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A Review on IoT based Real Time Patient Monitoring System and Analysis

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***Abstract*—Recent survey has proved that many people die due to lack of timely care and proper monitoring. IoT associated with information transferring technologies allow doctors or relatives to be informed about the physiological status of the patient periodically. Different physiological parameters are recorded using various biosensors, which are interfaced with Raspberry Pi, Arduino or micro-controllers. This information is collected in the cloud, processed and regularly monitored in real time from remote places. This gives an advantage of immediate treatment that can be provided to the patient. These mechanisms can also be used in alarming the authorized people.**

***Keywords*—Temperature sensor, Heart rate sensor, ECG sensor, Raspberry Pi, Arduino, Position sensor, GSM module, ThingSpeak Cloud.**

I. INTRODUCTION AND OVERVIEW

The Internet of Things has numerous applications in health, from remote monitoring to smart sensors and medical device integration. Health monitoring and proper health care becomes an important part in the day to day life of human beings. Technology has moved from the routines of medical checks from a hospital to patients' home. IoT provides real time monitoring and controlling of heath parameters such as blood pressure, temperature, humidity and ECG. The above data are collected by using different sensors and can be stored in the cloud which can be accessed within an authorized person. This will ultimately help in collecting the data regardless of the place and time. IoT in health enables machine-to-machine communication, information exchange, and data movement that make healthcare service more effective. IoT devices can collect report and analyses the data in real time and allows doctors and other related people to get the vital health parameters and their values which speed up the decision-making and is less prone to any kind of errors. Emergency alert are provided at the time of critical condition. IoT allows devices to gather the health parameters and allows dropping notifications to doctor and other people about critical parts via mobile apps and other linked devices. Reports and alerts about the patient give a firm opinion about the health condition, irrespective of place and time with on-time treatment. IoT enables real-time alerting, tracking, controlling and monitoring, which permits better accuracy and improve complete patient health care results. In case of an emergency, patients can contact a doctor who is far away with a smart mobile app thus providing mobility solution. IoT will improve the health parameters of a patient in a hospital.

II. RELATED WORKS

A. Monitoring of Patients Using Gsm Based Technology

The aim of the proposed system is to provide a reliable, efficient and continuous monitoring of patient from a local area to remote area. GSM based technology is used to send health parameters like temperature, heart condition and respiratory function in real time which helps to take necessary actions. GSM devices also provide emergency online activated services. The heart beat sensor used is IC LM358. The variation that occurs in the finger is converted to electrical pulse by the heart beat sensor. LM35 is used as the temperature sensor which operates over the range -55°C to 150°C temperature ranges. ECG signal is processed using IC A624AD. The rhythm pattern is sent to the microcontroller by the ECG signal. The values or parameters from the sensors which are attached to the patients are collected and send to the receiver side by using the RF module. The collected values are displayed at the receiver side. GSM technology is used in sending and receiving the data. This system provides the real time values and can control the patient from any remote area. Whenever there is an abnormality in the gathered value, an alarm is introduced which will help to take necessary measures. The doctor can also control and give necessary advices from a far distance.

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All the actions can be achieved using the GSM technology. The main advantage is that the system provides real time and continuous values, which can be controlled and monitored from anywhere by the doctor and other relatives of the patient. And also, the system provides emergency alarm in case of unusual conditions. The main disadvantage is that it uses GSM technology for displaying data at the receiver end. So, if there is any connection problem or loss in signal, the data will not be received and emergency alarm will not work properly.

B. Health Monitoring Using Raspberry Pi and Arduino

This paper proposes extensive and in cooperative health model for Chronic Heart Failure along with other parameters such as Pulse rate, Weight, Temperature and position detection. The values of these factors are connected by using sensors, which are connected to Arduino and Raspberry Pi. Here, Raspberry Pi act as a server since a connection is established with the Internet and a specific URL is used for transmitting the data. The same network can be used for displaying the values of the parameters. In noisy conditions, AD8232 ECG sensor is intended to extract, amplify and filter small bio potential signals. ADXL335 is used as the position sensor. The position sensor operates in the power range of 1.8V to 3.6V, 350 micro Amp. The weight sensor used is HX711 which is a precision 24-bit analog to digital converter. The supply voltage varies from 2.6V to 5.5V. To measure the temperature of the patient an LM35 temperature sensor is used which provides a higher accuracy of ±0.4 degree Celsius at room temperature. Real time monitoring of pulse can be carried out by using pulse rate sensor LM358. The latter can be clipped onto fingertip or ear lobe. Hence the sensors attached to the system and IoT provides more accurate analysis. The advantage is that the system is able to send and share data using IoT, which can be accessed from anywhere and can take necessary actions. Also, the sensors used in this system provide less power consumption. The main disadvantage is the use of Arduino which is more time consuming, therefore Mega Arduino can be used which is faster than Arduino and capable of interfacing many sensors.

C. Medical Data Monitoring Using LabVIEW

This proposed system is used in hospitals to monitor the essential health parameters such as ECG, temperature, heart beat and static or dynamic acceleration. By using Raspberry Pi, the values of these parameters can be recorded and displayed. Also, the resultant value can be sent to the PC by using RS-232 cable and store physiological data of the patients using LabVIEW. The hardware components include Raspberry Pi, Max232, Temperature sensor, Heart Rate sensor, ECG sensor, MEMS sensor and LCD. For the communication of microcontrollers with PC MAX232 IC is used. MAX232 IC is used to convert the TTL/CMOS logical levels to RS232 logical levels. LM35 is used as the temperature sensor which can operate in a temperature ranging from −55°C to 150°C. The output generated by the heart rate sensor is digital and is in beats per minute rate. ECG sensor used is AD8232. The static or dynamic acceleration in all axis can be measured using MEMS sensor. The software components include LabVIEW. LabVIEW is used to store physiological data of the patients in spread sheet. This system is able to display, record, and send patient's physiological data using LabVIEW. The proposed system provides continuous data, which can be accessed and monitored from anywhere by the doctor and can take necessary measures. Implementation cost of proposed system is less. The proposed system provides continuous value but it is not able to provide real time values. The accessibility of proposed system is limited to LCD display.

D. Patient Health Monitoring System Using Raspberry Pi 3 And Ubidots

Using IoT, the proposed system is designed to monitor and guide the health parameters such as temperature and heart rate of a patient. The doctors and relatives of the patient can get real time values of the above parameters from anywhere and can also get alert messages in case of emergency situation. And simultaneously a buzzer is attached which provides alert sound at critical condition. To measure the temperature and humidity of a patient, DHT11 temperature and humidity sensor is used. The temperature ranges between 0 to 50 degree Celsius. It provides +/-2 degree of accuracy. The humidity sensor provides 5% accuracy with 20 to 80% range. For the analog to digital conversion, an ADS1115 convertor is used which is then send to the Raspberry Pi 3. Principle of photophlethysmography is used by heart rate sensor. The values of the parameters are displayed using ubidots which can be accessed from anywhere. A continuous IoT patient monitoring system is designed using Raspberry Pi 3. Temperature, Humidity and heart rate of a patient is measured in this system with ubidots as the web server. The proposed system provides small size, low cost and portable device. The system gives continuous and real time data with an emergency alarm in case of emergency condition which will help to take necessary steps. The system uses Wi-Fi connection for sending the data, the range of communication is limited and signal can be interpreted.

E. Health Monitoring and Controlling Using Raspberry Pi 3 And GUI

The proposed system is used monitor and controls the health parameters such as temperature, heartbeat, ECG and respiratory function of a patient in real time using IoT. The sensors of the above parameters are connected to Arduino, Raspberry Pi and the values are updated on GUI. The doctor can access and monitor the data from anywhere and in case of critical condition, doctor can trigger the button of respective tablets. Therefore, the patient gets the tablet in real time. The proposed system consists of two parts: A Smart Bracelet and a Controlling Unit. The smart bracelet consists of LM35 temperature sensor, SUNROM-1437 blood pressure sensor. The internal convertor in Arduino will convert the analog output of temperature sensor to digital form. The Arduino will transmit the data to Raspberry Pi using HC-05 Bluetooth module. In controlling unit, the values from the Raspberry Pi are displayed to the GUI page. The medication box is connected to the GPIO pins. The system collects and monitors the health parameters in real

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time and updates it on GUI. In case of emergency condition, the doctor can trigger the button of medication box which provide tablets to patient in real time. Medication box reduces the mistakes in having the tablets by the patient and thereby reduces the physical effort. The proposed system uses Bluetooth technology which is meant for short distance communication. The values of the above parameters are experimentally verified and collected using IoT.

F. Health Monitoring Using Raspberry Pi 2 and Esp8266

The proposed system uses Raspberry Pi and IoT to monitor the pulse rate, body temperature with the help of dedicated sensors. Since the system is wearable it can support remote health monitoring. The latter is achieved by storing the collected data to Blue mix cloud so that the stored data can be accessed by the doctor from anywhere in the world thereby detecting any abnormalities in a timely manner. The hardware components include temperature sensor, pulse rate sensor, Arduino UNO, Raspberry Pi 2 and ESP8266 Wi-Fi shield. The temperature sensor DS18B20 has a unique one wire interface that helps to communicate easily with other devices. Since the thermo probe doesn't require any external power supply, it draws the power from the data line itself. For measuring in the harsh and wet environment, it makes use of a stainless steel at the probe head. It has a temperature ranging from -55°C to 125°C and it also has RJ11/RJ112, 3P-2510 connector. The heartbeat sensor helps in detecting the pulse of the finger where the output is an electrical signal which shows the count of the number of pulses. The software components include Integrated Development Environment (IDE), Node-RED and MQTT protocol. To develop projects on various sensors and Arduino projects, IDE acts a powerful platform for programmers and researchers. It has additional features such as highlighting the syntax, brace matching, cutting-pasting and automatic indenting. In order to integrate hardware devices for IoT developers, Node-RED can be used as a visual programming tool. MQTT can be used to connect different devices and applications together for machine to machine communication. The system provides accurate, low power and low-cost system for remote health monitoring system. The advantage of using this technique is that it saves time and effort that people put in traveling to hospitals. Also, the wearability of remote sensors, low power, accuracy and low cost makes the system more reliable and effective. The disadvantage is that the data generated by the IoT can be accessed by unauthorized individuals thus creating security issues.

G. Patient Monitoring in Real Time Using IoT Based Cloud

The proposed system helps to monitor the health condition of the patient using sensors which are connected to the network. The biological behaviours of patient can be gathered by using different sensors thereby sending the biological data to the IoT based cloud. The critical condition of a patient can be detected by processing the data inside the sensor and also providing instant push notification to doctors and nurses, thus making it an intelligent patient monitoring system. This system helps the doctors and nurses to observe the patient remotely even without visiting them. The hardware components include sensors for temperature and humidity, heart rate, ECG, blood pressure and movement. The temperature and humidity sensors are used for measuring the body temperature and humidity. The heart rate sensor helps to measure the pulse and ECG sensor measures the ECG data. The blood pressure is measured using its corresponding blood pressure sensor whereas the movement sensor helps to detect the unexpected movement. The software component used is a mobile application in which the real-time sensor's data can be displayed with the help of various charts and gauges. Using this application, even without visiting the ICU unit, the doctors or nurses can monitor their patients remotely. The paper is able to monitor the real-time patient in ICU thereby improving the efficiency and quality of service. The advantage is that the system is fully automatic and hence provide constant remote monitoring facilities. Also, the proposed system is less prone to errors and is therefore more accurate. The main disadvantage is that Arduino 101 micro-controller is costlier when compared to Arduino Uno.

H. Patient Monitoring Using Raspberry Pi Via Gateway

The main objective of this paper is to monitor real time patient health parameters such as body temperature, respiration rate, heart beat and body movement using Raspberry Pi board through medical devices via a gateway. The data is acquired using sensors, making it more efficient and thereby reducing the human error. Raspberry Pi sends all the health data of a particular patient to the web database. Transformers are used since the sensors do not have same power to operate. In order to measure temperature of the body, thermistor is used. The pulse rate is measured by using a sensor which is connected to the finger. IR transmitter and receiver are used to measure the heart rate. For measuring respiration, two thermistors are used where one is for respiration and another for measuring room temperature. Body movement is measured using accelerometer sensor MMA7260QT. The system is able to monitor the health status of the patient from anywhere in the world so that it is useful in providing first aid whenever necessary. The advantage is that the health status of the patient can be recorded on their own phone and then store the data. And also, the proposed system reduces patient's money and waiting time at hospital. The main limitation in using this technique is that the sensors don't have the same power to operate, therefore transformers are in turn used which makes it more complicated.

I. Health Monitoring Using Raspberry Pi and Various Sensors

The paper proposes a portable system wherein physiological parameters such as heart beat, body temperature, ECG and blood pressure are monitored continuously so that it finds useful for elderly and ill patients not in hospital. The sensor input devices which are attached to the patient uses Raspberry Pi board as a medium as well as to send the data of a patient to doctor's computer using Internet thereby taking necessary action. The hardware components used are various sensors such as heart beat sensor, body temperature sensor, ECG sensor, blood

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pressure sensor and patient position sensor. Heart beat sensor has a simple photo sensor along with an amplifier and unwanted noise remover circuitry which makes it reliable to get the pulse readings thereby using less power. The DS18B20 temperature sensor detects the temperature only after reaching a steady state and therefore it is accurate and finds use in many applications. ECG test is performed to measure whether the heart is working in normal condition where the electrodes placed on the skin are conductor type. Blood pressure sensor is used to measure the value systolic, diastolic and heart beat pulse rate with the help of intelligent automatic compression and decompression. Body position sensor finds its use in monitoring proper and wrong sleeping position of the patient as in most cases it is necessary to know the body movements depending on the disease. The system is portable and hence health analysis can easily be done at any place. The main advantage is that the system is integrated into a compact unit which makes it easy for patients to carry the device wherever they go. And the disadvantage is that the VNC server of Raspberry Pi is connected to Wi-Fi internet which limit the distance thereby making it less reliable.

J. Real Time Health Care Monitoring and Alert System Using ThingSpeak Cloud

The proposed system measures the patient's body parameters such as skin temperature, oxygen saturation, heart rate, ECG and blood pressure using sensors and later on the data is transferred to the cloud using Wi-Fi module. ThingSpeak database server is used to store and manage the data and the user can access the data using an Android application where both the patient and care takers get notification, if the data is abnormal. Various decision-making algorithms are used in order to make a decision so that people can have an access to the database. The hardware components used are Wi-Fi module, blood pressure sensor and temperature sensor. The ESP8266 Wi-Fi module has TCP/IP protocol stack which is integrated on the chip so that any microcontroller can be connected to the Wi-Fi network. Blood pressure sensor measures both the systolic and diastolic pressure along with pulse reading. The DS18B20 temperature sensor is used to measure the skin temperature wherein it provides 9-12-bit Celsius measurements along with an alarm. Also, it doesn't need an external power supply, since the power can be derived from the data line itself. The software component used is an open source IoT application – ThingSpeak. It is basically used to store and retrieve data using an HTTP protocol over the Internet. The paper is able to access real time and past physiological data of the patient remotely and provide necessary action when the value exceeds a particular threshold. The advantage is that the temperature sensor doesn't need an external power supply, since the power can be derived from the data line itself. The disadvantage is that the ECG and body temperature are continuously monitored which makes it more complex and critical.

III. PROS AND CONS OF VARIOUS METHODS USED

METHODS USED	ADVANTAGES	DISADVANTAGES
Smart health monitoring and controlling using Raspberry Pi 3	Real time, reduces physical effort, portable	Short range of communication
Medical data monitoring using Raspberry Pi	Continuous data, implementation cost less	No real time data, less accessibility
Health monitoring system using Raspberry Pi and Arduino	Less power consumption, reliable	Time consuming
Real time health monitoring using GSM module	Real time data, emergency alarm	Interruption in signal
Health monitoring using Raspberry Pi	Reliable, low cost, time saving	Unauthorized access, different power consumption for sensors
Real time patient monitoring system	Fully automatic, less error	High cost
Smart real time health care monitoring and alert system using IoT	Temperature sensor derives power from data	Complex monitoring of continuous ECG and temperature

IV. DIFFERENT COMPONENTS USED IN VARIOUS METHODS

METHODS USED	COMPONENTS USED
Smart health monitoring and controlling using Raspberry Pi 3	LM35 temperature sensor, Sunrom-1437 blood pressure sensor, Arduino
Medical data monitoring using Raspberry Pi	LM35 temperature sensor, Heart rate sensor, ECG sensor, Max232 IC, LCD,MEMS sensor
Health monitoring system using Raspberry Pi and Arduino	AD8232 ECG sensor,ADXL335 position sensor, HX711 weight sensor, LM35 temperature sensor, LM358 pulse rate sensor
Real time health monitoring using GSM module	LM35 temperature sensor, ECG sensor, heart beat sensor
Health monitoring using Raspberry Pi	Arduino UNO, DS18B20 temperature sensor, KG011 heart beat sensor
Real time patient monitoring system using IoT based cloud	Temperature and humidity sensor, heart rate sensor, ECG sensor, blood pressure sensor, movement sensor
Smart real time health care monitoring and alert system using IoT	ESP8266 Wi-Fi module, Sunrom Blood pressure sensor, DS18B20 Temperature sensor

V. CONCLUSION

The system overcomes the careless attitude shown by the in charge personal due to which many patients die in ICU unit. In this survey paper, real time monitoring of patients is been

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proposed where the sensors used are wearable and the data from these sensors are sent to the IoT based cloud which makes the system more efficient and reliable. Further processing can be done by extracting the data and transmitting it to web application. An alert message is sent to the doctor when the data value exceeds a particular threshold thereby taking necessary actions. The research can be extended by using more sensors for respiration, airflow, pulse oximeter which lessens the burden of nurses and hence eases the measuring process.

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