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Remote and Intelligent Health monitoring System through IoT and Edge Computing

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Abstract

Technology plays the major role in healthcare not only for sensory devices but also in communication, recording and display device. It is very important to monitor various medical parameters of the patient and also post operational days. Hence to keep track of patient medical parameters, the latest trend in healthcare communication method using IoT is adapted. Internet of things serves as a catalyst for healthcare and plays a prominent role in wide range of healthcare applications. The main advantage of IoT is , it makes medical equipments more efficient by allowing real time monitoring of patient health , in which sensor acquire data of patient's and reduces the human error. In IoT patient's health parameters get transmitted through medical devices via a gateway. Data is increasingly produced at the edge of the network, therefore , it would be more efficient to also process the data at the edge of the network using concept of Edge computing.

In this system there is a smart device through which we can monitor patient's pulse rate and temperature. We can store the sensor parameters in the local database, and we can monitor patient's pulse rate and temperature then we can retrieve those values and do some data analytics and send the analyzed data to the cloud, before sending the analyzed data to the cloud edge computing techniques are applied . Later these values can be retrieved to mobile application.

Keywords: Internet of Things (IoT), Edge Computing

1. Introduction

Health is one of the global challenges for humanity. In the last decade the healthcare has drawn considerable amount of attention. The prime goal was to develop a reliable smart health monitoring system so that the healthcare professionals can monitor the patient's, who are either hospitalized or executing their normal daily life activities.

The Raspberry Pi which is a cheap, flexible, fully customizable and programmable small computer board brings the advantages of a PC to the domain of sensor network. In our system we are measuring patient's parameters (Temperature, heartbeat, pulse etc with different sensors [1]. Today internet has become one of the important parts of our daily life. It has changed how people live, work, play and learn. Internet serves for many purpose educations, finance, business, industries, entertainment, social networking, e-commerce etc.

Now the next new mega trend of internet is IoT. Visualizing a world where several objects can sense, communicate and share information over a Private Internet Protocol (IP) or Public Networks. This is the world of the IoT, it is generally considered as connecting objects to the internet and using that connection for control of those objects or Remote Monitoring [2].

Data is increasingly produced at the edge of the network; therefore, it would be more efficient to also process the data at the edge of the network known as Edge Computing. Previous work such as micro datacenter [5], [6], cloudlet [7], and fog computing [8] has been introduced to the community because cloud computing is not always efficient for data processing when the data is produced at the edge of the network. The rationale of edge computing is that computing should happen at the proximity of data sources. From our point of view, edge computing is interchangeable with fog computing [9] Examples of edge: Power Grid , Mobile Networks etc. Edge Computing is a push from cloud services and pull from IoT [3].

This paper presents a Smart Health IoT enabled monitoring framework where health parameters related data are collected by mobile devices and sensors are first sent and analyzed at edge devices to and then the data is sent to the cloud or stored temporarily at edge for seamless access by healthcare professionals.

2. Problem definition

In today's Social Insurance Framework for patient's who stays at home during post operational days checking is done either via overseer/ medical caretaker ceaseless observing may not be accomplished by this system , on the grounds that anything can change in well being parameter inside

of part of seconds. And amid that time if attendant is not in the premises causes more noteworthy harm.

So with this innovation created period where web administers the world gives a thought to add to another keen health awareness framework where time to time constant checking of the patients is accomplished.

3. Literature Survey

Internet of Things (IoT) was first introduced to the community in 1999 for supply chain management [10], and then the concept of "making a computer sense information without the aid of human intervention" was widely adapted to other fields such as healthcare, home, environment, and trans-ports [11], [12]. Now with IoT, we will arrive in the post-cloud era, where there will be a large quality of data generated by things that are immersed in our daily life, and a lot of applications will also be deployed at the edge to consume these data. By 2019, data produced by people, machines, and things will reach 500 zettabytes, as estimated by Cisco Global Cloud Index, however, the global data center IP traffic will only reach 10.4 zettabytes by that time.

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. Patients body temperature, heart beat are monitored and sent to doctor in remote location. This system applies only for remote places such as inside of a hospital or a building [4].

Possibility of sharing the real time data and heterogeneous data is quite possible because of the advancement in IoT. But this has increased the challenge of managing the real time data. In this research, first a semantic data model is proposed to store and interpret IoT data.Then acquire ubiquitous data and process it .Then use the knowledge and apply the same for medical service [4].

A Body Sensor Network was designed to operate autonomously to connect the various medical sensors and implants located inside or outside of the human body, which helps in flexible operation. It is also cost saving option to both health-care professionals and patients.

Set of wearable sensors are used for real time sensing and collecting the patients parameter which later on will be shared with other devices and analysed at edge of cloud.

4. Working

Figure 1 shows the working of the proposed project. Here there is communication between Raspberry pi (rpi), android device and firebase database. Following are the flow in which the communication is done. First step is to initialize the Rpi and android app and connect both devices using Bluetooth. – After the connection is done, the user can initialize the sensor when the sensors are connected to the body to start sensing data.

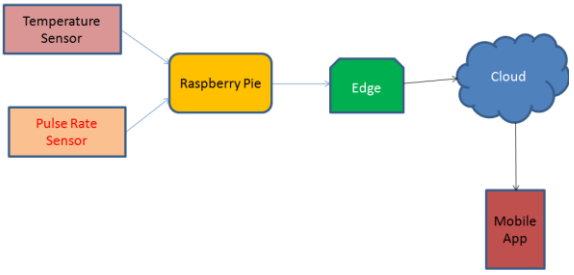

Fig 1: Proposed Architecture

The sensed the data is send to firebase and the user retrieves the data through firebase. – Here they are mainly two types of user:

1) Patient - The users who are using the sensors and is checking the sensed data.

2) Relative/others - The users who are checking patient user data. - For relative user able to access patient user data, the relative user contact must be entered in patient user's relatives field.

- The firebase also analyzes the data and checks whether the threshold values are met.
- If the threshold is not met then it sends notification to relatives.
- Before it is sent to the cloud the data is being analysed at edge where edge computing techniques are being applied.
- The app also features setting reminder for doctor's appointment.

5. Proposed system

The proposed system has an embedded microcontroller connected to a set of medical sensors (related to the patient case) and a wireless communication module (Bluetooth). Each patient is considered as a node in a wireless sensor network and connected to a central node installed at the medical center through an internet connection.

The embedded microcontroller checks if the patient health status is going well or not by analyzing the scanned medical signals. If the analysis results are abnormal, the embedded unit uses the patient's phone to transmit these signals directly to the medical center. In this case, the doctor will send medical advice to the patient to save his/her life.

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The main idea of the designed system is to continuously monitor the patient over internet.The system is proposed to provide LIVE updation of data and emergency alerts. It provides communication between doctors and patients through sensors. Remote monitoring of the patients through mobile app.

At last before the data is sent to the cloud it is being analysed at edge for temporary or permanent storage.

6. Implementation Methodology

HARDWARE DESCRIPTION

6.1 Heart Beat Sensor

The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

Functionality

+5V DC regulated operating voltage
Operating current 100mA
5v TTL output data level
Pulse detection: using LED

Fig 2: Heart Beat Sensor

6.2 HLK-RM04 WiFi Module

HLK-RM04 is a new low-cost embedded UART-ETH-WIFI module (serial port - Ethernet - Wireless network) developed by Shenzhen Hi-Link ElectronicTechnology co., Ltd This product is an embedded module based on the universal serial interface network standard, built-in TCP / IP protocol stack, enabling the user serial port, Ethernet, wireless network (wifi) interface between the conversions. Through the HLK-RM04 module, the traditional serial devices do not need to change any configuration; data can be transmitted through the Internet network. Provide a quick solution for the user's serial devices to transfer data via Ethernet.

Functionality

Built-in TCP / IP protocol stack
Maximum transmission rate 230400 bps
TCP connection Max connection number >20

Fig 3: HLK-RM04

6.3 Arduino Uno

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Functionality

ATmega328 microcontroller
Input voltage: 7-12V
4 Digital I/O Pins

6 Analog Inputs
16 MHz clock speed [11]

Fig 4: Arduino Uno

7. Future scope

Data Mining and Machine Learning Algorithms can be used to predict the disease or the condition through which the patient is suffering from, depending upon the recorded value. The project can be further developed in future to detect exact heart rate with analysis. A proposed system will extend the concept of tele-medicine which is use to provide the clinical health care from a distance. It will be beneficial for the study of wireless transmission of data of patients in case of emergency.

8. Conclusion

Here we conclude that sensors with the interconnection of microcontroller/System on chip and concept of edge computing will help to build an environment where it would be possible to monitor patient's body parameter.It will ensure safety of patient and help in keeping check of patient from remote location.

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