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IoT based Health Monitoring System

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***Abstract*: Monitoring beloved ones becomes a difficult task in the modern day life. Keeping track of the health status of the patient at home is a difficult task. Especially elderly or disabled patients should be periodically monitored and their loved ones need to be informed about their health status from time to time while at work. So this is an innovative system that automates this task with ease. This system puts forward a smart patient health tracking system that uses heartbeat and temperature sensors to track patient's health and uses internet to give alerts in case of any issues. A GPS is provided in the system to track the person's location. A GSM module is incorporated in the system to send SMS alert to doctors and also location information to ambulance in case of emergency. The sensors, GSM and GPS modules are connected to Arduino to track the status in order to transmit alerts. If the system detects any abrupt changes in patient's heartbeat and body temperature the system automatically alerts the user about the patient's status and also shows details of heartbeat and temperature of patient live over the internet. Thus the IoT based patient health tracking system effectively uses internet to monitor patient health status and saves lives on time.**

***Keywords*: IoT, Arduino Uno, Thingspeak, Temperature sensor, Heartbeat sensor, GPS, GSM, Wi-Fi module**

1. Introduction

Health monitoring systems are gaining their significance as the fast-growing universal elderly population increases which demands caretaking. Wireless sensor networks play a vital role in the research and technological community hence resulting in the development of various high-performance smart sensing system. Health monitoring is major problem in today's world. Due to lack of proper health monitoring, patients suffer from serious health issues. Health experts are taking advantage of these smart devices to keep an eye on their patients. With tons of new healthcare technology start-ups, IoT is rapidly revolutionizing the healthcare industry. The concept of internet of things is recent and is defined as the integration of all devices that connect to the internet, which can be managed from the web and in turn provide information in real time, to allow interaction with people who use it. The system makes use of an IoT based health monitoring system which records the patient heart beat rate and body temperature and also send an SMS alert whenever those readings goes beyond critical values. Pulse rate and body temperature readings are recorded over ThingSpeak so that patient health can be monitored from anywhere in the world over internet. A buzzer will also be attached for giving alert.

2. Proposed system

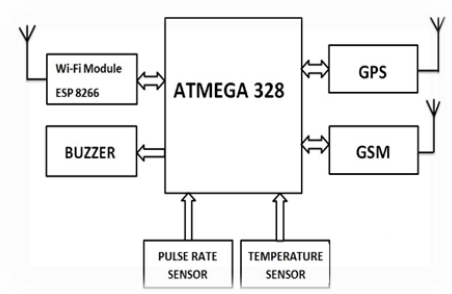

Fig. 1. Block diagram

Earlier the detection systems were only found in hospitals and were characterized by a huge and complex circuitry which required high power consumption. This is a system that is useful for the persons who need continuous monitoring for their vitals but are unable to go to hospital on a regular basis. So this system highlights its use for those people with disability or for those who are immobile or for those who have terribly weak body because of their old age. The added advantage of this system is that it uses IoT which makes anyone with the user id to attain the timely health status of the patient from anywhere in the world. Thus this system does the monitoring task with an ease and helps to save lives.

3. Components and tools

A. *Temperature sensor*

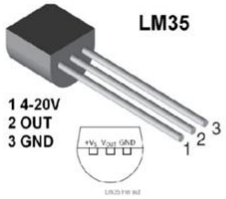

Fig. 2. Temperature sensor

LM35 is the temperature sensor used in the system. It is an integrated circuit sensor which is used to measure temperature

with an electrical output proportional to the temperature (in °C). It can measure temperature more accurately than a using a thermistor. The LM35 generates a higher output voltage than thermocouples so that output voltage need not be amplified. It has an output voltage proportional to the Celsius temperature. The scale factor is .01V/°C. Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and has a low self-heating capability.

B. Heartbeat sensor

Fig. 3. Heartbeat sensor

Heartbeat sensor is based on the principle of photo plethysmography. It consists of a LED and detector like LDR or photodiode. The heartbeat pulses cause a variation in the flow of blood to different region of the body. When a tissue is illuminated by the light source, the blood absorbs some of the light and other light is transmitted or reflected which is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue and this flow of blood volume is decided by the rate of heart pulses. The detected output is in the form of electrical signal and is proportional to heartbeat rate.

C. GSM

Fig. 4. GSM module

The GSM module used is SIM 900A GSM module. It is ultra-compact and reliable wireless module. It is a complete GSM/GPRS solution in a SMT module. It delivers GSM/GPRS 900/1800 mHz performance for voice, data, SMS with low power consumption. It has a dimension of 24mmx24mmx3mm and hence it can fit in almost all space requirements. It has 6 pins: - Vcc, GND, 3VR, 3VT, 5VR and 5VT.

D. Arduino

Arduino UNO is an open source microcontroller board based on microchip ATmega328P. The board has 14 Digital pins, 6 Analog pins and it programmable with Arduino IDE using a USB cable. It can be powered by the USB cable or using an external battery of 9V, though it requires an input voltage of 7-12 V. The operating voltage of Arduino UNO is 5V.

Fig. 5. Arduino UNO board

E. GPS

Fig. 6. GPS module

The GPS module has a NEO-6M GPS chip from u-blox. The chip is less than the size of a postage stamp but can packs a large amount of features into the frame. It can track up to 22 satellites on 50 channels and achieves highest level of sensitivity i.e. -161 dB tracking but consumes only 45mA supply current. It has a battery for power backup and EEPROM for storing configuration settings. Antenna is connected to the module through UFL cable which allow for flexibility in mounting GPS.

F. Wi-Fi Module

Fig. 7. Wi-Fi module

NodeMCU is an open source IoT platform. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability. NodeMCU is a Wi-Fi system on chip produced by Espress if systems. It is based ESP8266-12E Wi-Fi module. It is a highly integrated chip designed to provide internet connectivity in small packages. By simple programming we can establish a Wi-Fi connection and define IP/OP pins according to our needs exactly like Arduino.

G. Buzzer

Fig. 8. Buzzer

Buzzer is an audio signaling device that can be mechanical, electronic or piezoelectric. They are mainly used in alarm clock, timers and confirmation of user input such as mouse click or keystroke. RVFM 5V miniature buzzer is used here. These miniature buzzers have PCB pins for direct board mounting and are suitable for wider applications.

H. Arduino IDE

The Arduino IDE is a cross platform application and is written in the programming language java. It is used to write and upload programs to Arduino compatible boards. The source code for the IDE is released under the GNU General Public License, version 2. It supports the languages C and C++ using special rules of code structuring. It is originated from the IDE for the languages processing and wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple *one-click* mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. A program written with the IDE for Arduino is called a sketch.

I. Thing speak

The data that were collected from the sensors through the Arduino should be stored somewhere to analysis on those data. For that purpose, Thingspeak, a website that allows storing data and analysis them is used. The ESP-8266 is used for connecting the Arduino with the internet and stores that necessary data to Thingspeak server. The ESP-8266 will receive data from the Arduino and with the help of a Wi-Fi connection, the ESP-8266 will send the acquired data to Thingspeak server. For different data different types of channels are created in Thingspeak. Thingspeak is an open source IoT application and API. It helps to store and retrieve data from things using the HTTP protocol all over the internet or from the local area network (LAN).

4. Flowchart and working

This system consists of two sensors-temperature sensor (LM35) and the heart beat sensor. These two sensors continuously senses the temperature and the pulse rate and sends the real time values of the sensors to the cloud through the Arduino via the Wi-Fi module. These values can be accessed by the user anywhere in the world if the user knows the patient user id through the serial monitor. Each patient has a unique user ID.

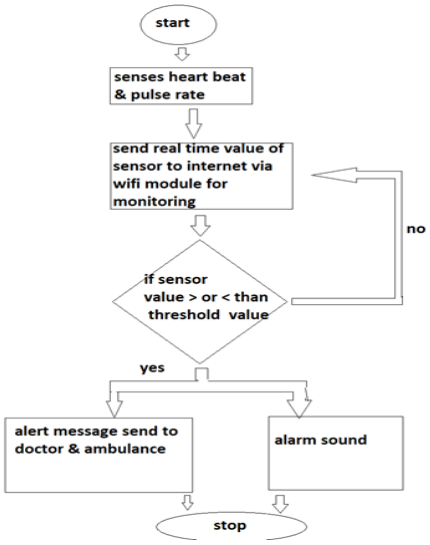

Fig. 9. Flowchart

When the sensor value drops or exceeds the threshold value of the temperature and heart rate the GSM and the GPS module gets activated. The GSM module sends an alert message and the GPS module sends the latitude and longitude of the patient location to the doctor and the ambulance. This makes it helpful for the doctor who is busy, to keep the track on the patient's health status. The latitude and the longitude help the ambulance to reach the patient's location. There is also a buzzer kept near the patient which beeps to alert the bystanders near the patient.

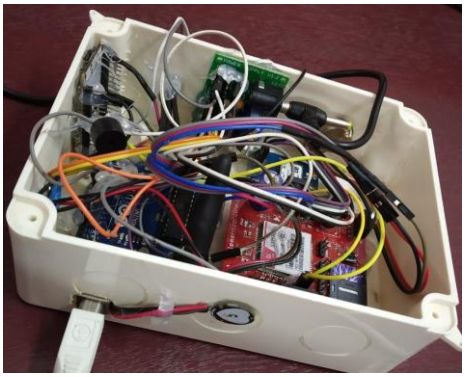

Fig. 10. Hardware setup

5. Results

This system can be used to transmit the patient's vital parameter information in real time to remote location and can be seen by the doctor. The sensors are connected to the Arduino board and are monitored continuously. The sensed values of both temperature and heartbeat sensors are transferred to internet via a Wi-Fi module. The output is received on the ThingSpeak website and is displayed as shown.

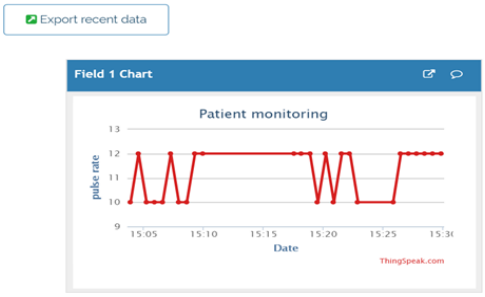

Fig. 11. Pulse rate monitoring in Thing speak

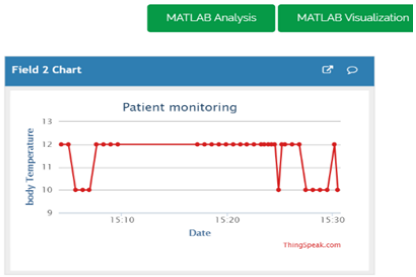

Fig. 12. Temperature monitoring in Thing speak

The doctor can easily access patient's health details continuously. The obtained values are compared with the threshold values to check for any abnormal condition. If any such condition prevails an SMS is sent to both doctor and ambulance using GSM and buzzer beeps. At normal condition, no indication will be produced. GPS identifies exact location of the patient.

6. Conclusion

Healthcare field is one of the most delicate and important fields to be developed and enhanced. The proposed system is designed and experimented to improve the quality of health services and to reduce the total cost in healthcare by avoiding unnecessary hospitalizations and ensuring that those who need urgent care get it sooner. Using this system any abnormalities in the health conditions can be known directly and are informed to the particular person through GSM technology in case of emergency and via internet under normal conditions. The proposed system is simple, power efficient and easy to understand. It acts as a connection between patient and doctor. The hardware for the project is implemented and the output results are verified successfully. With its potential use in the hospitals and home healthcare fields, wireless sensor networks have an important role in improving the lives of patients. Besides bringing comfort to patients, there are large commercial benefits in the area of reducing costs, rehospitalisation, and improving equipment and patient management.

7. Future scope

The future work of the project is essential in order to make the design system more advanced. In the designed system, the enhancement would be connecting more sensors, which measures various other health parameters and would be beneficial for patient monitoring i.e. connecting all the objects to internet for quick and easy access. Another future enhancement is the use of artificial intelligence to explore distributed storage, data robustness, simple parallel, distributed computation and auto classification of sensor reading to help the physician in the early interpretation of diseases. The current work can also be extended further to monitor sports personalities and patients affected by other specific diseases during their normal routine activities.

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