Design of IOT enabled Wireless Body Area Network System for Modern Medical Care Monitoring

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Abstract

In the recent years, new technological inventions have been evolved and there is enormous growth of smart gadgets that have been developed for wide range of applications. This Manuscript is focused on the Internet of Things (IOT) enabled Wireless Body Network system that have been used for the modern medical care monitoring. In this research, IOT is used to design the Wireless Body Sensor Network (WBSN) in which sensors can be handled and can be used for monitoring the medical conditions of the patients through the Wi-Fi access irrespective of any locations. This computing device is attached to electronics, software sensors, actuators and other network connectivity devices that makes the collection and thereby exchange of the data at the faster and easier pace. This paper focuses on designing the hybrid wearable sensor network application towards the focus of Internet of Things connected safety and medical care monitoring system.The proposed methodology consists of a wearable Wireless Body Area Network (WBAN) that will involve in collection of user data and a Low Power Wide Area Network (LPWAN) and having connection with the Internet so that the Patient can monitor from any location.

Introduction

With the efficient and advanced improvement of today's people living standard, people are paying more attention to their health. But the aging population in all over the world easily suffer from various diseases such as diabetes, cerebrovascular disease, hypertension and cardiovascular related issues. In the meanwhile, middle-aged and young age group patients with several chronic disease are increasing because of the rapid pace of the life, the high working pressure and stress, the unhealthy way of lifestyle. Health management problems are facing a tremendous challenge now a days.

At present, Information and communication technology enteringthe health related and associated field. The health management devices for the large audience, based on the combination of broadband mobile communication, Wireless Body Area Network (WBAN) and cloud computing, were made simple and possible. In order to sharply reduce the costs effect of medical and health related treatment, to modify the uneven distribution of current medical resources and to improve the present health care technology, developing the digital medical technology that turns out to be an important visibility.

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Today many researches emerged on Wireless Body Area Network (WBAN) technology, cloud computing technology, telemedicine,health assessment system and home-care model both in native and abroad which have taken forward a numerous count of innovative theories and their applications. In this research design, we used a Raspberry Pi that takes the role of a Central Processing Unit (CPU) of an embedded system. In contradiction to that, apersonal computer that has a large domain and variety of applications which can be implemented always depending upon the programming. This research aims at monitoring the various health related parameters of the patient by using various sensors. The sensors used in this research were attached to the patient's body and collect data in the analog data form.

The analog data which we fetched can be converted into digital form of output by using an Analog to Digital Converter (ADC) that was available in the RPi. The raspberry pi was acting as a Central Processing Unit (CPU) that will processes the digital data received from Analog to Digital Converter (ADC) and transfer this computed data to the cloud environment. In this manner, the raspberry pi has been used to implement Internet of Things (IOT) with association with various sensor devices and a Wi-Fi module. Whenever we found any discrepancy in the range of readings of the sensors associated which might be above or below the given threshold of the patient, an indicative alarm message will be send to the already registered mobile number which is usually the patient, care-taker of the patient and the

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doctor. Embedded systems always being flexible systems that employs the core programming which can be used in endless situations in the medical field concerned and enables them a really good alternative to costly devices or computers.

Raspberry pi provides several advantages.

- Raspberry pi helps in supervising the given environment; raspberry pi gets thedata from any input sensors. This apprehended data is then handled and then the results are shown in some format to an end user.
- Raspberry pi bridles the environment.
- Raspberry pi always accomplishes and addresses the commands / order for actuators and help in real time monitoring.
- Raspberry pi mutates the information that are to be used for additional consumption.
- Raspberry pi metamorphoses the data that were possessed in some meaningful way, such as data compression and data decompression which may be further used for better applications.

Literature Survey

- Numerous IT corporatespropose various schemes for the digital health management tool that were based on IOT enabled cloud computing. IBM along with ActiveHealth Management has introduced a new platform of cloud computing "Collaborative Patient Health Care Solution" that will help the doctors and patients to get periodical health related information which they are in need from the cloud and in order to improve the medical service quality as well as cut costs [1].
- Microsoft and IBM jointlyintroduce a health monitoring and management application platform for the individual patient and family members, which is called "HealthVault" [2]. This system is primarily used in sharing the patient'sElectronic Medical Record (EMR) with doctors, hospitals and family care taker in order to increase efficiency. In addition, there are many researchers and institutions that are working on the advanced digital health management system.
- Carlos OberdanRolim et al. [3] proposed the solution to automate the feature of processing from data collection to deliver the information by means of "sensors" and "actuators" attached to the existing medical equipment which inturn inter-connected to exchange the service concerned. The proposal was based on the concept of wireless sensor networks and cloud computing. Then this vital information will be available in the "cloud", from where the data can be processed by the introduced expert systems and distributed immediately to the medical representative for further analysis.

- Upkar Varshney [4] proposed the pervasive healthcare&wireless networking solution and several interesting and important research problems about the real-time health monitoring system. This pervasive and advanced healthcare applications contain pervasive health monitoring, pervasive healthcare data access, intelligent emergency management system and ubiquitous mobile telemedicine. The wireless networking solutions covered the usage of wireless LANs, cellular/GSM/3G infrastructure-oriented networks, ad hoc wireless networks and satellite-based systems. But Only some related concepts are proposed without being implemented in the real-life scenario.
- B.Eswara Reddy et al. [5] visualizes on the design and implementation of a Cloud based framework for Health Monitoring System. This system helps in collecting the patient's health related data which is being stored in a Cloud information repository.This system facilitates the data analysis using the services that were being hosted in the Cloud.
- Sudhamony et al. [6] depicts a system that provides telemedicine & tele-Health services for cancer-care delivery and the analysis have been provided in consideration of the data in India. These health services are primarily based on Oncology Network (ONCONET), which will be utilized not only by doctors but also other researchers,decision makers and professionals to make reduce the miseries of the cancer patients.
- Jones et al. [7] proposed the architecture for mobile health services that were based on body area networks. This system focuses on defining the generic mobile solution which can be adapted to different clinical applications.
- An adaptive middleware communication application for monitoring heart-patients at home was developed by the operating systems corporation at Hasso-Plattner-Institute which is being involved in the telemedicine-basedresearch project Fontane [8].
- UbiMon [9] proposes a platform for the patients' monitoring, which will be implanted the sensors into patient's bodies to get the vital data. This kind of platform uses the nodes to carry out the acquisition and then processing the data and storage tasks.
- Hiroshi Nakajima et al. [10] establishes a framework of Monitoring based Systems Health Care by employing the tools of Index, Causality and Criterion.

System Architecture
1. **Internet of Things**

IOT stimulates communication between various devices and prominently known as Machine-to-Machine

(M-M) communication. This will result in the physical devices to stay always connected and hence making sure the availability of the total lucidity with greater quality and high efficiency. As a result of this, the devices can be interacted with each other which results in the automation. Always, IoT is expected to perform exceptional connectivity of the concerned devices and systems and thereby services that goes above the limit of the proposed machine-to-machine (M2M) communications and camouflage the variety of intended protocols, applications and domains.

2.   Heart Beat Sensor

The heart beat sensor is placed to produce the digital output of the heartbeat of patient when their fingers are placed on it. The evolved digital output of the heartbeat sensor is intern connected to the raspberry pi in straight to gauge Beats per Minute rate and thereby giving the accuracy. It always works on the principle of the light modulation by various blood flow through the finger at each pulse rate, which intern detects the change in the volume of blood flowing through body vessels and cause an immediate change in the light intensity that were passing through the organ of the patient in the vascular region.

Fig 1.1 Heart Beat Sensor

Fig 1.2 SPO2 Sensor

3.   SPO2 Sensor

SPO2 is the device which evolves a calculated amount of oxygen that were saturated in the blood of the patient or which calculates to the amount of hemoglobin content in the blood. Hemoglobin is a protein that is primarily responsible for carrying out the oxygen in blood to different parts of the body concerned. It is found inside the red blood cells and gives them their red color.

4.   BP Sensor

The series MPX2050 based devices are silicon piezo resistive based pressure sensors that provides a highly accurate and linear voltage output that were directly proportional to the applied pressure.

5.   Temperature Sensor

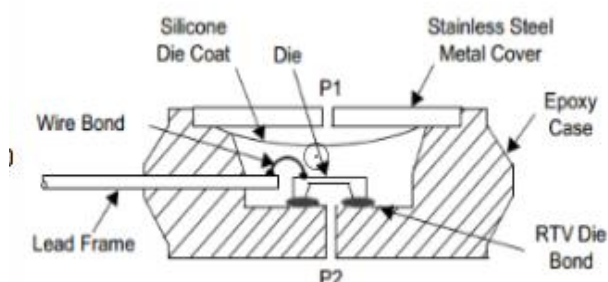Thermistors are basically the devices which

consist of series of resistors which are highly sensitive to heat and whose responsibility is to majorly detect and project a large, precise and predictable change in the electrical resistance that are subjected to a change in the temperature.

6.   Raspberry Pi Zero

The Raspberry Pi zero is an alternative device to the computer, much cost effective and can be used by plugging into a monitoring device. The raspberry pi is one of the cheapest ARM11 poweredsingle board computer board that runs on Linux operating system. It is a compatible and cheap computer which always helps and enables the people of all ages to learn about computers and various programing like Minecraft,pythonand other languages like scratch.

Fig 1.3BP Sensor

Fig 1.4Raspberry Pi Zero

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Proposed Methodology and Expected Outcomes

Wireless devices have evolved in the medical area with a widerange of applications and their capability. In order to monitor the patient records in a cyclic interim that is completely not possible using the present existing technologies. In order to overcome this, we have modified recent wireless sensor technologies. This research uses the MQTT (Message Queuing Telemetry Transport), which has a lot of positive response and advantages over the existing HTTP (Hyper Text Transfer Protocol).

MQTT relies on ISO standard which is published and subscribed-based messaging protocol. It is seated on top of the TCP/IP protocol. In accordance to this, six variety of sensors were used in this proposed research to gather the patient personal and medical information without being injecting or transplant inside the body. So, by means of this we are targeting and achieving remote monitoring and real time data gathering of patients.

In this proposed research, IOT is primarily used for monitoring various health aspects of the patients. All the different sensors like BP Sensor, temperature sensor, SPO2 sensor were helps in measuring various health related parameters of the patients. All the data obtained is converted in real time from Analog to digital using ADC in the raspberry pi.

The Converted data is thereby sent to the cloud platform by which the data can also be accessed by care takers and doctors from anywhere irrespective of any time. This data helps the doctors to monitor the real time condition of the patients even when they are not in nearby location. If any abnormalities found in the readings, an alert message will be sent to the doctor and care taker as well as to the registered number/email concerned. All these data will be shown on a webpage. Each patient and the concerned persons will have their own web portal and the doctor can access everyone's portal using his login credentials. The proposed research has an edge over the others as we can monitor the patient irrespective of any location. It is always more secure that other technology as we used MQTT protocol which has many secure advantages over HTTP protocol. MQTT always use lesser minimized bandwidth as a result of data transfer that is faster.
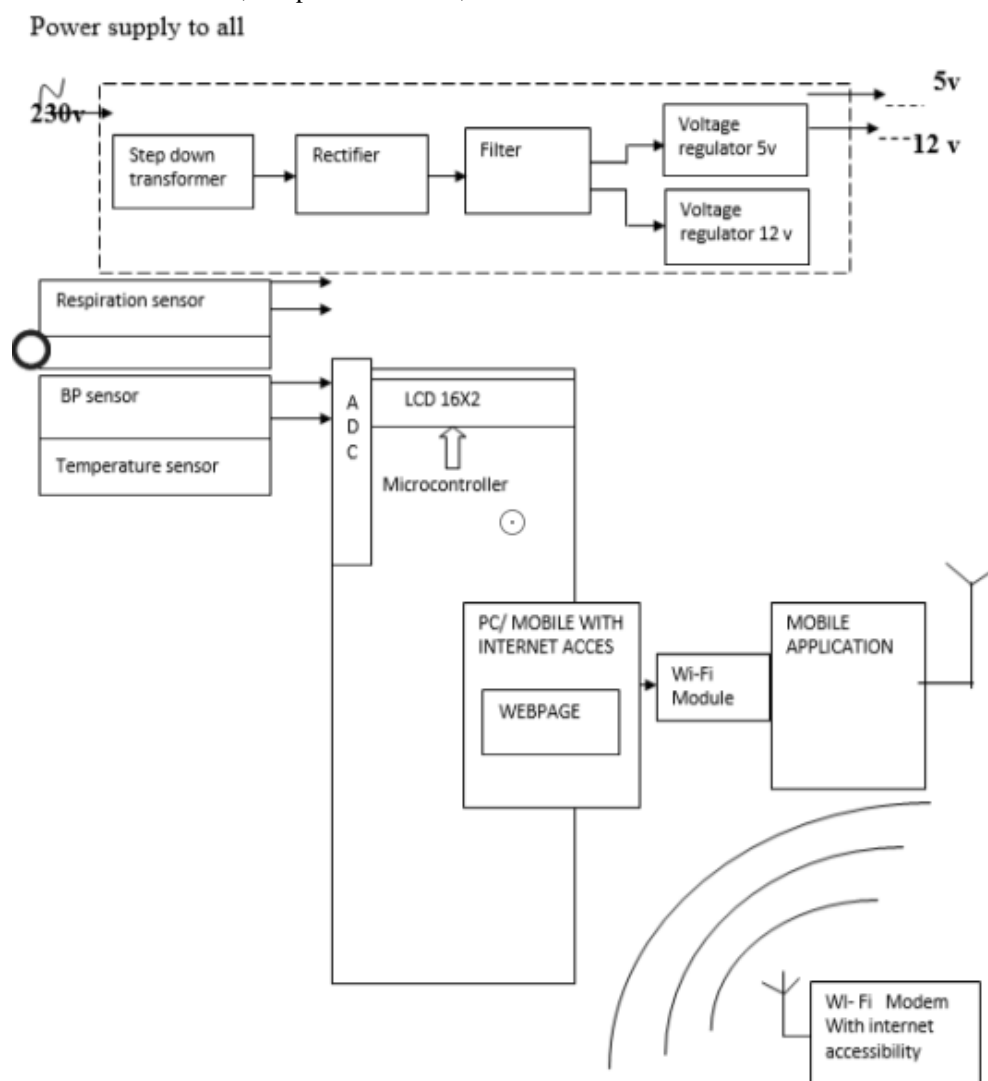

Fig 1.5 Proposed Methodology

This proposed research is aimed to monitor the various health related parameters of the patient using various sensors concerned. these sensors are intact attached to the patient's body and collect the data in analog form. This analog data is converted in real time into digital form using an ADC available in the RPi. The raspberry pi then acts as a central processing unit which processes these digital records and dataand then sends this computed data to the cloud. In thismannerthe raspberry pi is used to implement IOT with the help of various sensors, actuators and Wi-Fi module. Whenever there is a rapid discrepancy in the output of the sensors which might be below or above the prescribed threshold of the patient, an alarm message / signal indication is being sent to the registered mobile number / email which will be already defined.

Conclusion and Future Work

The proposed research on this WBAN based on IoT is a significant and vast field of research which comprises the complete health condition of the patient like ECG, EEG and other parameters related to the health of the patient can be checked. Here in our proposed system, we check the temperature of the patient, respiration and breathing, the pulse rate and Blood Pressure of the patient is being checked and all these detects the conditions of the patient and it can be examined by the doctor irrespective of any location in the world with the help of Wi-Fi connection and microcontroller device.

The research is having the greater usage in medical field and applications. This research presents a wearable sensor node that always enables the implementation of aunique and autonomous WBAN for an IoT related and connected applications. The proposed wearable sensor nodes always be placed on different positions of the patient's body in order to measure the physical signals like the temperature and the heartbeat.

In the future scope, the wearable sensor nodes can be accommodating more signal detections in order to cover many areas of WBAN applications. A web-based laptop or smartphone is primarily used to display the sensor data and send the emergency notifications to the doctor. The future work or future consideration of the research include that the doctor can give immediate response or actions to the patient in terms of any emergency caused with the help of motors and microcontroller and thereby taking the necessary actions or respond to thecondition of the patient with the help of internet.

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