DESIGN AND IMPLEMENTATION OF ECG MONITORING SYSTEM

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ABSTRACT

The goal of electrocardiographic (ECG) monitoring in hospital settings have expanded from simple heart rate and basic rhythm determination to the diagnosis of complex arrhythmias, myocardial ischemia, and prolonged QT interval. In this paper a simple 3-lead Electrocardiogram (ECG) monitoring and heart rate measurement system are designed.

The proposed system takes the physical pulse input using Bio potential electrodes disposable electrodes of type Ag/AgC1 (silver to silver chloride) because easiness of usage and to eliminate poor connection noise. In the second stage a patient's cable is used to carry the ECG signal from human body to instrumentation amplifier (IA) to reduce the interference. The amplification stage is followed by an analog active filtering stage. Finally, for more simplicity use microphone input of PC sound card has been successfully used as an interfacing card rather than conventional obsolete parallel or serial ports.

Keywords: ***ECG, Monitoring System, Heart.***

I. INTRODUCTION

Nowadays, the measurement of Electrocardiogram (ECG) recorded in hospitals isgrowing as the people suffering from heart illnesses are increasing at worrying rate. The ECG is one of the medical apparatus that can measure the heart rate, transform it into a signal and current the data on a piece of broadsheet or on a monitor[1]. Today, researchers and engineers employ advanced concepts and techniques from the field of electrical engineering, computer science, biomedical engineering and medicine to collect ECG signal via smart and advanced monitoring system using wearable technology. Electrocardiogram (ECG) is a diagnostic tool that measures and records the electrical activity of the heart in detail. Explanations of these details enablethe diagnosis of a wide range of heart conditions from minor to life threatening. Wearable monitoring systems involve the use of emerging and advanced communication techniques to collect and deliver biomedical signals over long distance [2].

Different monitoring systems are commercially available and some of the research proposals about monitoring systems are classified in respect of the following features [3].

1. Systems that record signals and perform analysis off-line. These systems only record the vital signals and no real time classification is done.

2. Systems that perform remote real time monitoring. Here the ECG signals are captured and sent to a monitoring center through some communication media. The limitation here is that the analysis is not performed in the place where the signal is acquired.

3. Systems that provide local real-time classification.

II. SYSTEM DESCRIPTION

Figure 1 shows the block diagram of the proposed system. Basically, the system consists of Bio potential electrodes, transmission media, instrumentation amplifier,filters, amplifier and ADC (PC sound).

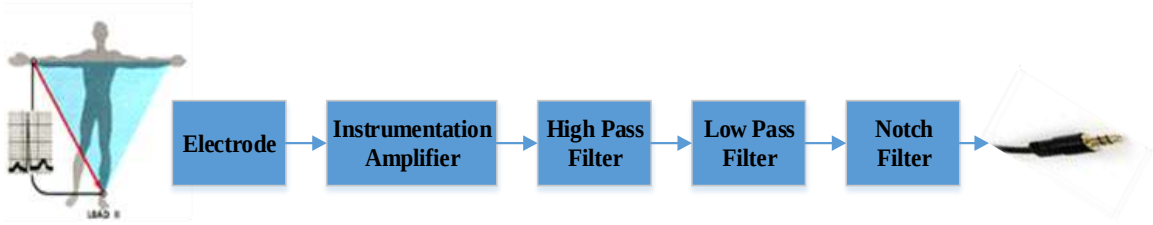

Fig. (1): Block diagram of the proposed ECG monitoring system

The description of each block will be discussed as below:-

A. **Electrode**: Bio potential electrodes disposable electrodes of type Ag/AgC1 (silver to silver chloride) are used because ease of use and to remove poor connection noise. A patient cable is used to carry the ECG signal from human body to instrumentation amplifier to reduce the interference noise[6,7].

B. **InstrumentationAmplifier**: In the proposed work use three operation amplifiers(LM324N) to find the voltage difference between two electrodes and then amplify the difference to 51 times as shown in figure (2). In this circuit the three operation amplifier U1C,U1E and U4A;(U1C and U1E) are connected in the non-inverting follower configurations, while the third amplifier (U4A)is connected as a D.C differential amplifier to produce an output voltage that is proportional to the difference between the voltages applied to the two input terminals [4].

$$A_{V1} = 1 + \frac{R7}{R1} \dots (1)$$

C. **Filtering**: In this work we use three type of filters, first one high pass active filter with cutoff frequency 0.5 Hz to remove base line drift, evaluate the cut off frequency depending on equation below [5]

$$Fc_{HPF} = \frac{\sqrt{2}}{2\times 3.14\times R15\times C} \dots (2)$$

Second filter is low pass filter with cut off frequency 100Hz to remove muscle contraction noise, evaluate the cut off frequency depending on equation below [5]

$$FC_{LPF} = \frac{\sqrt{2}}{4 \times R \times C10} \ldots (3)$$

Third filter is band stop (band reject) filter with cut off frequency 50Hz to block interference power supply depending on equation below:-

$$FC_{BRF} = \frac{1}{2\pi \times R4 \times C2} \ldots (4)$$

D. **Amplifier**: non inverting amplifier with high gain to amplify ECG signal from fractions of mille volts to few mille volt, depending on equation below [3]:-

$$A_{V1} = 1 + \frac{R16}{R17} \ldots (5)$$

E. Finally, for more simplicity use microphone input of PC sound card has been successfully used as an interfacing card rather than conventional obsolete parallel or serial ports. Microphone input in fact an ADC that converts the analog signals coming from the external microphone to discrete signals with certain sampling frequency.

F. The analog (audio) signal out from ECG card has the applied to the PC sound card. A visual basic program has be written to examine and plot the ECG signal in order to extract the number of heart beats .the results have been decided upon; wither they are normal or abnormal.

The following represents the designed Circuit diagram of the monitoring system

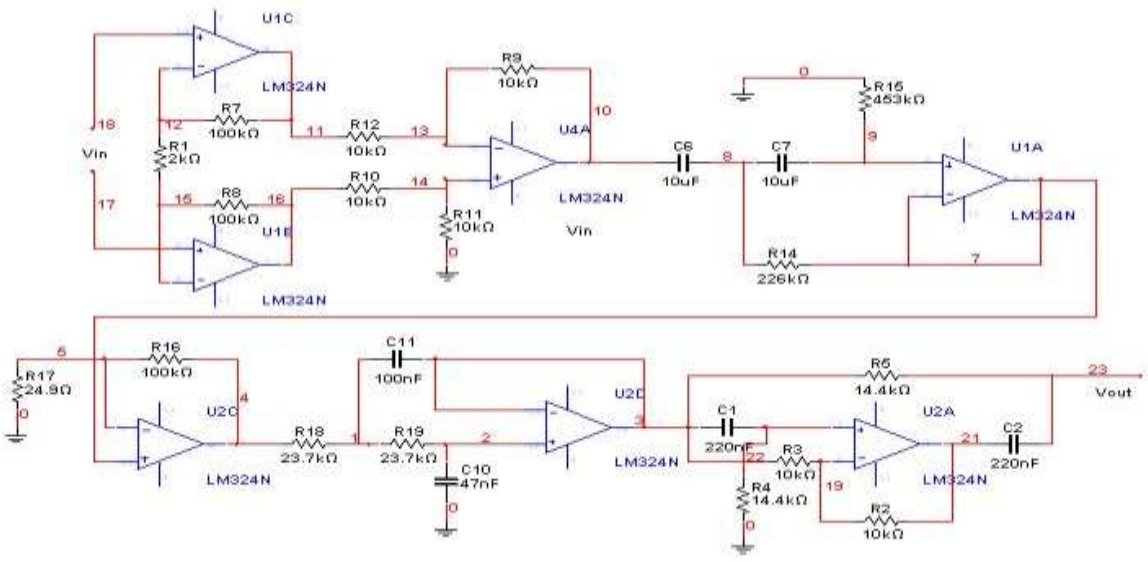

Fig. (2): Designed Circuit diagram of the monitoring system

III. RESULT OF THE PROPOSED SYSTEM

The initial circuit of hardware of our system is the instrumentation amplifier. The complete hardware setup is as shown in figure 3.

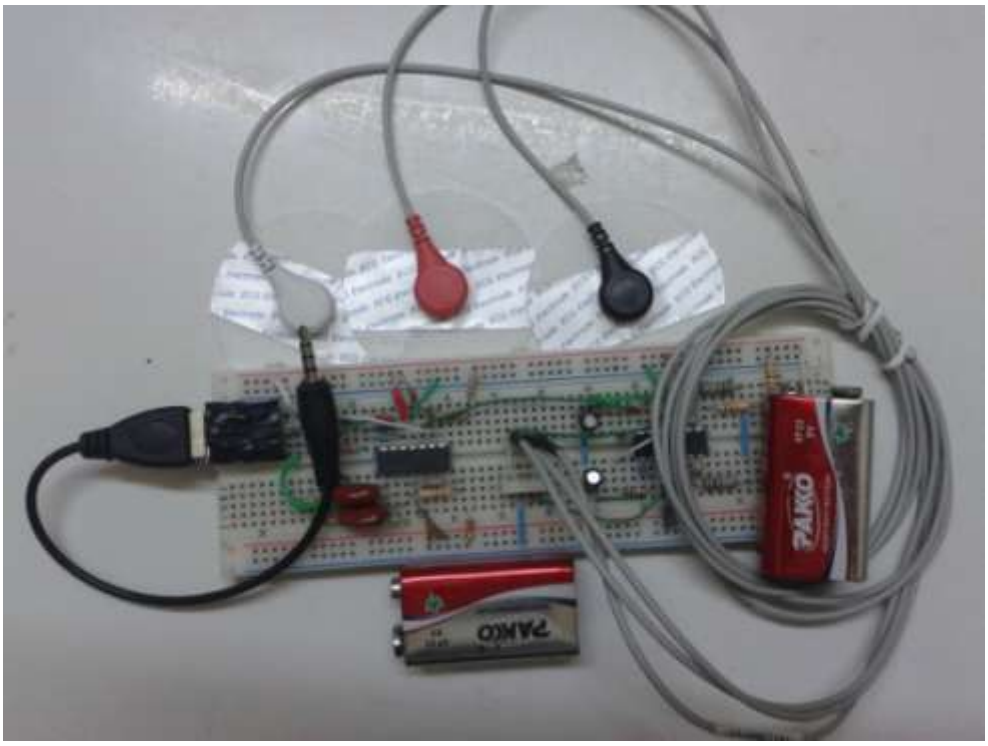

Fig 3: ECG experimental set up on bread board

We could get the display of ECG waveform on the PC monitor through electronic hardware implementation of our work successfully. This can be seen by Figure 4 and Figure 5, which shows the plotted ECG signal as produced in the PC monitor.

The analog (audio) signal out from ECG card then applied to the PC sound card. A visual basic program has been written to examine and plot the ECG signal in order to extract the number of heart beats. The results have been decided upon; weather they are normal or abnormal. Figure 6 demonstrates the proposed testing system .the plotted ECG signal as produced in the PC monitor, has been shown in fig. 7

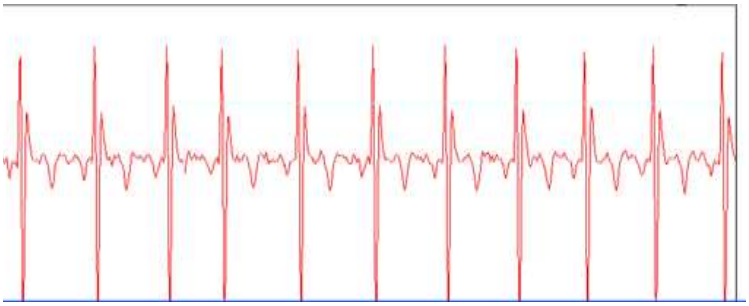

Fig 4: ECG waveform on PC monitor

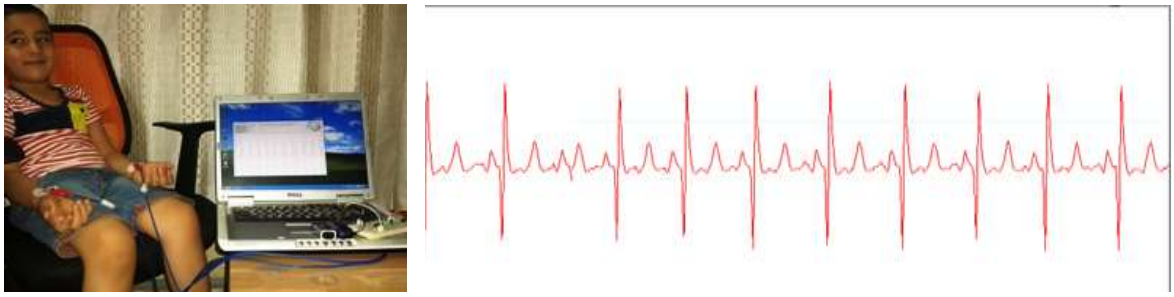

Fig 5: ECG waveform on PC monitor

Fig 6: a) Output at abnormal heart rate b) Output at normal heart rate

IV. CONCLUSION

This paper presents the implementation of an ECG Monitoring and Heart Rate Measurement System involving low cost amplifier, filter components coupled. The design of this system is simple and low cost implementation as it requires very less hardware for implementation.

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