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Remote Healthcare Monitoring System Using IOT

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ABSTRACT

The recent advancements in technology and the availability of the Internet make it possible to connect various devices that can communicate with each other and share data. The Internet of Things (IoT) is a new concept that allows users to connect various sensors and smart devices to collect real-time data from the environment. In hospitals, continuous monitoring is needed for heart attacks, after major/minor operations, temperature-related illness, and physical disorders. But the 24x7 monitoring of patients is difficult and also leads to high costs. Of many chronic illnesses hypertension has become common yet a serious disease that remains the root cause of major cardiac mortality and stroke mortality. This paper proposed a low-cost and easy-to-use remote healthcare monitoring system for hypertensive patients based on IoT. A bio-signal sensor and a microcontroller are the major components of the system. The data has been collected by the bio-signal sensor and is transmitted to an intelligent server. The IoT system can monitor the location of the patient. The proposed system consists of a body sensor network that is used to measure and collect Physiological data of the patient. In case of an emergency, the caretaker and doctor are intimated through a short message service for providing adequate help.

1. INTRODUCTION

Day by Day the world's population as well as chronic health problems would be increasing and needs to develop an efficient and good healthcare system for maintaining the healthy life of people. The number of users allows connecting the various resources like sensors and collecting the real-time data for processing. Especially for the old age health problem patient needs continuous monitoring but 24 * 7 continuous monitoring is difficult because such a system leads to high cost. A remote health monitoring 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. This has further seen development in the remote monitoring of vital life signs of patients, especially the elderly. Remote health monitoring can provide

useful physiological information in the home. This monitoring is useful for elderly or chronically ill patients who would like to avoid a long hospital stay. For Reducing this problem, we propose a low-cost and easy-to-use remote healthcare monitoring system for hypertensive patients based on IoT. A bio-signal sensor and a microcontroller are the major components of the system. The data has been collected using sensor technology and is transmitted to an intelligent server. The IoT system can monitor the location of the patient. The proposed system consists of a body sensor network that is used to measure and collect Physiological data of the patient in case of an emergency situation the caretaker and doctor are intimated through a short message service for providing adequate help.

The medical health problem is a big challenge that is facing today's world. An old age person who is suffering from a heart problem or any other chronic disease like hypertension and is at home for a long period and continuous monitoring of such patient is a tedious job. The solution to this situation is to use sensor technology in which patients can be monitored continuously without admitting to the hospital.

The sensor technology is a new approach used in the medical field for monitoring the patient continuously and analyzes the patient's condition in real-time. Wearable sensors collect the patient data like Pulse rate, Blood pressure (hypertension), Temperature, and breathing rate and send them continuously to a remote location using the technology based on the Internet of Things (IoT). The Internet of Things has a good impact on reducing the cost of healthcare and improving the treatment of the patient. This type of technology helps to track the patient's health information effectively and take immediate action. IoT provides tremendous changes in the daily activities of a person and also provides the alert mechanism i.e., sending SMS to family members or caretakers of the patient. Internet of Things has major advantages in the medical system used for analysis, diagnosis, and effective treatment.

Following are some health care challenges presented that inspired to this research work,

In India, sometimes in rural as well as urban areas the patients are died because of a lack of healthcare resources like medical instruments and most of the time doctors are not available in the hospital and also an unavailability of health monitoring devices. There are quantities of the healthcare framework was designed which gives remote medicinal services benefits however there has some restriction, for example, exorbitant, absence of patient information security, and profoundly computational and communication overhead. The number of people matured at 60 years and over in the world arrived at 910 million in 2015, and it is anticipated to develop to 1.5 billion by 2030 and about 2.5 billion every 2050. It is determined that the 65+ is the largest age group and the normal age will be roughly 51-55 in numerous nations in Asian Countries in 2050. Secondly, that increases the various chronic diseases like heart failure, arrhythmia, blood pressure, diabetes, etc. Hypertension is also a major health problem in India, as per the WHO hypertension led to 1.64 million people can be deaths per year in India. Hypertension is common even among younger age groups people with approximately one out of every 10 persons aged 20-28 yrs. suffering from it. The third challenges are to increase the cost of medical services.

To overcome the situation without hospitalization monitoring the patients using wearable sensors are used in our project. Wearable sensors are popular in many applications such as entertainment, security, and medical purposes. Wearable sensors are worn on the human body for temperature, pressure, heartbeat, etc., In the medical field, sensors are collected data about the person and send the information using wireless technology. This method reduces the health care cost of patients. With an improvement in technology and miniaturization of sensors, there have been attempts to utilize the new technology in various areas to improve the quality of human life. One main area of research has seen the adoption of technology in the healthcare sector. The people in need of healthcare services find it very expensive this is particularly true in developing countries. As a result, this project is an attempt to solve a healthcare problem currently society is facing. The main objective of the project was to design a remote healthcare system. It's comprised of three main parts. The first part being, detection of patient's vitals using sensors, the second for sending data to cloud storage and the last part was providing the detected data for remote viewing. Remote viewing of the data enables a doctor or guardian to monitor a patient's

health progress away from hospital premises. The following figure shows the health monitoring system in the hospital,

Health care is an essential part of everyday life for all human beings on the planet. Each of us requires periodic monitoring of vital parameters and the right treatments based on this data. These processes become even more crucial when people reach a certain age and are not able to follow their health condition properly without special medical personnel or sophisticated equipment to perform the monitoring. The older a person gets; the wider spectrum of possible diseases and emergency situations might occur. In order to avoid this, he or she needs to be transported to the hospital, observed by medical staff, and provided with immediate help if some of the parameters are abnormal. In many cases, even a short delay might lead to dangerous consequences including the death of the patient. Nowadays, there is a wide spectrum of modern monitoring devices which possess various capabilities and can assist personnel in the hospital to work with old or disabled people. However, normally, these basic health parameters are being monitored and measured by medical personnel only at discrete intervals. This common approach can sometimes lead to the loss of crucial data (e.g., during the night).

Therefore, a particular interest is focused on continuous monitoring techniques. Unlike spot-checking, this type of monitoring is capable of providing long-term information about the patient, helps to register emergency situations, and reacts adequately to any significant change in a person's health conditions in real-time. However, the correlation between certain health parameters during a long period of time is yet unclear. Therefore, this type of system could assist in studying this correlation and eventually provide us with a full and complete patient's health profile, which will be subsequently analyzed by professionals.

To Measure, Record, and monitor the health parameter of the patient with the help of sensors and Microcontrollers and visualize it with the help of the Internet of things (IoT).

Associated medicinal services programs use rare assets to give an enhanced nature of care, prompting better clinical results. Quantifiable advantages of associated restorative gadgets incorporate lessening in death rates, diminished center visits, crisis confirmations, and healing facility affirmations, incorporating a decrease in bed days of care and length of remain in clinics. The significant utilize cases in this space include:

- To study Personal health and fitness management through IoT
- To study various healthcare monitoring platforms using a various controller
- To study and develop an IoT system using Raspberry Pi and Wi-Fi
- To simulate the operation of various sensor interfaces to the controller
- Verify and analyze the sensor data for the patient healthcare monitoring system.

2. RELATED WORK

Here different papers are studied based on the approaches by different researchers,

A. J. Jaraet.al.[1], presented their own architecture for Remote Monitoring based on IOT, integration of different systems like hospital information system, services provider system, Context Management Framework, Knowledge Base Systems, and Environment Integration Platform. This architecture uses RFID, wireless personal devices, embedded systems, and 6LoWPAN, HDP, and, most important, a novel protocol called YOAPY. The proposed protocol appears to be promising; however, it does not explain the handling of emergency situations.

X. Boyi et. al. [2], proposed a semantic data model to store and access the IoT data. The proposed system, called UDA-IOT, highlights how it is used in emergency medical services. They implement the DSS (decision support system) to solve emergency problems.

R. Tabish, A. M. Ghaleb, R. Hussein, F. Touati, A. Ben Mnaouer, L.Khriji [3] developed a 6LowPAN-based ubiquitous healthcare system called U-healthcare which performs health monitoring in both indoor and outdoor conditions. The system uses a live streaming platform for reading remote monitoring sensors of ECG and temperature. The designed system can store the sensed data at a remote server and use free Cloud service like Ubuntu One. The system uses different devices and technologies like a router, PC, IPv6, Serial Line Internet Protocol (SLIP), 3G/4G, Microcontroller MSP430, and CC2420, Tiny OS and Contiki Open-source

operating system, ISR, and Wi-Fi. The system is capable of online streaming when the internet speed is good, also in emergency conditions.

D. W. Kumar [4], a present new architecture for Remote Monitoring based on IoT and makes use of a new protocol called YOAPY. The system is capable of continuously monitoring the patient health. There are people all over the world whose health may suffer because they don't have ready access to effective health monitoring. But small, powerful wireless solutions connected through the IoT are now making it possible for monitoring to come to these patients instead of vice-versa. These solutions can be used to securely capture patient health data from a variety of sensors, apply complex algorithms to analyze the data, and then share it through wireless connectivity with medical professionals who can make appropriate health recommendations.

Poonam Vyankatesh [5] proposed a ZigBee-based data model wireless Heartbeat monitoring system is designed and implemented using microcontroller LPC2148, in which signals directly measured from the human body and parameter values displayed on LCD on the transmitter side. This data is transmitted to the receiver wirelessly through ZigBee. The ZigBee receiver receives transmitted data and is given to the PC to show the data on the screen. The remote health care monitoring system (RHCMS) has drawn considerable attention for the last decade. As the aging population is increasing and at the same time the health care cost is skyrocketing there has been a need to monitor a patient from a remote location. Moreover, many people in the World are out of the reach of existing healthcare systems. To solve these problems many research and commercial versions of RHCMS have been proposed and implemented till now. In these systems, the performance was the main issue in accurately measuring, recording, and analyzing patients' data. With the ascent of wireless networks, RHCMS can be widely deployed to monitor the health condition of a patient inside and outside the hospitals. In this work, they present a ZigBee-based wireless healthcare monitoring system that can provide real-time information about the health condition of a patient. The proposed system can give alarm the healthcare professionals about the patient's critical condition. Besides the proposed system can send reports to the monitoring system, which can be used by healthcare professionals to make necessary medical advice at any time. Now a day's wireless sensors are used for homecare systems. There are many different technologies such as Infrared, Bluetooth, and ZigBee that are available for transmission purposes. There are many limited problems with Infrared, so it is not used commonly for physiological transmission purposes. Although Bluetooth is better than ZigBee for transmission rate, ZigBee has lower power consumption than Bluetooth so its used for long-term monitoring of the patient. ZigBee is used for 24 hours to monitor the communication transmission system as compared to Bluetooth. ZigBee provides higher network flexibility and a larger number of nodes, and a better transmission range with low power consumption. The patient monitoring system is useful for medical practitioners to do proper and better treatment; also, it is useful to improve disease monitoring. The patient is monitored from ICU and the data is transferred to the PC.

The ZigBee node is connected to every patient monitor system that consumes low power with minimum circuit requirements. To improve the accuracy and to increase the efficiency of this monitoring system Wireless Sensor Network and an LPC2148 microcontroller is used. The data exchange between the patient monitoring system and the microcontroller will be containing patient parameters like a heartbeat. The response includes the complete record of the patient. This technique is less expensive than other technologies such as Bluetooth.

Daniel Ruiz-Fernandez ID et.al. [6] Propose a model based on the Business Process Management paradigm, together with a group of technologies, techniques, and IT principles that increase the benefits of the paradigm. To achieve the proposed model, the clinical process of hypertension is analyzed to detect weaknesses and improve the process. Once the process is analyzed, an architecture that joins health devices and environmental sensors, together with an information system, has been developed. To test the architecture, a web system connected with health monitors and environmental sensors and with a mobile app has been implemented.

Sunil.L.Rahaneet.al. [7] developed the system Architecture for smart Healthcare using Wireless Sensor Network (WSN) with GSM Module and Microcontroller. They present a monitoring system to monitor the physiological parameters such as Blood Pressure (BP), ECG, Body Temperature and Respiration, etc. The coordinator

node has attached to the body of patients for collecting the signal from wireless sensors. The wireless sensors send this signal to the base station or control room of the physician. These wireless sensors form a wireless body sensor network (WBSN). A node of each WSN is composed of health care sensors and an RF transceiver that sends data to the backend server. Sensors can choose from the range of WSNs, while an RF transceiver is implemented as a coordinator which manages WSNs other than forwards data. The sensing data of each patient are stored in the back-end server with each having its own ID. The data analysis, database inquiry, data manning and system management are processed on the web page of the server. The system can detect the abnormal condition of patients and send SMS or e-mail to the physician. By using a wireless sensor network this system improves the quality of the medical healthcare system.

Amna Abdullah et.al. [8] Proposed a system mobile device-based wireless healthcare monitoring system that can provide real-time online information about the physiological conditions of a patient. Our proposed system is designed to measure and monitor important physiological data of a patient to accurately describe the status of her/his health and fitness. Besides the proposed system can send an alarming message about the patient's critical health data by text messages or by email reports. By using the information contained in the text or e-mail message the healthcare professional can provide necessary medical advising. The system mainly consists of sensors, the data acquisition unit, a microcontroller (i.e., Arduino), and software (i.e., LabVIEW). The patient's temperature, heartbeat rate, muscles, blood pressure, blood glucose level, and ECG data are monitored, displayed, and stored by our system. To ensure reliability and accuracy the proposed system has been field-tested. The test results show that the system can measure the patient's physiological data with very high accuracy. In the last decade, healthcare monitoring systems have drawn considerable attention from researchers. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor their patients, who are either hospitalized or executing their normal daily life activities. In this work, they present a mobile device-based wireless healthcare monitoring system that can provide real-time online information about the physiological conditions of a patient. To ensure reliability and accuracy the proposed system has been field-tested. The test results show that our system can measure the patient's physiological. A Smartphone-based health monitoring system has been presented in this work. By using the system, healthcare professionals can monitor, diagnose, and advise their patients all the time. The physiological data are stored and published online. Hence, healthcare professional can monitor their patients from a remote location at any time. Their system is simple. It is just a few wires connected to a small kit with a Smartphone. The system is very power efficient.

Only the Smartphone or the tablet needs to be charged enough to do the test. It is easy to use, fast, accurate, high efficiency, and safe (without any danger of electric shocks). In contrast to other conventional medical equipment, the system has the ability to save data for future reference. Finally, the reliability and validity of our system have been ensured via field tests. The field tests show that this system can produce medical data that are similar to those produced by the existing medical equipment.

M. N. Hindia1 et.al.[9] proposed a system two-stage fundamental approach to facilitate the implementation of such a system. In the first stage, sensors promptly gather together the particle measurements of an android application. Then, in the second stage, the collected data are sent over a Femto-LTE network following a new scheduling technique. The proposed scheduling strategy is used to send the data according to the application's priority. The efficiency of the proposed technique is demonstrated by comparing it with that of well-known algorithms, namely, proportional fairness and exponential proportional fairness.

SumitMajumderet.al. [10] Presented and compared several low-cost and non-invasive health and activity monitoring systems that were reported in recent years. A survey on textile-based sensors that can potentially be used in wearable systems is also presented. Finally, the compatibility of several communication technologies as well as future perspectives and research challenges in remote monitoring systems will be discussed.

III. PROPOSED SYSTEM

This system is mainly used to monitor health conditions automatically. In our system, we use the Blood pressure sensor, Temperature sensor, Pulse oximeter sensor, Breath Sensor, and Sensor for monitoring the patient's heath. Temperature Sensor LM 35 gives the Body Temperature of the patient, Heart rate sensor- Max 30100 gives pulse Rate/Heart Rate and Oxygen Concentration in Blood i.e., SpO2, Blood Pressure Sensor gives the Systolic Blood Pressure and Di-systolic Blood Pressure, Breathing Sensor gives the Breathing Rate and Air quality sensor MQ135 gives the Air Quality of environment. Anyone condition abnormal sending information is sent to the internet through IoT. A bio-signal sensor and a microcontroller are the major components of the system. The data has been collected by the bio-signal sensor and is transmitted to an intelligent server. The IoT system can monitor the location of the patient. The proposed system consists of a body sensor network that is used to measure and collect Physiological data of the patient. A system to monitor the blood pressure of a hypertensive patient using mobile technologies has been proposed. By using the system, a doctor can carefully monitor the patient and can perform a diagnosis.

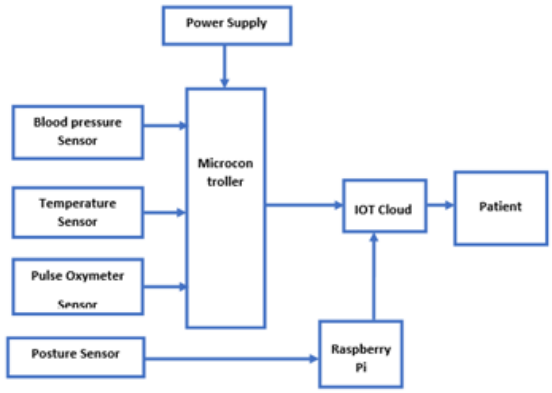

Figure 1: Block Diagram of Proposed System

We have proposed a system in which the various sensors interface with the controller Raspberry pi. We will use Thingspeak web to collect and analyze the sensor data and develop IoT applications. if any abnormal condition occurs in a patient's health that means the patient heart rate, and blood pressure is increasing above the normal range then Thingspeak web monitors the patient's health and get current information regarding patient health.

A. System Components Description

Raspberry Pi: the raspberry pi is a low-cost, credit-card-sized computer that plugs into a computer monitor or tv, and uses a standard keyboard and mouse. 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.

Figure 2: Raspberry Pi

Pulse Oximeter and Heart Rate Sensor IC (MAX30100): This sensor will give us the heart rate, pulse rate and oxygen concentration in blood i.e., spO2 of the patient. In our system we use MAX30100 heart rate sensor.

Figure 3: max 30100 pulse oximeter

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current,

permitting the power supply to remain connected at all times.

Temperature Sensor (LM 35): The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in degrees Celsius). The normal range due to an increase in the body's temperature is set. There is not a single agreed-upon upper limit for normal temperature with sources using values between 37.5 and 38.3 °C (99.5 and 100.9 °F). The increase in set-point triggers increased muscle contraction and causes a feeling of cold. This results in greater heat production and efforts to conserve heat. When the set-point temperature returns to normal, a person feels hot, becomes flushed, and may begin to sweat. Rarely a fever may trigger a febrile seizure. This is more common in young children. Fevers do not typically go higher than 41 to 42 °C (105.8 to 107.6 °F).

Figure 4: Temperature sensor (LM35)

Breath Sensor: For the breath sensor, we are going to make a respiratory belt using a Force Sensitive Sensor (FSR). This is a force-sensitive resistor with a round, 0.5" diameter, sensing area. This FSR will vary its resistance depending on how much pressure is being applied to the sensing area. When no pressure is being applied to the FSR its resistance will be larger than 1M. This FSR can sense applied force anywhere in the range of 100g-10kg.

IV. RESULTS AND DISCUSSION

In our project, we have used LM 35 for the body temperature sensor, Max 30100 for pulse rate and oxygen concentration in blood, a Force-sensitive resistor for breath i.e., respiratory analysis, blood pressure sensor to measure systolic and diastolic blood pressure. Hardware Interfacing of Our system with sensors is shown in the figure below,

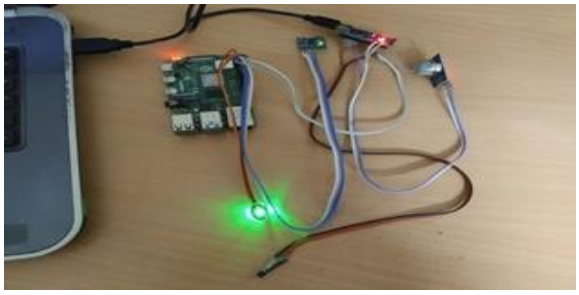

Figure 5: Hardware interfacing with sensors

Figure 6: Experimental Setup

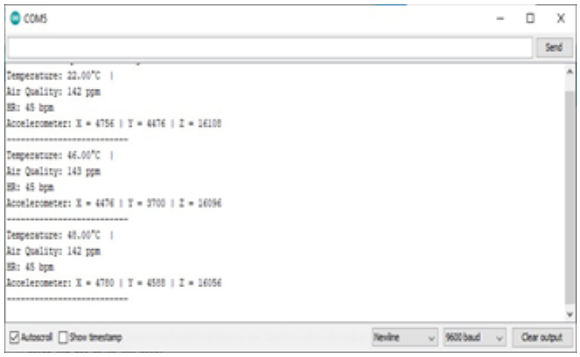

Figure 7: Temperature Sensors reading

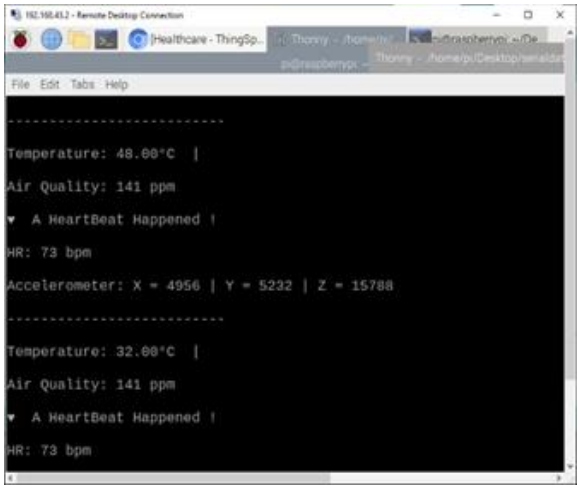

Figure 8: Sensors reading

Figure 9: Body Temperature reading in cloud

Figure 10: Air Quality reading in cloud

Figure 11: Heart Rate reading in cloud

Figure 12: Dashboard UI visual when device sends real time value of Body Position using IOT (Online)

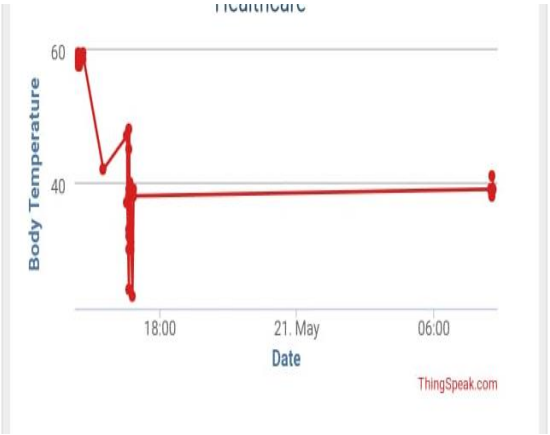

Figure 13: Dashboard UI visual when the device sends the real-time value of Body Temperature using IOT (Online)

Figure 14: Periodic value of Body Position

V. APPLICATION

1. It is used in hospitals

2. It is used in personal healthcare

3. It is used to monitor diabetes and also reduces the risk of heart failure

4. It is useful for continuous monitoring of hypertensive patients.

VI. ADVANTAGES

1. It is useful for critical cases patients are supposed to be monitored continuously for their, Heart Rate as well as temperature.

2. In the earlier methods, the doctors need to be present physically, or in several cases, SMS will be sent using the Android app ThinkSpeak. In the earlier case, the history of the patient cannot be displayed, only current data is displayed. In the current study, we are using a novel idea for continuous monitoring of patients' health conditions.

3. The health care scheme is focused on the measurement and Monitoring of various biological parameters of a patient's body like heart rate, oxygen saturation level in the blood, and temperature using a web server and android application, where a doctor can continuously monitor the patient's condition on his smartphone using an Android application.

4. And also the patient history will be stored on the webserver and the doctor can access the information whenever needed from anywhere and need not be physically present.

CONCLUSION AND FUTURE SCOPE

Health is one of the global challenges for humanity. According to the constitutions of the World Health Organization (WHO), the highest attainable standard of health is a fundamental right for an individual. Healthy individuals also reduce pressure on the already overwhelmed hospitals, clinics, and medical professionals and reduce the workload on the public safety networks, charities, and governmental (or non-governmental) organizations. Hypertension affects one in five adults worldwide. Healthcare processes require interdisciplinary cooperation and coordination between medical teams, clinical processes, and patients. The lack of patients' empowerment and adherence to treatment makes it necessary to integrate patients, data collecting devices, and clinical processes. For that, we will develop a model which is low power & low cost also we are using an application which is having global reliability and low barriers to entry. we will propose a healthcare monitoring system for the hypertensive patient in remote areas using various body sensors like temperature, blood pressure, pulse rate sensor, raspberry pi, and microcontroller have a connection to the internet of things (IoT) which reduces the healthcare cost of patients also save our time and resources.

We have presented a system that monitors various health parameters and prediction of any kind of disease or disorder that prevents the patient from the pain of paying frequent visits to the hospitals. The proposed system can be set up in the hospitals and a massive amount of data can be obtained and stored in the online database. Even the results can be made to be accessed from mobile through an application.

The data, consisting medical history of many patients' parameters and corresponding results, can be explored using data mining, in search of consistent patterns and systematic relationships in the disease. For instance, if a patient's health parameters are changing in the same pattern as those of a previous patient in the database, the consequences can also be estimated. If similar patterns are found repeatedly, it would be easier for doctors and medical researchers to find a remedy for the problem.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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The author declares that they have no funding support for this study.

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