Real Time ECG monitoring system based on Internet of Things (IoT)

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Abstract- Heart rate, body temperature and blood pressure are very critical parameters of human body. Doctors use various kinds of medical apparatus for measurement of these parameters like thermometer for checking body temperature, BP monitor for blood pressure measurement and heart rate monitor for heart rate measurement. In this paper, we have proposed ECG MONITORING SYSTEM based on IoT (Internet Of Things). This system calculates heart rate of patient and sends the value of heart rate in beats per minute (bpm) to a database on cloud. Using this system doctors at hospital can analyse the critical parameters sent by this system. Doctors can also analyse the real time health related parameters of a patients which are not admitted in hospital. This system can be integrated in ambulance wherein all the critical health related parameters of patients can be acquired and sent to the cloud. All these critical parameters can be analysed by a doctor in advance while the patient is still in ambulance. The main objective of this system is to acquire the physiological parameter using sensors and uploading these parameters to cloud. We have integrated ECG sensor in this system.

Index Terms- Wireless ECG, Ambulatory Data, AD8232

I. INTRODUCTION

As we are well aware that death and disability due to heart attacks is increasing day by day in India. The Registrar General of India reported that cardiovascular diseases led to 17% of total deaths and 26% of adult deaths in 2001-2003, which increased to 23% of total and 32% of adult deaths in 2010-2013 [1]. A government in each financial year allocates a huge amount of money for health budget which is utilized on performing various operations at subsidized rates. This system facilitates the process of performing diagnosis and treatment of patients suffering from heart diseases. Using this system the physician can use the cloud platform to diagnose patients at remote locations (like home). The patients can also access their medical records via this cloud service. Various kinds of ECG recorders are available in market manufactured by reputed organisations , but till date there are very less devices available which can record the ECG signals and transmit them to a remote database server on cloud .In this research paper we have proposed a system that will record ECG signals of patient using a sensor and also store the ECG signals to a database server .These signals can be analysed by a doctor at remote location or can be saved and retrieved later for analysis. The conventional ECG monitors are used to measure electrical activity of heart for short time, there is high possibility that Heart related issues are not occurring at that time. So a real time system is required that can measure heart rate at any time.

II. PROPOSED SYSTEM

Proposed system consists of two blocks as shown in figure 1
1 .Patient monitoring location
2 .Signal analysis location

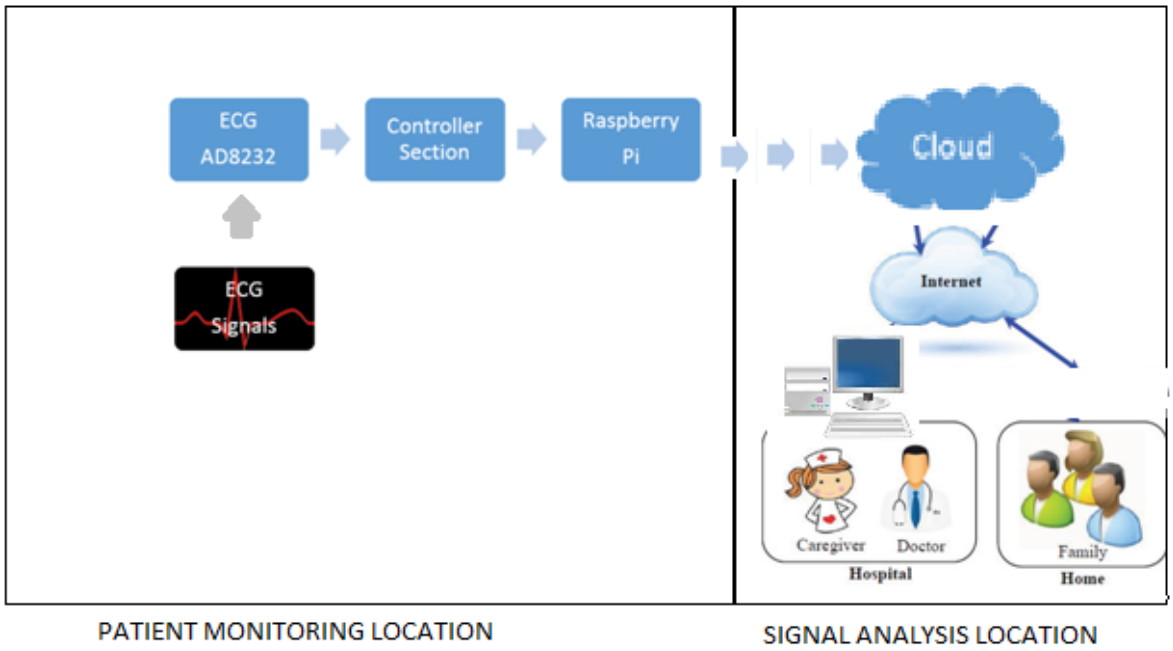

Figure 1 : Block diagram of proposed system

PATIENT MONITORING SYSTEM

It consists of ECG sensor AD8232 which acquire Electrocardiograph (ECG) signals. AD8232 is preferred over another chips, HM301D is three channel, while we only need single channel ECG and ADS1191 doesn't provide high enough gain to get good resolution. AD8232 has the best output impedance and gain [2]. ECG is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electrophysiologic pattern of depolarizing and repolarizing during each heartbeat. The AD8232 is a neat little chip used to measure the electrical activity of the heart. The AD8232 Single Lead Heart Rate Monitor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor has as an op amp to help obtain a clear signal from the PR and QT Intervals easily. The AD8232 has an integrated signal conditioning block for ECG and other bio potential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. The AD8232 Heart Rate Monitor consists of 9 pins- LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins through which ECG electrodes are connected to as shown in diagram below Figure 2.

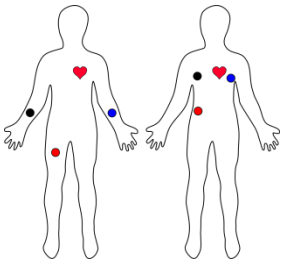

Figure 2:AD8232 electrodes placement

AD8232 works on 3.3 volts [3] . The ECG sensor AD8232 supplies the ECG signal to the controller section. The system is based on ARM 7 controller which is used to acquire the ECG signals. Microcontroller acquires the ECG signals data and processing can be done using embedded C programming. Microcontroller sends the data serially to a single board computer called Raspberry Pi. The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. Raspberry pi works on raspbian operating system which is linux based OS . A Raspberry Pi is a credit card-sized computer. The Raspberry Pi is slower than a modern laptop or desktop but is still a complete Linux computer and can provide all the expected abilities that implies, at a low-power consumption level. We have used this system because it is a portable computer which can be used in any moving vehicle like ambulance and requires dc voltage to operate which is also available in a vehicle .Through the use of AD8232 sensor and the logic used in the program we can see the ECG signals on serial plotter of controller as shown in Figure 3

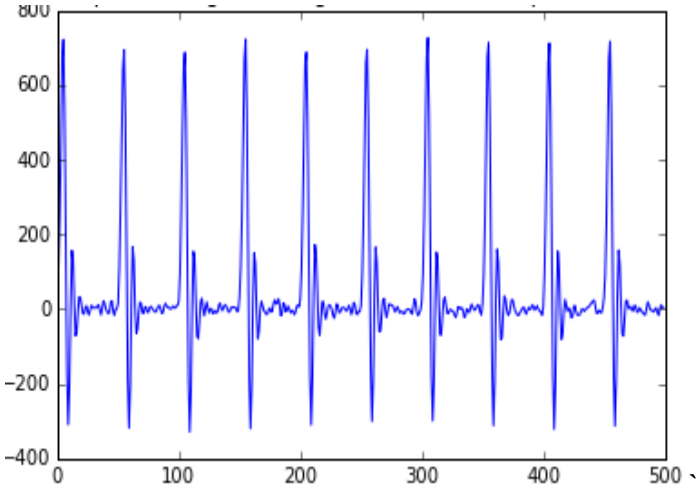

Figure 3:ECG signal plotted on serial plotter

The raspberry pi has also been used to send the data to the cloud through the use of APACHE –an open source web server. The heart rate of patient on being calculated in bpm and sent to database server on cloud .The Table 1 shows the value of bpm of patient with time stamp, this value is acquired by a python code through USB port and filled into a database.

Table 1:Heart beat values in bpm posted on database server with timestamp

id	Username	heart beat	creationtime
7207	Mehak	82	2017-07-25 12:36:51
7206	Mehak	82	2017-07-25 12:35:25
7205	Mehak	82	2017-07-25 12:34:18
7204	Mehak	88	2017-07-25 12:32:27

SIGNAL ANALYSIS LOCATION

The doctors analyses the heartbeat values and ECG signals recorded by this system. Through this the doctors can alert the patient if they found any deviation of heartbeat values or signals from normal heart beat value and ECG signal of a normal person.The doctors can also analyse the signals of the patient in ambulance before the patient reaches hospital.

III. TIME DOMAIN ANALYSIS

Time domain analysis uses temporal data of ECG signals to calculate various parameters like RR interval (RRI) variability, heart rate etc [4]. Before discussing these parameters some understanding of ECG signal is required

Our heart is divided into 4 chambers –left atrium, right atrium, left ventricle, right ventricle. The right atrium first experiences the electrical impulse. Now this impulse travels from right atrium to left atrium. This electrical impulse is referred to as P wave as it compresses the right atrium so in this way the deoxygenated blood flows from right atrium to right ventricle. This deoxygenated blood then flows to lungs through preliminary arteries. Now the electrical impulse that has travelled to left atrium compresses it. Here oxygenated blood flows into left atrium through veins from lungs. Now the heart beat is measured by noting how many QRS complex has passed in one minute. Heart rate is expressed in bpm(beats per minute).In ST segment the ventricles are waiting to get repolarised. When T wave comes the ventricles gets repolarised so that blood can be pumped into it by atrium. The full ECG cycle with P,Q,R,S and T is shown in figure 3.

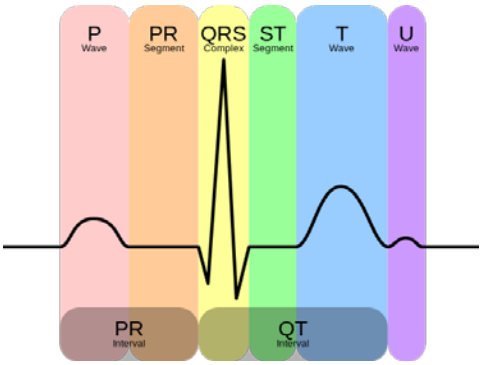

Figure 3: ECG signal showing P,Q,R,S and T waves

The system proposed acquire the ECG values from AD8232 in time domain.QPS complex detector has been applied on the ECG signal to calculate the heart rate in bpm. Raw ECG signal can also be acquired and transmitted to Raspberry Pi and analyse can be done at Raspberry Pi also.

IV. ADVANTAGES

- Portability is given to a great extent

As this system size is quite small so it can be carried at various locations with ease.

- Doctors can see data remotely and analyze the ECG signals of patients

This is the most important advantage of this system. The persons living in remote locations who have no access to a doctor can be helped through a greater extent through this system, as this system sends all the values and signals on the website and the doctors which are far away can get an accurate idea of heart condition of a person. Furthermore this system can be used in ambulance which saves a lot of time and can save a life of a person because every second counts.

- ECG signals are stored for further analysis

Here the ECG signals and heart beat values firstly gets stored in database in mysql and then this value is transferred on website through raspberry pi. The storage is required so that if doctor wants to check the previous condition they are able to do so.

- This device is quite useful for real time ECG monitoring. The emphasis must be laid on removing noise and it will then result in very efficient system.
- Very small electrodes can be built in future so there will be no need to carry extra electronics.
- Patient is not tethered to huge machines

One of the biggest advantage of this system includes that through the use of small circuitry the heartbeat and ECG signals of a patient can be viewed rather than using large machines for it.

V. LIMITATIONS

- The noise may disturb the readings. The noise may deviate the actual graph of ECG to an undesired level.
- The system requires good internet connectivity at all the times so that it can be accessed by doctors at any time.

VI. CONCLUSION

This research paper aims at initial prototype development for wireless transmission of ECG signals. It is evident that designing such a system will help in early detection of abnormal conditions of cardiovascular diseases and prevention of its serious consequences [5].

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