



Designing Safe Patient Healthcare using IoT

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Abstract:

In today's world, Internet is playing a major role in fetching information from various sources. IOT plays an important role in the field of Smart Hospital or Smart Healthcare Systems. Data can be fetched from the hospitals to monitor and track the patients through the Internet of things. So it can be helpful to monitor the patients at remote locations. In healthcare application wearable devices play a important role in monitoring various medical parameters. IOT enables Electronic Health (EH), Mobile Health (MH) and Ambient Assisted Living (AAL) that allow remote monitoring and tracking of patients living alone at home or treated in hospitals. Smart sensors have been developed and are widely used in WSN to make the diagnosis and treatment faster with more accuracy. IOT play an important role in monitoring and diagnosing the patient's health. Healthcare professionals/smart doctors want real-time, reliable, and accurate diagnostic results provided by devices that can monitor the patient wherever the patient is located. It helps the doctor to monitor their patients at any time apart from their working hours.

Keywords: IoT, RPM, MH, EH, Sensors, WSN, Smart Hospital, Smart Health Care Systems. ATMEGA Atmel 328PU, Ultrasonic sensor (HC-SR04), Temperature sensor (LM35), Light Dependent Resistor (LDR), MQTT protocol.

I. INTRODUCTION

Smart healthcare is an emerging research field as the world, moves towards remote monitoring, real-time and fast detection of illnesses. Smart healthcare has many categories, (e.g. telehealth, mobile health, Electronic Health) all of which mean monitoring of patients outside hospital conditions by the means of technology. The advantages of remote monitoring of patients are early and real-time detection of illnesses, ability to continuously monitor patients, prevention of worsening of illnesses and untimely deaths, cost reduction in hospitalizations, minimize the number of hospitalizations, obtain more accurate readings while permitting usual daily activities for patients, improve efficiency in healthcare services by utilizing communication technology, emergency medical care, service for patients with mobility issues, emergency care for traffic accidents and other injuries and usage of non-invasive medical interventions. Remote monitoring of patients target several sub-groups of patients, such as patients diagnosed with chronic illnesses, patients with mobility issues, or other disability, post-surgery patients, neonates and elderly patients. All these types of patients have conditions that are better to be monitored continuously. The aim of good healthcare is the ability to support ordinary life as much comfortable as possible to all patients.

- End-Terminal at the Hospital and
- Communication Network

Data acquisition system

This system is consisting of various types of sensors or devices with data transmission capability wirelessly.

Data processing system

A system with data receiving and data transmitting capability and a data processing unit or processing circuitry.

Terminal at the hospital

Terminal can be a computer at the hospital, or any dedicated device or the Smartphone available with the doctor.

Communication network

This network connects the data acquisition system to data processing system and transmits the detected data or information and conclusions to a healthcare professional or doctor who is connected to the system via the communication network.

Problem Statement

Prior to smart sensors, medical professionals/doctors were dependent on manual tasks for diagnosing the root cause of a medical problem. The patient has to go through some medical tests, the lab technician prepares a report which is further verified by a pathologist. The doctor, after looking at the patient history, examines the medical report to give the treatment to the patient. This process of diagnosing the root cause appears to be a time consuming method and lot of manual inputs are involved. To overcome these, Smart healthcare/smart hospital provides the better solution

Implementations of Internet of Things in various Health Care System

Outpatient Monitoring.

It allows the doctors to capture various health related data and provide proper guidance to patients even remotely. So, the need of patient's hospital visit is limited and needs to visit only on long interval basis, which also helps hospitals to manage resources efficiently and subsequently increase revenues at the

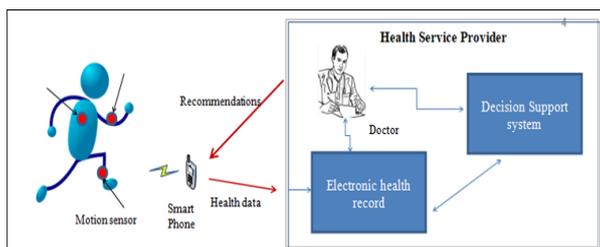


Figure .1. Patient Monitoring using IoT

Primitive elements of a remote monitoring system are

- Data Acquisition System
- Data Processing System

same time providing better treatment to patients. A monitoring device helps the doctor to continue evaluation of the patient and suggest curative measures at regular interval basis.

Clinical Care

Patients admitted in hospital requires close attention and can be continuously observed using IoT driven systems. Sensitive Sensors are used to collect the data and examine data using cloud technology which also helps to improve the value of health care through persistent evaluation.

Remote Patient Monitoring

This technique uses digital technologies to collect medical and other forms of health related data from individual patients and electronically communicate this data to the health care service providers. RPM can help to bring down the number of hospital readmissions time and prolonged lengths of stay in the hospitals.

Device Monitoring

Linked IoT device can provide notification when there is a problem with a device or with its functioning which will prevent the device from executing its functions improperly down and avoid patient rescheduling.

5. Smart Healthcare System using Internet of Things

Most of the time, due to negligence of hospital staff, excessive number of patients or inattentiveness of relatives it may possible that saline bottle is not monitored properly which may lead to cause heart attack due to "AIR EMBOLISM". In a hospital, numbers of electrical equipments (fan, lights) are more in number so energy consumed is more. So, it is important to use electricity as per the need, with the combination of sensor technology and Internet of Things (IoT) we can control switch of the electricity and monitor level of the saline bottle from distant place. The main causes of excessive energy use in hospitals comes from amount of electrical equipments, lighting, and electronics and how often it is left ON when not needed or required. The basic environmental effect of energy overuse is an increase in carbon footprint, For example, if the devices are kept running when they're not in use, the result is an increase in electrical use may result in greenhouse gases that enter the atmosphere. This module helps to control consumption of electricity. And one more important problem related to hospital is nurse or hospital staff need to constantly monitored the level of saline bottle. So ,it may happen that due to the negligence of the hospital staff saline bottle may not monitored properly which can lead to the death of the patient. This can happen when saline bottle is fed completely to the patient and when it is not removed then due to the pressure difference between the patient's blood flow and empty saline bottle, blood can causes outward flow of blood into saline bottle. In this system using IoT, one can control switch of the electricity and continuously monitored the level of the saline bottle from the distant position.

Working of Block diagram

The block diagram below consisting of three parts

1. Consisting of Fan, Light, Ultrasonic Sensor etc. at the Back End
2. Arduinomega(ATMEGAAtmel328PU)+Ethernetshield (W5100)
3. MQTT broker as a cloud server
4. HTML Page or Mobile device having MQTT lens application which includes switch controller for fan and light at the Front end

Here ultrasonic sensor, light dependent resistor and temperature sensor are interfaced with Arduino mega board(ATmega Atmel 328PU). This Arduino mega board is connected to MQTT server via ethernet cable. This will provide connectivity to the server for the transmission of the data on to the internet, and this data then monitored arbitrarily using Mobile device or by using MQTT lens application.

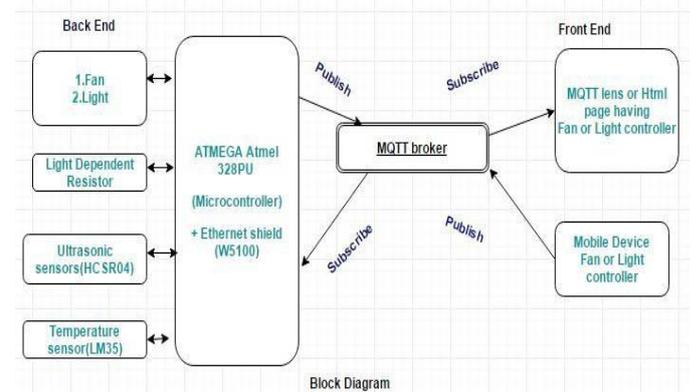


Figure 2. Block Diagram

In the above system sensor will acquire the data from the surrounding that is temperature sensor will constantly monitor the temperature of the patient's room, ultrasonic sensor will monitor the level of saline bottle and LDR(Light Dependent Resistor) will monitor the illumination of a light on it in terms of resistance value. Data acquire by all of the sensors will be transmitted by USB(Universal Serial Bus) which is used for the data transfer to the Arduino mega board. This data is then publish to the MQTT broker server via ethernet cable. Whenever one wants to acquired this data then that person has to subscribe to the MQTT server and then hospital staff he/she can monitor the data received. MQTT platform is used to control to the switch which will ultimately control electrical appliances (fan ,light etc.). Whenever temperature of the patient's room increases above the mentioned /predefined level, it will send the data to the page and then from the webpage or from the mobile device. In case of saline bottle, level of the saline bottle continuously send on to the server so that hospital staff need not to go to each and every patient's room to monitor it. As soon as the level of liquid in a saline bottle falls below predefined level then nurse can go to the particular patient's room and change that bottle.

Components of the System

Temperature Sensor (LM35)

The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 is suitable for many general temperature sensing applications.

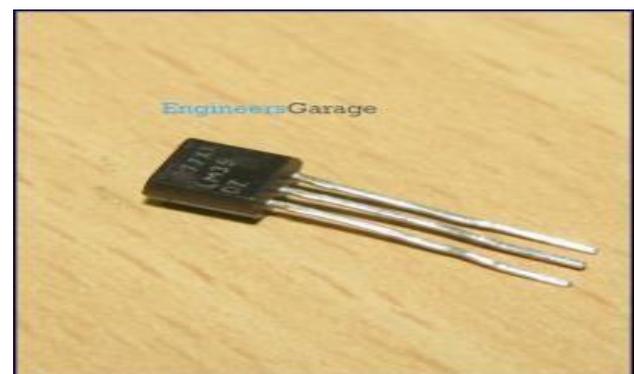


Figure.3. Temperature sensor (LM35)

LDR (Light Dependent Resistor)

LDR sensor has two cadmium sulphide photoconductive cells(cdS). The cell resistance will fall with the increasing light intensity. Its application are smoke detection, automatic lighting control system, batch counting and burglar alarm systems. Light dependent resistors have property to store the lighting conditions in which they have been stored. Light storage reduces equilibrium time to reach steady state resistance values.



Figure.4. LDR Sensor

Ultrasonic sensor (HC-SR04)

Ultrasonic sensors includes ultrasonic transmitters, receiver and control circuit. The basic working principle of Ultrasonic sensor is as follows: a)Using IO trigger for at least 10us high level signal. b)The module automatically sends eight 40kHz and detect whether there is a pulse signal back. c)If the signal back ,through high level, time of high output IO duration is the time from sending ultrasonic to returning. Test distance=(high level time × velocity of sound(340M/S)/ 2)



Figure 5. HC-SR04 sensor

ATmega Atmel 328PU

The ATmega Atmel 328PU is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle ATmega Atmel 328PU achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. Power saving is the major important factor. It is easy to do coding for the arduino board as various libraries are available to use in the code.

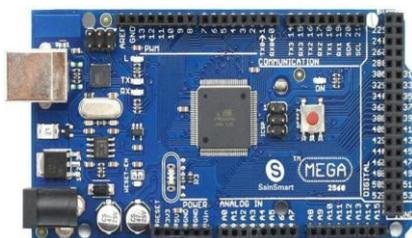


Figure.6 Arduino mega board having ATmega Atmel 328PU Microcontroller

MQTT Protocol

In this system use of MQTT protocol has been used because it has advantages over http protocol. This protocol gives faster response output. It has lower battery and bandwidth consumption. It works efficiently enterprise level applications which includes transfer data to server or to mobile application. It assures data transmission and efficient distribution. It is suitable for constrained environment than http. It is a light

weight publish and subscribe protocol and runs on IP. It is open standard protocol.

Merits of Internet of Things in Healthcare organization

Minimized Operational Costs

HealthCare solution providers have seamless connectivity to the healthcare solutions, thus patient observation can be carried out in real time basis, thus drastically reducing number of unnecessary visits by doctors. Such home care facilities also help to reduce number of hospital stays.

Results of Enhanced Treatment

Connectivity of health care solutions through cloud computing or other virtual infrastructure gives caregivers the ability to access real time information that enables them to make informed decisions as well as offer treatment that is evidence based. This ensures health care provision is timely and treatment outcomes are improved.

Prevention and Treatment management

If patients are monitored continuously, the health care providers are able to access real time data, diseases are treated in time.

Human errors reduction

Accurate collection of data, automated workflows combined with data driven decisions are an excellent way of cutting down on waste, reducing system costs and most importantly minimizing on errors.

Enhanced Patient Experience

The connectivity of the health care system through the internet of things, places emphasis on the needs of the patient. Such as quick/fast and responsive treatments, improved accuracy and efficiency. when it comes to diagnosis, timely intervention by physicians and enhanced treatment outcomes result in accountable care that is highly trusted among patients.

Management of Drugs

Management of drugs is a major expense in the healthcare industry. But with the IoT processes and devices, it is possible to manage these costs better.

8. Future of IOT in Healthare System

Integrating IoT in healthcare system is finally turning into reality. It has been projected that the global healthcare industry going to invest about \$410 billion into procure IoT devices, services, and software in the year 2022, as per the report generated by research firm Grand View Research. Till 2014, about \$58.9 billion have been invested in IoT for Healthcare Industry

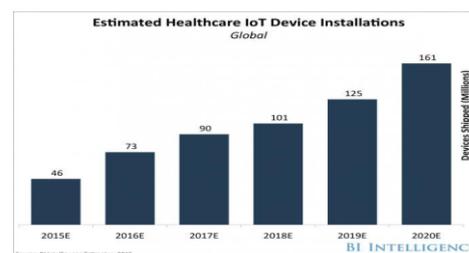


Figure .7. Estimation Healthcare IoT Devices installations Hospitals need to provide patients with efficient with cost effective treatment. To reach these demands, hospitals are using IOT based solutions to capture and examine that data to

help hospitals to make smarter decisions which help them in providing excellent and cost effective treatment to their patients. There are lot of things in a healthcare system that needs to be managed on a regular basis which includes medical monitoring devices/equipment, human resources, and patients. With the help of IoT based technologies, we can determine how to improve the quality of healthcare, timely service, and to provide care with minimum costs.

II. CONCLUSION

Health of the patients are monitored using internet of things (IoT) which makes/enables the doctors to monitor their patients outside the clinic and also apart from their consulting hours. Connected health care devices utilize resources to provide an improved quality of healthcare to their patients, resulting with better clinical outcomes. IOT enables the Healthcare Staff to do their work more precisely and actively with less effort and intelligence.

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