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Remote Health Monitoring using Embedded Systems

Dr. Reshma J

Assistant Professor, Dept of CSE

B N M Institute of Technology Bangalore, Karnataka, India.

Abstract:

The increase in the population of aged people is now the leading healthcare concern of many countries in the world. With 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. The people in need of healthcare services find it very expensive. This is particularly true in developing countries. The developments have seen a trend known as Remote Healthcare or previously known as Telemedicine. With improvement in technology, previously expensive hospital equipment has been redesigned using current technology. As a result, Remote Health Monitoring is an attempt to solve the healthcare problem facing the society. The main objective of the Remote Health Monitoring is to design a remote healthcare system. In real life, the patient has to be monitored constantly. An automatic alerting system will notify a helper or relative of the patient who is at a remote location. Sensors are used to monitor the pulse rate, temperature and generate ECG of the patient. Sensors senses the values and sends it to the android phone. In case of emergency, message is sent to the patient's relative. And also the appointments at the hospital will be reminded to the patient. The focus of this work is to survey the existing Remote Health Monitoring System using embedded systems. The main intention of Remote Health Monitoring is to automatically provide the prescription to the patient according to their condition.

Keywords: **Cloud Computing, GSM (Global System for Mobile communication), IOT, Embedded System, ECG Kit, Heart rate, Blood Pressure Device, Android, Temperature**.

Introduction:

The rural communities depend on a system of small claims and health centers to provide the primary care services utilizing non- physician health professionals. There is a short supply of pharmacists, dentists and mentalhealth professionals in this area. The primary care physicians identify diabetes, cardiovascular disease and canceras majorchallenge andare the most prone chronical diseases. Hence a mobile clinic that is equipped with new technology can move beyond traditional functions [1].

Embedded systems have extensive applications in consumer, commercial, automotive, industrial and healthcare markets. Generally, an embedded device's operating system will only run a single application which helps the device to do its job. The system which is completely enclosed by the object may or may not be able to connect to the Internet. The heart of electronics system is the embedded system managing biometric data from numerous human bodies. This simply means that the device's software does not have a user interface (UI). In such cases, an in-circuit emulator (ICE) is temporarily installed between the embedded device and an external computer is need to debug or update the software. Because embedded systems have limited computing resources and strict power requirements, writing software for embedded devices is very specialized field that requires knowledge of both hardware components and programming [2].

Health telematics plays a major role in improving the health of patients, particularly in the weaker

sections of the society including disabled, aged and chronically ill patients. Real-time health monitoring devices provide real-time analysis of the patient's health parameters. Patients are sharing their healthcare information in real time with their caregivers through these devices for flexible health monitoring and management. Internet of medical things is vastly improving the healthcare condition of patients. Application of Real Time Health Monitoring devices collect physiological data such as blood pressure and subjective patient data through sensors on peripheral devices. The data are transmitted to healthcare providers or third parties via wireless telecommunication devices. The data is evaluated for potential problems by a healthcare professional or via clinical decision support algorithm and the patient, caregivers and health providers are immediately alerted if a problem is detected. The main advantage of mobile health- monitoring devices offer great help to both patient and doctors; doctors can focus more on tasks with high priority by saving time normally spent with treating chronically ill patients [3].

The doctors would like to constantly monitor the vital parameters so that they always know what the history is and how big is the change with their findings and when they can have these findings as well as the data points, a much earlier intervention can happen for a patient[4].

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 require high power consumption. To overcome this problem, a system is designed in such a way that the system takes the ECG (Heartbeat), blood pressure, heart rate, temperature of the patient and calculates the obtained data and automatically generates the prescription for the patient and uses the concept of IOT for alerting the patients [5].

The Internet of things (IOT) is the large network of devices, vehicles and appliances which are used at home and the embedded devices with network connectivity enable connection and exchange data. Internet infrastructure helps in identifying the devices uniquely and can inter-operate with other devices in the infrastructure. Remote sensing of the devices and direct interaction with them across the network infrastructure is quite possible because of IOT and results in accuracy and economy in addition to reduced human intervention. The concept of IOT is used in health-care and when the patient is in abnormal condition, there will be a pop-up alert and also the emergency option to contact the doctor.

Literature Survey:

Subject of study "remote healthcare monitoring systems" covers areas of interest in both electrical engineering and medical field of study. It has led to the direction of Biomedical engineering field of study. Remote health monitoring systems are generally based on wearable sensors on the patients body that collect data remotely and transfers it to a database. The data is then accessed remotely by doctor or healthcare specialists who monitor and may make a decision based on the data. Previous research referred to remote "health detection systems" as "mobile health" or "health". This was because they used mobile phones prior to smartphone era. At that time, a health alliance existed that identified barriers, gaps in scaling and use of mobile technology in healthcare. Proactive efforts have seen the barriers in healthcare and mobile communication technology being reduced. According to the Journal of Neuron Engineering and Rehabilitation, most of non-invasive techniques used in acquiring critical signals from the human body are of microvolt (μV) nature signal. Signal processing by use of microcontrollers is then done on the detected signals to acquire the meaningful information from the signal data. Errors such as physical body modeling errors, source modeling errors and noise (instrumentalor biological) are factored in the computation during signal acquisition and processing [6].

To keep individuals healthy an effective and readily accessible modern healthcare system is a prerequisite. The modernized healthcare system should provide better healthcare services to people

at any time and from anywhere in an economic and patient friendly manner. This method uses modern bioinstrumentation, computers and telecommunication technologies. The modern patient monitoring system should acquire, record, display and transmit the physiological data from the patient body to a remote location at any time. For more efficient, timely and emergency medical care, the patient monitoring system must also be incorporated with an alarm system. In order to alert the patient as well as the health care service providers, the patient monitoring system should not only monitor and analyze the critical patient's data, but it should also send alarming messages in case the monitored data go outside their normal ranges. The main drop in this system is the patient remains admitted in the hospital, wired to bedside biomedical instruments for a period of time [4].

There are advancements in various aspects of sensing. These advancements have been possible with arrival of smart sensing techniques, smaller transceiver and sensing modules as well as stronger processing units. The patients are monitored using a portable and mobile device which accumulates and processes data from an array of wearable sensor. A set of medical and environmental sensors are used to monitor the health as well as the surrounding of the patients. The architecture is designed for monitoring a unitary patient privately at home as well as multiple patients in hospitals and public health care units. The main disadvantage in this system is that the medical data and history acquired for the patients are personal in nature. Hence the system ensures security of the highest order for the medical data on cloud storage. Though it uses cloud computing for storage, it is difficult to maintain and access it at times. To overcome these problems, the systems itself checks the medical health of the patient and gives the prescription without the help of doctor. In case of emergency, the system alerts the patient about the problem in the health of patient and alerts are send to ambulance for visiting the hospital. IOT consists of a large number of small devices coupled with one or more sensors, some processing circuits and a wireless transceiver. These devices are termed as sensor nodes or motes. The patients body temperature and heart beat are monitored. A microcontroller is used to get the efficient results in this system. A Body Sensor Network is designed to operate autonomously and connects to the various medical sensors and implants located inside or outside of the human body, which helps in flexible operation. It is also a cost saving option to both health-care professionals and patients. This work illustrates the design and implementation of a smart health monitoring system. Here, the set of wearable sensors are used for real time sensing and collecting the patients parameter which later on will be shared with other devices [5].

The system isused to monitor physiological parameters such as temperature and heart rate of the human subject. The system consists of an electronic device which is worn on the wrist and finger of risk person. Using several sensors to measure different vital signs, the person is wirelessly monitored from his home. An impact sensor has been used to detect falls. The device detects if a person is medically distressed and sends an alarm to a receiver unit that is connectedto a computer It is able to send parameters of patient in real time. If a particular patient's health parameter falls below the threshold value, a buzzer alert is triggered by the ARM server [8].

A wearable health monitoring system called "button system" is attached over the chest for monitoring electro cardio gram (ECG), heart rate; temperature and another type of sensors acquire sufficient accuracy of the heart rate comparable to the classical ECG devices [9].

Wearable health devices continuously measure the patient's heart values and when a symptom of a heart attack has occurred, may send information about the patient's health condition to the family members and the doctor. Continuous monitoring of a person's health through wearable biomedical devices is now possible with many wearable health kits. However, real-time analyzes and estimates, warnings and alarms on health hazards are not adequately addressed in these devices [10].

Vast potential is acquired by internet connected devices by pushing our lives towards automation and the rapid decrease in prices is motivating people to do new innovations. A combination of embedded system, software and sensors is referred

as Internet of Things. Since everyone is prone to health issues, a continuous health monitoring system in name of IoT can be used. Remote observation is possible now as the internet is available throughout.

The relatives of the patient are anxious about his/her health condition when he/she is admitted in the hospital. The anxiousness can be removed by the use of Raspberry Pi and IoT used in new innovative technologies to monitor the health condition of the patients. The patient's heart rate, body temperature, respiratory rate, blood pressure and body movement are measured in this proposed system. The hospitable management will be more liable and responsible to the patients' relatives. Huge machines are used to measure the health data of the patient by the hospital management.

By using E-health sensor platform, the health data can be measured according to the health of the patient, the appliances are automatically controlled by Raspberry Pi. The sensors are present to monitor the critical health parameters
like blood pressure, heart rate, blood sugar level etc. sensors send the signals to the Raspberry Pi which runs on Linux based operating system which works like a small PC. Programming can be done according to the project's requirement and the screen can display the patients' health parameters with pi. More than this, the system can be accessed from any part of the world through internet. The health data which is displayed on the website will be stored in the cloud.

An ECG sensor will measure the heartbeat of the patient in the system. Bioelectrical signals of low amplitude are used to trigger the heartbeats generated by a special set of cells in the SA node of the heart. Electrical signals are converted into various numerical values through electro-cardiography (ECG) by which the signals could be used in wide range of applications. When a finger will be placed on the sensor, it provides the digital heartbeat of the person. With every individual heartbeat detected by the heart detector, the uppermost LED will start flashing. For the measurement of heartbeat per minute (BPM), the microcontroller is connected to the heart detector. At every single pulse, the microcontroller will function according to the principle of the light modulation by blood flow. Blood pressure is also one of the health parameter to which most of the people are prone to. As the heart pumps, the pressure of the blood circulating in the arteries is called blood pressure. Blood pressure has two common medical terms [11].

Health monitoring system consisting of a wearable device that will continuously monitor the health of patient. This wearable device consists of different sensors such as temperature sensor and heart rate sensor. The device will collect the data in form of bio signals from sensors and send it to hospital server for further storage and processing using wireless communication. This data will be available to the doctors on server from any location using IOT application. This paper aims ultimately to build a health monitoring system for cardiac patients to monitor his/her vital body parameters especially related to heart problems like ECG and heart rate. We have made a prototype of an automated health monitoring system based on 3 - tier architecture of Wireless Body Area Network (WBAN) comprising various sensors for monitoring cardiac patients in ICU of hospital. In tier I, Arduino Nano board based on the ATmega328P micro-controller is used to collect data from sensors and send to server using ESP8266 Wi-Fi wireless communication in tier II. In tier III existing internet is used to send data to remote servers for further use over IOT application.

Much advancement can be done in these systems to make them more accurate, reliable, cost effective and wearable using biosensors. In hospitals and in homes cardiac patients can be monitored using healthcare monitoring system based on wireless sensor networks. The focus of our work is on continuous monitoring of cardiac patients in hospital especially in ICU and in homes using healthcare monitoring system based on wireless sensor networks. It achieves various goals like decrease in cost and long hospital stays and continuous and remote monitoring without experts' attendance is possible.

Design and implementation of healthcare

monitoring system for cardiac patients to monitor significant body parameters of patient inside hospital as well as in home. Different sensors are attached or induced to the patient's body to collect vital body parameters like temperature, SPO2, heart rate, pulse rate etc. to be monitored. Heart rate and ECG sensor probes are also attached to patient's body. The sensor data is in the form of analog signals and to be converted into digital form using inbuilt circuits of Arduino board which collects and processes sensor data for further communication. For further use and storage it is then send to server using suitable wireless communication [12].

Wearable health-monitoring systems (WHMS) have drawn a lot of attention from the research community and the industry during the last decade as it is pointed out by the numerous and yearly increasing corresponding research and development effort healthcare costs are increasing and the world population is ageing [4], there has been a need to monitor a patient's health status while he is out of the hospital in his personal environment. To address this demand, a variety of system prototypes and commercial products have been produced in the course of recent years, which aim at providing real-time feedback information about one's health condition either to the user himself or to a medical center or straight to a supervising professional physician, while being able to alert the individual in case of possible imminent health threatening conditions. In addition to that, WHMS constitute a new means to address the issues of managing and monitoring chronic diseases, elderly people, postoperative rehabilitation patients, and persons with special abilities.

Wearable systems for health monitoring may comprise various types of miniature sensors, wearable or even implantable. These biosensors are capable of measuring physiological parameters like heart rate, blood pressure, body and skin temperature, oxygen saturation, respiration rate, electrocardiogram etc.The obtained measurements are communicated either via a wireless or a wired link to a central node, for example, a Personal Digital Assistant (PDA) or a microcontroller board, which may then in turn display the according information on a user interface or transmit the aggregated vital signs to a medical center. The fact that a wearable medical system may encompass a wide variety of components: sensors, wearable materials, smart textiles, actuators, power supplies, wireless communication modules and links, control and processing units, interface for the user, software, and advanced algorithms for data extracting and decision making [13].

The personal health monitoring of each individual is considered very important because of rise in health problems in today's world increasing stressful lifestyle is taking maximum toll on the public health. With the ever increasing queues at hospitals and ever increasing number of patients, the doctor fees which is affecting especially those patients who cannot afford the fee or who are not suffering from major alignments but get to know so only after paying a hefty fee to the doctor.

The needs of both patients and health care providers must be addressed. This is essential, challenging, and achievable. Information privacy in health involves optimizing individual rights and public good. The benefits expected include: Improved clinical decision making. Reduced duplication of diagnostic testing, imaging and history taking. Better medication management. Increased adoption of screening programs and preventive health measures. Communication between all healthcare providers involved in care of patients will be via electronic means. Healthcare providers will still be allowed to maintain detailed and confidential paper medical records.

In the advanced development of technology, IoT makes all objects interconnected and it's been recognized as the next technical revolution .One such application in healthcare to monitor the patients‟ health status. Internet of things makes medical pieces of equipment more efficient by allowing real-time monitoring of patients health in which sensor acquire data of patient and reduces human error. The significant challenges in implementation of internet of things for health applications are monitoring data of all patients from various places. Thus internet of things in the

medical field brings out the solution for effective patient monitoring at reduced cost and also reduces the trade-off between patient outcome and disease management. From the analysis of results using raspberry pi platform efficiency of this system is high and also time reduces while measuring medical parameters of patient with help of internet of things.

The system has been designed for health monitoring process. One such application is in healthcare to monitor the patient health status Internet of Things makes medical equipment's more efficient by allowing real time monitoring of patient health. We have a designed a system which is very helpful in monitoring & updating the patient health status in a graph report format to the doctor via PC or Desktop.

Implementation of the WLAN Technology is done for the faster communication. Thus the system is implemented in pulse monitoring for continuous pulse rate measurement for an Hour's/Day is done by Blood pulse sensor. Likewise Body Temperature has been noted by using Temperature Sensor with help of ADC converter. A Raspberry PI module picks up the sensor data and sends it to the network through Wi-Fi and hence provides real time monitoring of the health care parameters for doctors. These data can be accessed anytime by the doctor. The proposed system of the Project is to report a clear notification of patient database health status in graphical form to the doctor side [14].

Conclusion:

The Remote Patient Monitoring System is researched, designed and presented around the concept of Internet of things. Personal physiological data from the patient is collected that stimulates the vital conditions of the body such as ECG, Heart rate, Temperature, Pulse rate. The system automatically generates the prescription according to the vital conditions of the patient.

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