ISSN: 2321-2152

IJMECE

International Journal of modern electronics and communication engineering

E-Mail
editor.ijmece@gmail.com
editor@ijmece.com

www.ijmece.com

ISSN2321-2152
www.ijmece .com
Vol 11, Issue.4Nov 2023

Design and Implementation of IOT Based Health Monitoring System Using Raspberry Pi

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ABSTRACT: The paper introduces the design and implementation of an IoT-based Health Monitoring System utilizing Raspberry Pi. With the increasing prevalence of chronic diseases and the growing importance of remote healthcare, the integration of Internet of Things (IoT) technology becomes imperative for real-time health monitoring. This research endeavors to address this need by proposing a comprehensive solution that leverages the capabilities of Raspberry Pi, a versatile and cost-effective single-board computer. The system encompasses a network of wearable health devices equipped with sensors for monitoring vital signs such as heart rate, body temperature, and blood pressure. These devices communicate seamlessly with the Raspberry Pi, acting as a central hub, through wireless protocols. The collected health data is then processed and transmitted securely to a cloud-based server for storage and analysis. Furthermore, the paper delves into the architecture of the proposed system, detailing the functionalities of each component and the communication protocols employed. The Raspberry Pi's role in data aggregation, preprocessing, and secure transmission is expounded upon, emphasizing its suitability for such applications. Additionally, the integration of cloud computing ensures scalability, accessibility, and robust data management. The implementation of the IoT-based Health Monitoring System is validated through experimental results, demonstrating the system's efficacy in real-world scenarios. The paper concludes by highlighting the potential impact of the proposed solution on healthcare, emphasizing its ability to provide timely and accurate health information, facilitating early intervention and personalized care.

KEYWORDS: Health monitoring system, heart beat sensor, temperature sensor, vibration sensor, BP sensor, IOT.

INTRODUCTION

The population in the world is increasing day by day. This brings a need for more healthcare options. To developed healthcare technologies and facilities. The proportion of senior citizens is increased in the society. These senior citizens which requires proper medical care than the rest of the population. So, the monitoring and recording of Physiological parameters of patients outside the clinical environment is becoming increasingly important in order to take care of senior citizens. Today the networking technologies are very much developed. So that the communication or connection between the people, multimedia and services have been greatly changed. Wireless communications technologies have greatly affected on the people's lifestyle. The "Internet of things" - IOT is a concept and mode consisting of sensors, actuators, and development boards interacting with each other connected over the internet without any human intervention resulting into a more intelligent system. In simple words, IOT refers to a network of objects all connected to the internet at the same time. The main principle of Internet of things (IOT) is that the objects/things i.e., sensor nodes identify, sense, process and communicate with each other. IoT has a substantial influence in healthcare domain. Still, there are so many people who do not have access to quality healthcare services, thus remote patient monitoring becomes a need. Presently Healthcare system is shattered with the lack of communication between the patients and the doctors. Thus, to address this problem information technology becomes a need. Healthcare services can be improved a lot

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ISSN2321-2152
www.ijmece .com
Vol 11, Issue.4Nov 2023

with IoT-enabled healthcare devices. By applying IoT concepts in healthcare, there is a great possibility of virtually saving the lives. Ehealth solutions based on IoT should provide worth information about health to the patients and the doctors can make better decisions irrespective of their patient's location [2]. IoT has already brought changes in various domains of health care like intelligent healthcare tools and devices, diagnostics and monitoring of patients, data storage, transfer, and collaborations.

I. LITERATURE REVIEW

In the early days of the automation and digital era, ensuring safety and security was a more manual and rudimentary process. The literature emphasizes the widespread adoption of wearable health devices equipped with various sensors for continuous monitoring of vital signs.

The literature review establishes a foundation for the design and implementation of the IoT-based Health Monitoring System using Raspberry Pi. By synthesizing existing knowledge, identifying gaps, and drawing upon established frameworks, the study positions itself within the broader context of IoT-enabled healthcare systems, aiming to contribute novel insights and solutions to the field.

II. SYSTEM ARCHITECTURE

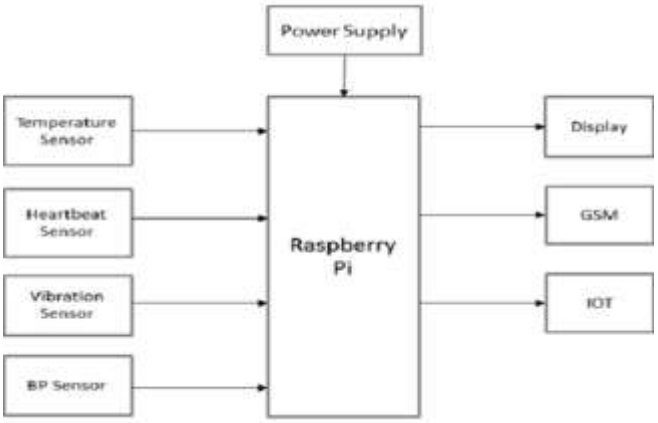
The design part consists of mainly two sections:

- Hardware architecture
- Software architecture

VI. Hardware Architecture

It includes temperature sensor, heart beat sensor, raspberry pi, vibration sensor.

III. BLOCK DIAGRAM



IV. COMPONENTS DESCRIPTION

1.Raspberry pi:

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

2. Heartbeat sensor:

The heartbeat sensor is based on the principle of photoplethysmography. The blood volume changes through any organ of the body due to which the light intensity also changes through the vascular region/organ. The rate of heart pulses decides the rate of flow of blood volume and since light is absorbed by blood, the heart beat pulses are equivalent to signal pulses. The timing associated with the pulses is more important in the case where the pulse rate is to be monitored. Working of a Heartbeat Sensor: The heartbeat sensor consists of an Infrared LED and a photodiode (light detecting resistor) to detect the pulse of the finger. On one side infrared LED is present whereas on the other side photodiode is present. When the light source illuminates the tissue, the reflected rays are being captured by the Photodiode [3]. The output of the detector is an electrical signal which basically gives the number of pulses counted by the sensor. This pulse rate sensor is shown in fig. 2 has the following features –LED for the heartbeat indication, Digital output, Compact in size with the operating voltage of +5 V DC.

Heartbeat sensor

3. Temperature sensor:

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ^{o}C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and

ISSN2321-2152
www.ijmece .com
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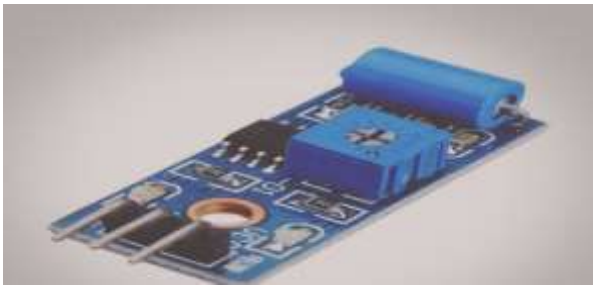
other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possesses low self-heating and does not cause more than 0.1 ^{o}C temperature rise in still air. The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ^{o}C rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ ^{o}C.figure show the typical view of temperature sensor.

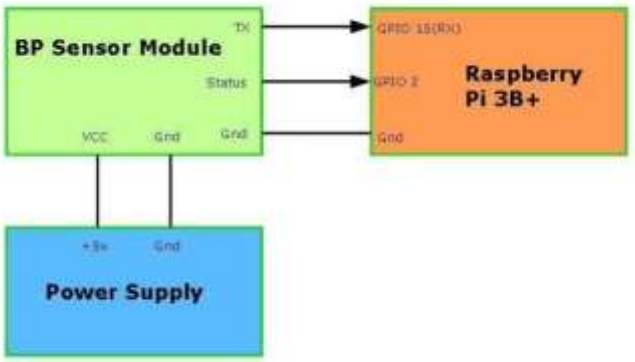
4. Vibration sensor:

An SW-420 vibration sensor module is a small, self-contained device that is used to measure levels of acceleration, vibration, or both. and Comparator LM393 is used to sense vibrations. The SW-420 is designed to be mounted on a machine or structure, and it uses an accelerometer to measure vibrations. The module also has a built-in amplifier and filter, which helps to reduce noise and improve the accuracy of the measurements.



5.Blood pressure sensor:

Blood pressure is the pressure of the blood in the arteries as it is pumped around the body by the heart. When your heart beats, it contracts and pushes blood through the arteries to the rest of your body. This force creates pressure on the arteries. Blood pressure is recorded as two numbers— the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). The unit which measures this is called a Sphygmomanometer. Monitoring blood pressure at home is important for many people, especially if you have high blood pressure. Blood pressure does not stay the same all the time. It changes to meet your body's needs. It is affected by various factors including body position, breathing or emotional state, exercise, and sleep. It is best to measure blood pressure when you are relaxed and sitting or lying down.



B. Software Architecture

It includes MQTT protocol,

1. MQTT protocol

MQTT (Message Queuing Telemetry Transport) is a low bandwidth, a lightweight protocol which was developed in1999 for connecting different devices and applications together especially for the machine-to-machine communication (M2M). Unlike HTTP protocol which uses request/response architecture, MQTT protocol follows publish/subscribe architecture. It provides great flexibility to the clients to connect as a publisher, subscriber or both. By using this protocol, the user gets connected to MQTT broker which is solely responsible for all the messages being transmitted and received.

6.POWER SUPPLY

At the coordinator end and sensor node, many components are used. These components have different operating voltage such as controller operates at 3.3 – 5v. ZigBee transceiver operates at 1.8 V to 3.8 V, LM 35 and LCD display operates at 5 V. To meet these requirements of different operating voltage ranges a proper arrangement of power supply is required. The 7805-voltage regular is used to provide 5 V regulated power supply.

7.GSM modem Section:

This section consists of a GSM modem. The modem will communicate with microcontroller using serial communication. The modem is interfaced to microcontroller using MAX 232, a serial driver. The Global System for Mobile Communications is a TDMA based digital wireless network technology that is used for communication between the cellular devices. GSM phones make use of a SIM card to identify the user's account.

V. WORKING

A health monitoring system consists of several sensors connected to a patient and they communicate the data through the processing unit. In the project, Raspberry Pi is used as a data aggregator as well as a processor. The patient and doctor

smartphone/computer are used as a monitoring system. As in figure, the sensors system is used to obtain the information or readings from the patient and the reading which is read is converted into signals. These signals are provided for processing to Raspberry Pi, which is the IoT module. The Pi then displays the information on a Monitor and also stores the information over the cloud. This information can be accessed by the doctor on his phone/computer and get the information. If any emergencies, the patient is sent an alert automatically through the mail for medical medication. The flow diagram of the paper is shown in figure, the sensors value is read and displayed on the monitor and stored in the cloud for future use. If blood pressure sensor output is above 120 an alert mail is sent to the patient automatically to consult the doctor. The Mouse and Keyboard connected to the USB port of Pi and the Monitor connected to the HDMI video port. The sensors connected to the GPIO pin through which the data from the Pi is transferred to the server and the patient can monitor the data on the monitor.

Above figure shows the display of the health monitoring system on the patient's monitor. After the use of the pulse rate, blood pressure and heart sound sensor, the digital output from the sensor through the Pi is displayed on the Monitor.The Sensors output is displayed on the server, the IP address of the server is the same as the IP address of the raspberry pi which is shown in figure. This is a database where the patient's health report is stored for future requirement by the doctor and the patient. If the patients' blood pressure >120 an alert mail is sent to the patient by the doctor for the medical medication.

VI. METHODOLOGY

In this paper we have temperature, heart beat reading results are monitored. These sensors signal is send to the Raspberry Pi via ADC8080 because signals are in analog form. To convert into digital form and send to Raspberry Pi. Raspberry pi is Linux based operating system works as small pc processor system. Hear patients body temperature and heart beat is measured using respective sensors and it can be monitored in the monitor screen of computer using Raspberry pi as well as monitoring through anywhere in the world using internet source.

VII. CONCLUSION

In this paper, we designed system gives minimum complexity and very portable for healthcare observing of the patient. Furthermore, it disregards of the need of usage of costly facilities. The specialist or the doctor can readily get to the patient's information at any place with the help of internet services. The proposed system used sensors platform integrated with Raspberry pi board. Three sensors have been utilized in this paper and which temperature sensor, heart beat sensor. All the patient's vital signs sent remotely and displayed via system website. The system is implemented for one-to-one access, which can be implemented for many by giving a unique id for each member/patient in the home or the hospital. The enhancement for the designed system will connect more sensors and connect all the objects to the Internet for quick and easy access. Further enhancement of the existing model can also be deployed as a mobile application in order to become easy to access the model around the world. The mobile application can be enhanced with the ambulance services, doctor's list, nearby hospitals.

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ISSN2321-2152
www.ijmece .com
Vol 11, Issue.4Nov 2023