IOT Based Heartbeat, Oxygenand Body Temperature Monitoring System Using NodeMCU

Ms. Shilpa Mazumdar[1], Mr. ShubhamGhodpage[2], Ms. Ayushi Urade[3], Ms. Shivani Bhardwaj[4], Ms.Purvaja Sawarkar[5], Mr. Vijay Chakole[6]

[123456]Department of Electronics Engineering, K. D. K. Collage of Engineering, Nagpur (Maharashtra), India.

Abstract:

The Internet of Things (IoT) platform offers a promising technology to achieve the healthcare services, and can further improve the medical service systems.In this paper we have discussed about Heartbeat, Oxygen and Body Temperature Monitoring System (HBMS), in which we tryto solve a healthcare problem currently facing by people. The aim of this project is to design a remote healthcare system. It's comprised of three main parts. The first part being, detection of patient's health issues using sensors, second for transfer data to cloud storage and the last part was providing the detected data for remote viewing. Reserved viewing of the data permits a doctor or guardian to observe a patient's health progress away from hospital premises.

Keywords *– IOT, NodeMCU, Heartbeat Sensor, Temperature Sensor, about Heartbeat and Body Temperature Monitoring System (HBMS), Microcontroller.*

Introduction:

The emerging Internet of Things (IoT) framework allows us to design small device that are capable of sensing, processing and communicating, allowing sensors, embedding devices and other things to be created which will help to understand the surrounding. A Heartbeat and Body Temperature Monitor system is an extension of a hospital medical system where a patient's vital body state can be monitored remotely. Traditionally the detection systems were only found in hospitals and were characterized by huge and complex circuitry which required high power consumption.Continuous advances in the semiconductor technology industry have led to sensors and microcontrollers that are smaller in size, faster in operation, low in power consumption and affordable in cost.The basic objective of this development is the design and implementation of a insolent patient health tracking system that uses Sensors to track patient health and uses internet to update their loved ones in case of any issues.

The objective of developing monitoring systems is to reduce health care costs by reducing physician office visits, hospitalizations, and diagnostic testing procedure.In addition, Doctors play a very important role but the process of check-up is quite lengthy like first a person need to catalogue then he/she will get the selection and then later on the check-up reports are generated. Due to this long-lasting process working people tend to disregard the checkups or reschedule it. This modern approach reduces time consumption in the process.

Literature Review:

Several inclusive reviews about the subject of health observing with wearable sensors have been formerlyoffered in the literature form. Several such journals focus on giving a worldwide synopsis of the subject. Studies on healthiness monitoring systems include wearable, mobile and isolated systems.

In paper [1] the literature review is carried on to study to get information about the IOT based Patient Health Monitoring System using Raspberry pi 3 in which the system used to measure the temperature, humidity, blood pressure (bpm).

In paper [2]the research was successfully obtained temperature of the patient, ECG and heart rate. Every time there is an rise of fever and heartbeat rate of patient the official care givers get message so that they can take some immediate measures.

In paper [3] authors proposed a system consisting of an Arduino microcontroller, temperature sensor, heartbeat

Sensor, Wi-Fi module. Bluetooth module and Network Radio Frequency (NRF) module. It handles together in-patients and out-patients of a hospital. In-patients' data is transmit byusing NRF module to a local receiver and further processed and displayed on the website while outpatients' data is transmitted to Wi-Fi.

In paper [4]"Digital hospital"term is introduce for hospital management. It permits programmed electronic medical records in small duration. Similarly talk over with the employed real-worldsituation of smart self-directed hospital administration with IOT.

Components Used:

1] NodeMCU ESP8266 :

Figure 1: NodeMCU [5]

NodeMCU is an opened-sources Lua based firmware and development board specially embattled for IoT based Applications. It contains firmware that goes on the ESP8266 Wi-Fi SoC from Espressif assembly, and hardware which is grounded on the ESP-12 module.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL grounded on CP2102 is comprised onboard, Allowing Plug n Play.
- PCB Antenna
- Minor Sized element to fit elegantly inside your IoT projects.

Other Espressif Boards are mention below:

ESP8266, ESP12E, ESP32

Its Pin Configuration is shown below:

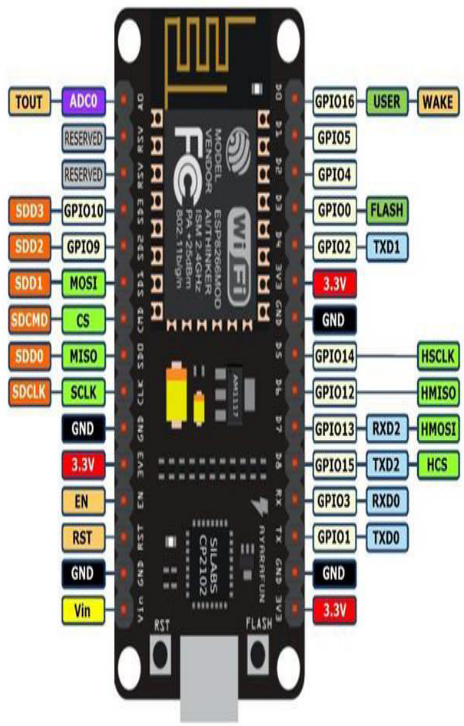


Figure 2 : Pin Diagram of NodeMCU [6]

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be motorized through the USB port **3.3V:** synchronized 3.3V can be provide to this pin to control the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Applications of NodeMCU

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projectnecessitating multiple I/Oborders with Wi-Fi and Bluetooth functionality.

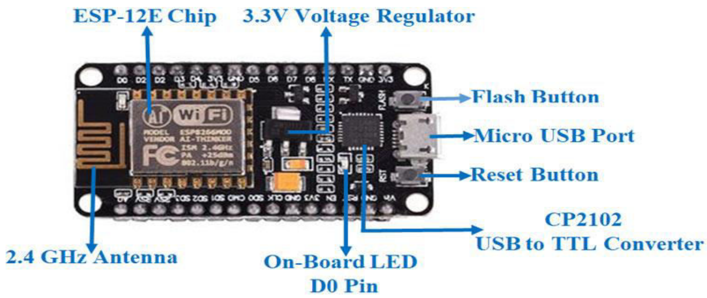


Figure 3 : NodeMCU Microcontroller Board [7]

2] DS18B20 Temperature sensor:

Pin configuration is shown below:

No:	Pin Name	Description
1	Ground	Connect to the ground of the circuit
2	Vcc	Commands the Sensor, can be 3.3V or 5V
3	Data	This pin provides output the temperature value which can be read using 1-wire scheme.

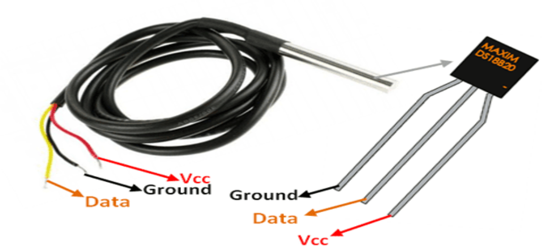


Figure 4: DS18B20 Temperature sensor [8]

DS18B20 Sensor Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Programmable alarm options
- Available as To-92, SOP and even as a rainproof sensor

DS18B20 Equivalent Sensors

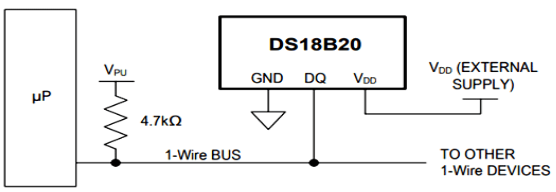
DS18S20

Where to use DS18B20 Sensor

The **DS18B20** is a 1-wire programmable Temperature sensor commencing maximumincluded. It is extensively use to measure temperature in hard environments resembling in chemical solutions, mines or soil etc. The constriction of the sensor is strong and also can be purchase with a water-resistant option making the swelling process easy. It can calculated a wide range of temperature from **-55°C to +125°** with a decent accuracy of **±5°C**. Each sensor has aexclusive address and requires only one pin of the MCU to transfer data so it a very superior choice for measurethe temperature at many points without compromise much of your digital pins on the microcontroller.

How to use the DS18B20 Sensor

The sensor works as amanner of 1-Wire communication. It require only the data pin connected to the microcontroller with a drag up resistor and the additional two pins are used for power as shown above.



The pull-up resistor is used to remain the line in elevated state when the bus is not in use. The temperature value measure by the sensor will be stored in a 2-byte record inside the sensor. This data can be read by the using the 1-wire method by transfer in a sequence of data. two types of commands are to be sent to read the values, one is a ROM command and the other is function command. You have to read through it to understand how to converse with the sensor.

If you are setting up to interface it with Arduino, then you need not worry about all these. You can develop the gladly available library and use the in-built functions to access the data.

Applications:

- Measuring temperature at hard environments
- Liquid temperature measurement
- Applications where temperature has to be measured at multiple points

3] **MAX30102 Pulse Oximeter & Heart-Rate Sensor:**

MAX30102 is an assimilated pulse oximetry and heart-rate monitor instrument solution.It assimilates two LEDs (IR and Red), a photodetector (visible + IR), optimized optics, and low-noise analog signal handing out to detect pulse oximetry and heart-rate signals. It is entirely configurable through software registers and the digital output data is stored is stored in a 32-deep FIFO inside the device.

It has an I2C digital interface to correspond with a host microcontroller. The pulse oximetry subsystem in MAX30100 consists of ambient light termination (ALC), 18-bit sigma delta ADC, and proprietary separate time filter. It has an ultra-low-power function which makes it ideal for battery operated systems.

Figure 5: MAX30102 Pulse Oximeter/Heart-Rate Sensor [9]

It has an included temperature sensor for calibrating the temperature reliance of pulse oximetry system.It also has proximity recognition function to reduce power consumption and visible light emission when the user's finger is not a sensor.

Features:

- Heart-rate monitor and pulse Oximeter sensor in an LED reflective solution
- Tiny 5.6mm x 3.3mm x 1.55mm 14-pin optical module
- Integrated cover glass for optimal, robust performance
- Ultra-low power operation for mobile devices
    - Programmable sample rate and LED current for power saving
    - Low-power heart rate monitor (<1mW)
    - Ultra-low shutdown current (0.7µA Typ.)
    - Fast data output capability
    - High sample rates
    - Robust motion artifact resilience
    - High SNR
    - -40°C to +85°C operating temperature range

Methodology:

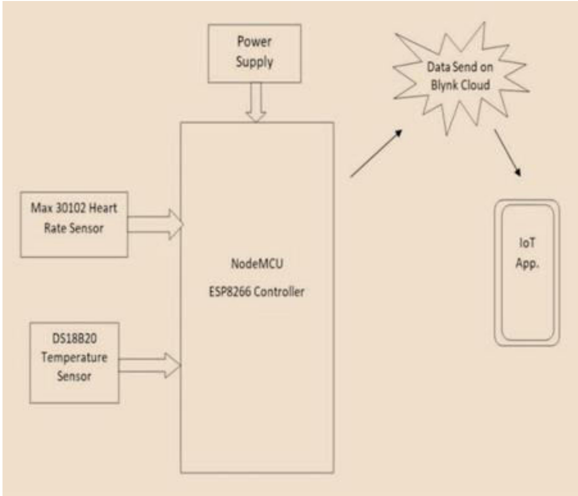


Figure 6: Block Diagram of Heartbeat and Body Temperature Monitoring System

The NodeMCU was programmed in embedded C using the PlatformIO IDE. After booting up, the NodeMCU automatically starts collecting data from the DS18B20 Temperature sensor and MAX30102 Pulse Oximeter & Heart-Rate Sensor. As both sensors are digital sensors so they are connected to digital pins of NodeMCU which are D0 to D8. DS18B20 temperature sensor gives us accurate reading with 0.5% tolerance in Degree Celsius which we will convert into Fahrenheit later. The another sensor is used to measure BPM that is beat per minute and oxygen level. We will provide power supply to NodeMCU up to 3.3 V through its controller pin. NodeMCU consists of Wi-Fi IC which will help us to send our data to cloud. We had created an app where doctor can create his account and check temperature, oxygen and BPM of patient. Doctor will receive an pop up message if patient's temperature will increase above 102 and oxygen level will be below 96.

Result:

Here doctor can see history of patient vitals that has been recorded and stored in server in tabular form. This data can specifically be used by doctor to perform analysis on patient health condition to predict any irregularities in health conditions, to recommend change in medication or treatments etc. and can be used to recommend patient regular visits.

Figure 7: App outlook showing patient's parameters

Table given below shows the parameter and readings detected by HBMS of several people taken in different date and time.

Date and Time	Temp	O2	BPM
14-04-21 4:53:09	99	96	86
14-04-21 4:53:20	99	96	86
15-04-21 6:12:13	101	92	88
15-04-21 6:15:43	104	92	87
16-04-21 9:13:09	100	84	86
16-04-21 9:53:27	100	84	87

We had created an app named as BlINK where doctor can create his account and able to watch user's or patient's vital information. Temperature in calculated in Fahrenheit, oxygen in percentage and heartbeat per

Minute.

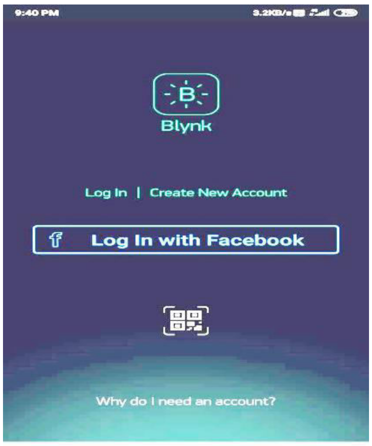


Figure 8: User/Doctor login display

In this app we are representing three parameters which include temperature, BPM and oxygen of patient which will display as shown in fig 9. Doctor will receive an pop up message if patient's temperature will increase above 102 and oxygen level will be below 96.

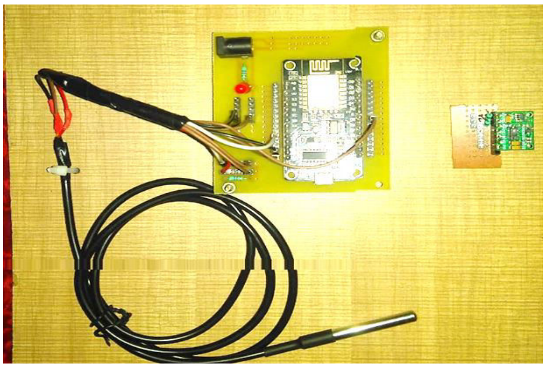


Figure 9: Final look of HBMS

Conclusion:

In these cutting edge time, IoT has gotten one of the most splendid fields by which human existence has gotten simpler, safe and proficient through assortment of its applications. In each area of our everyday life, we understand the effect of this specific field. Nonetheless, our work was to build up a lifeline. Heart rate and temperature of an individual was resolved on- gadget and delivered over the web through a Wi-Fi network. Transferred information was put away in a distant webserver and shown through the HBMS app. Correlation with another gadget was led to guarantee accuracy what's more, exactness. At long last, benefits and spaces of further advancement were examined. Far off wellbeing conclusion frameworks, especially those furnished with IoT innovation, offer admittance to expanded recurrence of patients' wellbeing information, help to lessen clinic stays and empower patient observing even after discharge. They can save lives through continuous mediations and backing while at the same time lessening cost and analysis time. These frameworks have potential for improving medical care offices all throughout the planet. Be that as it may, a challenge in detecting, examination, and representation of well-being information requires further exploration and conversation. They should be tended to before these frameworks can be intended for consistent joining into clinical practice.

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