Low Cost Ecg Monitoring using Internet of Things

G.Chamundeeswari, S.Srinivasan, S. Prasanna Bharathi

Abstract*: Patient monitoring is the heart of the health care domain in day to day life either at home or at hospital. This paper focuses an Intelligent ECG Monitoring System to monitor the heart patients residing at distant places at low cost and complexity using Internet of Things. The proposed system automatically screens the health condition of the patient and records their Electrocardiogram through heart rate sensor and ATtiny Board. ATtiny is a low cost IoT device used along with heart rate sensor and ESP8266 to record the electrocardiogram of the patients. The ECG is sent to the doctors, nurses or the patient's relatives residing in the remote places through the internet to help them in remote monitoring of the patients with ease.

***Keywords* : Patient monitoring, ATTiny 85, Pulse Sensor, ESP8266, IoT.**

I. INTRODUCTION

Heart patients need to be continuously monitored throughout the day, which is a very challenging task either at hospitals or also at homes situated at remote places. The proposed intelligent ECG monitoring system eases this problem through automatic monitoring of the elderly heart patients continuously and helps in alerting the doctors, care takers and nurses at critical c

onditions. The information recorded through the system can be saved to the cloud environment and then is later accessed to analyze the patient's health condition over a continuous period of time. At time of critical condition of the patient, it alerts the doctors, caretakers and nurses with the mail notifications also. This helps us in saving precious lives.

II. RELATED WORKS

Alvee Rahman Et al. [1] proposes an intelligent ECG monitoring system to help the doctors, nurses and care takers to monitor the heart patients staying at home and hospitals remotely. This system comprises of Raspberry Pi processor and pulse rate sensor along with ESP8266, the internet module. The pulse rate sensor records the patient's electrocardiogram signal and sends the recorded graph through the internet and also the information has been updated in the cloud for future diagnosis. If the health condition of the patient goes critical, a mail notification is sent to the doctor's/ nurses/ relatives to alert them and also there is a provision to start the video call from either side in case of emergencies.

Vivek Pardeshi Et al. [2] propose a patient ECG monitoring system using Raspberry Pi, Temperature sensor and ECG sensor. This system records the patient's ECG signal through the ECG sensor and patient's body temperature using the temperature sensor and displays the temperature values and ECG pattern through the LCD connected in the set up. The same information can be transmitted to the doctors via the internet and the GSM to ease the job of doctors and nurses.

M. Ryan Fajar Nurdin Et al. [3] proposes a ECG monitoring system using Zigbee module. It supports transmission of ECG signal over the Zigbee module for about 20 users simultaneously. The ECG signal is recorded through the ECG electrodes and the Atmega328 processor is used to convert the analog signal to digital signal to facilitate a serial transmission via Zigbee. Each and every ECG machine is identified by an unique code as a password to download the ECG signal which has been transmitted through the Zigbee module to differentiate among the different users. A web application portal is developed on the doctor's end and by specifying the unique code of ECG machine and the Patient corresponding information of the patient can be accessed.

Gaurav Rajendra Deshmukh Et al. [4] proposes ECG monitoring system for monitoring the heart functioning by using the three lead ECG electrode and signal conditioning system, TIVA TM4C123GH6PM C Series Microcontroller and a Wifi Module. By placing the three lead ECG electrodes over the left arm, right arm and the left leg of the patient, ECG graph of the patient has been recorded in the analog form. To enhance the signal quality a preamplifier and two stages of filtering has been used. The recorded ECG signal has been passed through the preamplifier stage of considerable gain and then to the low pass and high pass filter to filter off the noises thereby to increase the signal quality. Then the recorded analog ECG signal is passed through the Tiva series microcontroller and then to converted to digital version. The CC 3100 WiFi booster pack is used to transmit the digital signal through the internet. This can be even made as a wearable device to monitor the ECG signal from a human continuously throughout the day. Parmveer Singh [5] proposes heart rate monitoring system using AD8232 ECG Sensor, Arduino Uno, Raspberry Pi, internet module using MQTT protocol.

Manuscript published on 30 September 2019
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The low cost AD8232 ECG sensor is used to record the electrocardiogram signal and is fed as an input to the Arduino Uno and then to the Raspberry Pi 2 for data processing. The information collected from the patient has been transmitted through the light weight messaging protocol namely MQTT and also it is saved in the cloud environment for continuous diagnosis.

Udit Satija Et al. [6] developed a real time ECG monitoring system and Signal Quality Assessment System to assess the ECG signals recorded from the patient. This framework records the real time ECG signal from the patients and classifies whether it is an acceptable or unacceptable signal or intermediate signal based on the threshold signal values given and it is verified using the machine learning methods. The standard ECG databases such as MIT-BIH arrhythmia (MITBIHA) and Physionet Challenge databases are used as test databases against the real time signal for various human activities. The software used for assessing the signal quality system has been developed using MATLAB.

Shreyaasha Chaudhury Et al. [7] proposes an intelligent ECG monitoring system using Arduino Uno and ESP8266. Three lead ECG sensors are used to record the ECG signals and the information recorded is communicated to the doctors / nurses using the internet module ESP8266. If the condition goes critical, an alarm signal is given using a buzzer which is incorporated to alert the caretakers to take care of the patient.

Malti Bansal Et al. [8] propose a nanomaterial based ECG electrodes to record the electrocardiogram over the heart patients. Carbon Nano Tubes based electrodes have been suggested in this paper to continuously monitor the functioning of the heart of the patients and the usage of dry electrodes avoid the signal degradation. The advantage of using dry electrodes over conventional wet ECG electrodes in the human avoids the skin irritation when used for continuous monitoring.

Neethu Anna Mathew Et al. [9] proposes a real time Health monitoring system that includes the monitoring of ECG, Temperature and Blood pressure of the patients at hospitals or at homes located at remote places using Raspberry Pi 3 and GSM Model as hardware and Python as software. If the condition goes critical the doctors/caretakers are given notification through their phone via GSM model.

Omkar Udawant Et al. [10] proposes a Smart Ambulance System using IoT to monitor the health of the patient using the sensors and when the ambulance arrives near the traffic signal with in 100m range, the traffic light indication is preempted from red to green and avoids the vehicle from wasting the time over the traffic and also by saving the man kind.

III. PROPOSED SYSTEM

The block diagram of the proposed system is shown. The ATtiny 85 is connected with the pulse rate sensor to detect the heart beat rate and the information can be communicated via the ESP8266, the Internet module. It is programmed in the Arduino IDE Software environment to send the information to the doctor / caretakers and it is also saved in the cloud environment to monitor the health history of the patient over a period of time. If the condition worsens a mail alert is sent to the doctor / care taker.

A. Hardware Components

Heart rate sensor, ATtiny 85, ESP8266, Development board and connectors.

B. Heart Rate Sensor

Fig 1. Heart Rate Sensor

The Pulse Sensor is a plug and play IoT device used for measuring heart beat rate among the humans. It has two sides, one side is fixed with the ambient light sensor and the other side with the circuitry. The circuit is responsible for noise cancellation and amplification purpose. The pulse sensor is fixed over the human finger, the front side LED of the sensor is placed over the top of a vein in our human body. Now the LED light falls over a vein in the human body. The veins will have blood flow in the human body when the heart is pumping. If the flow of blood is detected, the ambient light sensor will emit light. According to the blood flow change the light emitted by the LED changes. The change in the intensity of the received light is analyzed over a period of time to determine the heart beat rate in the human body.

C. ESP8266 Module

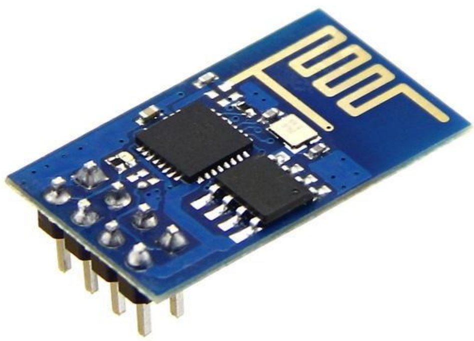

Fig 2. ESP8266 – Wi-Fi Module

ESP8266 is a standalone Wi-Fi module that can be used for end-point IoT developments. It has 16 GPIO pins. It supports 2.4 GHz Wi-Fi supporting 802.11 b/g/n, WPA and WPA2

D. ATtiny 85

Fig 3. ATtiny 85 System on Chip

ATtiny 85 is a low power 8 bit microcontroller constructed based on CMOS logic. It is based on AVR enhanced RISC architecture. It can execute around 1 Million instructions per second. It is a low power device operating at high speed. The ATtiny provides 8K bytes of flash memory, EEPROM ranging from 128 to 512 bytes, 256 bytes of SRAM, six GPIO lines, 32 general purpose registers, 8 bit timer / counter with compare modes, External and Internal Interrupts, One 8 bit high speed timer, 10 bit ADC, a watch dog timer with internal clock oscillator along with three power saving modes. ATtiny 85 is compatible with Arduino IDE working environment.

E. BLOCK DIAGRAM OF THE PROPOSED SYSTEM

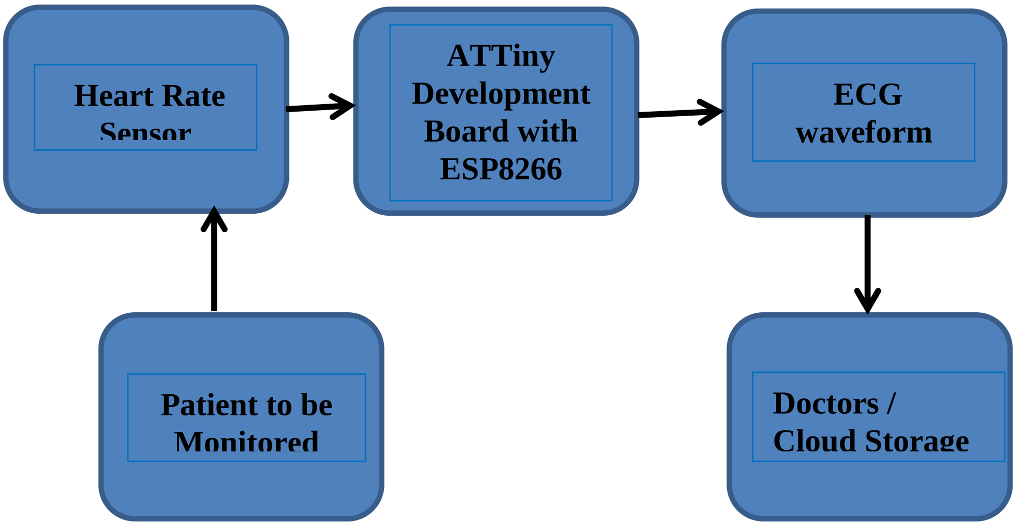

Fig 4. Block Diagram

F. ATtiny 85 Pin Configuration

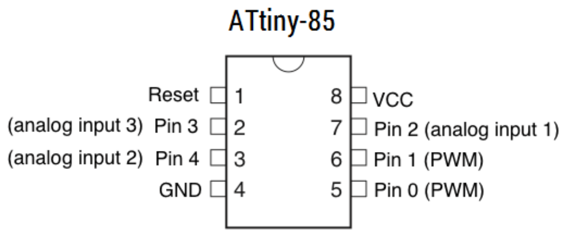

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Fig 5. ATtiny 85 Pin Configuration

G. Software Components

The code for the application is written using the Arduino programming language in IDE (Integrated Development Environment) of Arduino. According to the requirement the application code can be written in the text editor of the IDE. The codes written in text editor of the IDE are called as sketches which are saved, compiled and uploaded into the ATtiny Board using .ino extension.

IV. RESULTS AND DISCUSSIONS

When the pulse sensor is in proper contact with the finger the ECG graph is recorded as above. The sample recorded ECG graph from the pulse sensor in the IDE is shown below in the Fig 5. The sample output consists of four intervals P, Q, R and S.

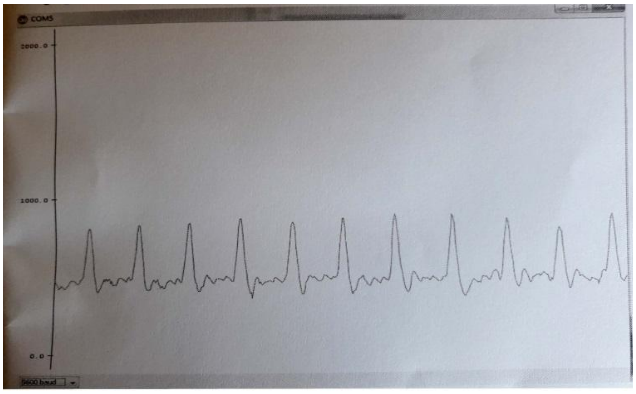

Fig 6. Output ECG waveform

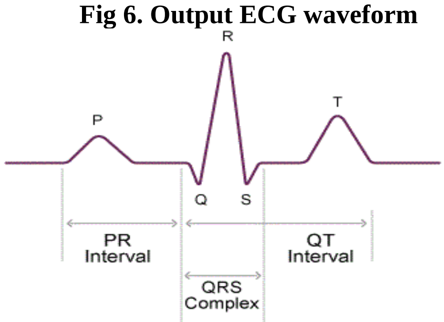

Fig 7. Standard ECG Waveform

By looking into this a doctor can identify the abnormalities of the patient and can provide treatment accordingly. The total cost of the proposed system is very cheaper when we compared with the other existing systems and the same is mentioned in the tabulation below. The proposed system is less complex and simple also.

Table 1. Costing Table

Hardware Component	Approx. Cost (INR)
ATTiny with ESP8266 Development Board	1035
Heart Rate Sensor	150
Total Cost (Hardware)	**1085 (INR)**

V. CONCLUSION

The intelligent ECG monitoring is implemented and the output graph is shown in the Fig 5. This system incorporates a low cost and less complex system to supervise the ECG of the patient. In future, application program can be written to start the video call to help in case of emergencies. The ATtiny chip is incorporated for other applications such as Blood Pressure Monitoring and Body temperature measurement in the health care system so as to reduce the cost.

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