Gesture Recognition Using Real Time EMG

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***Abstract*—Electromyography shows the electrical activity of the muscles of the body. EMG signals can be recorded using surface electrodes. The SEMG signals thus obtained are used for varied applications most of which contribute towards prosthetic technology and rehabilitation engineering. SEMG signals are used as control signals for robotic arm functions as well. The aim of this study is to construct a prototype which uses these SEMG signals recorded form the brachioradialis muscle of the forearm to control the movement of powerpoint slides transmitted wirelessly in real time. The methodology involves using surface electrodes to acquire EMG signals which is sent to an ADC interfaced with a microcontroller. Using Zigbee protocol the signal is transmitted wirelessly to a PC where the powerpoint slides are contained. The powerpoint is displayed in visual basic window and embedded C language is used for microcontroller programming. The results showed 100mV voltage threshold for opening and closing of the fingers in the EMG signal. For the operation of the slides the fast upward action of the forearm caused a voltage higher than 90mV which leads to the backward movement of the slide and slow upward action of the forearm caused a voltage range between 85mV-89mV which leads to the forward movement of the slide. When this voltage is matched in the database the slides move. In conclusion a wireless control using EMG in real time application is achieved for operation.**

***Index Terms*—SEMG, EMG, powerpoint**

I. INTRODUCTION

Electromyography signals show the amount of electric potential generated by the cells of the muscle when any muscular activity involving motion is performed or when the muscles are at rest. The central nervous system (CNS) activates muscles which causes muscle fiber contraction, followed by the depolarization of the outer muscle fiber membrane. The depolarization regions will arise at the regions of innervations and will move towards the outer tendons. Each motor unit (MU) will have these depolarization regions and each of these will give rise to an electric field and generate voltage. These voltages are added up on the skin forming a voltage distribution. This sum depends on the distance of each source from the skin and hence the contribution to skin potential of superficial MUs is higher than the deep MUs.

A signal which appears like a properly acquired SEMG can be obtained by placing two electrodes on two different muscles. When one of these muscles get activated the signal displayed will increase because of the voltage difference arising between the two locations but it does not give information on which of the two muscles is active. To avoid misinterpretations several protocols for electrode placement have been developed to relate the presence of SEMG signals to the activity of a specific muscle [1]. To study the motions of human hand, EMG signals are important biological signals and therefore they can be used as input information to control robotic systems. The surface EMG signal xan be extracted easily without applying a non-invasive method [2].

Disposable electrodes used for SEMG detection during motion are typically made out of metallic part in Ag-AgCl (electrode part) covered by an adhesive conductive gel (electrolyte), surrounded by a plastic cap adhesive in the lower part. The pick-up area of the electrode is the whole gelled region which touches the skin. The objectives of this study is as follows: i) To design and construct a prototype for controlling powerpoint presentation in real time. ii) To obtain opening of the presentation by hand motion and forward and backward movement of slides by another hand motion.

II. MATERIALS AND METHODS

A. Design and Construction of Prototype

The block diagram of the proposed design of the prototype for powerpoint movement using SEMG is given in Figure 1 and Figure 2. The system can be divided into two sets consisting of the transmitting end as seen in Figure 1 and the receiving end seen in Figure 2. In the transmitting end: it consisted of two EMG sensors[3]; one sensor placed near the wrist and the other sensor placed at the forearm muscle.

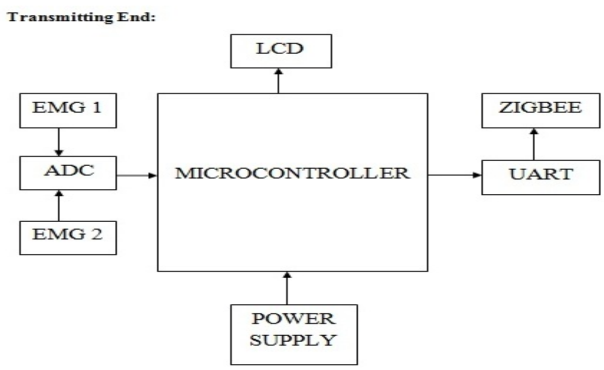

Fig.1 Block diagram of transmitting end of prototype

Receiving End:

Fig 2. Block diagram of receiving end of prototype

The two sensors were connected to an Analog to Digital converter (ADC) to convert the biosignal into digital form for the microcontroller. An LCD screen displays the values of the voltages detected from the sensors. From the microcontroller the output is sent to an universal asynchronous receiver transmitter (UART) where the signal was received wirelessly through ZIGBEE protocol and sent to a PC.

B. EMG Signal Recording

The EMG signals used for this study were recorded using disposable surface electrodes containing the electrolyte gel and the metallic part made of Ag-AgCl. The placement of the electrodes is vital for the accurate working of the device and the surface of the skin should be free from an foreign particles which may reduce the adhesive properties of the electrodes.

The EMG sensors used in this study is the 'Grove EMG detector' from seedstudio and can be easily interfaced with microcontrollers.

C. Movement

The movement of the hand used in this study for the SEMG signals are ideally three. One movement included the opening and closing of fingers which was used for starting the powerpoint and the other movements consisted of fast and slow upward action of the entire forearm which caused the backward and forward movements of the slides respectively.

III. RESULTS

Figure 2 shows the photograph of the transmitting section of the designed and constructed prototype and Figure 3 shows the receiving section of the prototype connected to a PC.

The values obtained from the sensors for the various movements: For the opening and closing of fingers the threshold achieved was set at 100mV. For the operation of the slides, the fast upward action of the forearm caused a voltage higher than 90mV which leads to the backward movement of the slide and slow upward action of the forearm caused a voltage range between 85mV-89mV which leads to the forward movement of the slide. The powerpoint was programmed to run in visual basic and was displayed in visual basic window. The microcontroller was programmed with Embedded C.

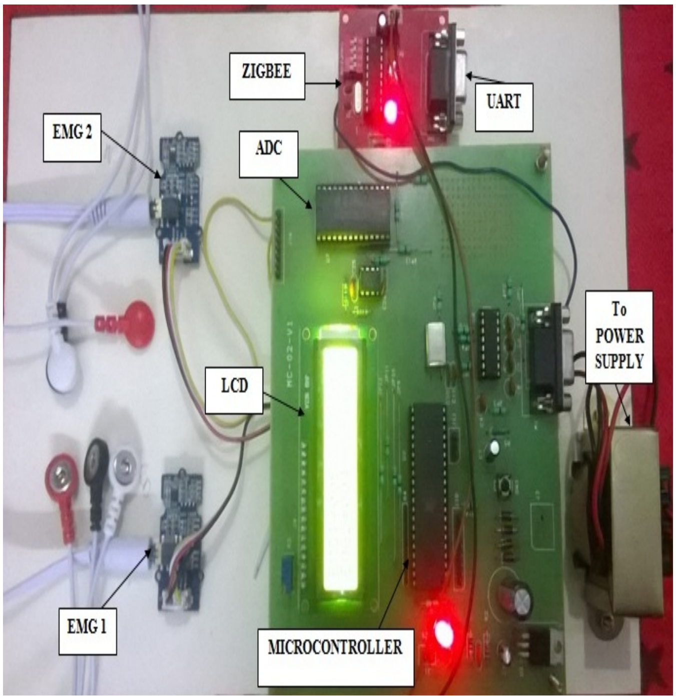

Fig.2 Transmitting section of prototype

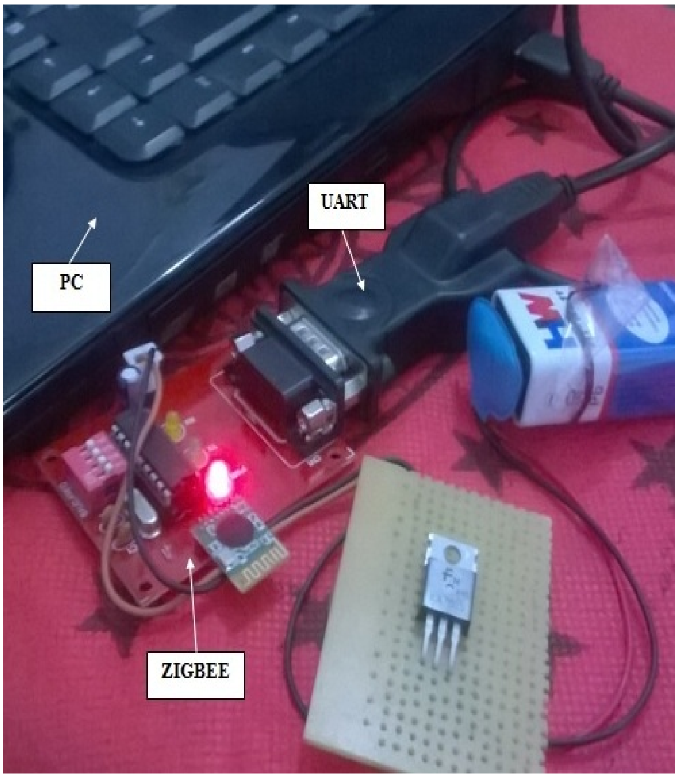

Fig.3 Receiving section of prototype connected to PC

IV. DISCUSSION

Rajesh et al (2009), proposed method for distinguishing finger gestures using SEMG signals that could be applied to control advanced multi-fingered myoelectric prosthesis for hand amputees. In this study finger motion discrimination was the key focus. Based on SEMG obtained from the subject's forearm the EMG classification was established. Six types of finger gestures were performed and the signals were recorded using four pairs of surface electrodes. The feature extraction technique that they have used is the minimum distance classifier which provided satisfied results with 88% accuracy[4].

Angkoon et al ,2009 ,came up with a method to select a feature which can tolerate White Gaussian Noise(WGN).Using algorithms to remove WGN in the preprocessing step of SEMG causes the useful data of the signal to also be partly removed. Strong SEMG signals and weak SEMG signals were collected from the forearm and the feature extraction was done on these signals. Modified Mean Frequency(MMNF) is the best feature when compared with others in quality of robustness keeping WGN in the signal. Multi feature sets along with MMNF are recommended to be combined in the future work.[5].

In an experimental study conducted by Gopura et al (2012),for upper limb SEMG signals and applying these for controlling upper limb exoskeleton. An Exoskeleton robot is one which can be worn and used as an orthotic device and operated on different modes can be used for different applications like power assist, human amplifier, rehabilitation device and haptic interface[6]. The input signal to control this is given by SEMG. The electrodes are placed along the entire shoulder and arm length. The studies were performed on an exoskeleton with 3DOF (degree of freedom) and 6DOF. The results concluded that EMG signals acquired from the surface can be effectively used to assist human upper-limb motions[7].

Tacar et al,2014, discuss a method to provide real time tracking algorithm for human hand motion. Powered hand prosthetics is a field which uses EMG signals for design and a lot of research is currently involved in the use of SEMG for this control and to get the neuromuscular activity of the muscle it is important to obtain valuable information from the EMG signals. The EMG signals are obtained by using surface sensors attached to the brachioradialis muscle and these signals are preprocessed followed by noise removal using bandwidth filters. For the motion generation of hand in real time simulator these SEMG signals are used. Using MATLAB GUI, this simulator was designed and contains upto 14 degrees of freedom[7]. There is hence a wide application of these Surface EMG signals to control robotic hand movements which is also useful in the rehabilitation field. The data collected in our study using 2 EMG sensors enabled a real time use of the signals to operate a powerpoint.

In conclusion this study has demonstrated the application of Surface EMG signals in operating a powerpoint.

ACKNOWLEDGMENT

We extend our sincere gratitude to the engineers of ACME AUTOMATION (Dubai) for their timely help and support towards this study.

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