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Wireless Health Monitoring System for Detection of ECG, EMG and EEG

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Abstract: In the field of human health care, health monitoring system has a great significant role. The health monitoring contributes a wide variety of applications such as hospital, home care unit, sports training and emergency monitoring system. In this work, a wireless biosignal system is designed for health monitoring which integrates both the extracting and monitoring of the biosignal such as ECG, EEG and EMG. The developed integrating system is used for wireless monitoring of patient's biopotential changes of the heart, neuronal activity of the brain and muscles of the body. Dry electrodes, biosignal amplifier and filters are used for the development of this wireless system. The system also allows the continuous monitoring and graphical representation of the health condition of patient on a computer screen, even if the physician is away from the patient. The successful implementation of this wireless system is help to overcome the limitations of wired health monitoring system. Obviously it is a solution to bridging the gap between the doctor and the patients and best to be used on rural areas. Ultimate goal of this paper is to implement a low cost, high efficient wireless system for health monitoring.

Keywords: ECG, EEG, EMG, biosignal, biopotential.

I. INTRODUCTION

Different signals are generated by human body. Such signals are called biosignals. Biosignals can be defined as any signal in living being that can be continually measured and monitored. It may be electric and non electric signal. This bioelectric signal can be formed in certain cells of the body due to differences in concentration of certain chemical ions such as sodium, chloride and potassium ions. Biosignals can be measured using sensors such as electrodes that are skin surface transducers. The transducers are a device which converts the one form of physical signal into electric signal. The signal can be processed in electric circuits, that are bio electrodes, which are commonly used for measuring biosignals. In this proposed method, electrodes made up of silver-silver chloride metal is used.

Among the biosignal measuring devices well known devices are electrctrocardiogram (ECG), electroencephalogram (EEG) and electromyogram (EMG). These signals are mainly used for application like disease diagnosis. ECG signals are bipolar low frequency signal. The normal range of ECG signal is 0.05-100Hz having its amplitude range from 10 microvolt to 5 millivolt. 1mv is typical value for ECG amplitude. For EEG signal at low frequency 0.5-100Hz, 1-100 microvolt peak to peak is voltage range at cranical surface. ECG signal voltage is 100 times greater than EEG signal. So EEG signal requires input preamplifier with high gain.The information about frequency and voltage of signals from different measuring devices helps in diagnosis of the disease corresponding to the body part. Among them ECG is for diagnosing heart related diseases and disorders such as sudden cardiac arrest, cardiovascular diseases and so on. EEG measures biopotential generated by neuronal activity of brain. It is very complex than ECG.

In the medical field, evolution of technology is extremely fast passed. Separate devices are present for measuring ECG, EEG and EMG. In this proposed methodology aim is to develop a low cost biosignal acquisition system which is affordable for the people of developing and under developed country. In previous papers, separate devices were used for ECG, EEG, and EMG. This paper presents a biosignal acquisition system, which is portable, battery powered and also includes wireless facility. Biosignal is transferred by Bluetooth serial communication and it gives wireless connectivity up to 9 meter, which consumes low power.

II. LITERATURE SURVEY

Several studies are focusing on the patient health monitoring to improve the health care system in the medical field. Many inspiring designs can be found in the health monitoring system literature.

Koji Morikawa et al, have reported a compact health monitoring EEG system with active electrodes for daily health monitoring [10]. In this paper, to reduce noise from impedance changes caused due to body motion and to prevent noise from power line interference, real-time impedance monitoring and active electrodes are used. The authors have developed the EEG ASICs for the system. So the complete system has a low noise and is packaged in a compact enclosure (38mm x 38mm x 16mm). This

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system is evaluated for key performance parameters in order to verify the susceptibility against specific types of artefact. In result the readout ASIC in the system enables simultaneous recording of EEG and electrode tissue impedance (ETI). The use of system with dry electrodes improves the signal quality and avoiding the use of gel electrodes. Le Tai et al, designed a low cost mobile ECG monitoring device using two active dry electrodes [9]. A buffer circuit is applied to remove the oversensitivity effect of the electrodes. They also have made a comprehensive comparison of wet and dry electrodes in terms of SNR, Correlation, amplitude of Q, R, S waves. The validity of the signal reading is also confirmed by many field tests. In this design, a simple active dry electrode circuit is used. To reduce the high output impedance of the dry electrode and the interference from the environment, the unity gain buffer is used. Ching-Sung Wang et al, introduced a system for ECG monitoring in Vehicles [13]. In day care for a driver, continuous ECG monitoring is required because symptoms of hypoxia and cardiac arrhythmia can occur unexpectedly. To enhance quality and care service for the driver, this study has implemented a real-time system for ECG monitoring and transmitting ECG signals to tablets or android mobile phones through Bluetooth transmission in vehicles. These signals are then uploaded to a cloud database for enabling healthcare physicians and nurses to instantly monitor and access ECG data.

III. SYSTEM ARCHITECHURE

The system architechure of this system is shown in Fig. 1. In this system, signal transmission and analog to digital conversion is done by arduino uno.

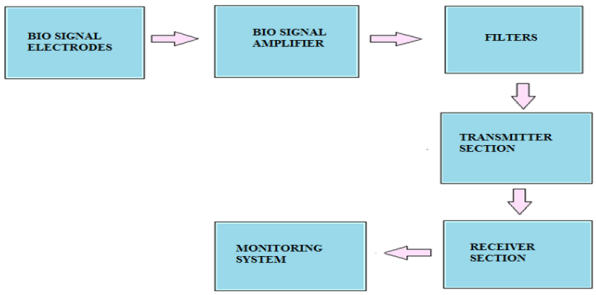
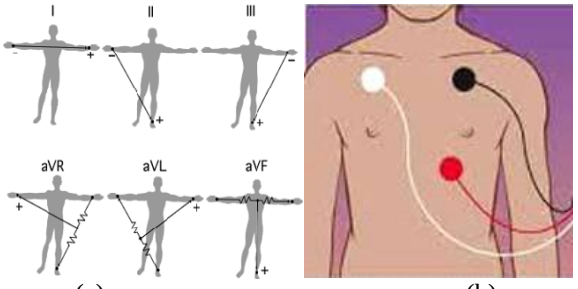


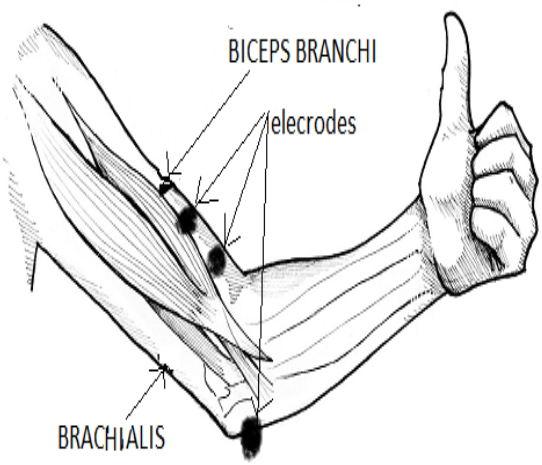
Fig. 1. Block Diagram



(a)

(b)

(c)



(d)

Fig. 2. (a) Limb leads and augmented limb leads for ECG (b) Electrodes positions of ECG (c) Electrodes positions of EEG (c) Electrodes positions for biceps EMG

Fig. 2 shows the electrodes positions of the ECG, EMG and EEG.
This system consist of three dry electrodes. By this system, ECG can taken from the electrode positioning on the chest, EMG from the musle biceps and EEG from the scalp and forehead.

IV. PROPOSED METHODOLOGY

The proposed system mainly consist biosignal electrodes, bioamplifier, filters, wireless transmission, reception and monitoring section.

A. Biosignal electrodes
A biosignal electrode is a transducer that senses ion distribution on the surface of tissue, and converts the ion current to electron current. An electrolyte solution/jelly is placed on the side of the electrode that comes into contact with tissue; the other side of the electrode consists of conductive metal attached to a lead wire connected to the instrument. At the interface between the electrolyte and the electrode a chemical reaction occurs. In this system very popular electrode silver/silver choloride (Ag/AgCl) is used to sensing ECG, EEG and EMG signals. Ag/AgCl electrodes allows current to pass across the interface between the electrolyte and the electrode which are nonpolarized electrodes.
B. Bioamplifier
A bioamplifier is an electrophysiological device. In this system, a commercially available low cost instrumentation

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amplifier is used. It is used to increase the signal integrity of physiologic electrical activity for output to various sources. A medical grade DC-DC converter and high voltage optical isolation components are used to isolate the entire amplifier. In this system, a commercially available low cost instrumentation amplifier is used. An instrumentation (or instrumentational) amplifier is a type of differential amplifier that has been outfitted with input buffer amplifier, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment.

C. Filters

Filtering is an important issue for design consideration of real time health monitoring systems. The Output corrupted with noise must be either filtered or discarded using suitable filters for better signal extraction. The filtering of the biosignals are contextual and should be performed only when the desired information remains ambiguous. Many studies have worked towards reduction of noise in biosignals. Most types of interference that affect biosignals may be removed by band pass filters. At the same time, the filtering method depends on the type of noises in ECG, EMG and EEG signal. In some signals the noise level is very high and it is not possible to recognize it by single recording, it is filter or preprocess a signal. The ECG, EMG and EEG signals are very sensitive in nature, and even if small noise mixed with original signal the characteristics of the signal changes. Three switches are used to select filtering path of the ECG, EMG and EEG signals as per the requirement.

D. Transmitter section

This section consist of Arduino Uno board and Bluetooth module. Arduino UNO board has 6 channel 10-bit analog to digital converter (ADC) and it returns a linear value from 0 to 1023 corresponding to 0V and +5V respectively. As the ADC works between 0 to 5V, a 3.3V virtual ground is used for making the bipolar signal to unipolar. For serial transmission baud rate is taken as 38400 bps and sampling rate of 1270 samples per second is obtained. Bluetooth module does signal transmission between Arduino UNO and laptop.

E. Receiver section

HC-06 module is a an bluetooth SPP (Serial Port Protocol) module. It is easy to use and designed for transparent wireless serial connection setup. This unit consists of receiver bluetooth module. Typically modules are small PCB's. The PCB's includes a blutooth processor and other hardware equipment to run the device properly. Blutooth will help for exchanging data between device without using wires over a short distances normally up to 30 feet (10 meters). A high speed low powered wireless technology is used in blutooth. This feature will help to link phones, computers and other network devices. This transmits signal between Arduino UNO and laptop.

F. Monitoring section

In this section, lab view is used for monitoring the signals. It helps to analyse the bio signals and record the data for further uses.

V.EXPERIMENTAL MEASUREMENTS AND RESULTS

For visualizing and storing signals, a laptop running on windows 7 operating system having 4 GB ram was used. ECG, EMG and EEG signals were taken from a boy of 21 years old. Labview is used for the graphical pepresentation of the biosignals.

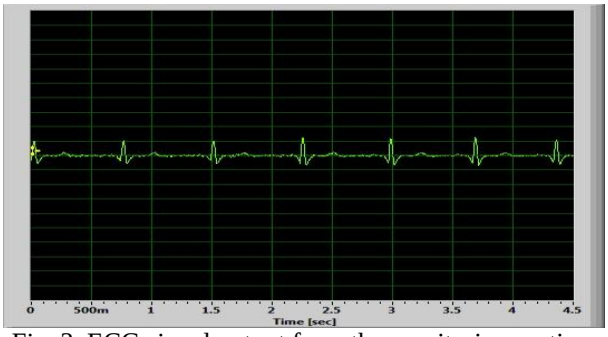

Fig. 3. ECG signal output from the monitoring section

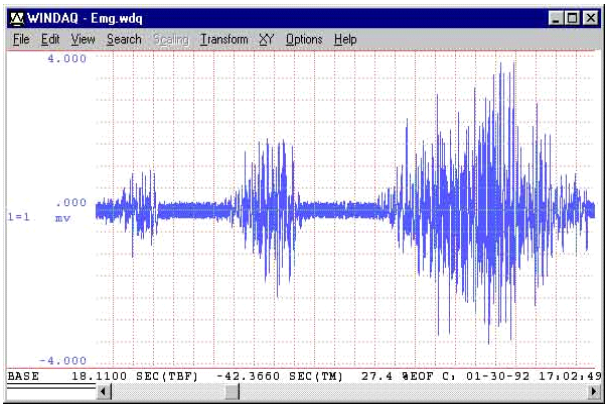

Fig. 4. EMG waveform from the muscle biceps

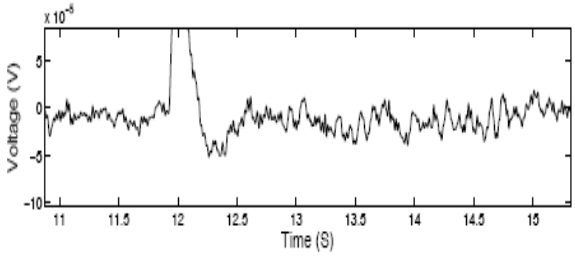

Fig. 5. EEG waveform obtained from the scalp

VI. CONCLUSION

In this paper, a simple wireless health monitoring system is introduced which integrates the extracting and monitoring of three biosignals such as EEG, ECG and EMG. This system enables the continuous monitoring of patient, immediate graphical representation of signals and synchronously store data to a database. This paper

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describes a new device which can be used to obtain the EEG, EMG and ECG signals. The extracting signals will be amplified and filtered to obtain good output. Also it can be monitored and analyze easily. The Health Monitoring system can wirelessly monitor the patient, notify the medical department and family members immediately in case of emergencies. The successful implementation of this wireless system is help to overcome the limitations of wired health monitoring system. Obviously it is a key solution to bridging the gap between the doctor and the patients. In result, this paper develops a simple and faster medical diagnosis wireless system with low cost and high efficient settings.

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