IOT BASED HEALTH MONITORING SYSTEM

Abstract:

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 that has seen an adoption of the technology is 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, 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 Internet of Things (IoT) concepts have been widely used to interconnect the available medical resources and offer smart, reliable, and effective healthcare service to the patients. Health monitoring for active and assisted living is one of the paradigms that can use the IoT advantages to improve the patient’s lifestyle. In this project, I have presented an IoT architecture customized for healthcare applications. The aim of the project was to come up with a Remote Health Monitoring System that can be made with locally available sensors with a view to making it affordable if it were to be mass produced. Hence the proposed architecture collects the sensor data through Arduino microcontroller and relays it to the cloud where it is processed and analyzed for remote viewing. Feedback actions based on the analyzed data can be sent back to the doctor or guardian through Email and/or SMS alerts in case of any emergencies.

**Introduction:**

Background of the study What is a Remote Health Monitoring System? 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. The remote health monitoring system can be applied in the following scenarios:

1. A patient is known to have a medical condition with unstable regulatory body system. This is in cases where a new drug is being introduced to a patient.

2. A patient is prone to heart attacks or may have suffered one before. The vitals may be monitored to predict and alert in advance any indication of the body status.

3. Critical body organ situation

4. The situation leading to the development of a risky life-threatening condition. This is for people at an advanced age and maybe having failing health conditions.

5. Athletes during training. To know which training regimes will produce better results. In recent times, several systems have come up to address the issue of remote health monitoring. The systems have a wireless detection system that sends the sensor information wirelessly to a remote server. Some even adopted a service model that requires one to pay a subscription fee. In developing countries, this is a hindrance as some people cannot use them due 2 to cost issue involved. There is also the issue of internet connectivity where some systems to operate, good quality internet for a real-time remote connection is required. Internet penetration is still a problem in developing countries. Many of the systems were introduced in the developed countries where the infrastructure is working perfectly. In most cases, the systems are adapted to work in developing countries. To reduce some of these problems there is need to approach the remote detection from a ground-up approach to suit the basic minimal conditions presently available in developing countries. A simple patient monitoring system design can be approached by the number of parameters it can detect. In some instances, by detecting one parameter several readings can be calculated. For simplicity considerations parameter detection are: i) Single parameter monitoring system: In this instance, a single parameter is monitored e.g. Electrocardiogram (ECG) reading. From the ECG or heartbeat detection, several readings can be got depending on the algorithm used. An ECG reading can give the heart rate and oxygen saturation. ii) Multi-parameter monitoring system: This has multiple parameters being monitored at the same time. An example of such a system can be found in High Dependency Units (HDU), Intensive Care Units (ICU), during the surgery at a hospital theatre or Post surgery recovery units in Hospitals. Several parameters that are monitored include the ECG, blood pressure, respiration rate. The Multiparameter monitoring system basically proof that a patient is alive or recovering. In developing countries, just after retiring from their daily career routine majority of the elderly age group, move to the rural areas. In developed countries, they may move to assisted living group homes. This is where a remote health monitoring system can come in handy. 3 1.2 Statement of the problem REMOTE HEALTH MONITORING 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. Wireless sensors are used to collect and transmit signals of interest and a processor is programmed to receive and automatically analyze the sensor signals. In this project, you are to choose appropriate sensors according to what you would like to detect and design algorithms to realize your detection. Examples are the detection of a fall, monitoring cardiac signals. Using a single parameter monitoring system an approach to a remote health monitoring system was designed that extends healthcare from the traditional clinic or hospital setting to the patient's home. The system was to collect a heartbeat detection system data, fall detection system data, temperature data and few other parameters. The data from the single parameter monitoring systems was then availed for remote detection. During design the following characteristics of the future medical applications adhered: a) Integration with current trends in medical practices and technology, b) Real-time, long-term, remote monitoring, miniature, wearable sensors and long battery life of a designed device. c) Assistance to the elderly and chronic patients. The device should be easy to use with minimal buttons. 4 1.3 Purpose of the study Design a Remote Patient Health Monitoring System (RPHMS) which has heartbeat detection system, a fall detection system, temperature detection system, a humidity detection system, a toxic gas and air quality detection system and SPO2 detection system. A doctor or health specialist can use the system to monitor remotely of all vital health parameters of the patient or person of interest. An attempt at designing a remote healthcare system made with locally available components. i) The fall detector, temperature, humidity, pressure, toxic gas, air quality control, SPO2 modules comprise of an accelerometer, wireless transmitter and microcontroller. The data collected was transmitted wirelessly to a receiver module. ii) ECG consists of a non-invasive infrared finger detector, Liquid Crystal Display (LCD), a designed circuit for cardiac signal detection and microcontroller. The detected analog signal was then digitized to give a digital value that was read on the LCD. iii) A simple cloud server where hosted with a database for all the vital data to be accessed remotely whenever required. 1.4 Objective of the study Here the main objective is to design a Remote Patient Health Monitoring System to diagnose the health condition of the patients. Giving care and health assistance to the bedridden patients at critical stages with advanced medical facilities have become one of the major problems in the modern hectic world. In hospitals where many patients whose physical conditions must be monitored frequently as a part of a diagnostic procedure, the need for a cost-effective and fast responding alert mechanism is inevitable. Proper implementation of such systems can provide timely warnings to the medical staffs and doctors and their service can be activated in case of medical emergencies. Present-day systems use sensors that are hardwired to a PC next to the bed. 5 The use of sensors detects the conditions of the patient and the data is collected and transferred using a microcontroller. Doctors and nurses need to visit the patient frequently to examine his/her current condition. In addition to this, use of multiple microcontroller based intelligent system provides high-level applicability in hospitals where many patients must be frequently monitored. For this, here we use the idea of network technology with wireless applicability, providing each patient a unique ID by which the doctor can easily identify the patient and his/her status of health parameters. Using the proposed system, data can be sent wirelessly to the Patient Monitoring System, allowing continuous monitoring of the patient. Contributing accuracy in measurements and providing security in proper alert mechanism give this system a higher level of customer satisfaction and low-cost implementation in hospitals. Thus, the patient can engage in his daily activities in a comfortable atmosphere where distractions of hardwired sensors are not present. Physiological monitoring hardware can be easily implemented using simple interfaces of the sensors with a Microcontroller and can effectively be used for healthcare monitoring. This will allow development of such low-cost devices based on natural human-computer interfaces. The system we proposed here is efficient in monitoring the different physical parameters of many number bedridden patients and then in alerting the concerned medical authorities if these parameters bounce above its predefined critical values. Thus, remote monitoring and control refer to a field of industrial automation that is entering a new era with the development of wireless sensing devices. 6 The Internet of Things (IoT) platform offers a promising technology to achieve the healthcare services, and can further improve the medical service systems. IoT wearable platforms can be used to collect the needed information of the user and its ambient environment and communicate such information wirelessly, where it is processed or stored for tracking the history of the user. Such a connectivity with external devices and services will allow for taking preventive measure (e.g., upon foreseeing an upcoming heart stroke) or provide immediate care (e.g., when a user falls and needs help). 1.5 Limitation of the study The scope of the project was limited to ECG, fall, temperature, humidity, pressure, toxic gas, air quality and SPO2 detection and remote viewing of the collected data for a single patient. Here, the most important specification considered was that they should be safe to use and accurate. This is because the physiological information being detected determines the severity of a critical life-threatening situation.

Literature Survey:

Development and Clinical Evaluation of a Home Healthcare System Measuring in Toilet, Bathtub and Bed without Attachment of Any Biological Sensors Daily monitoring of health condition at home is important for an effective scheme for early diagnosis, treatment, and prevention of lifestyle-related diseases such as adiposis, diabetes and cardiovascular diseases. While many commercially available devices for home health care monitoring are widely used, those are cumbersome in terms of self-attachment of biological sensors and self-operation of them. From this viewpoint, we have been developing a non-conscious physiological monitoring system without attachment of any sensors to the human body as well as any operations for the measurement. We developed some devices installed in a toilet, a bath, and a bed and showed their high measurement precision by comparison with simultaneous recordings of ordinary biological sensors directly attached to the body. To investigate that applicability to the health condition monitoring, we developed a monitoring system in combination with all the monitoring devices at hospital rooms and previously carried out the measurements of patients' health condition. Further, in this study, the health conditions were measured in 10 patients with cardiovascular disease or sleep disorder. From these results, the patients’ health conditions such as the body and excretion weight in the toilet, the ECG during taking the bath and the pulse and respiration rate during sleeping were successfully monitored in the hospital room, demonstrating its usefulness for monitoring the health condition of the subjects with cardiovascular disease or sleep disorder. 8 2.2 Intelligent wireless mobile patient monitoring system Nowadays, Heart-related diseases are on the rise. Cardiac arrest is quoted as the major contributor to the sudden and unexpected death rate in the modern stress filled lifestyle around the globe. A system that warns the person about the onset of the disease earlier automatically will be a boon to the society. This is achievable by deploying advances in wireless technology to the existing patient monitoring system. This paper proposes the development of a module that provides mobility to the doctor and the patient, by adopting a simple and popular technique, detecting the abnormalities in the bio signal of the patient in advance and sending an SMS alert to the doctor through Global System for Mobile(GSM) thereby taking suitable precautionary measures thus reducing the critical level of the patient. Worldwide surveys conducted by World Health Organization (WHO) have confirmed that the heart-related diseases are on the rise. Many of the cardiac-related problems are attributed to the modern lifestyles, food habits, obesity, smoking, tobacco chewing and lack of physical exercises etc. The post-operative patients can develop complications once they are discharged from the hospital. In some patients, the cardiac problems may reoccur, when they start doing their routine work. Hence the ECG of such patients needs to be monitored for some time after their treatment. This helps in diagnosing the improper functioning of the heart and take precautions. Some of these lives can often be saved if acute care and cardiac surgery is provided within the so-called golden hour. So, the need for advice on first-hand medical attention and promotion of good health by patient monitoring and follow-up becomes inevitable. Hence, patients who are at risk require that their cardiac health to be monitored frequently whether they are indoors or outdoors so that emergency treatment is possible. Telemedicine is widely considered to be part of the inevitable future of the modern practice of medicine. 9 2.3 The real-time monitoring system for in-patient based on ZigBee The system is made up of two sub-systems: patient physical states data acquisition and communication system based on ZigBee technology, and hospital monitoring and control center. The patient physical states data acquisition and communication system monitors the main physical parameters and movement status continuously. The information from data acquisition system is sent to hospital monitoring center by ZigBee wireless communication module. The monitoring center receives the information from each patient and save them to the database, and then judges the states of the patient by fuzzy reasoning. The data from the patient can be displayed as a graph or numeric on the monitor if it is necessary, and then the doctor can diagnose the patient according to the recorded continuous data. Wireless sensor network is made up of a lot of wireless sensors based on ZigBee technology. The ZigBee technology provides a resolution for transmitting sensors’ data by wireless communication. ZigBee technology can transmit data with a rate of 250kbps, and then it is enough for the physical parameters of the patient. The communication distance of ZigBee node can be over 200 meters and can be spread by add route node, and then ZigBee technology is suited to a short distance wireless sensors network. ZigBee technology owns many virtues, such as low power consumption, low cost, small size, free frequency, etc. To know the physical states of in-patient, the physical parameters need to be monitored real-time. The traditional medical test instrument is a large size and connected by wire often, and the patient is required to be quiet during the test. In most of the hospital, the medical instruments need to be read by doctor or nurse, and the physical parameters are tested and recorded one or two times each day, the real-time monitoring is expensive for most of the patients, and can be only acquirable for ICU by a nurse. For this reason, the worsening of patient can’t be found in time, and then the patient can’t be helped in time. For most of the patients can be monitored real-time in hospital, we should 10 find a new method. Consider that the movement of the patient is limited in hospital, we adopted the ZigBee and wireless sensors network to acquire the physical parameters of the patient.

Problem Defination:

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. Wireless sensors are used to collect and transmit signals of interest and a processor is programmed to receive and automatically analyze the sensor signals. In this project, you are to choose appropriate sensors according to what you would like to detect and design algorithms to realize your detection. Examples are the detection of a fall, monitoring cardiac signals. Using a single parameter monitoring system an approach to a remote health monitoring system was designed that extends healthcare from the traditional clinic or hospital setting to the patient's home. The system was to collect a heartbeat detection system data, fall detection system data, temperature data and few other parameters. The data from the single parameter monitoring systems was then availed for remote detection. During design the following characteristics of the future medical applications adhered: a) Integration with current trends in medical practices and technology, b) Real-time, long-term, remote monitoring, miniature, wearable sensors and long battery life of a designed device. c) Assistance to the elderly and chronic patients. The device should be easy to use with minimal buttons.

Methodologies:

In which our main aim is to moniter the patients all the parameters to get to know the condition of the patient who is someware away from the person who want to get to know the patient details.in that case what we need to do is first we will get thwe temparature of the patient to get to know initial condition if the temparature is low then the expected then the patient may be sweating and if the body temparature of the body is above the normal condition then the patient is having the fever .

Then our aim is to monitor the condition which can affect the mans body working I.e hes body blood circulation that can be measured by knowing hes pulse rate foor that purpose we are using the pulse rate detecting sensor.by getting all the parameter we can now analyse that whether the patient is alright or whether he is having any problem .based on that messages will be sent to the particular mobile numbers

Power

supply

ESP32

Power

supply

Temperature sensor

server

ECG sensor

Message notification

Pulse oxygen

GSM module

Heart beat sensor

Gps module

DHT 11

App

And also we will be continiously checking the glucose concentration level of the blood.

After getting all the health information from the sensors we need to send it to the some servere. For that we are using the android app .

And finally we are goingnto plot the graphs of the parameters for the best visualisation process.

**Applications:**

Physiological data such as blood pressure and subjective patient data are collected by sensors on peripheral devices. Examples of peripheral devices are: blood pressure cuff, pulse oximeter, and glucometer. The data are transmitted to healthcare providers or third parties via wireless telecommunication devices. The data are evaluated for potential problems by a healthcare professional or via a clinical decision support algorithm, and patient, caregivers, and health providers are immediately alerted if a problem is detected.[3] As a result, timely intervention ensures positive patient outcomes. The newer applications also provide education, test and medication reminder alerts, and a means of communication between the patient and the provider.[3] The following section illustrates examples of RPM applications, but RPM is not limited to those disease states.

Dementia and falls

Telehealth Response Watch

For patients with dementia that are at risk for falls, RPM technology promotes safety and prevents harm through continuous surveillance.[3] RPM sensors can be affixed to the individual or their assistive mobility devices such as canes and walkers.[3] The sensors monitor an individual’s location, gait, linear acceleration and angular velocity, and utilize a mathematical algorithm to predict the likelihood for falls, detect movement changes, and alert caregivers if the individual has fallen.[3] Furthermore, tracking capabilities via Wi-Fi, global positioning system (GPS) or radio frequency enables caregivers to locate wandering elders.[3]

Diabetes

Diabetes management requires control of multiple parameters: blood pressure, weight, and blood glucose. The real-time delivery of blood glucose and blood pressure readings enables immediate alerts for patient and healthcare providers to intervene when needed. There is evidence to show that daily diabetes management involving RPM is just as effective as usual clinic visit every 3 months.[8]

Congestive heart failure

A systematic review of the literature on home monitoring for heart failure patients indicates that RPM improves quality of life, improves patient-provider relationships, shortens duration of stay in hospitals, decreases mortality rate, and reduces costs to the healthcare system.[9]

Infertility

A recent study of a remote patient monitoring solution for infertility demonstrated that for appropriately screened patients who had been seeking In-Vitro Fertilization (IVF) treatment, a six-month remote monitoring program had the same pregnancy rate as a cycle of IVF.[10] The remote patient monitoring product and service used had a cost-per-patient of $800, compared to the average cost of a cycle of IVF of $15,000, suggesting a 95% reduction in the cost of care for the same outcome.

Telemedicine in prison systems

A forerunner to RPM, Florida first experimented with "primitive" telemedicine use in its prisons during the latter 1980s.[11] Working with Doctors Oscar W. Boultinghouse and Michael J. Davis, from the early 1990s to 2007, Glenn G. Hammack led the University of Texas Medical Branch's development of a pioneering telehealth program in Texas state prisons.[12]

Veterans Health Administration

The Veterans Health Administration (VHA), United States’ largest integrated healthcare system, is an early adopter which became highly involved in the implementation and evaluation of RPM technologies. It has expanded use of RPM beyond common chronic disease applications, to post-traumatic stress disorder, cancer and palliative care. VHA’s findings indicate improvements in a wide range of metrics, including decrease in emergency department visits, hospitalizations, and nursing home admissions.[5] Findings from the VHA Care Coordination/Home Telehealth program show that RPM deployment resulted in significant savings to the organization.[13]

Whole System Demonstrator Trial in UK

The UK’s Department of Health’s Whole System Demonstrator (WSD)[14] launched in May 2008. It is the largest randomised control trial of telehealth and telecare in the world, involving 6191 patients and 238 GP practices across three sites, Newham, Kent and Cornwall. The trials were evaluated by: City University London, University of Oxford, University of Manchester, Nuffield Trust, Imperial College London and London School of Economics.

45% reduction in mortality rates

20% reduction in emergency admissions

15% reduction in A&E visits

14% reduction in elective admissions

14% reduction in bed days

8% reduction in tariff costs

In the UK, the Government's Care Services minister, Paul Burstow, has stated that telehealth and telecare would be extended over the next five years (2012-2017) to reach three million people.

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