IoT Cloud-Based Remote Patient Health Monitoring and Alarm System

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Abstract: Using cloud computing and furthermore the Internet of Things (IoT), the world is changing nowadays. The development and revolution of modern technology caused by IoT and the cloud made our lives easier. Technology is changing each year, so there is an attempt to consume new technology in several areas to boost human life quality. Specific of the numerous research fields which are essential in our healthy life is the healthcare sector. Our project's main theme is to design a remote healthcare system using IoT and cloud, which monitors patients continuously 24 hours and sends information to doctors and registered hospitals. In this paper, the critical research addressed is to transmit a remote healthcare network infrastructure for monitoring patients and sending updates to doctors. This paper, tries to identify the key remote patient health monitoring systems critical network requirements in real-time data generating updates. This network infrastructure is considered a better way to continuously monitor a patient's health condition before any infection and serious issue occur. This architecture consists of Arduino, cloud computing, alarm, different types of sensors. The sensor senses the health data and generates it. The alarm data generation is sending in such a way that patient can take medicine and get his body situation information on time. In case the patient health parameter crosses the threshold level, a notification will sent through SMS or Email alert. The discussion of different kinds of sensors is done in this paper. The data will generate and shares digitally with the hospital using the Zigbee module. It will help doctors to send the required medicine and suggestion to patients. All instruments consist of hub need to work with Wi-Fi protocol and batteries used for sensors nodes power. Using the concept together, we want to create low and affordable costs which make remote-based health monitoring systems digital and efficient.

Keywords: IoT, Cloud, Remote healthcare system, Arduino UNO, Sensors, Zigbee technology.

1. Introduction

The world population is increasing day by day. By comparing there on, medical facilities and resources are expended but insufficient level [1]. During this situation, the remote healthcare systems will play a vital role because medically challenged people's rates are increasing. Within the healthcare arena, information and communication technology (ICT) network topologies have helped improve health monitoring systems. Between ICT network topologies internet of things and cloud computing carried out the healthcare technology towards the next level [2]. It ensures affordable, low-cost, handy, and reliable devices called remote health monitoring system devices embedded with the patients. This structure is an extended potion of clinic health systems where remotely patient health can monitor and send updates to doctors [3]. Everyone seems to concern about health issues. We will use a continuous remote health monitoring system in form of IoT and cloud. This system can use Arduino and IoT cloud together in the form of an innovation system to monitor a patient's health

condition. This network will be effective in the COVID-19 pandemic situation. Due to this pandemic time, a vast number of people are affected on COVID-19 [1]. This module will be a better choice for developing countries also. In those countries, populations are increasing, but healthcare resources are not sufficient by comparing. Proper medical facilities and resources are still not available for many people, especially those who have low incomes and live in rural areas. There is an urgent need to develop highly reliable technology and low-cost health monitoring systems [4]. So, we proposed the architecture of an IoT cloud-based remote health monitoring system in those areas. Sensors will measure the patient's temperature, blood pressure, respiratory rate, movement, heart rate, ECG, Toxic level, SPO2. The sensors will record signals in continuous time. Sensors provide information about the patient's temperature, blood pressure, respiratory rate, movement, heart rate, ECG, Toxic level, SPO2, and patient current information [5]. After that resulting data generate process and analyze by intelligent machines. Arduino automatically makes these applications. It shares information digitally in hospitals using the Zigbee module with the help of cloud

computing and enables full visibility that provides a higher level of evidence. Doctors required consideration about patient's past for his/her better treatment, so this tool is helps to produce valued information about patients, like the symbol of illness [9]. It also delivers related critical perceptions into better care and faster treatments. So the hospital management will be more accessible and liable to the family member [7]. It is also helpful for patients to save time and money. The remote health systems are often functional within the following aspects [6]:

a) Patient who has an unstable regulatory health condition. In this case, the body sensor and the alarm will suggest taking new medicine to replace old medicine to work optimally faster to return the body regulatory system stable.

b) Patient has a risk of heart attack or mile stroke. In this case, the sensor senses it by monitoring and sends an alert in advance that he needs emergency medication at that time.

c) Critical body situation in case of COVID infection, asthma, etc.

d) Will be a helpful network infrastructure for the hospital to monitor emergency and updating monitoring service as well.

e) This system will be a development for life-threatening conditions.

If we measure the aspects, Remote monitoring systems using IoT and cloud can be handy and valuable tools.

2. Overview of Study:

The main theme in this paper is to plan a remote patient monitoring system with two communication tracks. It sends patient records to the doctor by SMS or Email, and the doctor can send recommendations and medicine to patients or family members using the identical way [7]. A doctor or their family member can track patient area at anywhere through a Google map. It's also used to send medicine or any emergency kits

also. In this module, patient monitors their health condition from home effectively. It's an excellent way to give early information about any diagnosis, prevention of lifestyle diseases, and treatment [8]. In recent times many commercial devices for home healthcare monitoring is used widely. Comparing those devices, we try to design a remote-based monitoring system device in combination with monitoring tools. This device will be effective for heart diseases patient because nowadays, heart-related diseases are increasing. Many cardiac-related diseases happen for the modern lifestyle, food habits, obesity, smoking tobacco, and physical exercise [10]. For a few patients, the cardiac problem can reoccur after treatment, once they switch daily routine work. For those patients, ECG needs to monitor consistently after some time of their treatment. So they need the advice of first-hand medical attention and doctor follow-up for those who have a risk of cardiac tissue [11]. In recent times we undergo a pandemic situation which is called COVID-19. In these diseases, patient lunges are poorly affected by the SARS-COV-2 virus. Patients are affected by this disease by pneumonia, normal fever, dry cough, breathing problem, diarrhea, etc. If the lungs' respiratory system is poorly affected, the patient will have a risk of the die. If any patient affected by it the family member will be affected too because it's the exchange by air, sweat also. So people need to take a safe distance from the patient. The patient needs to maintain quarantine and to review physical data every day. For these diseases, a remote healthcare monitoring system device is effective and also required [12]. The device will monitor patient health data rapidly if any breathing problem or other issue occurs it will send an alert to the patient mobile and automatically generate and send data to a nearly located hospital. This device warns a person who is a heart disease patient by monitoring his heart bit and others' physical condition. Sensors will measure the patient's temperature, blood

pressure, respiratory rate, movement, heart rate, ECG, Toxic level, SPO2. The sensors will record signals in continuous time. Sensors provide information about the patient's temperature, blood pressure, respiratory rate, movement, heart rate, ECG, Toxic level, SPO2, and the patient's current condition [5]. It gives the patient a signal by sending SMS and email alerts and doctors through the Global system of mobile (GSM) that doctor can take the necessary steps [9]. This module structure is prepared of two sub-frameworks. One is a patient physical situation data gaining and the other is a Communication plan to support Zigbee technology for hospital monitor and control. The patient physical measurements sense by monitoring scheme sensors and the data is generated in the cloud, it sends data to the SQL database system which analyzes and processes data and sent those data to the hospital by Zigbee technology. Then patient statistics can be showed as a numeric value on the hospital control monitor. By using this data duty doctor can diagnose the patient [13]. Wireless sensor node network is created of lots of wireless sensors, based on Zigbee. Zigbee innovations deliver a resolution to transmit numbers by wireless communication. Zigbee technology can communicate up to 250 kbps which is enough for patient physical parameter sending. This technology is good for short-distance wireless networks because of low power depletion, ease, little size, and free frequency. Evaluating patient location and doctor's flexibility we use the Zigbee and wireless sensor network [14]. In this modern world and with the risk of a pandemic situation, Telemedicine will be widely considered the best part of the upcoming of the modern repetition of medicine. This E-health monitoring system will be lifesaving and revolution for the digitalization of the health sector. It's efficient and ubiquitous healthcare service with fewer errors and sustainable [15].

3. Methodology:

3.1 Proposed Diagram:

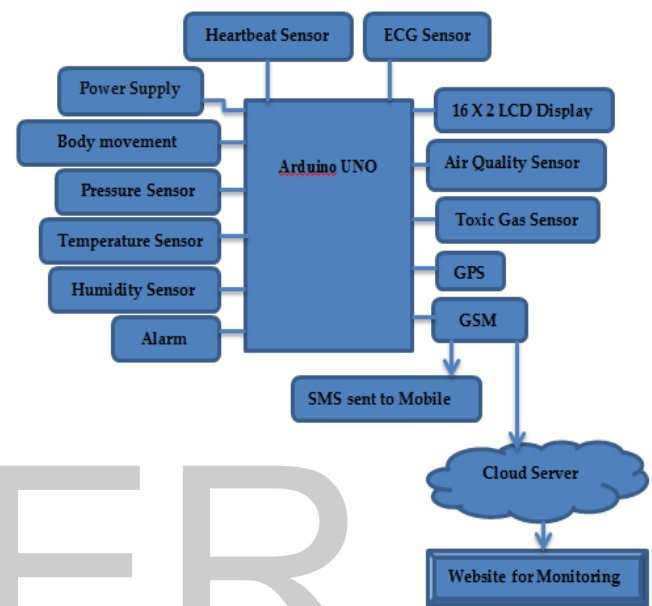The block diagram of proposed system using Arduino UNO is shown here:

Fig 1: Remote patient Health monitoring system proposed System Block Diagram [9]

This proposed system is divided into some parts:

3.2 Health monitoring and data collection:

Sensors are using in health monitoring systems is to collect data and health parameters from patients. This proposed system; sensors monitor the critical health parameter like temperature, blood pressure, respiratory rate, movement, heart rate, ECG, etc. Sensors send the signal data to Arduino [6].

3.2.1 Arduino UNO:

Arduino UNO is a microcontroller built on the ATmega328p. Its 14 computerized input/output pins, six analog inputs, a 16 MHz quarter gem, a USB connection, a power jack, an ICSP header, and a reset button. It contains all to sustenance the microcontroller interface it to a PC with a USB link.

An AC-to-DC Adapter is employed towards provide power on Arduino to start [16].

Figure 2: Arduino UNO

3.2.2 ECG Sensor:

ECG sensor will measure the heart rate of the patient in the system. Bioelectric signals contain low amplitude are used to trigger the heartbeat and its data are generated. Electric signals are converted into numeric values through electrocardiography [6].

Figure 3: ECG Sensor

3.2.3 Temperature Sensor:

The temperature sensor is castoff to measure the patient's internal body temperature. LM35 remains an IC temperature sensor with its output in °C. Temperature can measure more accurately with LM35. The functional temperature range is from -55°C to 150°C [9].

Figure 4: Temperature Sensor

3.2.4 Pressure Sensor:

Pressure sensor which is used to measure pressure usually gas and liquids. In electric circuits pressure

sensor stands in a procedure of an IC that performance as a transducer. It's referred to as a pressure force transmitter, pressure pointer, piezometer, etc. [17].

Figure 5: Pressure Sensor

3.2.5 Body Movement Sensor:

MMA7260QT is used to sense the body movement of the patient. Using X, Y axis, each motion of movement can sense. This sensor is a micro-machined IC accelerometer [6].

Figure 6: Accelerometer Sensor

3.2.6 Humidity Sensor:

A humidity sensor is used to sense, measure, and report humidity within the air. It processes both air temperature and moisture. The sensor comprises of two metal plates and contains a non-conductive polymer film. This film gathers moisture from the air, which reasons for the voltage. The voltage converts into digital input and displays the amount of humidity within the air [17].

Figure 7: Humidity Sensor

3.2.7 Heartbeat sensor:

A heartbeat sensor delivers a straight forward method to contemplate the purpose of the heat. Blood inside the fingertip change with to time. To beat made on blood flow to the fingertip, a pulse sensor assembling with LM350 OP-AMP for checking heartbeat pulse [7].
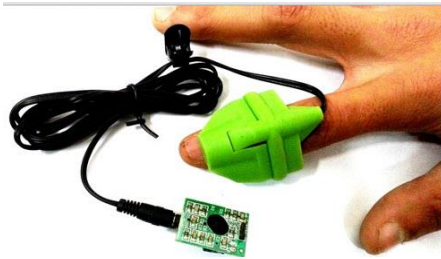

Figure 8: Heartbeat Sensor

3.2.8 Toxic Gas Sensor:

A gas sensor (MQ9) is beneficial for gas spillage detection. Because of high sensitivity and fast reply, measurement can take as soon as possible [9].

Figure 9: Toxic Gas Sensor

3.2.9 Air Quality sensor:

This sensor is used to observe inside air conditions. It has the possibility to measure injurious gases like monoxide, alcohol, thinner, and so on [13].

Figure 10: Air Quality Sensor

3.2.10 GSM module:

GSM (SIM 800L) module is deployed to form a communication path among computers and GSM-GPRS systems. GPRS is an expansion lead of GSM that allows high information transmission. GSM/GPRS module comprises of a GSM/GPRS modem amassed with a power supply circuit and communication interface. It needs a SIM card like mobile to form communication with the network. It also consumes an IMEI number for identification. It needs AT command on behalf of interaction with a processor which is connected with serial communication. The controller sends those commands. AT command maintained by modem will be sent by the PC to interrelate with GSM cell network [18].

Figure 11: GSM (SIM 800L) Module

3.2.11 GPS module:

GPS (Vk-16E) is a tracker use to track anyone location with the help of satellite. For remote patient monitoring system it is quite helpful for patient to inform about his place and doctor and guardian can easily trace his location using this. It is small in size, highest performance, and most sophisticated module [9].

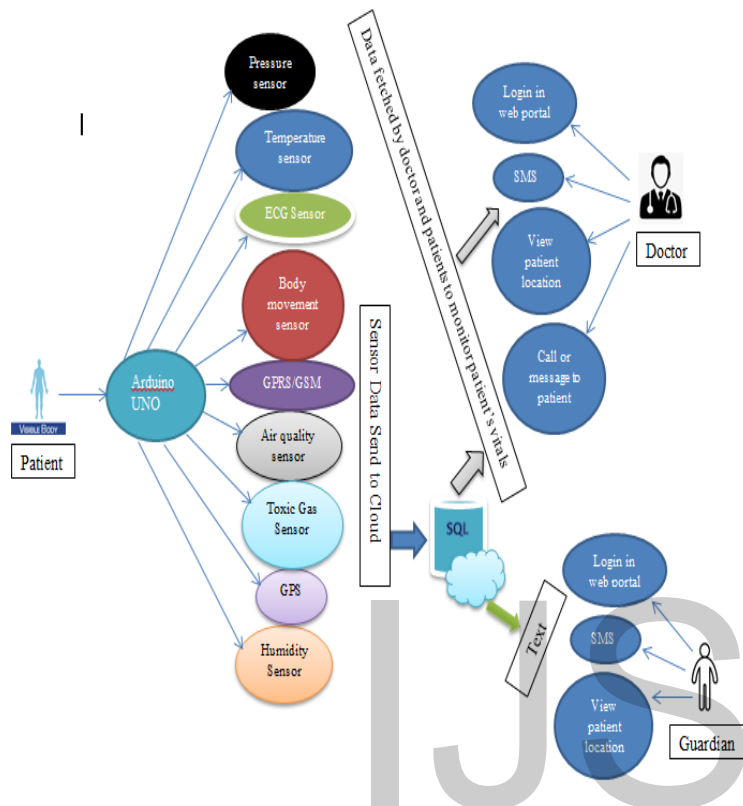Figure 12: GPS (Vk-16E) Module

3.3 Use Case Diagram:

Figure 13: Use Case Symmetric Block diagram [19]

3.3.1 Use Cases:

Keynote people of the structure are patient, Guardian and Doctor. We are identifying a collection of usage belongings supported the functionalization and objectives of the application [9]:

a) Login: Network interface circumstance donates a group of activities needed for the patient, guardian, and doctor to login in to this application.

b) Call service: Network interface circumstance donates a group of activities needed for the doctor to call the guardian or patient in the event of emergency.

c) View location: Network interface circumstance donates a group of activities needed by the

guardian or doctor to find the patient on the map after getting the facts.

d) Message Service: Network interface circumstance donates a group of activities needed by the doctor to send a message to the patient's guardian or family member in emergency situation.

3.4 Medication and Precaution where patient need attention and Appliance control:

Whenever a better health monitoring system available, the patient needs alarm quickly in case of a critical issue that he/she can move to the hospital quickly or inform the doctor. In this case, appliance control is not apart. But on other hand, the appliance part plays a major role in a patient's need to catch his/her condition. Transmit monitor data to Arduino and convert it into a code script that communicates the appliance of the patient to make his/her health condition normal and fast response [13]. But this response would not be helpful in case of critical health issues. The Arduino module will display immediate medicine which will need for a patient in this situation. The alarm wills activate both times that how many doses of medicine will be taken and it displayed on the LCD monitor. It is also helpful for a guardian or other family members to take care of the patient [6].

3.5 Database design and preparation from acquired data:

MySQL is that the current most mainstream open-source SQL data set administration framework. It is one amongst the finest RDMBS existence based on developed various web-based software applications. It delivers a simple, automatic, combined, enterprise-ready MySQL database for patient data and also the longitude and latitude of patient's locations [19]. The data is stored in the MySQL database cloud with the help of Arduino. It is necessary to store the medical data of patients. This would be helpful for patients to make decisions. The doctor also benefited from the database cloud which would pretend the physical

problems of patients. If the doctor diagnoses faster, the patient will cure diseases too quickly [20].

3.6 Sending alerts and Medical reports to patient's guardian and doctors:

Doctors, patient's guardians get an alert which is the main issue of this project if any problem patient fell or patient health condition crosses the threshold level. This alert will give the doctor a concern for better diagnosis and help the guardian or family member to take care of the patient. This would help for the patient to monitor the health and take care of him/her [6].

4. Challenges:

The remote healthcare monitoring system is a new revolution in medical science. It makes healthcare services cost-effective. However, using this system has various challenges because there is no medical staff to ensure proper use of this system [21]. To make this system more useable, all problems must be clarified. So the main challenges are:

4.1 Network connectivity:

Remote monitoring system depends on network connectivity and it gives the availability of patients and doctor premises. Wearable devices transmit data over a network, if any interrupts occur it hampers patient health diagnosis. So connectivity is a major issue and challenge [22].

4.2 Sensors, wearable device and its wear ability:

The remote monitoring system is totally based on sensors and wearable devices. The device must be available upon the patient's requirements and it should be energy efficient, low cost, low weight, and easy to use [21-22].

4.3 Security and Privacy:

This system works on network availability, all networks have a risk of hack and security issues. RPM system must be incorporated with security measures to provide guaranty and privacy of patient's record [21]. To accept this system widely there is a various common issue like cost and affordability, data manipulation and violence of patient's right, the accuracy of data, data authentication and flexibility [23].

5. Conclusion and Future work:

Alarm notification and medicine prescribe along with the dose displayed on the screen is the purpose of the paper. It is the advanced IoT cloud-based remote patient monitoring system that reduces the data accuracy of human error. The doctor and patient guardian can take necessary steps by using health data and the patient can measure his/her health data using this device instant of going hospital [6-7-8].

In the future the sensor data can be managed by fully formed append devices, thus the patient can communicate by using apps and gets notifications about their current health status. The digital hospital system is now introduced widely in the world. If we implement this remote healthcare system along with a digital hospital it can be benefited for the patient and it may not create any confusion inpatient mind about treatment [10-11]. Strict security protocol must be ensured for data protection. For a better progression about it, a video call system along with remote monitoring together can be provided.

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