International Association of Scientific Innovation and Research (IASIR)
(An Association Unifying the Sciences, Engineering, and Applied Research)

ISSN (Print): 2279-0047
ISSN (Online): 2279-0055

International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

www.iasir.net

REAL TIME PATIENT MONITORING SYSTEM BASED ON ECG SIGNALS

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Abstract*: At Present, cardiovascular disease (CVD) is the leading cause of global death. The Electrocardiogram (ECG) is the most widely adopted clinical tool that measures the electrical activities of the heart from the body surface. In this research, it is seeked to establish a cell phone-based real-time monitoring technology for CVD, capable of performing continuous on-line ECG processing, generating a personalized cardiac health summary report automatically detecting and classifying abnormal CVD conditions, all in real time. Specifically, we developed a MATLAB programming a -based machine learning technique is developed combining both an individual's cardiac characteristics and information from clinical ECG databases. The real time cardiac signal is being analysed by means of MATLAB to classify the respective cardio vascular diseases of a particular subject. If a critical waveform is being obtained then by means of GSM module message will be sent to the doctor indicating the respective identification of the subject.*

Keywords*: Cardio vascular diseases, Heart rate sensor, ECG Electrodes, MATLAB programming.*

I. Introduction

Embedded technology can be found inside everything from computerized fitness equipment to lifesaving medical monitoring devices. These systems used in medical care increasingly help to improve the quality of diagnostic tools available to the physicians and treatment available to patients. In our projects here we are using different parameter to be monitored via PC. Cardio vascular diseases (CVD), are group of disorders of heart and blood vessels and the number one cause of death globally. More people die annually from CVDs than from any other cause .An estimated 17.3 million people died from CVDs in 2012[1], representing 30% of all global deaths, of these deaths, an estimated 7.3 million were due to coronary heart disease and 6.2 million were due to stroke .CVDs are projected to remain the single leading cause of death. Electrocardiography has a basic role in cardiology since it consists of effective, simple, non-invasive, low-cost procedures for the diagnosis of cardiovascular disorders [2]. ECG is defined as trans thoracic (across the thorax or chest) interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the surface of the skin and recorded by a device external to the body. It picks up electrical impulses generated by the polarization and depolarization of cardiac tissue and translates into a waveform. The waveform is then used to measure the rate and regularity of heartbeats, as well as the size and position of the chambers [2], the presence of any damage to the heart as shown in table 1, and the effects of drugs or devices used to regulate the heart, such as a pacemaker. Usually, more than two electrodes are used[4], and they can be combined into a number of pairs (For example: left arm (LA), right arm (RA), and left leg (LL) electrodes form the three pairs LA+RA, LA+LL, and RA+LL).

Figure 1 Placement of electrodes

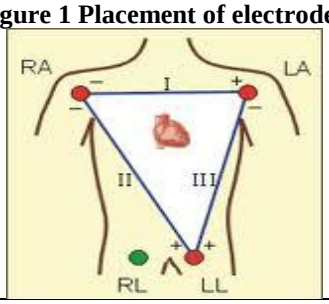


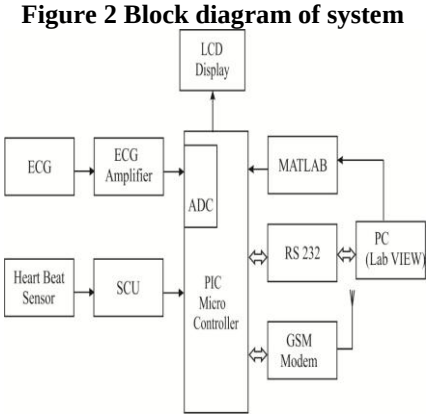
Table I: Showing the Pathological conditions due to ECG Intervals

ECG intervals	Pathological conditions
Shortend QT interval	Hypercalcemia, certain genetic abnormalities,hyperkalemia
Prolonged QT interval	Hypocalcemia, certain genetic abnormalities
Flattened or inverted T waves	Coronaryischemia, hypokalemia, leftventricularhypertrophy, digoxineffect.

Hyperacute T waves	Possibly the first manifestation of acute myocardial infarction, where T waves become more prominent, symmetrical, and pointed
Peaked T wave, QRS wide, prolonged PR, QT short	Hyperkalemia
Prominent U waves	Hypokalemia

Heart rate refers to the speed of the heartbeat, specifically the number of heartbeats per unit of time. The heart rate is typically expressed as beats per minute (bpm) [1]. The heart rate can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide. Activities that can provoke change include physical exercise, sleep, anxiety, stress, illness, ingesting, and drugs. The normal human heart rate ranges from 60–100 bpm. Bradycardia refers to a slow heart rate [1], defined as below 60 bpm. Tachycardia refers to a fast heart rate [1], defined as above 100 bpm at rest. When the heart is not beating in a regular pattern, this is referred to as an arrhythmia [1]. These abnormalities of heart rate sometimes, but not always, indicate disease.

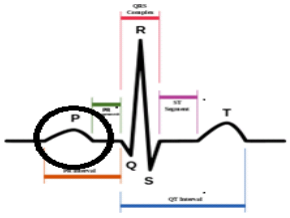
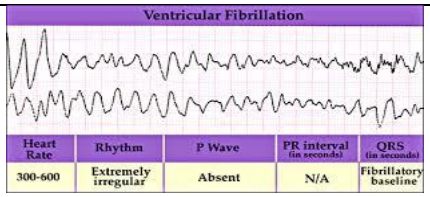
Figure 2 Block diagram of system



II. Cardiovascular Diseases

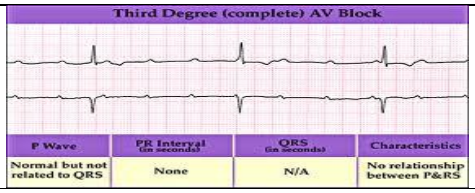
The various cardiovascular diseases that are used to train our MATLAB programming are shown in table 2:

Table II Showing different kinds of cardio vascular diseases and their corresponding ECG interpretation

DISEASES	ECG INTERPRETATION
ATRIAL FRIBRILATION: Atrial fibrillation (AF or A-fib) is the most common cardiac arrhythmia (heart rhythm disorder). Its presence can be confirmed with an Electrocardiogram (ECG or EKG) that demonstrates the absence of P waves and an irregular ventricular rate.	 Absent of P-wave
VENTRICULAR FIBRILLATION Ventricular fibrillation (V-fib or VF) is a condition in which there is uncoordinated contraction of the cardiac muscle of the ventricles in the heart[3]	
ISCHEMIC DILATED CARDIO-MYOPATHY: **Cardiomyopathy** ("heart muscle disease") is the measurable deterioration of the function of the myocardium (the heart muscle).	

COMPLETE HEART BLOCK:

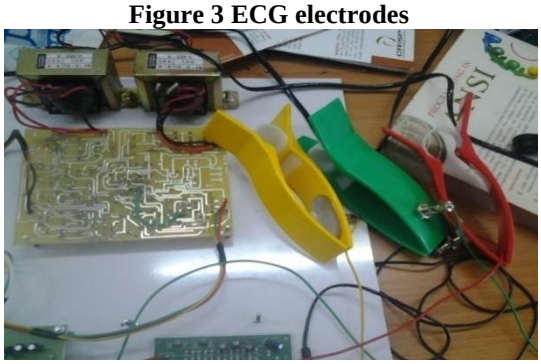
Third-degree AV block, also known as complete heart block, is a medical condition in which the impulse generated in the SA node in the atrium does not propagate to the ventricles[3].



III. Hardware Description

In this the instrumentation amplifier is constructed by the TL 072 operational amplifier. The TL072 are high speed J-FET input dual operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset current and low offset voltage temperature coefficient. The instrumentation amplifier amplifies the differential signal from the both electrode. This amplified ECG waves contains the line frequency, high frequency and low frequency noise signals. So the ECG wave is fed to filter section. The filter section consists of high pass filter and low pass filter which is used to remove the high frequency and low frequency noise signal. After the filtration the ECG wave is given to pulse width modulation unit. In this section the ECG wave converts to pulse format in order to perform the isolation. The isolation is constructing by the opto coupler. The isolation is necessary to isolate the human body and monitoring equipment such as CRO, PC etc. Then the ECG pulse format wave is given to PWM demodulation unit in which the pulse format is reconstruct to original wave. Then the wave is fet to notch filter section in order to remove the line frequency noise signal.

Figure 3 ECG electrodes



A notch filter is a band-stop filter with a narrow stopband (high Q factor). Notch filters are used in live sound reproduction (Public Address systems, also known as PA systems) and in instrument amplifier to reduce or prevent feedback, while having little noticable effect on the rest of the frequency spectrum. Other names include 'band limit filter', 'T-notch filter', 'band-elimination filter', and 'band-rejection filter'. Typically, the width of the stop band is less than 1 to 2 decades. In the audio band, a notch filter uses high and low frequencies that may be only semitones apart. Here the notch filter is constructed by the operational amplifier TL074. Finally noise free ECG wave is given to amplifier. Then the amplified signal is given to monitored device such as CRO, PC etc. In case of heart rate sensor, the signal condition circuit consists of two identical active low pass filter with a cut-off frequency of about 2,5Hz.This means the maximum measurable heart rate is about 150 bpm. The operational amplifier IC used in this circuit is MCP602, a dual OPAMP chip .It operates at a single power supply and provides rail-to-rail output swing. The signal conditioning circuit consists of two identical active low pass filters. The filtering is necessary to block any higher frequency noises present in the signal. A 1 µF capacitor at the input of each stage is required to block the dc component in the signal. The two stage amplifier/filter provides sufficient gain to boost the weak signal coming from the photo sensor unit and convert it into a pulse. An LED connected at the output blinks every time a heart beat is detected.

Figure 4 Interfacing PIC Microcontroller with LCD display

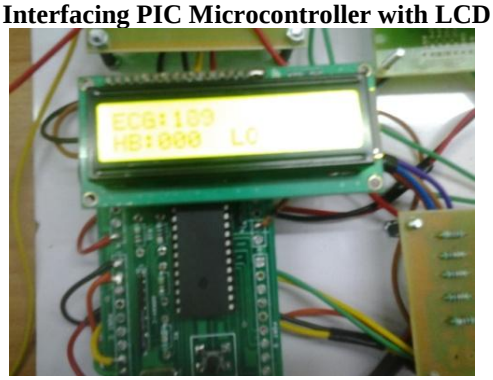


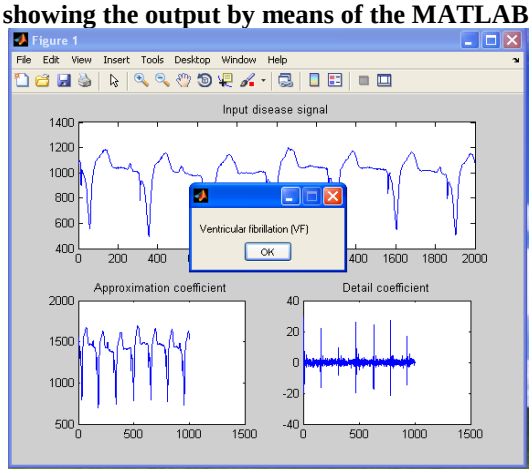
Figure 5 Hardware module

III. Conclusion

Thus the real time ECG signals are displayed in the LABVIEW software from the patients and the corresponding data are sending to the Doctor's phone by means of GSM module. If in case of any diseases is being detected the signal is displayed in LABVIEW and the signal displayed is analysed by means of MATLAB programming software and the corresponding data is sent to the Doctor's phone along with Heart rate Measurement.

Figure 6 Real time ECG wave measured from a normal healthy person and displayed in LABVIEW software.

Figure 7 showing the output by means of the MATLAB analysis.



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V. Acknowledgements

We take this opportunity to express our profound gratitude to our guide Ms.Swagata B.Sarkar, ASST. Professor, Department of Electronics and Instrumentation, for her exemplary guidance, monitoring and constant encouragement throughout the course and we also thank Chengalpattu medical college hospital for their constant support for our project.