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Raspberry Pi Based Patient Health Monitoring Systems Using Iot

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ABSTRACT: *The project aims at designing a system which monitors the health parameters of a patient and send the details through Wi-Fi module to the user android phone. Wi-Fi (Short for **Wi**reless **Fi**delity) is a wireless technology that uses radio frequency to transmit data through the air. Wi-Fi has initial speeds of 1mbps to 2mbps. Wi-Fi transmits data in the frequency band of 2.4 GHz. It implements the concept of frequency division multiplexing technology. Range of Wi-Fi technology is 40-300 feet. The Raspberry Pi is a low cost, credit-card sized computer that can be used in electronics projects. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. The device which is able to perform the task is a Raspberry Pi processor. There are different sensors such as Temperature, Heartbeat and ECG sensors. Temperature sensor measures temperature of a person. Heartbeat sensor measures heartbeat rate and Breath analyzer sensor records electrical activity of lungs of a person. All these parameters values are fed to the Raspberry Pi processor. All the parameter values are sent to the user mobile phone through Wi-Fi module and also constantly displayed on the LCD.*

I. INTRODUCTION

In today's era, health problems are increasing day-by-day at a high pace. The death rate of 55.3 million people dying each year or 151,600 people dying each day or 6316 people dying each hour is a big issue for all over the world. Hence it is the need of hour to overcome such problems. We, therefore, proposing a change in wireless sensors technology by designing a system which included different wireless sensors to receive information with respective human body temperature, blood pressure, saline level, heart rate etc. that will be undoubtedly further transmitted on an IoT platform which is accessible by the user via internet.

An accessible database is created about patient's health history which can be further monitored & analyzed by the doctor if necessary. The data storage can be saved on the server permanently or can be reset via the software. This project proposes a health monitoring system which is capable of detecting multiple parameters of our body such as blood pressure, temperature, heart rate, ECG & further transmitting this information on an IoT server through 2G/3G/4G GSM technologies. Also in case of emergency, automatically generating alerts will be sent to doctors and family members if any unusual activity is detected by or near the patient. A continuous record of body health parameters can be used to detect the disease in a more efficient manner. Now-a-days, people pay more attention towards prevention & early recognition of disease.

In addition to it, new generation mobile phones technologies & their services provides an important impact on the development of network varieties (3G, Bluetooth, wireless LAN, GSM) etc. Various sensors have been used like AD8232 ECG sensor for remote ECG monitoring, blood pressure sensor (4811) is used to measure systolic pressure and diastolic pressure & pulse rate for few seconds. LM35 temperature sensor is used to measure surface temperature of skin. Satisfactory work is done in health monitoring by using raspberry pi as well as IoT, but this project gives embedded concept of both the platform. By using combination of these, the proposed structure will be more effective. In this project, we investigated recent projects related to health monitoring systems & IoT. IoT is nothing but an advanced concept of ICT (Information Communication Technology).

IoT is the interconnecting of devices and services that reduces human intervention to live a better life. This project as showing the advancements in health care management technology, it would save patients from the future health problems that would arise and would also help doctors to take an appropriate measure or action at a proper time regarding patient's health.

II. LITERATURE REVIEW

Many researchers did their work on health monitoring system using IOT.M. Wcislik et al [2] monitors patient's body temperature, pulse rate, ECG wave and patient's body position using AR cortex M4F micro controller. Android app is created for monitor these values. Bluetooth connection is used for connecting microcontroller and Android phone. In my project monitor patient's body temperature, Respiration rate, heart rate and body movements using Raspberry Pi board and sensors. Android app is support only android phones.

Bluetooth is very short distance for communication. It supports only within 100 meters. In my project webpage is

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created. Using IP address anybody can monitor patient's health status anywhere in the world.

Amir-Mohammad Rahmani et al [3] monitor ECG wave using panda board. Ethernet connection is used for connecting internet to the panda board. In my project monitor body temperature, Respiration rate, heart rate and body movements using Raspberry Pi board. Panda board is very difficult to operate compare to Raspberry Pi board. Ethernet connection is also very short distance. So i use USB modem for connecting internet to the Raspberry Pi board. Hoi Yan Tung [3] et al monitors body temperature, ECG, heart rate using DRZHG micro controller.

A Dual Radio ZigBee Homecare Gateway (DRZHG) has been proposed and implemented to support remote patient monitoring. The idea of remote patient monitoring is to simultaneously track the status of long-termpatients at home by using mobile medical sensors. The sensorscollect medical data from patients and feedback the data to thedoctors. Zigbee module is used for connected to the micro controller. Zigbee module is used for transfer the values to the receiver side. It is send data to only nearest place. But my project internet is connected to the Raspberry Pi board. So using IP address anybody can monitor patients health status anywhere in the world. Joao Martinhoa [4] et al describe the design and successful implementation of a remotely operated physiological monitoring device.

The prototype performs acquisition of three types of physiological measurements electrocardiography, finger photoplethysmography, and blood pressure plethysmography. Atmega 328 microcontroller is used for connecting these sensors. Wifi connection is used for connecting internet to the atmega 328 microcontroller. After connecting Wifi connection it will transfer the values. If wifi hotspot is no means it is not transfer the values. Wifi is also works on short distance. In my project USB modem is used for connecting internet to the Raspberry Pi board. So it is easily connect to the internet in any place

III. DESIGN OF HARDWARE

This chapter briefly explains about the hardware implementation of health monitoring systems using iot and raspberry pi. It discusses the circuit diagram of each module in detail. For implementing the health diagnosis system, there is a need of essential components that are suitable and manipulate health problems. The components use generally includes temperature sensor LM-35, blood pressure sensor, heartbeat sensor, ECG sensor, raspberry pi and GSM module.

3.1. Temperature Sensor-LM35

It is an IC sensor that is used to measure temperature with an output voltage linearly proportional to the Centigrade temperature. The LM35 sensor has an advantage over linear temperature sensor, as the user has not to make the conversion of Kelvin to Centigrade. This is major significance of LM-35 that it calibrates directly in Celsius and it is also suitable for remote applications. It has better efficiency than thermistor.

Temperature is one of the most commonly measured parameter in the world. They are used in your daily household devices from Microwave,fridges, AC to all fields of engineering. Temperature sensor basically measures the heat/cold generated by an object to which it is connected. It then provides a proportional resistance, current or voltage output which is then measured or processed as per our application. Temperature sensor are basically classified into two types

- Non Contact Temperature Sensors: These temperature sensors use convection & radiation to monitor temperature
- Contact Temperature Sensors: Contact temperature sensors arethen further sub divided into three type
    1. Electro-Mechanical(Thermocouples).
    2. Resistive Resistance Temperature Detectors (RTD).
    3. Semiconductor based. (LM35, DS1820 etc).

In this project, we will be discussing about LM35 Temperature Sensor which is a semiconductor based sensor. LM35 is an integrated analog temperature sensor whose electrical output is proportional to Degree Centigrade. LM35 Sensor does not require any external calibration or trimming to provide typical accuracies. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

3.1.1 Features of LM35 Temperature Sensor

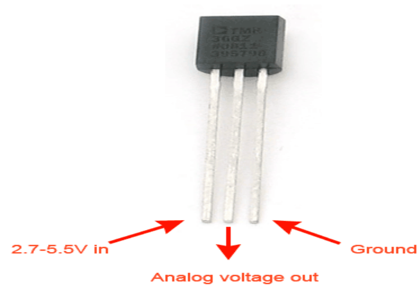

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Fig 1: Pin diagram of LM35

- Calibrated directly in Degree Celsius (Centigrade)
- Linear at 10.0 mV/°C scale factor
- 0.5°C accuracy guarantee-able (at a25°C)
- Rated for full -55°C to a 150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 mA current drain
- Low self-heating, 0.08°C instill air
- Non-linearity only 0.25°C typical
- Low impedance output, 0.1Ωfor 1 mA load

3.1.2 LM35 Interfacing Circuit

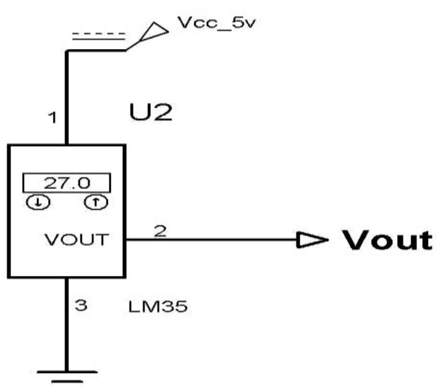

Fig 2 LM35 Interfacing Circuit

As such no extra components required to interface LM35 to ADC as the output of LM35 is linear with 10mv/degree scale. It can be directly interfaced to any 10 or 12 bit ADC. But if you are using an 8-bit ADC like ADC0808 or ADC0804 an amplifier section will be needed if you require to measure 1°C change.

LM35 can also be directly connected to Arduino. The output of LM35 temperature can also be given to comparator circuit and can be used for over temperature indication or by using a simple relay can be used as a temperature controller.

3.2 Heartbeat Sensor

It is used to measure the heartbeat of the patient. It gives a digital output of heart beat when a finger is placed on it. It is compressed in size. The working voltage of heart beat sensor is +5V DC. It works on the principle of light modulation by blood flow through finger at each pulse. Heart beat sensor is used to measure heart beat which normally lies between 60- 100bpm.

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

3.2.1 Features

- Heat beat indication by LED
- Instant output digital signal for directly connecting to microcontroller
- Compact Size
- Working Voltage +5V DC

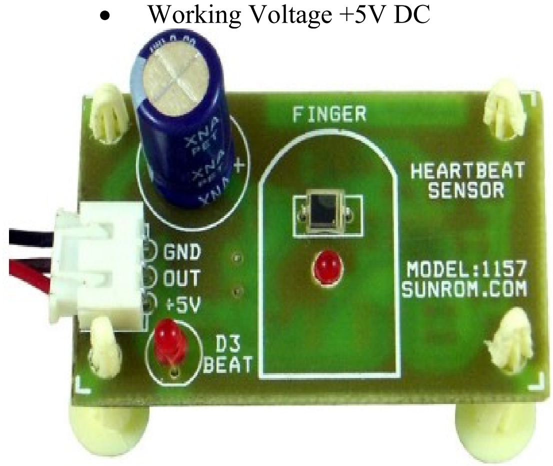

FIG 3 Heart beat sensor

Pin Details Board has 3-pin connector for using the sensor. Details are marked on PCB as below. Pin Name Details 1 +5V Power supply Positive input, 2 OUT Active High output and 3 GND Power supply Ground.

3.2.3 Working: The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat.

Using the Sensor: Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB. To test sensor you only need power the sensor by connect two wires +5V and GND. You can leave the output wire as it is. When Beat LED is off the output is at 0V.Put finger on the marked position, and you can view the beat LED blinking on each

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heart beat. The output is active high for each beat and can be given directly to microcontroller for interfacing applications.

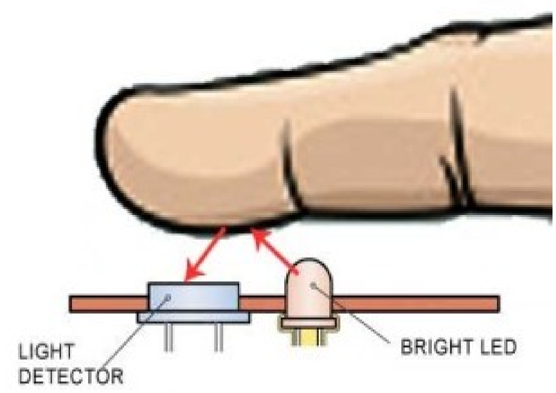

Fig 4sensor principle

3.3. Raspberry Pi

It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply.

Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. It also has 4 pole stereo output and composite video port. Video processing applications are also possible using raspberry pi like video compression.

Compressed video can successfully decrease the bandwidth required to transmit the video through terrestrial broadcast, cable TV, or satellite TV services [19]. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi for the system implementation is Python.

3.3.1 Hardware

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

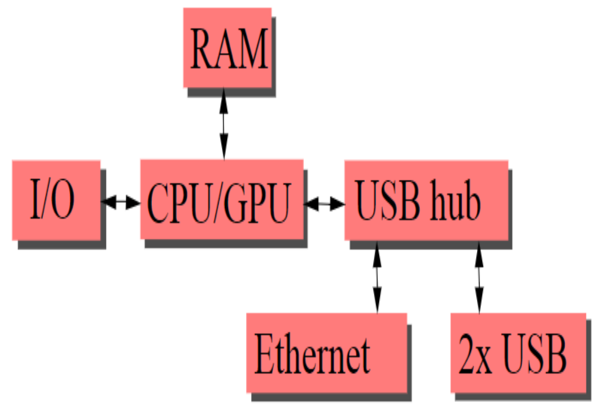

Fig 5 Raspberrypi block function

This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

3.3.1.1 Processor

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7 processor. The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones

(its CPU is an older ARMv6 architecture),[22] which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[23] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The earlier models of Raspberry Pi 2 use a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.[24] The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor,[25] the same SoC which is used on the Raspberry Pi 3. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.[26]

Fig 6 The Model B boards incorporate four USB ports for connecting peripherals.

3.4. POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as "Regulated D.C Power Supply".

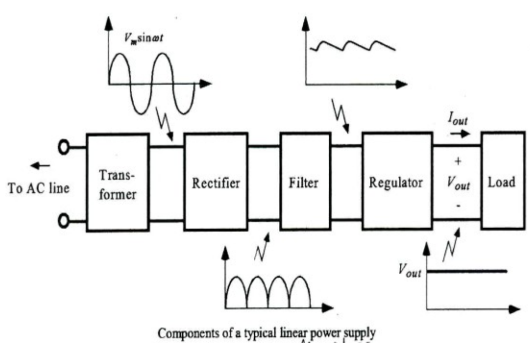

Fig:7. Block Diagram of Power Supply

IV. PROJECT DESCRIPTION

This chapter deals with working and circuits of "**HEALTH MONITORING SYSTEMS USING IOT AND RASPBERRY PI**". It can be simply understood by its block diagram &circuit diagram.

4.1. BLOCK DIAGRAM:

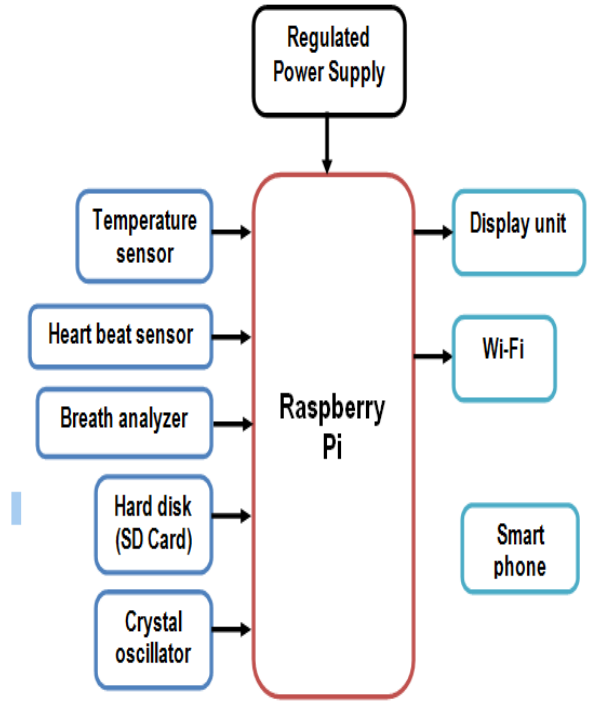

Fig 8: block diagram

4.2. SOFTWARE REQUIREMENTS:

- MATLAB
- Flash Magic

4.3. HARDWARE REQUIREMENTS:

- Power supply
- LPC2148
- IR sensor
- Alcohol sensor
- LCD
- APR9600
- Speaker

4.4. WORKING:

The system is classified into two parts, viz. Hardware & Software; whereas hardware unit consists of transmitter section and receiver section and software unit consists of software languages like python, MATLAB, etc as well as their interfacing. Here we discuss IoT applications that are useful to health monitoring.

The general operation stages of an IoT application include

1) data acquisition,
2) data processing,
3) data storage, and
4) data transmission.

The first and last stages exist on every application, while the processing and storage may or may not exist in some applications [10].Here data acquisition is

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used as real-time raw data transmission, raw data transmission and real time on-board process. The energy consumption of data acquisition can be reduced with MEMS technology. Many IoT applications have the data sparsity property and can exploit the compressed sensing paradigm. In health monitoring applications and wireless body sensor network, compressed sensing has been investigated and studied extensively [12].

Energy efficiency in a processing unit can be achieved by

1) ultra-low power processors [13] and
2) efficiently customized co-processors [14].

An ultra low power near- threshold processor alongside with a high performance processor in addition to a task scheduling framework brings energy efficiency for IoT applications. Energy reduction in memory has received significant industrial and academic attention in embedded system design community [16], but there are some characteristics specific to IoT applications that can be exploited for further improvements in energy efficiency of memory in IoT embedded devices.

Data transmission can be improved by integrating radio transceivers into SoCs, providing low power multi-radio chips, etc. In order to reduce the amount of data to be stored or transmitted, new data compression techniques, especially for the streams of data, are needed [17]. Figure 2 shows a general architecture of the main components of an IoT SoC platform [16]. An IoT embedded device has many - if not most– of these components, e.g. at least one RF component for the connectivity.

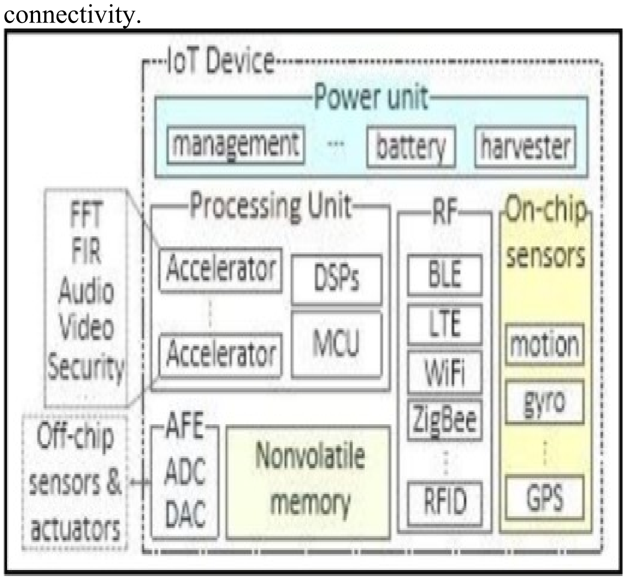

Fig. 9: Architecture of IoT device

The system is divided into hardware and software section. Software is responsible for better working of the system, also for interfacing. Both sections work in parallel process. Hardware is again classified into transmitter section and receiver section. Implementation of transmitter is important part, because transmitter section is directly attached to the patient or human body.

Raspberry Pi is a master device in proposed system; all the other devices like different sensors are connected to it. A DC power supply of 5V is provided for working of raspberry pi. IoT server is attached to the system; it allows the connectivity for data exchange with other devices. IoT allows connected objects to identify and control remote access across network. The output of temperature sensor and heartbeat sensor is displayed on LCD at user end too. The output of ECG is sent to the receiver or doctor end. All the information is first acquired, processed and stored at memory of raspberry pi. The stored information is then transferred to the receiver by means of IoT server. The Receiver section is present at doctor end. At receiver section, all the information is received. Monitor displays the result of each sensor which is attached to raspberry pi.

4.5. FLOW CHART:

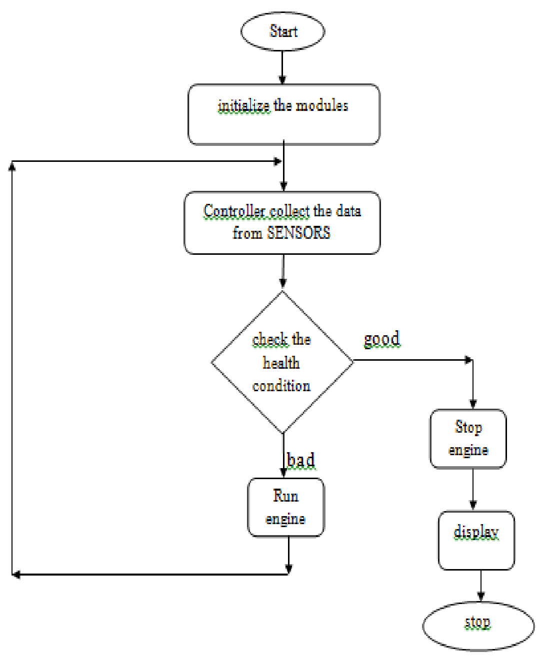

Fig 10. Flow chart

RESULTS:

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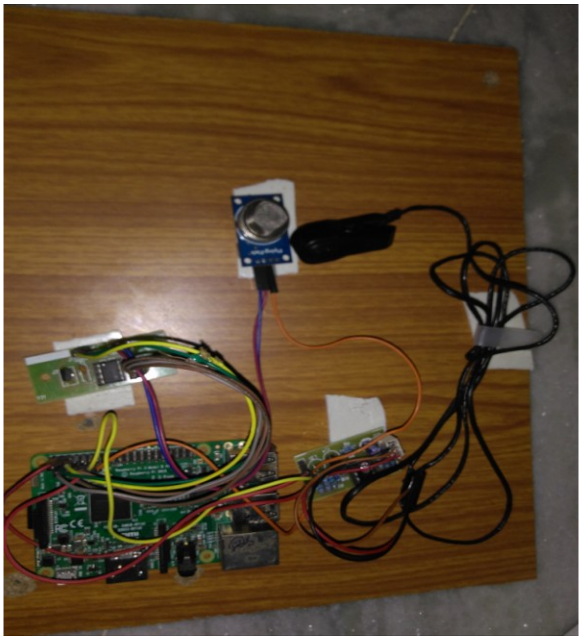

Fig11: Hardware kit of proposed

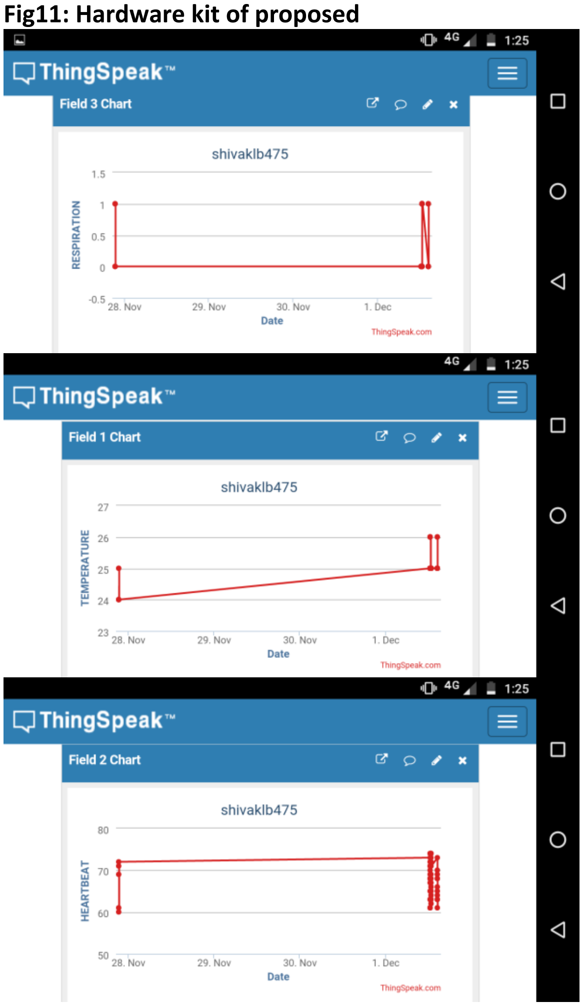

Fig12 : Graphs taken from sensors

V. CONCLUSION

In this project, we have analyzed Raspberry-Pi based health monitoring system using IoT. Any abnormalities in the health conditions can be known directly and are informed to the particular person through GSM technology or via internet. 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.

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