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# Wearable System for Device Control using Bio-Electrical Signal

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## Abstract

In today's world, wearable devices are progressively being used for the enhancement of the nature of the life of individuals. Human Machine Interface (HMI) has been studied for dominant the mechanical device rehabilitation aids through bio-signals like EOG and EMG etc., and so on. EMG signals have been studied in detail due to the occurrence of a definite signal pattern. The current proposal focuses on the advancement of a Wearable Device control by using EMG signals of hand movements for controlling the electronic devices. EMG signals are utilized for the production of the control indicators to develop the device control. Also, an EMG sign procurement framework was produced. To create different control signals relying on the sufficiency and length of time of signal segments, the obtained EMG signals were then prepared for device control.

**Keywords:** Electromyography (EMG), HMI, Wrist movements, Wearable

## 1. Introduction

### 1.1 Need for Rehabilitation Techniques

A major a part of our society is littered with one or the opposite reasonably disabilities owing to accidents and neuro-logic disorders. These patients rely upon the members of the family or care takers for his or her day to day activities like quality, communication with atmosphere, mistreatment the home instrumentation, etc[1,2].

Rehabilitation devices facilitate the patients with disabilities to measure, work, play or study severally. Moreover, they improve the standard of life led by these individuals and maintain their shallowness.

### 1.2 EMG based Methods

Electrical potentials generated during muscle contraction are measured by EMG. The contraction of somatic cell takes place once it receives associate degree impulse. The myogram ascertained is that the add of all the action potentials that occur round the conductor site. In most of the cases, the amplitude of the myogram will increase as a result of contraction. Myogram signals is used for a range of applications together with clinical applications, HCI and interactive gaming. They're non-heritable simply and are comparatively high in magnitude than alternative bio-signals. On the opposite hand, myogram signals area unit simply liable to noise. myogram signals contain difficult styles of noise as a result of

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inherent instrumentation noise, non-particulate radiation, motion artifacts, and therefore the interaction of various tissues. Hence, to filter the unwanted noise in myogram, preprocessing is critical[3]. The myogram signals even have completely different signatures counting on age, muscle development, motor unit ways, skin fat layer, and gesture designs. The external appearances of 2 individuals' gestures would possibly look identical, however the characteristic myogram signals area unit completely different[4].

## 2. Proposed Algorithm

The main aim of this work is to develop a reliable and easy to use bio-signal acquisition system and control of electronic devices using EMG.

The signals generated from the body is amplified and acquired as rectified EMG signal through Data Acquisition system made on Labview platform and then it is further processed in the microcontroller to determine the particular features and classification of the signals. After classification, the digital output is generated through microcontroller to control the particular device. The basic block diagram for the developing a device control using a bio-signal is as shown in Figure 1.

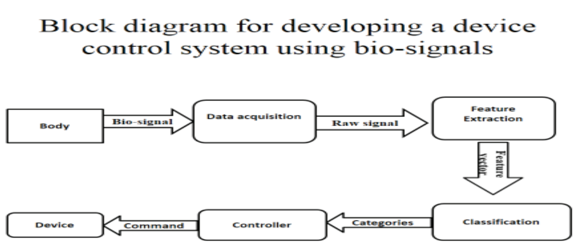


**Figure 1.** Block diagram of proposed system.

The EMG signal is acquired from the EMG sensor as in the rectified form from the interosseus site. The raw EMG signal patterns are shown in the Figure 2. The EMG sensor consists of instrumentation amplifier which is made from the IC AD8221 having band pass filter of 20 to 500Hz. A smoothening circuit is applied to it for making it insusceptible to noise[5]. After that it is rectified and enveloped by the enveloping circuit to get the final EMG signal as shown in Figure 3[6,7]. The basic circuit schematics of the EMG sensor amplifier are as shown in Figure 4.

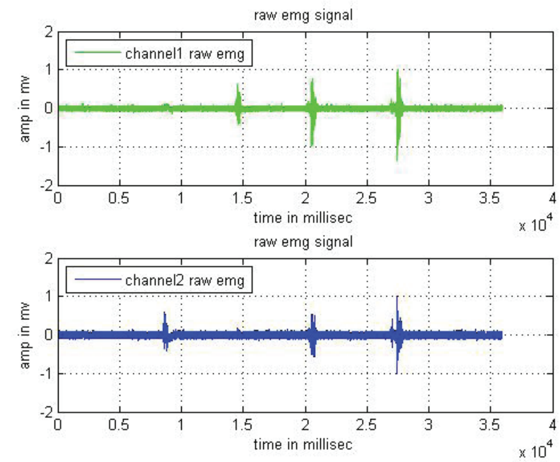


**Figure 2.** A raw EMG signal.

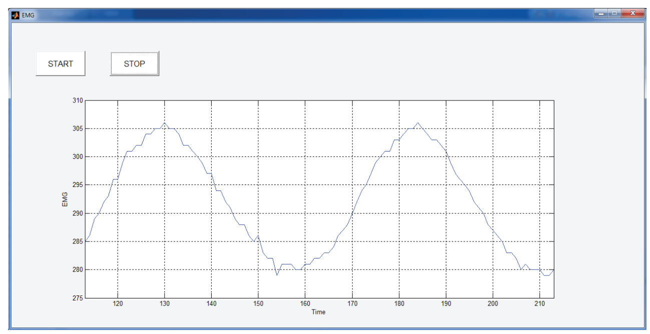


**Figure 3.** Rectified and enveloped EMG

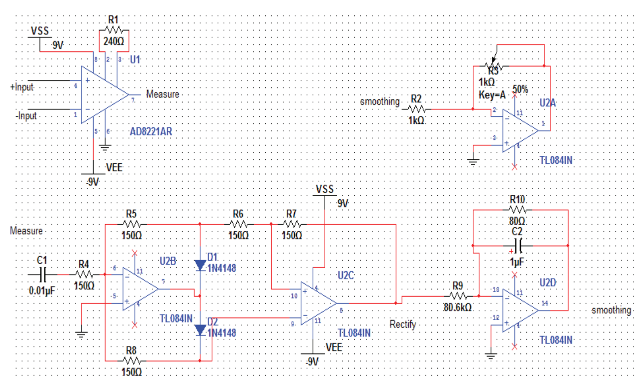


**Figure 4.** Circuit schematics of EMG sensor.

## 3. Experiment and Result

### 3.1 Data Acquisition System

The data Acquisition and Control system is made up with the help of EMG Sensor and Ardiuno nano, interfaced at analog pin0. The Arduino Firmware was used to link the

Arduino IDE and Labview. The front panel (Figure 5.) shows the basic interfaces status like com port, baud rate, type of board used etc., and waveform coming through the sensor.

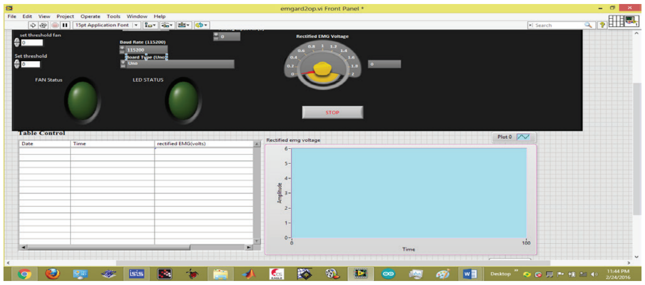

**Figure 5.** Front panel.

## 3.2 Feature Extraction and Classification

Author in[8,9] have described several feature extraction techniques of bio-signals which can be broadly classified in:

- Time domain.
- Frequency domain.
- Time-frequency domain.

Mean, standard deviation, integrated EMG, Averaging, rectification are the some techniques which are used in time domain. Power spectrum, Power spectrum density, Mean Power spectrum density is the some techniques in frequency domain and Short time fourier transform, wavelet transforms are the techniques for time frequency domain. As it is easy to compute and do time domain analysis, the feature is extracted in time domain itself by getting the EMG amplitude in rectified and enveloped form. Based on the amplitude of the interosseus muscle, the gesture of the wrist movement is detected and classified by threshold algorithm as: extensive, moderate and relaxed.

Based on the time domain feature extraction that is using rectified amplitude value of raw EMG signal and using threshold algorithm to detect the wrist movement i.e., extensive, moderate and relaxed, the threshold value is defined to switch on and off of two devices such as: a DC fan and DC led light of 12 volts respectively. The basic hardware schematics of the system is designed on proteus platform and shown in the Figure 6. Here the threshold value of the wrist movement has to be decided, once the user fed the threshold value in to the system then the algorithm works as follows:

```
If (threshold>defined threshold)
Then led ==On
Else
Led ==OFF
Else if (threshold<defined threshold)
Then Fan==On
Else Fan ==off;
Else
LED==off;
Fan==off;
```

## 3.3 Data Acquisition and Recording

The data has been recorded from the ten different subjects; four females and six male aged between 24 to 29 years. A paradigm was designed for the movement of the wrist. Based on the paradigm designed the maximum and minimum amplitude of the extension and relaxation was determined and through that the threshold value was determined.

**Table 1.** Experimental data recording of different subjects

| Sl. No. | Sex (age) | Maximum amplitude(V) | Minimum amplitude(V) |
|---|---|---|---|
| Subject1 | 24(female) | 4.8 | 0.9 |
| Subject2 | 23(female) | 4.9 | 1 |
| Subject3 | 25(female) | 4.8 | 1.5 |
| Subject4 | 24(female) | 4.75 | 1 |
| Subject5 | 28(male) | 5.0 | 1.0 |
| Subject6 | 26(male) | 4.7 | 1.5 |
| Subject7 | 24(male) | 4.8 | 1.0 |
| Subject8 | 25(male) | 4.9 | 1.4 |
| Subject9 | 29(male) | 5.0 | 1.4 |
| Subject10 | 23(male) | 4.75 | 1.45 |

## 3.4 Threshold Calculation

To set the average threshold for the device mean rectified EMG value was calculated for the recorded EMG

Mean value is calculated as $2.1896 \approx 2.2$ volt (experimental)

Maximum output strength of the signal = 5 volts (experimental)

$\therefore$ average threshold = 40% of max output = (5*40)/100 = 2 volts (theoretical) which is near to the experimental value. Using the equation for finding the mean value, it is found to be 2.18 volts. In paper[10] has shown the determination of threshold value of EMG at 25%, 35% and

45% respectively, based on this result the threshold value has been set at 40% which is approximately equals to the average value found by the analysis. Hence by deciding the threshold for maximum and minimum at 80% and 20% we get the 4 volts and 1volt respectively. The minimum threshold value is decided as 20% to remove the motion artifacts and white noise of the signal. From which it can be inferred that when the amplitude of the EMG crosses the maximum level it represents the excessive movement and when it is minimum or below it, represents relaxed condition and between the max and min i.e., between 80% and 20% there is moderate value of wrist movement.

**Table 2.** Device status on the basis of wrist movement

| Mode of wrist movement | EMG amplitude (voltage) | Device status |
|---|---|---|
| Extensive | Above 4 volts | LED bulb ON |
| Moderate | Between 4 to 2 volts | LED & Fan OFF |
| Relaxed | Below 2 volt | Fan ON |

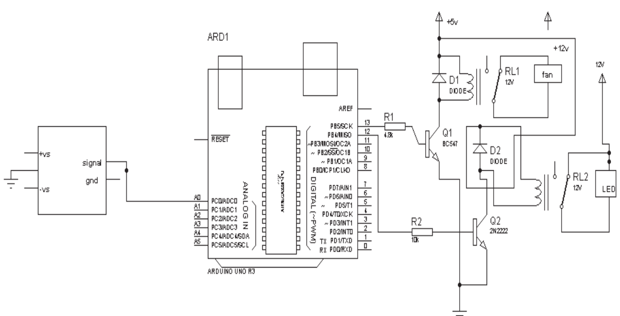


**Figure 6.** Hardware schematics.

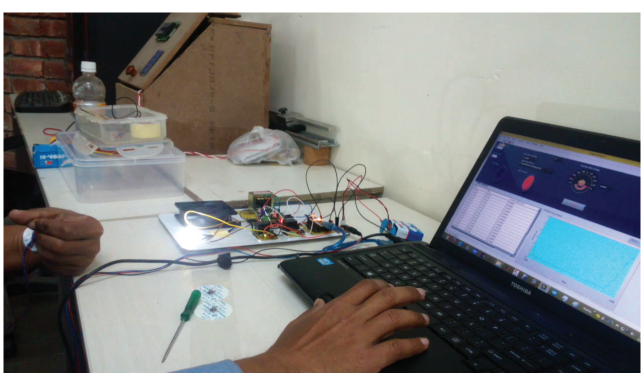

**Figure 7.** Hardware setup and showing led status on

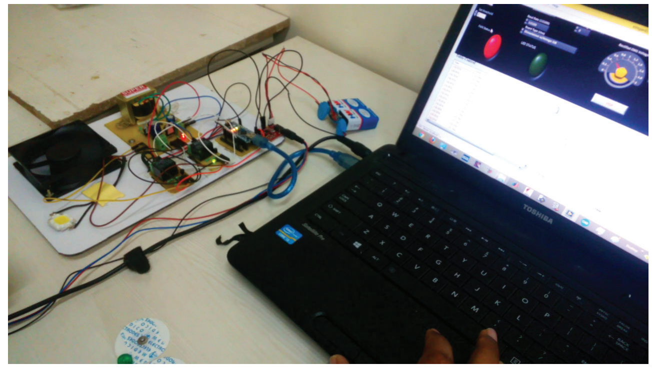

**Figure 8.** Fan status on at relaxed condition at extensive wrist movement.

## 4. Conclusion

In the present work, a wearable device controlled system using EMG signals has been designed and implemented for the controlling of two electrical devices based on the wrist movements. The proposed system provides the idea of controlling the generic electrical devices based on the desired hand or wrist movement gesture. A new algorithm was also developed to classify the control signal generated. The proposed system is not only user friendly but also cheap in cost and requires less training with respect to other classification techniques. The improvement of EMG based gadget control framework can be advantageous for the general population who are experiencing to a great degree limited fringe developments. From the application perspectives the produced control computerized yields from the gadget can likewise be utilized to control other rehabilitative gadgets like automated arm or electro-mechanical prosthetic arm. The present prototype system has some major issues like system warm up time and power consumption which can be improved by better algorithm design and miniaturization of the system in compact form in future.

### 4.1 Future Scope

The future parts of the current proposed framework are enormous. In future, it can be executed to control other restoration gadgets and other electronic gadgets in light of the signal acknowledgment. The scope of the framework can be expanded by making it remote utilizing RF, GSM or Wi-Fi module. The scope of control signs can likewise be expanded by change in the system and interfacing with more information channel. The comparable calculation can likewise be utilized to control distinctive gadgets by various electrophysiological signals furthermore for various applications like muscle weakness checking. With combination of other signals, a hybrid system can be made in near future for device control or for rehabilitation.

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