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Heart Monitoring System

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Abstract

Consistently numerous lives are affected by heart attacks and all the more vitally on the grounds that the patients do not get timely and proper help. If the patient is under constant observation then the parameters that are responsible for causing heart attack can be continuously monitored, and the right treatment at the correct time may be provided in case of emergency. So a system needs to be developed that helps in monitoring the patients suffering from heart disease at any point of time. The proposed system uses a sensor that reads both heart rate and blood pressure. These values are continuously tracked by Raspberry Pi and stored in the master node. The parameters are analysed at regular interval. If these parameters cross their normal range, then an automated message is sent via Short Message Service (SMS) gateway to the preconfigured numbers of the relatives and the doctor. The message contains the parameter values and the patient's current location is recognised through GPS (Global Positioning System) technology, thus making it possible for the patient to get help at the right time when required.

Keywords: Blood Pressure and Heartbeat Sensor, Raspberry Pi, SMS Gateway

Introduction

World Health Organization (WHO) states that good health is a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity. Good health is a fundamental human right(www.who.int). Health is a condition resulting from a body's constant adjustment and adaptation as a response to the everyday stresses and changes in the environment (www.businessdictionary.com).

Maintaining good health for a happy living is an ongoing process. Today different types of health issues have become common with many people across the globe. According to GlobalIssues.org, approximately 36 million people die each year from non-communicable (not contagious) disease including cardiovascular disease cancer, diabetes, and chronic lung disease.

In the current hi-tech world, all the real time applications are running on wireless technology. Due to this tremendous development in wireless technology, it is been used almost everywhere. We can say that wireless technology has connected the entire world. Due to increase in population and the life style of today's world people find no time for their healthcare. To get timely and legitimate help there needs to be a proper facility to constantly observe their health. It is most important that people having heart problem need to be more careful, because these people will be having a high risk of heart attack.

According to recent data, approximately 15 percent of the rural population and 30 percent of the urban population suffer from heart attack (food.ndtv.com). The numbers continue to grow lack of sleep, unhealthy eating habits, due to stress and addiction to alcohol and cigarettes. Thus a large section of the population has adopted an unhealthy lifestyle combined with increasing stress levels, decreasing physical activity, and a higher intake of saturated tobacco and fatsetc.

The common symptoms of heart attack are:

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- Chest pain
- Shortness of breath
- Jaw pain, headache and toothache
- Heartburn and indigestion
- Discomfort in the upper body – arms, shoulder, neck and back
- Vomiting, sweating, and light-headedness

Over the last decade, the demand for efficient healthcare monitoring has increased, that has forced the healthcare department to embrace modern technological advances. Sensors, low power integrated circuits, and wireless communications have enabled the design of low-cost, lightweight, intelligent healthcare systems.

The main goal of this project is to continuously monitor the blood pressure and heartbeat of the patient. The parameters are analysed at regular intervals. If these parameters cross their normal range, then an automated message is sent to concern people (relatives and doctor) through SMS gateway. The people to whom the message has to be sent are already preconfigured. The message contains the parameter values and the patient's current location. These parameters are also communicated to the master node wirelessly so that it helps the doctor for future reference.

Related Work

Every year 2.4 million Indians are losing life due to heart attack. According to government data, the condition of heart failure in India because of hypertension, coronary heart disease, diabetes and obesity heart disease ranges from anywhere between 1.3 to 4.6 million, with an annual incidence of 491,600 to 1.8 million (food.ndtv.com). It is required to question ourselves regarding our own complex ways of life decisions, eating regimen, and level of physical work. Heart attack is a leading killer in India. People dying because of heart assault consistently in India are four every minute and the age rangeis between 30 and 50. About 900 people under 30 die every day because of coronary illness in India. Twenty-five percent of heart attack deaths occur in people less than 40 (www.thehindu.com).

Shelar, Singh, and Tiwari (2013) have proposed a system that monitors the heartbeat and temperature values and if needed, SMS is sent only to the doctor. Relatives will not be aware of the patient's condition.

Shaikh and Skhaikh (2013) have proposed a system to monitor the patient's heartbeat, temperature, and ECG values and send SMS to the doctor. They do not speak about the current location of the patient.

Kothari (2014), on a similar basis, proposed to send the SMS in case the patient's condition is critical. SMS includes the location of the patient in the form of longitude and latitude which should be input to the GPS navigator to know the patient's exact location.

In a study by Al-Omary, El-Medany, and Al-Hakim (2014), patient's ECG is monitored by the authorised person through the hospital web using PC or smart phone with the Android application.

Yadav, Yadav, Satyanarayan, and Desai (2013) have proposed a system that monitors the heartbeat and temperature values and send SMS in emergency case. They do not speak about the current location of the patient and the health parameters of the patient are not stored in the database.

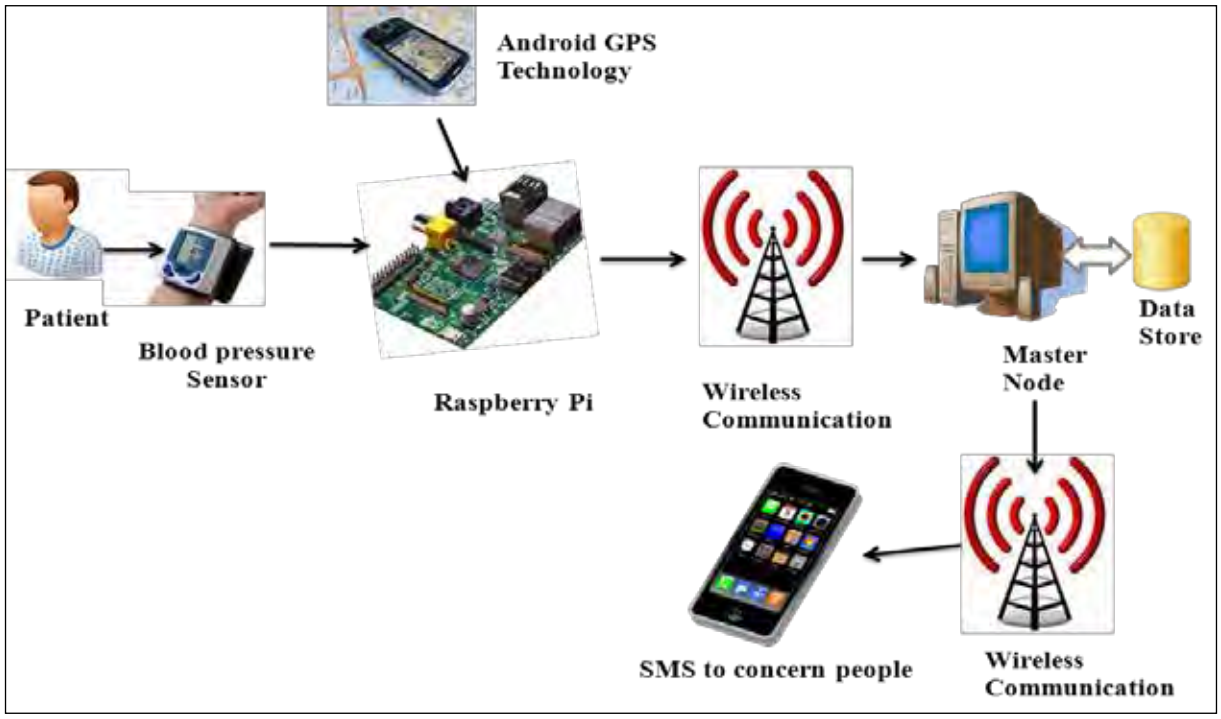
Drawbacks of these existing systems are that they do not perform round the clock monitoring of the patient which is highly essential. They do alert the concerned in case of emergency situations but they do not provide the current location of patient. They do not store the health parameters in the database for the future reference. This makes it difficult to provide the treatment to the patient at the right time.

Proposed Work

Now-a-days heart attack is one of the leading killers in India. Over 50 percent of patients suffering from heart attack die just because they are unable to reach the hospital in time and unable to get the help immediately.

Since variation in blood pressure and heart beat are the initial effects of heart attack we use blood pressure and heart beat sensor that helps to keep track of the blood pressure as well as the heartbeat of the patient. Then check for any record that varies from the normal range. These values are then sent to the master node through wireless technology. In case of any variations noticed that far exceeds the normal range, notification message may be sent to the concerned people through SMS gateway.

Fig. 1: Architecture of System



The notification contains the parameter values and the patient's current location, thus making it possible for the patient to get help at the correct time when required.

Our proposed system monitors the patient round the clock, alerts the relatives and the doctor in case of emergency by sending SMS to the preconfigured contact numbers. SMS includes the patient's current location and health parameters. It also stores the health parameters of the patient in the master node. Then these health parameters are graphically represented which helps doctor to take the correct action at right time. Thus it helps the person to lead a safe and secure life.

System Design

The architectural design as shown in Fig.1 consists of a blood pressure and heartbeat sensor directly interfaced with Raspberry Pi. The blood pressure and heartbeat sensor data can be used to measure the patient's health. The sensors data are sent serially to the TTL converter to convert the serial signal to USB signal. This USB signal is collected by the Raspberry Pi. The Raspberry Pi monitors and collects the data from sensors and sends it to the master node along with the current location collected through GPS technology. The master node keeps on monitoring the health of the patient. If the patient's observed data arefound to be critical above or below the specified threshold values of the blood pressure and heartbeat then it sends SMS to the preconfigured relatives' numbers and as well as to the doctor. Raspberry Pi continuously transmits the health parameters information to a master node through wireless network. Master node plots the graph that contains the current and the previous 9 values of the blood pressure and heartbeat.

Implementation

Blood pressure and heartbeat sensor is used to get the patient's blood pressure and heartbeat. Every 15 seconds, the Raspberry Pi receives data from the sensors and immediately sends to the master node. Master node keeps on monitoring the patient's health and checks for the critical condition.

Sensor and Raspberry Pi Module

The Raspberry Pi is a credit card sized single board computer. The Raspberry Pi primarily uses Linux-kernel-based operating systems i.e. Raspbian. Raspbian is a free operating system based on Debianoptimised for the Raspberry Pi hardware. An operating system is the set of

basic programs and utilities that make your Raspberry Pi run. Tools are available for Python as the main programming language, with support for C, C++, Java, Perl and Ruby (www.raspberrypi.org).

The Raspberry Pi requires appropriate operating system and drivers for integrating the blood pressure sensor on the board. The blood pressure sensor is connected to the TTL converter. The TTL converter will convert the serial signals to the USB signals. The TTL converter is connected to the USB port of the Raspberry Pi. To power up the blood pressure sensor connects one wire to +5V of the raspberry Pi i.e. pin 2 as shown in Fig. 2. The sensor pinouts are:

- TX-OUT = Transmit output.
- +5V = Regulated 5V supply input.
- GND = Board Common Ground.

Fig. 2: Sensors Connection

Python is a widely used general-purpose, high-level programming language(oitibs.com). Python language is the main language for Raspberry Pi. To collect the blood pressure and heartbeat values from the sensor Raspberry Pi has been programmed using python. It also continuously gets the latitude and longitude values from the Android application in the patient's mobile phone. The latitude and longitude values are converted to the street address by forward geocoding method of Location Based Services (LSB) class(www.raspberrypi.org). These three values are continuously collected and sent to the master module.

Master Node Application

VB.Net provides an application that will fetch the blood pressure and heartbeat values continuously from the Raspberry Pi and stores it in the database. After fetching the values, these are compared with the threshold values for every 6 secs to test for critical condition. The required threshold value for the high blood pressure is 160 over 100 and low blood pressure is 90 over 60 and heartbeat 60 to 100. If the blood pressure is greater 160 or greater than 100 or less than 90 or less the 60 and heartbeat is less than 60 or greater than 100 then the patient's condition is critical.

If the patient's condition is critical then an SMS is sent to the concerned people and doctor. The SMS contains the values of blood pressure, heartbeat and the current location of the patient. After sending the SMS the values are displayed on the master node. If the condition is not critical the values of the blood pressure (systolic and diastolic), heartbeat, latitude and longitude are displayed without sending SMS. Simultaneously it will also continuously plot the graph of the current fetched values of blood pressure and heartbeat. This graph contains the current and the previous 9 values of the blood pressure and heartbeat. This graph will help doctor to know the patient condition.

Results

Fig. 3 shows the graph of 'NO' critical condition. Click on the start monitoring button for executing the master node application. The application will continuously monitor the health parameters and the current location of the patient. It will plot the graph of the blood pressure and heartbeat by taking the current and the previous 9 values of the sensors.

Fig. 4a shows the graph of 'YES' critical condition. The application will continuously monitor the health parameters and the current location of the patient. If any critical condition is observed, an alert message is sent as shown in Fig. 4b to the preconfigured relatives and doctor numbers. It will display the critical values and also plot the graph of the blood pressure and heartbeat by taking the current and the previous 9 values of the sensors.

Fig. 5 shows the sent message that displays blood pressure and hearbeat values and the current location of patient. Fig. 6 shows the current location of the patient on Google Map.

Fig. 3: Graph Showing Normal Condition

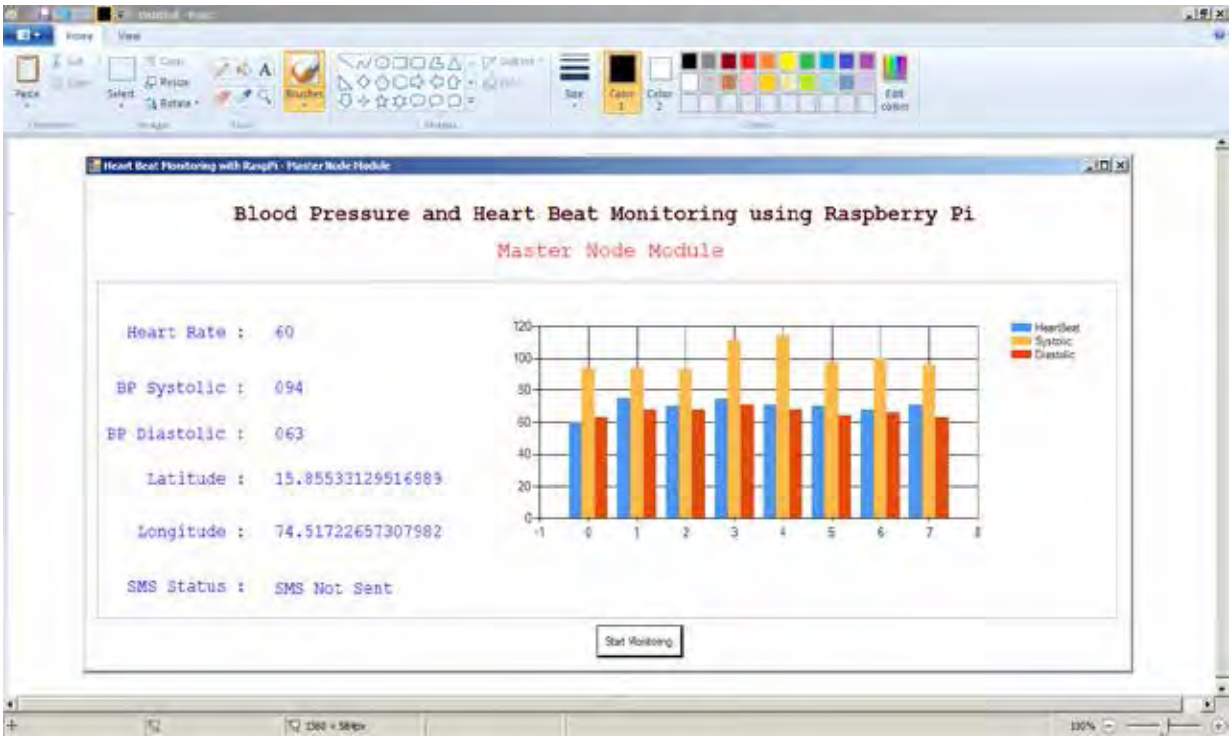


Fig. 4a: Graph Showing Critical Condition

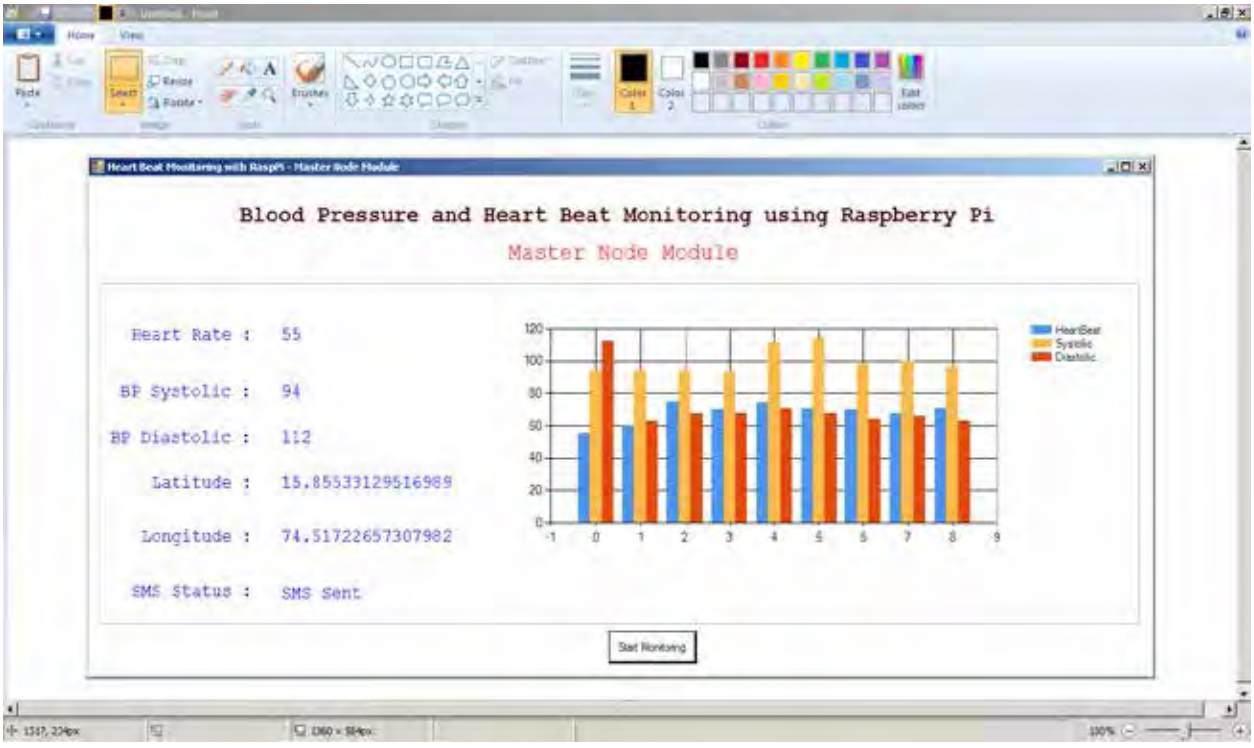


Fig. 4b: Screen After Sending Message

Fig. 5: Sent Message with Patient Details

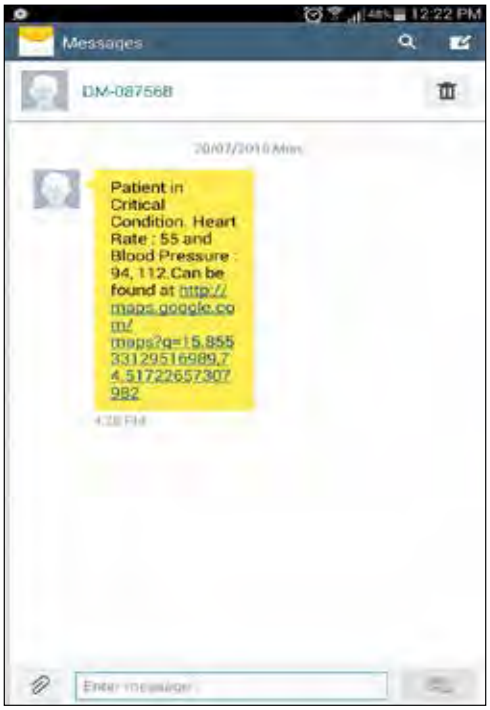
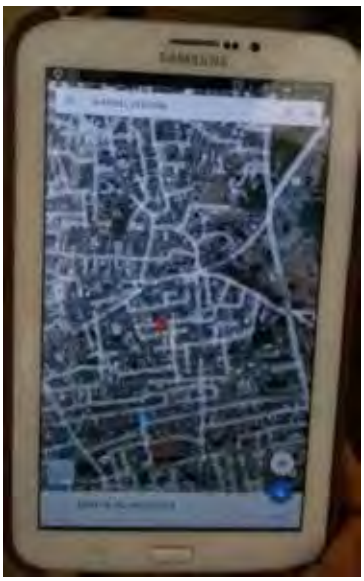


Fig. 6: Google Map



Applications

- For people where hospital facility is not immediately available.
- The heart patient who is traveling daily.
- Post operation monitoring.
- To monitor the heart patient at home.
- People on tour.

Conclusion

Heart monitoring system using sensor is a promising technology that can revolutionise next-generation healthcare applications. It is expected to be a very useful technology with potential to over a wide range of patients, medical personnel and society. It helps in early detection of possible health issues. This system is will help lot of people to get the proper treatment on time thus save lives.

Future Scope

The proposed system makes use of blood pressure and heart beat sensor. As an enhancement to this system ECG sensor may also be used. There are various sensors available in the market. By integrating different sensors to the embedded module, other parameters of the human body can be monitored and necessary measures may be taken to save the life of a person.

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