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An IoT based Patient Health Monitoring System using Arduino Uno

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Abstract— Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. IOT devices are used in many application fields which make the users' day to day life more comfortable. These devices are used to collect temperature, blood pressure, and sugar level etc., which are used to evaluate the health condition of the patient. Communicating the collected information to the doctor, making accurate decision on the data collected and notifying the patient is the challenging task in the IOT. In this project, An IoT based Patient Health Monitoring System (PHMS) using Arduino is proposed to collect the required parameters and evaluate the data obtained from the sensor devices. PHMS with arduino also gives the notifications to patient with possible precautionary measures to be practiced by them. This system suggests the patient with medical care and next step to be followed in case of critical situation. The combination of IoT with arduino is the new way of introducing Internet of Things in Health care Monitoring system of patients. Arduino Uno board collects data from the sensors and transfer wirelessly to IoT website. The Proposed PHMS system is evaluated for certain parameters like heartbeat, body temperature, blood pressure etc. and the decisions can be made based on the data obtained from IoT website.

Keywords— Internet of things; health care; arduino; sensors

I. INTRODUCTION

In low and middle income countries, there is increasingly growing number of people with chronic diseases due to different risk factors such as dietary habits, physical inactivity, and alcohol consumption among others. According to the World Health Organization report, 4.9 million people die from lung cancer from the consumption of snuff, overweight 2.6 million, 4.4 million for elevated cholesterol and 7.1 million for high blood pressure [1]. Chronic diseases are highly variable in their symptoms as well as their evolution and treatment. Some if not monitored and treated early, they can end the patient's life.

For many years the standard way of measuring glucose levels, blood pressure levels and heart beat was with traditional exams in a specialized health centers. Due to the technological advances in today, there is great variety running sensor reading vital signs such as blood pressure cuff, glucometer, heart rate monitor, including electrocardiograms[2], which allow patients to take their vital signs daily. The readings which are taken daily are sent to doctors and they will recommend the medicine and workout routines that allow them to improve the quality of life and overcome such diseases.

The internet of things applied to the care and monitoring of patients is increasingly common in the health sector, seeking to improve the quality of life of people. The Internet of things is defined as the integration of all devices that connect to the network, which can be managed from the web and in turn provide information in real time, to allow interaction with people they use it [3]. On the other hand, the Internet of things can be seen from three paradigms[4], which are Internet-oriented middleware, things sensors oriented and knowledge-oriented semantics.

The arduino is a programmable device that can sense and interact with its environment. It is great open source microcontroller platform that allows electronic enthusiasts to build quickly, easily and with low cost small automation and monitoring projects. The combination of IoT with arduino is the new way of introducing Internet of Things in Health care Monitoring system of patients[5]. Arduino Uno board collects data from the sensors and transfer wirelessly to IoT website.

II. PATIENT HEALTH MONITORING USNING GSM

Purnima and puneet singh [6] designed a Patient helath monitoring system using Zigbee and GSM. Here the parameters of a patient (temp, heartbeat, ECG, position) are wirelessly transmitted using Zigbee and if any parameter falls below threshold, an SMS is sent to predefined doctor's mobile number using GSM module.

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GSM based Patient Health Monitoring Project mainly works for allowing doctors or relatives of patient to check the status of patient health remotely. The system calculates the heartbeats and body temperature of patient and if it goes above certain limit then immediate informative alert message will be sent to the registered number. For this system we used AVR Family Microcontroller which is interfaced with LCD display, heartbeat sensor and temperature sensor. The GSM based Patient health monitoring system works with GSM modem to send the data remotely to the registered number, system powered by 12V transformer. The system also featured with manual health button using that the patient with some other issues will also able to contact with doctor so, the system is very helpful for saving life of patient. The system also introduced a function through which a doctor will able to check the status of patient after a certain interval of time by sending message. The system efficiently updates doctor about health of patient as well as accurately calculates the health parameter of patient.

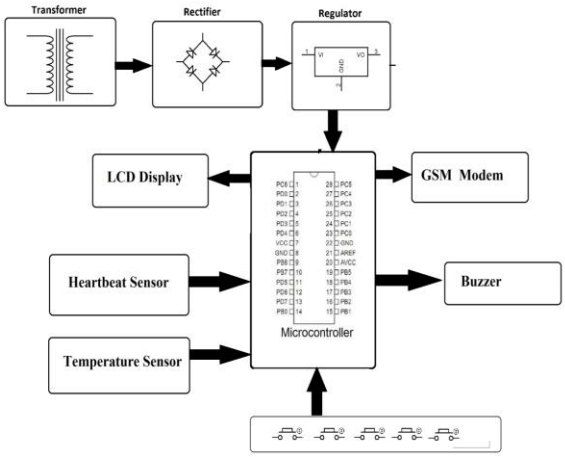

Fig. 1. Architecture of PHMS using GSM Module

In this fast pace of life, it is difficult for people to be constantly available for their near ones who might need them while they are suffering from a disease or physical disorder. So also constant monitoring of the patient's body parameters such as temperature, pulse rate, sugar level etc. becomes difficult. Hence to remove human error and to lessen the burden of monitoring patient's health from doctor's head, this method presents the methodology for monitoring patients remotely using GSM network and Very Large Scale Integration (VLSI) technology. Patient monitoring systems measure physiological characteristics either continuously or at regular intervals of time. The device alarms when the heart beat & the body temperature exceed the provided threshold value. This threshold value is defined by the programmer at the time of programming the microcontroller. The threshold value given for the project is as 20 to 120 pulses per minute for heart beat indication& 18°C to 38°C for temperature.

Using this technology an alarm is generated whenever the patient is at risk but it could not provide the detail information about the patient health status. And it is not possible to view all the recorded data at the same platform.

III. PRPOSED METHOD

Internet of Things (IoT) is the emerging paradigm, which contains huge amount of smart object and smart devices connected to the internet for communicating with each other. IoT devices are used in many fields which make the users' day to day life more comfortable. These smart devices are used to collect temperature, blood pressure, sugar level etc., which are used to evaluate the health condition of the patient. Communicating the collected information to the doctor, making accurate decision on the data collected and notifying the patient is the challenging task in the IoT. In this project, the architecture of the Patient Health Monitoring System (PHMS) using IoT devices is proposed to collect the required parameters and evaluate the data obtained from the IoT devices. PHMS also notifies the patient with possible precautionary measures to be practiced by them. This system suggests the patient with medical care and next step to be followed in case of critical situation. The PHMS system is evaluated for certain parameters and the decisions made on the data obtained from the source are assumed to evaluate the system. The simulated results experiments the correctness and effectiveness of the proposed system.

In this project, an IoT based Patient Health Monitoring System (PHMS) using arduino device is proposed to collect the required parameters like temperature, heart beat and blood pressure and evaluate the data obtained from the IoT devices. Over the last few years, the usage of arduino increases exponentially due to its reliability, easiness, open source programming, and low cost. In this paper, we introduce a new way of implementing PHMS with Arduino Uno named as an IoT based Patient Health Monitoring System using Arduino. Data generated by the sensors are processed by arduino microcontroller ATMEGA 328P. ESP8266 provides unsurpassed ability to embed Wi-Fi capabilities within other systems. It offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application

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processor. The data generated from arduino is available in the IoT website thinkspeak.com with the use of Wi-Fi module. The PHMS also notifies the patient with possible precautionary measures to be practiced by them. This system suggests the patient with medical care and next step to be followed in case of critical situation.

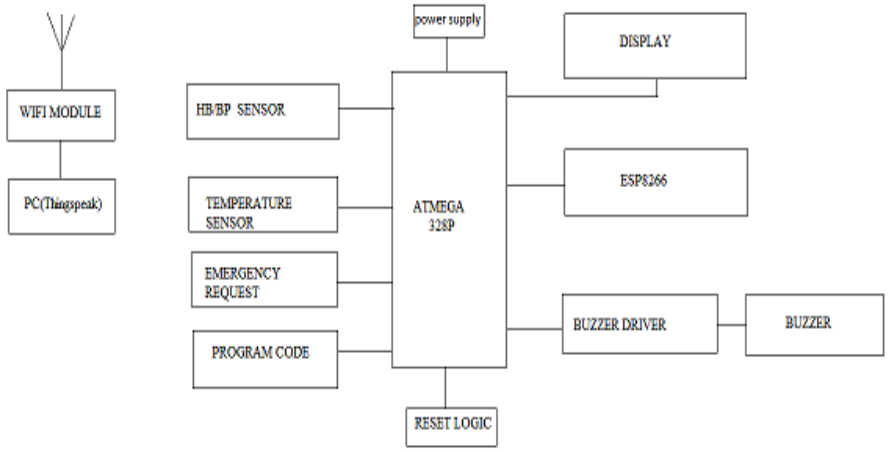

Fig. 2. IoT based Helath Monitoring System using Arduino

IV. IMPLEMENTATION DETAILS

A. ARDUINO IDE

An integrated development environment (IDE) (also known as integrated design environment or integrated debugging environment) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of:

- A source code editor
- A compiler/or an interpreter
- Build automation tools
- A debugger

Sometimes a version control system and various tools are integrated to simplify the construction of a GUI. Many modern IDEs also have a class browser, an object inspector, and a class hierarchy diagram, for use with object-oriented software development.

IDEs are designed to maximize programmer productivity by providing tightly-knit components with similar user interfaces. This should mean that the programmer has to do less mode switching versus using discrete development programs. However, because an IDE is a complicated piece of software by its very nature, this higher productivity only occurs after a lengthy learning process. Typically an IDE is dedicated to a specific programming language, allowing a feature set that most closely matches the programming paradigms of the language. However, there are some multiple-language IDEs, such as Eclipse, Active State Komodo, recent versions of NetBeans, Microsoft Visual Studio, WinDev, and Xcode.

IDEs typically present a single program in which all development is done. This program typically provides many features for authoring, modifying, compiling, deploying and debugging software. The aim is to abstract the configuration necessary to piece together command line utilities in a cohesive unit, which theoretically reduces the time to learn a language, and increases developer productivity. It is also thought that the tight integration of development tasks can further increase productivity. For example, code can be compiled while being written, providing instant feedback on syntax errors. While most modern IDEs are graphical, IDEs in use before the advent of windowing systems (such as Microsoft Windows or X11) were text-based, using function keys or hotkeys to perform various tasks (Turbo Pascal is a common example). This contrasts with software development using unrelated tools, such as vi, GCC or make.

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

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B. Getting Started with arduino

Step1: Get an Arduino board and USB cable

Fig. 4 Arduino with USB

Step2: Download the Arduino environment- get the latest version from the download page.
Step3: Connect the board- Connect the Arduino board to your computer using the USB cable. The green power LED (labelled PWR) should go on.
Step4: Install the drivers.
Step5: Launch the arduino application- Open the blink example.

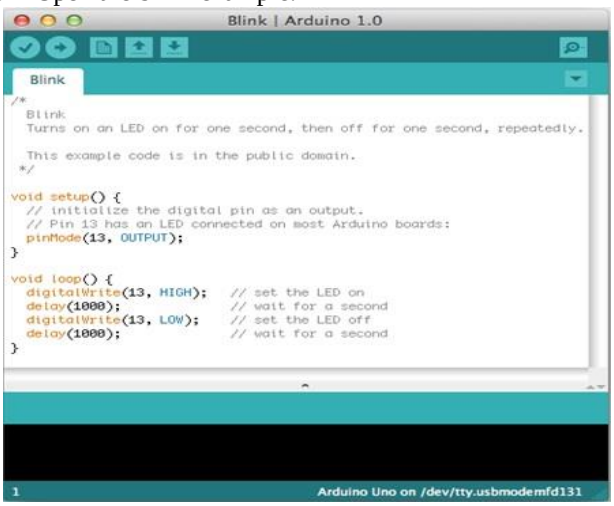

Fig. 5. Sample code for LED blink

Step6: Select your board.

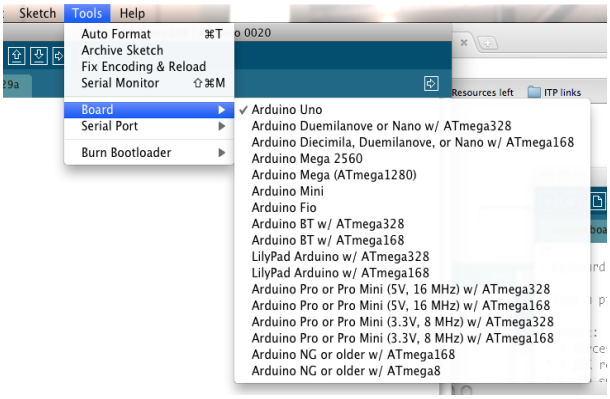

Fig. 6. Board selection

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Step7: Select your serial port- Select the serial device of the Arduino board from the Tools | Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports).
Step8: Upload the program.

Fig. 7. Upload the code at the top menu

C. IOT DATA BASE thinkspeak.com

ThingSpeak is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications. The ThingSpeakIoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to ThingSpeak from Arduino, Raspberry Pi, BeagleBone Black, and other hardware. The following are the steps to use thinkspeak.com:

Step1: Collect the data in the new channel- Create a channel, collect data and write it to a new channel.
Step2: Analyze your data- Analyse and visualize data using MATLAB®.
Step3: Act on your data- Set threshold limits on data to send a tweet under certain conditions.

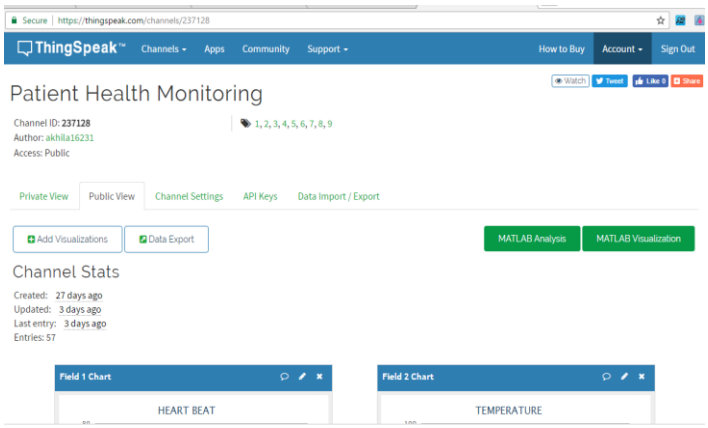

Fig. 8. Thinkspeak.com home page

V. RESULTS AND ANAYSIS

The output from sensor and amplifier circuit was connected to the arduino. The observed output signal was periodic ac signal with amplitude varying from peak to peak according to person. A model sinusoidal signal and the output from sensor were fed to arduino and the counted pulse rate was successfully sent via Wi-Fi module. The counted signal from the sensor to measure the heartbeat was relatively a weak signal which needed to be amplified and filtered before it was sent to the arduino. So, the signal was amplified using an operational amplifier. The amplified signal was then filtered to get the desired output of heartbeat which was then sent to the microcontroller for further processing. The microcontroller then sent the received data of both heartbeat and temperature of a patient to a remote end via Wi-Fi module. The output is received on the thingspeak website and is displayed as shown in the Figure 9.1. The output consists of the data from sensors. It provides the data of heartbeat and body temperature which was found out to be 76 bpm and 36.2 degree C respectively. Also, the measured heartbeat and temperature for different individuals vary depending upon their age-group. The data of heartbeat and body temperature of an individual was posted to the web.

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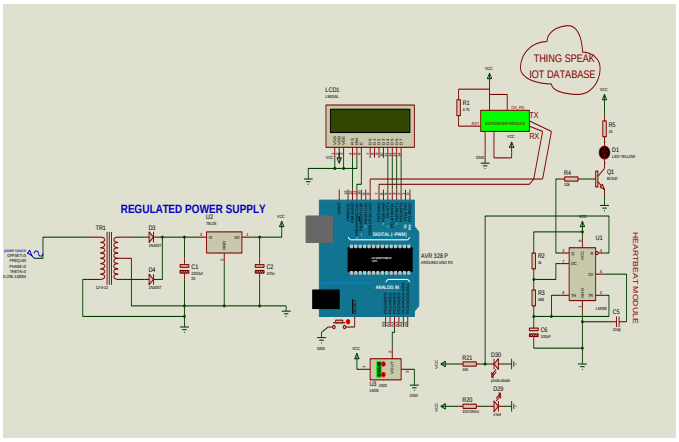

Fig. 9. Circuit design

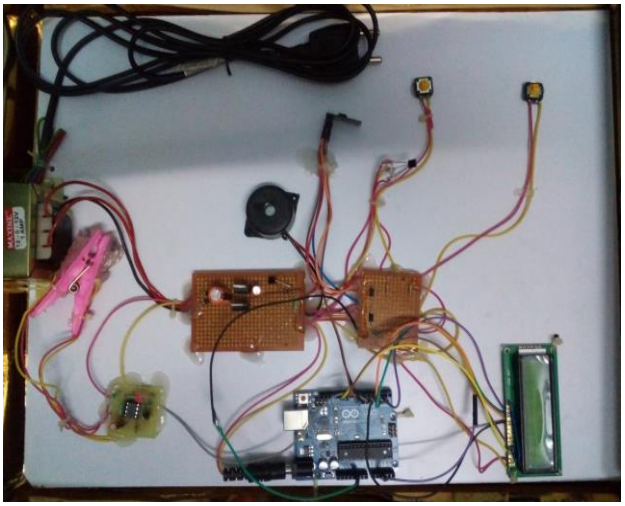

Fig. 10. IoT based PHMS hardware kit

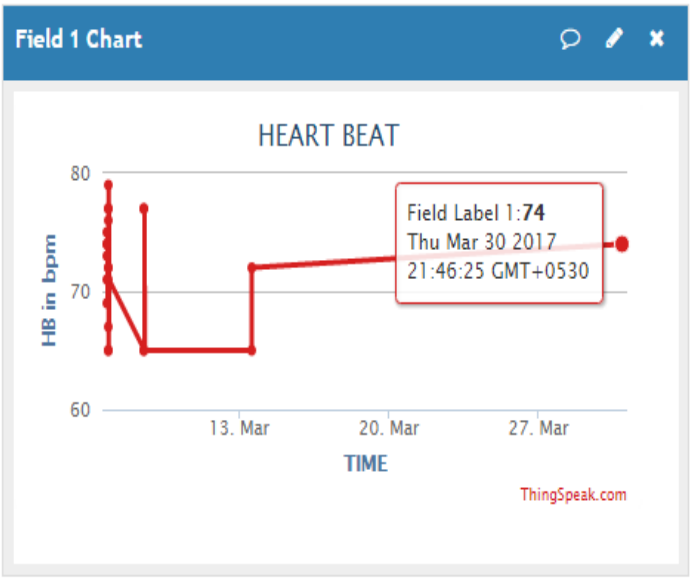

Fig. 11. Heartbeat of a patient monitored for a period of time

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The above figure indicates the measurement of heart beat (in bpm) of a patient for a particular period of time and the same can be representes in the below table.

S.No	Day	Time	Reading
1	06/03/2017	21:49:47	71
2	08/03/2017	13:47:39	65
3	13/03/2017	14:04:12	65
4	13/03/2017	14:09:50	72
5	30/03/2017	21:46:25	74

Table 1. Heartbeat of a patient monitored for a period of time

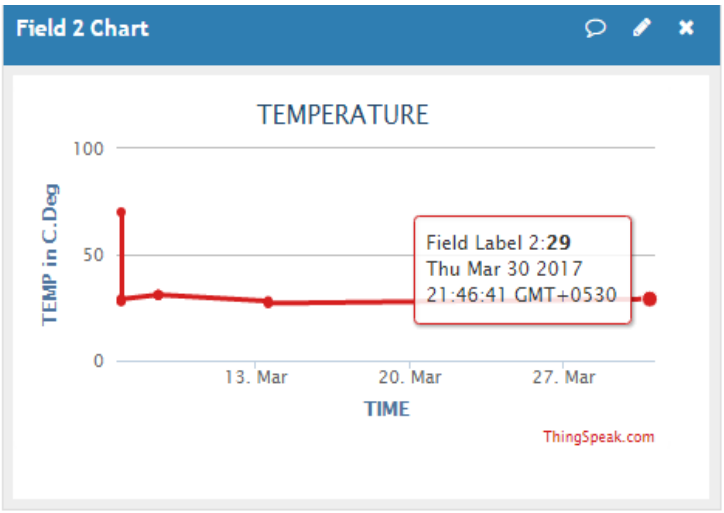

Fig. 12. Body Temperaure of a patient monitored for a period of time

The blood pressure has been calculated by considering on and of clock pulses of the output from sensor. The max value is obtained by dividing the ON clock pulses by 10. Similarly the min value is obtained by dividing the OFF clock pulses by 10.

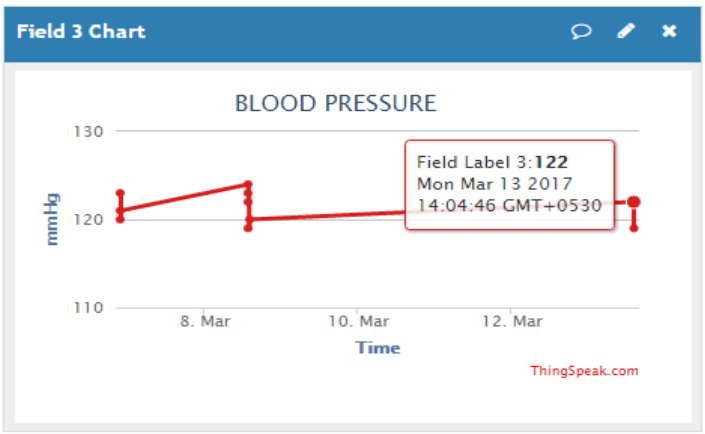

Fig. 6. Blood Pressure of a patient monitored for a period of time

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The maximum and minimum Blood Pressure readings (measured in mm Hg) of a patient for a specific instants of time are tabulated as given below.

S.No	Day	Time	Reading	
			max	min
1	06/03/2017	21:49:47	122	79
2	08/03/2017	13:47:39	120	82
3	13/03/2017	14:04:12	119	84
4	13/03/2017	14:09:50	124	87
5	30/03/2017	21:46:25	122	81

Table 2. Blood Pressure of a patient monitored for a period of time

The normal value of blood pressure for an adult must be less then 120/80 mm Hg. A diagnosis of high blood pressure must be confirmed with a medical professional. A doctor should also evaluate any unusually low blood pressure readings [12]. Based on the above reading the decisions can be made by the medical professional which are used to evaluate the system.

VI. CONCLUSION AND FUTURE WORK

This research led to the development of a system which measured heartbeat and temperature of a patient and sent it to a remote end by the use of a Arduino and Atmega328 microcontroller at a reasonable cost with great effect. It utilized remote patient monitoring system technology which enabled the monitoring of patients outside of clinical settings and leads to increasing access to health care as well as decreasing the health care delivery costs. Nowadays, most of the systems work in offline mode. The research utilized two sensors for measuring heartbeat and temperature of a body. These sensors are controlled by the Atmega328 microcontroller. For measurement of heartbeat, we used fingertip to measure it accurately. The device uses the optical technology to detect the flow of blood through the finger. The heart beat monitor in our research counts the heart beat rate in beats per minute (bpm) for specific interval and transfers the calculated rate via Wi-Fi module and sends it to a remote end where it displays the observed data in the website called Thingspeak.com. Optical sensor with combination of infrared light emitting diode (IR LED) and IR photodiode senses the pulse rate that produces weak output of analog signal. The signal is then amplified and filtered and fed to the microcontroller input. The microcontroller processes the input and calculates heart beat rate in beats per minute. Thus, calculated heart beat rate is displayed in liquid crystal display (LCD). The data is also displayed on the screen of a mobile device or PC by using WiFi module.

LM35 is used as a temperature sensor in this project which measures the temperature of the body and the measured data is fed to the transmitter module. Wireless system is used to transmit the measured data to a remote location. The transmitter transmits the calculated beat rate and is received in another terminal called receiver module. Inconvenience of using wire is avoided in this research. Finally, the data are displayed in the mobile screen or PC at the receiving end where the specialist or physician can analyze the data and will be able to provide aid. The developed system is reliable, economical and user friendly.

The current version of the system can post three parameters (Heartbeat, Temperature, Blood pressure)on to the web. But still there is room for improvements. Few other parameters like glucose levels, BMI (Body Mass Index), waist circumference etc., can also be measured. Then the complete health status of patient will be recorded and readily available on the web. Such that it will be much easier to the doctor to monitor the progress of patients' health now and then to advise them about their health.

The system can be extended by adding more features like linking the ambulance services, leading doctor's list and their specialties, hospitals and their special facilities etc., Doctors can create awareness about diseases and their symptoms through the mobile application. From the evaluation and the result obtained from analysis the system is better for patients and the doctor to improve their patients' medical evaluation.

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