin1, HIGH);       // turns on Red Led.
    digitalWrite (Buzzer, HIGH);      // turns on  Buzzer.
  }
   else                // if the if equation evaluates to false the else statement will execute.
  {
    digitalWrite (ledPin1, LOW);        // turns off Red Led.
    digitalWrite (Buzzer, LOW);        // turns Off  Buzzer.
  }
 delay(500);

 //You can use serial monitor to set THRESHOLD properly, comparing the values shown when you open and close your hand.
  Serial.println(value);
}
```

4. HARWARE RESULTS

The position control of servo will takes place by Arduino. The results of the actuation are shown below.

4.1 Arm none flex condition

When the arm is in Non-flex condition the servo motor position will be in zero degree & LED, Buzzer are turn off condition for the voltage depolarization in the forearm muscle gives the frequency rise up 162Hz.
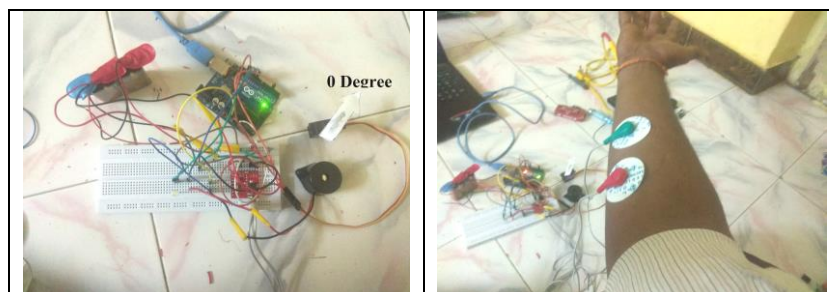

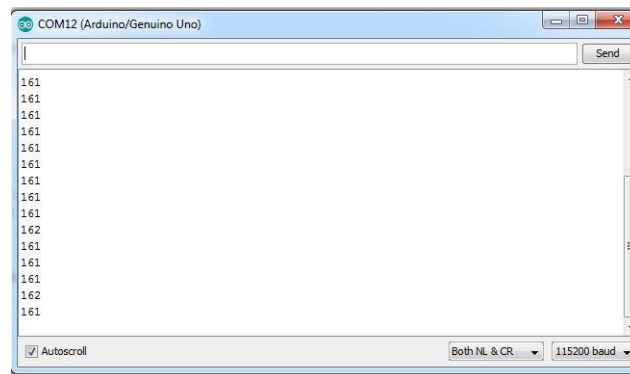**Fig -6**: Servo Motor "0 Degree position" at forearm None Flex condition

Fig -7: Serial monitor display 162 Hz frequency value during forearm None Flex condition

4.2 Arm flex condition

When the arm is in flex condition the servo motor position will turn 180 degree & LED, Buzzer are comes to ON state.

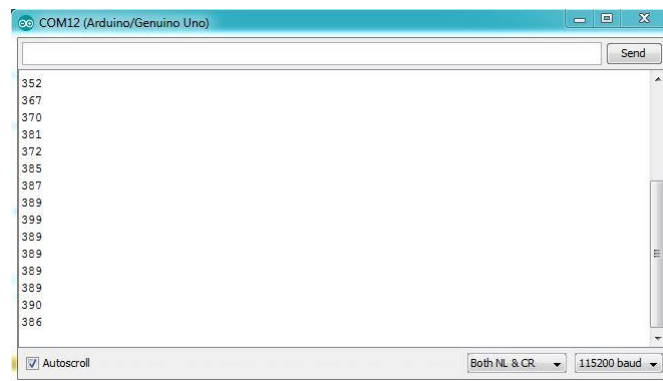**Fig -8**: Servo Motor "180 Degree position" at forearm flex condition

Fig -9: Serial monitor display greater than 350Hz Frequency value during forearm Flex condition
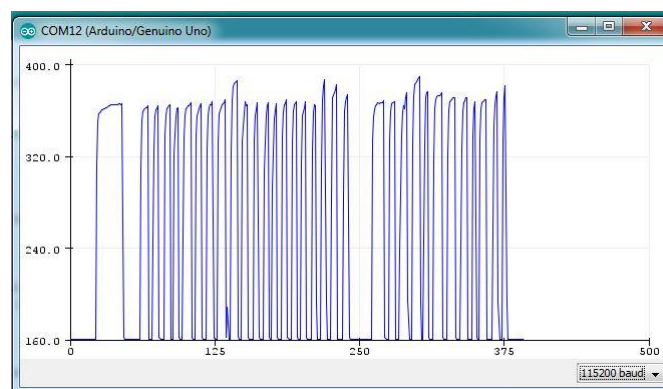

Fig -10: Serial plot display frequency oscillation between 162 to 400 Hz during forearm flex & none flex condition.

5. CONCLUSION

The study of EMG sensor based servo motor position controlled successfully validated for the forearm skeletal muscle action potential signal, through the help of Arduino controller. In future the study further developed for prosthetic arm development for amputee lost person.

ACKNOWLEDGEMENT

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BIOGRAPHIES

Act as an Assistant Professor to follow pedagogy way of Teaching Profession & An Enthusiastic researcher for future prosthetic limb