SMART HOSPITALS USING SENSOR TECHNOLOGY AND INTERNET OF THINGS (IoT)

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Abstract

The advancement and growth of IoT which is referred to as the Internet of Things. The Internet of Things is influencing us in our day-to-day activities. In one form or another, the IoT control our life from the way we react to the way we behave. In IoT where the internet is connected via our computer, which is implanted in our daily using objects, which enables them to send and receive data. Some common examples of IoT are the Air conditioner which can be operated and accessed using our smartphones. In smart cars, it is used in providing the shortest route. Our smartwatches which are used to control our daily activities. All these devices use IoT. IoT is a giant network with connects devices, these devices gather and share data about how they are used, and the environment in which they are operated. The activities of IoT's are done through sensors, and sensor implanted devices. The use of the Internet of things which makes data handling manageable and time consumable. In this paper with the use of the IoT system in the Healthcare Sector by which electrical appliances like fans, lights are monitored. By the IoT sensors, one can easily access these devices with our smartphone being in any place. It is important in places like hospitals to use the Internet of Things that can easily be handled and record things. The MQ Telemetry Transport is a messaging protocol used in IoT for giving messages and communication between 2 devices. This MQTT will help in the administration of electrical devices in the hospital.

Keywords: Internet of Things (IoT), Smart hospital, Temperature sensors (LM35), Heartbeat Sensor, LDR(Light Dependent Registor) Wi-Fi module, microcontroller, 2-way communication, Arduino UNO, MQTT platform

1. Introduction

The **H**ospital **I**nformation **S**ystem mainly focuses on maintaining records of the hospital information and details. Which helps hospitals in the recording of patient's details. But this HIS also has some default in maintaining records due to the errors committed by a human, mismanagement of data, handlings of data between several departments in the hospital which some time leads to misinformation. These errors can be avoided by using mechanical tools like computers and IoT's which keep track of this information correctly [1-3].

IoT uses the sensor's in tracing different device and gathers information. Sensors are found in all devices like touch phones, electronic devices, bar-code sensors, traffic lights, etc. the IoT in smartphones with multiple sensors, GPS and chips are the new way to use it in a hospital for tracking information [4-5]. Hence this paper deals with the usage of IoT in hospitals for managing information and tracking details of the patients, and how these help hospitals in keeping up to the information [7].

IoT usage in hospitals can easily control electronic devices. Sometimes in hospitals, they are possibilities of electronic appliances to be overused or unnecessarily used. Which in turn leads to wastage of electricity. Electric energy can be saved, and the over-usage of energy will increase the cost of electricity bills and the lifespan of the devices can also be affected by it. The IoT has gained more attention in hospitals and health care sectors [8-9]. Not only in controlling electronic devices but it is also used in recording or focusing on patients and their health reports. IoT devices with sensors also help in tracking medical equipment like wheelchairs, medicines, oxygen pumps, and other medical equipment. This IoT provides a digitally caring environment around the hospital and it monitors things so frequently in order to avoid mismanagement. Most of the hospital adopts the idea and usage of IoT in their hospital management [10-15]. Some importance of using IoT's in healthcare:

- Monitoring and keeping check on the maintenance of hygiene
- Providing a central monitoring system for handling core functionalities of the healthcare system and integrating each functional role such as a front desk and billing staff and providing facility to numerous patients and doctors.

• Providing support in optimizing quality and processes by regulating a standard method to operate various functions such as analytics and connect machines, data, and people.

The IoT has created a progressive way in hospitals for delivering high-quality healthcare services to patients. These IoTs builds good communication between patients and doctors in transferring of data and health-based information. IoT helps in advanced health care systems focusing on advanced treatment and health care support system. With the use of multi-technology device providers, the workers in the hospital with an auto-generated work style and a digital equipped environment. Hospitals use IoT to even monitor temperature by controlling from a control room [16-18].

The process of which IoT is used in the healthcare sector:

1)Monitoring of Outside Patients: This helps doctors to provide treatments for outside patients. It helps the patient to get guidance from doctors any time, this may assist them not to visit the hospital frequently. Health care service is widely provided to a lot of patients which also increases the income source for hospital management. The list of visited and monitoring them based on the details can be tracked easily, and treatment can be provided to them at a proper interval of time [19].

2) Health Care: Patients being hospitalized can be given more healthcare service and observation of their health can be closely monitored. IoT with Sensors helps in tracking these data and makes the patients safe and they will be given importance based on their health condition.

3)Special care for RPM: The Remote Patient Monitoring can be done through IoT where the patient's data are collected, and RPM helps in the administration of patients admit time and extended stay of patients in hospital can be avoided.

4) Equipment Management: The devices connected with IoT can get a notification if any equipment is found with a fault in it. This may help in avoiding default mistakes committed within the hospital.

2. Major Technology in the Internet of Things

The IoT using the internet to become the most advanced technologies in the healthcare sector in the future. The technology used in IoT are mentioned below:

2.1 Web Technology

The internet of things works with the help of the world wide web with the internet as the base. Where the knowledge transfer between people has made it easier and significant [20].

2.2 Radio Frequency Identification

The RFID is a way of wireless communication which is incorporated with the electromagnetic technology used to identify any object, human and animal. The RFID is classified into 3 groups: The RFID passive, The RFID semi-passive & the RFID active. The main factor of RFID is tagged to any object or person. With the tag, the information about the tagged object can be identified. It operators as a back source of data to be used later for future use. It can be tagged to many people and the communication of that tagged people can be tracked with the sensor & GPS embedded in it [21].

2.3 Sensor-based Equipment

The sensors used in both IoT and the RFID [22] helps in tracking of objects, climate, and the motion of the objects easily. The nodes in the sensor help in wireless communication. With the advancement in these types of sensors are made use in multiple fields like environment-based sensing, health care, information communication.

2.4 Wireless Communication Technology

The wireless technology like net broadband, Bluetooth, smartphones, etc which transfers the data stored in RFID to the IoT. The wireless communication is the base for the IoT.

2.5 Embedded Technology

In essence, IoT is an embedded system based on the internet. Just because more and more intelligent terminal products have the requirements to network, it hastens the production of the IOT concept [23-25], so IOT is the inevitable outcome of embedded technology development and it cannot do extensive use without embedded technology supporting.

3.The International usage of IoT in the Healthcare Sector

The IoT has been used in almost all healthcare sectors to keep in track with patient's information, data, and tracking of medical equipment. This has made patients feel safe in the hands of the healthcare sector. The communication between patient and the doctors are made so easier which gives more satisfaction for patients.

The IoT's are going to be overpowering the healthcare with a greater number of hospitals adopting it and upgrading to a digital-based environment. The IoT's make hospitals a friendly space. The laboratories, pharmaceutical companies, and shops to go on with the usage of the internet for upgrading the work structure and to get more access to medical supplies.

The international focus of IoT in the healthcare sector was reported in TMR with the market value of $ 102.8 Billion in the year 2019. With more upgrading and global reach of IoT in the health care sector expected to value $469.4 Billion in 2027. Which is a 20.9 percent CAGR increase between the year of 2019 and 2027.
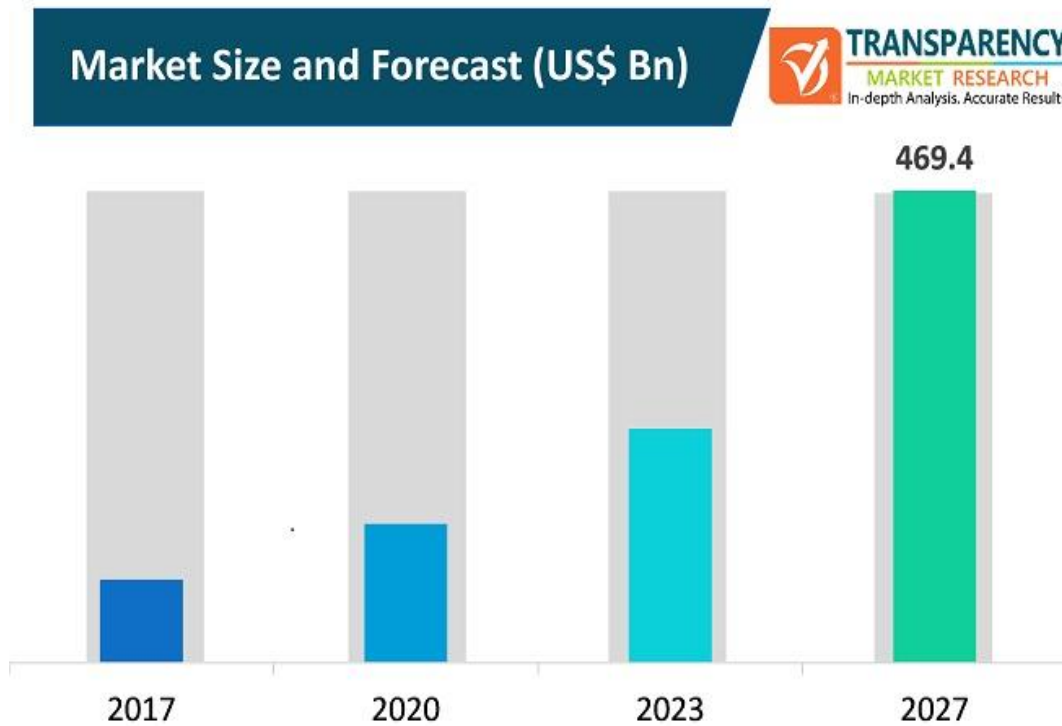

Figure 1 The usage of IoT in the Healthcare Sector

4.Problem Statement

This study focuses on IoT and its utilization in hospitals and healthcare sectors which keep track of all information about the trips bottles, medical equipment, monitoring patient's blood pressure values, and administrating electronic applications, etc. One of the most important factors of it is that they will create an alarm sound if the condition of the patient worsens so that the patient will be given special treatment and care according to the condition. It also helps in saving more electrical energy.

5. Preferred System

In a recent study which showed that the Healthcare sector is one of the leading sectors in using the IoT. The IoT is easily accessible with the internet with multiple objects connected to maintaining data and information of the patients. This is one of the ways of controlling data mismanagement by the hospital staff. Improper managing of trips bottles can even cause a severe heart attack. This paper used sensors and the Internet of things and proposed a proper system on how hospitals can handle information and monitor the patient's care, keeping track of trips bottle and electronic appliances from any place.
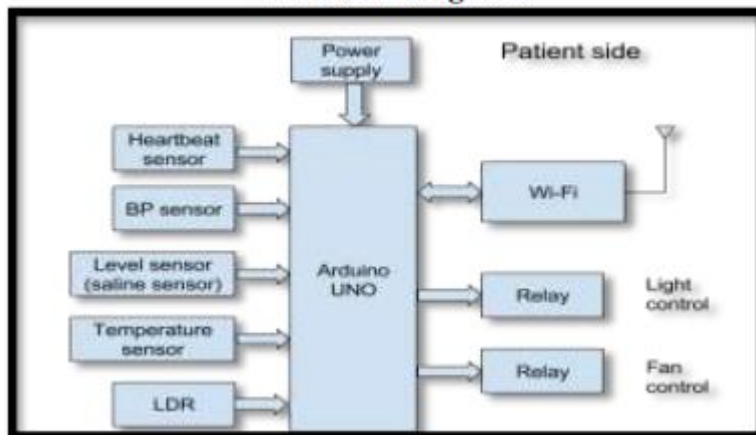

Figure 2 Block Diagram
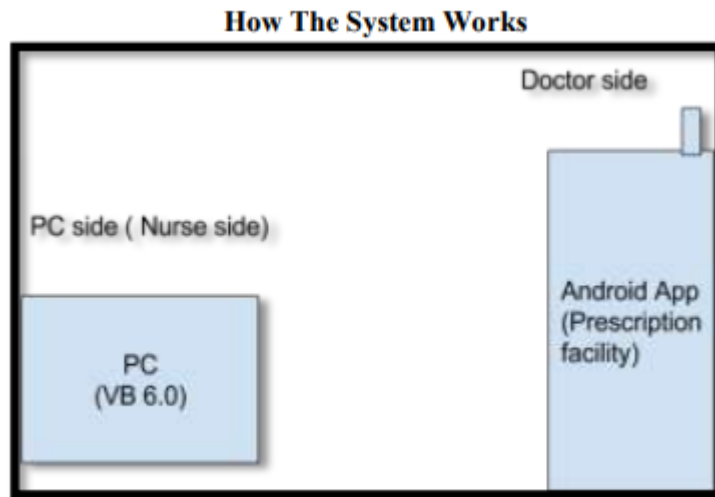
How The System Works

Figure 3: Doctor and Nurse side Applications.

Arduino module: Patient side

1. Heartbeat sensor helps in giving the pulse count,
2. With the Arduino Module, the level of trips in the bottles is checked.
3. The sensor is leveled, in order to send a notification for Nurses.
4. The **L**ight **D**ependent **R**esistor sensor is used to monitor electricity in the room. With the relay, lights will be controlled, and with temperature sensors, fans will be monitored.
5. The resistance of the LDR will be minimum in day and maximum in the night time. With the high resistance, lights will turn on automatically.
6. The temperature sensor the temperature of the room can be monitored.
7. The automatic control of lights and fans is based on the data given by the temperature and LDR sensor.
8. All the data regarding the sensor are upgrading in the server which is later uploaded in the data log of the server in an excel sheet. This is done using the WIFI Modules.

Server (PC): Nurse side

The data from the patient are collected using the server from the patient's kit. Then these data are uploaded in the app of the doctor's. this helps in giving treatment for the patient. The prescribed medicine from the doctor will be sent to the patients by the nurse.

Doctor side (android app):

1. The doctors will receive sensor data through an android application from the server.
2. The Prescription will be sent to the patients from the server by Android Apps.
3. All these information transfers are done through the WIFI Module.

6. Working Methodology

The system developed for this module works with the combination of multiple sensors such as the temperature sensor used in controlling the room temperature, the ultrasonic sensor in monitoring the level of saline in Trips bottle, and LDR used in monitoring the lights. The data from these sensors are directly transmitted to the USB. Which will be used in transmitting data for the Arduino Circuit. The acquired data are then produced in MQTT. To know about the data subscription to the MQTT server is essential. The MQTT is responsible for controlling electronic device such as fans, when the temperature increased too high the data will be to the webpage from which it can be controlled. The prescribed medicine dosage can also be monitored.
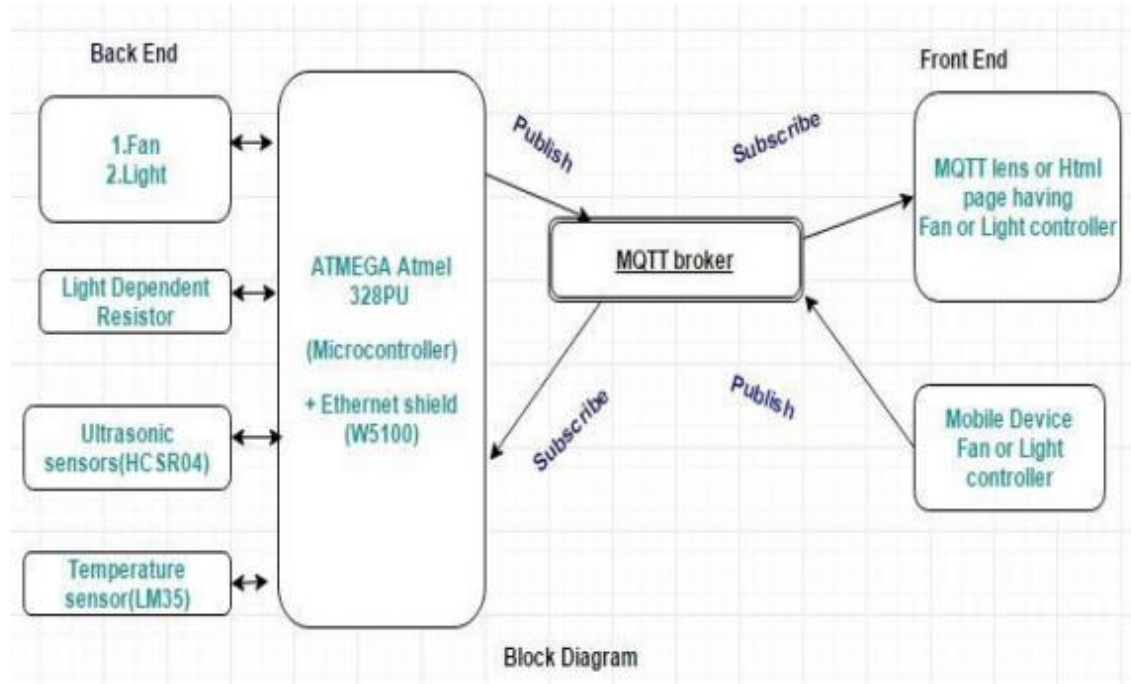
Figure 4. MQTT – with Back End and Front-End Interconnection

Fig 4, which shows the 3 important part
    1. Back End shows about the fans, lights, and an ultrasonic sensor.
    2. Arduino circuit board: Multi-controller (ATMEGA Atmel328PU) + Ethernet shield board (W5100).
    3. MQTT server as a cloud-based server.
    4. Front End with HTML page, mobile with MQTT lens. The MQTT in controlling fans & lights.

The ultrasonic, light, and temperature sensors are connected with the Arduino board, and it is further connected with MQTT through Ethernet cables. The data from the server are transmitted to the Internet by which the data can be checked in any mobile with the usage of the MQTT lens.

7. Details of Component Tools.
7.1 Arduino UNO (ATMEGA328)

Figure 5 Arduino UNO (ATMEGA328)

The Arduino is used for developing computers with more sensing and controlling power than regular desktops. It is a physical Computing program with a simple micro-controller and an advanced place for writing software.
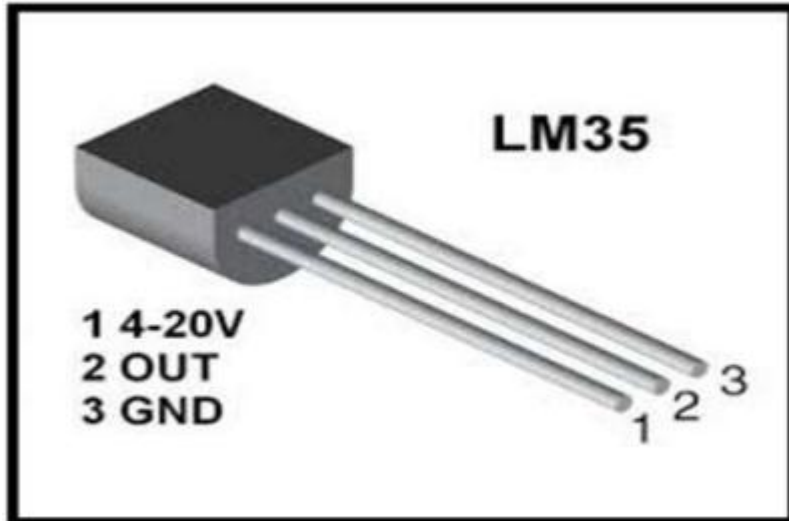
7.2 Temperature sensor (LM35)

Figure 6 Temperature sensor (LM35)

The Temperature Sensor is an ic temperature sensor. Where the output volt is proportional to Celsius temperature. It can be used with + & - supplies.
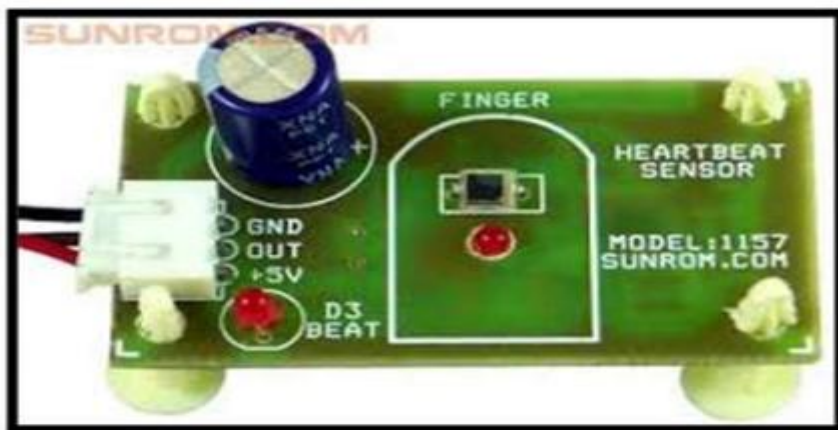
7.3 Heartbeat sensor

Figure 7 Heartbeat sensor

This heartbeat Sensor is built with flexible Silicon material which can be tightly held in our finger. The IR LED & photo-detector are placed in the opposite direction inside the sensor. When plugged the sensor illuminates the IR which comes from an LED.

7.4 Blood pressure sensor

Figure 8 Blood pressure sensor

This sensor contains a Blood Pressure Sensor (MPX10DP), a Standard adult size adjustable cuff (27cm-39cm), and a Bulb pump (with release valve).

7.5 LDR

Figure 9 Light Dependant Resistor

The LDR is a photo-resistor. The resistance of the resistor increases/decreases based on the amount of intensity of light. LDRs are an important device in light and dark circuits with multiple resistances and functionality.

7.6 Wi-Fi module - ESP8266

The WIFI Module is the integrated solution for power-based efficient usage and better performance for IoT. With a WIFI Module, the ESP8266 can be used as a self- employed for MCU.

Some of the Wi-Fi Protocols
1. 802.11 b/g/n/e/i support.
2. Wi-Fi Direct peer to peer -P2P support.
3. P2P Discovery, P2P GO mode, GC mode, and P2P Power Management.
4. Infrastructure BSS Station mode - P2P mode - Soft AP mode support.

7.7 MQTT Protocol

The MQTT protocol gives a faster response to the output. It pledges a significant transmission of data and its distribution. This protocol is environment friendly, and it runs with an Internet protocol it is sometimes referred to as an OS (open standard) protocol.

8. Experiment and Result

This paper has been experimented by setting up a Smart Hospital with IoT. It is well structured with the use of the Arduino Board (ATMEGA328), MQTT. This structure was made with low energy consumption, having protocol which is light weighted. It can control the electronic device through a mobile app or website. This system is friendly and the maintenance of it costs very low. The knowledge of how an IoT based health care sector can be built is identified.

Some advantages of the healthcare sector having the IoT's are as follows:
1. Decreased Operational Costs: With the IoT, the frequent visit of patients to the hospital can be highly managed and controlled. The IoT gives access to the doctors through smartphones so the medical facility was now home-based care.
2. Enhanced Treatment Results: The IoT's in the health care sector gives more knowledge about the treatment given to the patient. It gives better communication and connectivity of doctors with the patient which may give them more satisfaction with the treatment and the intense care. The treatment quality is also improved widely.
3. Intense HealthCare: The patients are monitored so closely by which the treatment has been provided at the right time.
4. Elimination of Man-made Errors: With the access of the IoT in health care the data are managed in a highly efficient manner, which is more time consuming with the data been driven to an Internet-based world. This is highly useful in the reduction or elimination of man-made errors.
5. Improvement in the Experience of Patients: The IoT has made the hospital a good and healthy environment for patients visiting hospitals. They are monitored so often and treatment is provided on a timely basis. The IoT's are digital caring services for the patients.
6. Management of Drugs: With the use of IoT the drugs are acquired in a cost-friendly manner.

9. Conclusion

The Internet of Things is the advancement and future of the healthcare sector. The IoT plays an important role in the managing of data, monitoring of patients, avoiding mismanagement of data, tracking of medicines and

medical equipment, etc. The Healthcare sector is operated under multiple divisions where maintaining data and managing the patient report is difficult but the IoT has made things simple and internet-based. With IoT, the hospitals are now highly focusing on giving advanced and cost less treatment for the patients. This paper has been experimented by setting up a Smart Hospital with IoT. It is well structured with the use of the Arduino Board (ATMEGA328), MQTT. This structure was made with low energy consumption, having protocol which is light weighted. It can control the electronic device through a mobile app or website. This system is friendly and the maintenance of it costs very low. The knowledge of how an IoT based health care sector can be built is identified.

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