Diagnosis of Cardiac Based on Heart Beat Analysis Using Embedded Systems

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Abstract

In recent years, the most of the people are suffering from heart diseases. The early detection of cardiac diseases helps timely diagnosis. This model is used for regular screening of patient's cardiac characteristics. The heart beat would be monitored and classified into normal sinus rhythm, tachycardia, bradycardia, atrial flutter. On analysis, if any abnormality is found, the patient or cardiologist will be intimated. This can be developed as a Point of Care device to serve rural population and in hospitals. This model aims to design a framework for community healthcare with the help of heart sound analysis system. This design includes various innovations including the effective use of heart beat sensor. Medical Physicians also suggested this type of device is useful in early diagnosis of common cardiac diseases.

1. Introduction

The physicians make use of Cardiac auscultation for monitoring heart sound which helps in early diagnosis of cardiac conditions. But in real time application this tends to be a very tedious process and lacking in development. Cardiovascular disease is a disease that influences the cardio vascular system. It mainly includes cardiac disease and vascular disease. There are many types of cardiac diseases such as heart valve problem, arrhythmia, heart attack and stroke. Every heart problem is identified with the help of the heart beat or with the help of Electrocardiogram [1]. Heart beat is a one cycle where heart's chambers relax and contract to pump blood, includes opening and closing of valves. ECG records the electrical signal from the human body with the help of array of electrodes hence some prevention factors must be followed such as healthy eating, exercise and regular diagnosis of heart conditions.

Two basic method involved in diagnosis of heart diseases are Stethoscope and Electrocardiogram. But this method does not seem to be a system to obtain accurate result [2]. Identifying heart diseases through sound of heart is complex process. Because while using of stethoscope the physician not only hears the beat of heart but also there is an interference due to the lung sounds thus making to hear a noisy system. Thus this kind of diagnosing Heart disease is not accurate and also a difficult process which is likes a trial and error method [3]. In developing countries even the population is increasing every year but the number of cardiologist is same. Hence some device has become mandatory for assisting the people in case of emergency and to do early diagnosis of cardiac conditions with the help of cardiac prescreening device. Stethoscopes like HD Medical HD fono and 3M Sthethos are mainly used for training and educational purposes. In general the devices for cardiac prescreening and early diagnosis are very few.

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2. System architecture

The great challenge in healthcare is cardiology field and inspired in designing the device with various advantages which includes analyzing of data in real time, low cost device, hand held recording services enabled by portable or mobile devices, classifying the heart beat and send it to medical professionals in case of emergency with the help of Global System for Mobile Communication [4].

2.1 System specification

The device is built with various technological innovations which has created a great added advantage in cardiology.1) Implementation based on Heart beat sensor; 2) From the health care centers the medical professionals can monitor the patient's heart function with the help of this device; 3) The system includes appropriate functions which is suited for field use in the non-clinical setup; 4) The heart beat analysis is based on medical domain knowledge and physiological conditions [5]. These two factors are employed for classifying the heart beat into four different conditions.

Various hardware modules are 1) Heart beat sensor where it is the heart of the cardiac prescreening device. It is used to sense the heart beat from human body and produces the digital output for further processing. 2) PIC

Microcontroller 16F877A is used because it has features such as high performance RISC CPU, Analog to Digital converter, UART and Interrupt sources. 3) Liquid Crystal Display (LCD) is used to display the condition of patient's heart beat.4) Electrically Erasable Programmable Read only Memory (EEPROM) is a memory which is non-volatile used in this device to store the patient's data for future analysis. 5) Global System for Mobile. Communication is included in cardiac pre-screening device for communication purpose from device to medical professionals [6].

2.2 System Workflow

The proposed device is able to differentiate the patient's heart beat depending upon the medical domain knowledge.

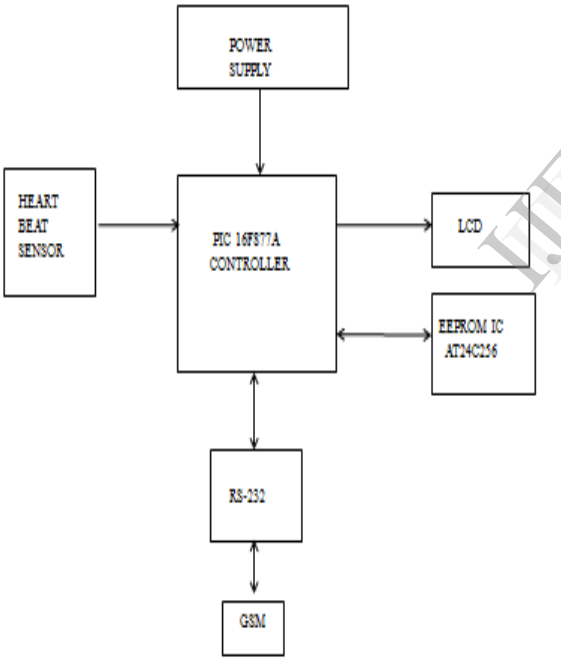

Fig.1. Block diagram of system

The workflow can be illustrated clearly in the following:

- The main modules in the system are Heart beat sensor [9], PIC microcontroller, GSM, EPROM IC.
- Heart beat sensor has a combination of an LED and LDR. Thumb is placed in between an LED and LDR in the heart beat sensor .The LED light is exposed on LDR through thumb.
  - In the case of logic 1- it means no blood flow passage.
  - In the case of logic 0- it means indicates the flow of blood.
  - Depending on the intensity of LDR it can classify heartbeat to be either normal or abnormal.
- When the signal is sent to the PIC microcontroller and if detected to be either lower or higher than the standard level, then the heart beat can be classified.
- EPROM IC stores the monthly database of the patient's heart parameters and sends it to the physicians during emergency or in the request of physicians with the help of GSM.

3. Hardware Implementation

3.1 Heart beat sensor

When a finger is placed on a heartbeat sensor, it gives digital output of a heartbeat. It has a combination of LED and LDR. When the heart beat detector starts working then the beat LED flashes with each heartbeat [7]. The digital output from the heartbeat sensor can be connected directly to microcontroller to measure Beat per Minute (BPM).the heart's function can be clearly understood by Heart Beat Sensor. Through ear lobe the sensor can monitor the blood flow where the amount of blood changes with time [8]. Then the signal is amplified, inverted and filtered. The features are as follows:

- With the help of LED, the heart beat can be indicated
- Portable and compact size
- Working Voltage is +5V DC
- Instant output digital signal for directly connecting to microcontroller
- Operating Current 100 mA
- Output Data Level 5V TTL level
- Light source 660nm Super Red LED

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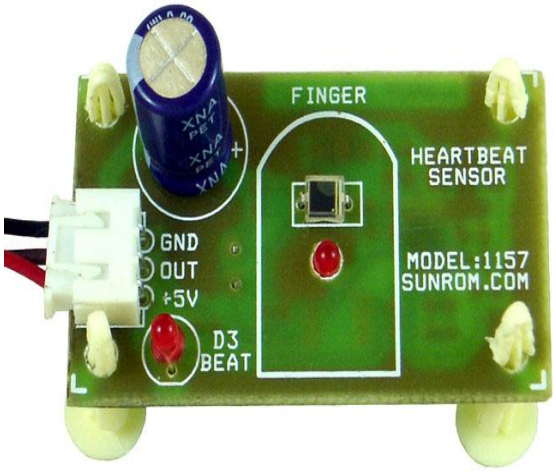

Fig.2. Heart Beat Sensor

3.2 PIC 16F877A Controller

The Peripheral interface controller is used for processing the signals acquired from heart beat sensor. The various features of PIC controller are high performance RISC CPU, 8 channels Analog-to-Digital converter with 10 bit each. It has a Synchronous Serial Port (SSP) with SPI (Master/Slave) and I2C, USART with 9 bit detection. Memory organization, Interrupts.

3.3 EEPROM IC

Electrically erasable programmable ROM (EEPROM) has excellent performance and capabilities. It requires only one external power supply because high voltage is generated internally for program and erase mode. There are two operations namely write and erase where these operations are based on a byte per byte basis. The principle behind the EEPROM is UV-EPROM. On the floating gate, the electrons will get trapped and it modifies the characteristics of the cell. It will get stored as logic "0" or logic "1". It is actually a memory device which implements very few standards in cell design. The floating gate is included in the storage transistor which will trap electrons. it also has access transistor which is included for operations. Each cell in EEPROM consists of two transistors. In the floating gate when electrons are removed, the EEPROM cells get erased and also it is erased when electrons are trapped from the floating gate.

3.4 GSM

The global system for mobile communication (GSM) is a combination of Time Division Multiplexing (TDMA) and Frequency Division Multiplexing. Both the user A and user B are sharing the channel in time and frequency. This indicates the user A is present on the channel which has 890Mhz for two seconds and then it switches to channel 900Mhz for next two seconds and again it jumps to 910Mhz for next Two Seconds and vice versa. in different time slots each user uses a different frequency. This process is termed as Frequency Hopping. Some types are GSM are 900, 1200, 1800 and 2100.The first type of GSM 900 works on the operational frequency of mega Hz. Here it has 125 up link channel and 125 down link channel. The communication from mobile to base station is uplink channel and the communication from base station to mobile means it is downlink channel. In GSM, 124 channels are allocated for communication and 1 channel is used for safe guard where it requires 100 Hz in each. It provides the separation between the channels. The content data is referred as payload data where the messages and information gets transmitted.

3.5 RS-232 Interfaces

It is defined as data communication equipment where control signals connecting between data terminal equipment (DTE) and data circuit terminating equipment (DCE).this interface is mainly used in computer serial ports. The timing of signals, electrical characteristics, the meaning of signals, pin out of connectors and the physical size are defined in the standard.

4. Classification of Heart beat

The Cardiac Pre-screening device analyses the heart beat and it classifies the heart beat into various categories. It can also indicate the heart beat into either normal or abnormal [10]. The various categories are

- Normal sinus rhythm- heart rate of 60-100 beats/min
- Bradycardia – if heart rate is lower than normal.
- Tachycardia – if heart rate is higher than normal.
- Sinus bradycardia –if heart rate <60 beats/min.
- Sinus tachycardia -if heart rate >100-180 beats/min
- Atrial flutter – heart rate of 250-350 beats/min

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5. Simulation

The simulation is carried out using PIC Simulator in the MPLAB IDE compiler.

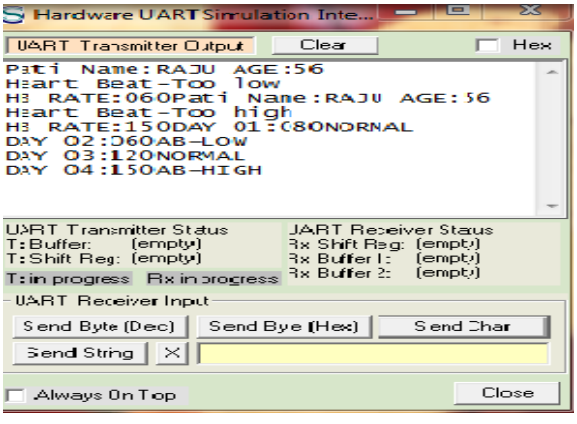

Fig.3. Simulation showing Patient's details

As shown in fig. 3. The details of the patient will be sent to the mobile of the physician through GSM

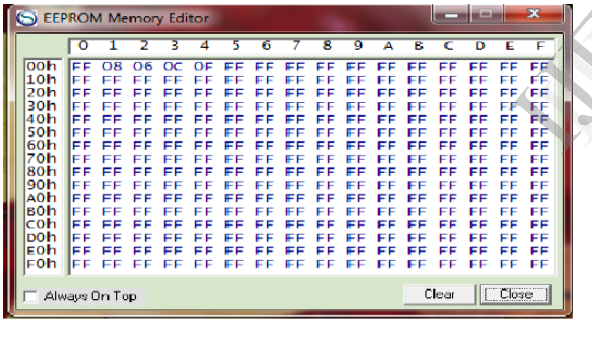

Fig.4. Simulation showing the data stored in EEPROM memory

6. Conclusion

Thus any abnormality in the heart rate can be identified by this system. Any changes in the heart rate will be monitored continuously by the PIC Controller. The physician will be indicated about the abnormalities of the patient heart rate. This system is more reliable and portable in real time systems. This kind of system helps in earliest detection of abnormality and provides timely treatment to the patient. The project is feasible and flexible, so that its basic idea, essence can be absorbed and inherited .This device is more economic, it is accessible to common people. It is so simple in its working so that it does not need the assistance of any trained technicians for its operation.

7. References

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