

Smart Hospitals using Internet of Things (IoT)

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Abstract— Many times, due to inattention of hospital staff, or inattentiveness of relatives it may happen that medication is not observed properly and it may lead to cause heart attack or other life threatening situations. Thus, this research study presents a proposed system which include combination of sensor technology and Internet of Things (IoT). Using this system one can control electricity equipment's and monitor level of the medication from a remote place and monitor entire process.

Index Terms— ATMEGA Atmel 328PU, Ultrasonic sensor (HC-SR04), Temperature sensor (LM35), Light Dependent Resistor (LDR), MQTT protocol.

1. INTRODUCTION

The research is based on the use of Internet of Things (IoT) technology to can solve the various problems related to hospitals. In hospitals, electrical and medical equipment's use excessive amount of electricity.

The primary ecological effect of energy overuse is an increase in amount of carbon footprint. For example, if the devices are kept running when not necessary, the result is an increase in electrical use. This segment helps to control consumption of electricity.

One more important problem related to hospital is to constantly monitored patients. So, it may sometimes occur that due to the carelessness of the hospital staff, some medication may not be properly monitored which can lead to the serious health issues of the patient.

In this system using IoT, one can regulate electrical appliances and continuously supervised patients from distant position. The internet of things technology is a revolutionary change maker for the health care industry. It is changing healthcare domain by reducing operational costs and helping caretakers focus on treating patients in a better manner. Nowadays, health care industry is investing its resources in IoT to promote innovation and improvement in their procedures. With intelligent and advanced systems, they can accomplish an unmatched, real-time, life-critical data to consume it in the best possible manner. Various hospitals use various ER services, and are already using smart healthcare solutions to achieve precision in results, for better prediction and for preemptive management plans.

IoT can be deeply integrated in healthcare system in various ways.

- Monitoring and keeping check on maintenance of hygiene

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protocol to decrease spread of infections among patients.

- Providing a central monitoring system for handling core functionalities of the healthcare system and integrating each functional role such as 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 functionality such as analytics and connect machines, data, and people.

Internet of Things is impacting the healthcare field in a positive way by completely building platform for applications, devices and people to interact and connect with each other in delivering and availing benefits of healthcare solutions.

IoT is providing various tools and resources to develop an integrated healthcare system to provide patients with better treatment, cost effective health care and positive treatment outcomes.

Thus, it is a combination of multiple resources aggregated that will help healthcare solutions provider serve patients in a better way and assist systems to optimize their resources through automated workflows. For example, many hospitals use IoT system for resource utility management and controlling temperature and surrounding atmosphere within operating rooms.

Different ways to implement Internet of Things (IoT) in health care industry:

1. Outpatient Monitoring.

It permits doctors to capture various health constraints and provide guidance to patients even remotely. Therefore, need of patient's hospital visit is limited and needs to visit only on long interval basis. It helps hospitals manage resources efficiently and subsequently increase revenues at the same time providing excellent treatment to patients. A monitoring device helps the doctor to continue evaluation of the patient and recommend curative measures at regular intervals.

2. Clinical Care

Hospitalized patients who requires close attention can be continuously observed using IoT driven, non-intruding systems. Sensors are used to collect such data and using cloud technology to examine data. It also helps to improve the value of care through persistent evaluation.

3. Remote Patient Monitoring

RPM technique uses digital technologies to gather medical and other forms of health 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.

4. Device Monitoring

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

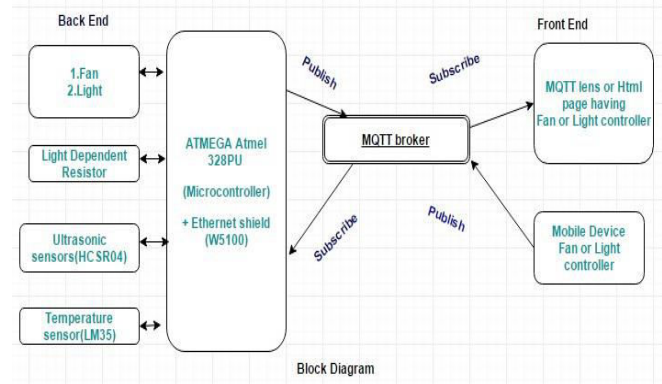


Fig. 1. MQTT – Back End and Front End Interconnection

In the above block diagram, there are three parts which as follows:

1. BackEnd structure includes fan, light and an ultrasonic sensor.
2. Arduino circuit board (ATMEGA Atmel328PU) + Ethernet shield board (W5100)
3. MQTT server broker as a cloud server
4. Front end structure has an html page and/or mobile device having MQTT lens application includes switch controller for operating fan and light.

In this system, ultrasonic sensor, light dependent resistor and temperature sensor is interfaced with Arduino board. Arduino board is connected to MQTT server via Ethernet cable. This provides data connectivity to the server to transmit the data on to the internet medium. Data is then monitored randomly using mobile device or by using MQTT lens application.

2. WORKING METHODOLOGY

In the above system sensor will procure data from various sensors such as temperature sensor will constantly monitor the temperature of the patient's room, ultrasonic sensor will monitor the level of saline bottle and LDR will monitor the glow of a light on it in a way denoted as a resistance value.

Data obtained by all of the sensors will be transmitted by USB port, which is used for the data transfer to the Arduino circuit board. This data thus obtained is then publish to the MQTT server.

Whenever one wants to acquire this data then that person has to subscribe to the MQTT server. MQTT platform is used to control to the switch which will ultimately control electrical appliances.

When temperature of the patients room increases above predefined level/threshold limit, it will send the data to the page and then from the webpage or from the mobile device. Also it can be used to monitor medication dosage prescription to be administered to patients.

2.2 COMPONENTS USED

1. Temperature sensor (LM35)

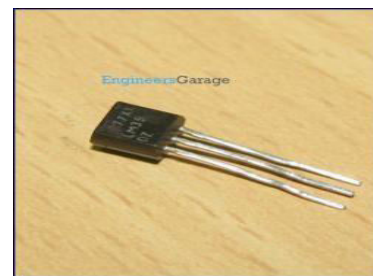


Fig. 2. Temperature sensor (LM35)

The LM35-series devices are very accurate and have integrated-circuit temperature sensors. Output voltage of IC is proportional to the Centigrade temperature. The advantage of LM35 over temperature sensors that are calibrated in Kelvin. The features of the LM35 make it suitable for many general temperature sensing application usage.

2. LDR (Light Dependent Resistor)



Fig. 3. LDR Sensor

LDR sensor has two cadmium sulphide photoconductive cells (cdS) with spectral response similar to that of the human eye. The cell resistance level will gradually fall with the increasing intensity of light. Its applicational use includes smoke detection alarms, automatic lighting control system and burglar alarm systems. Light dependent resistors have capacity to store the lighting conditions in which they have been stored. It reduces stability time to reach steady state resistance values.

3. Ultrasonic sensor (HC-SR04):



Fig. 4. HC-SR04 sensor

Ultrasonic sensors chip module includes ultrasonic transmitters, receiver and control circuit. It provides 2cm-400cm non-contact measurement function. Ranging accuracy range may reach 3mm.

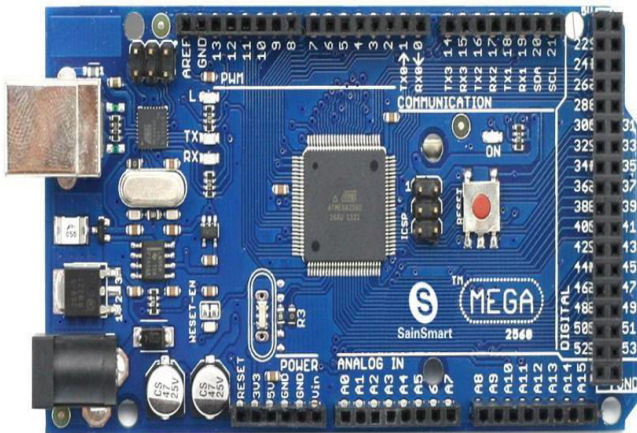


Fig. 5. Arduino board having ATmega Atmel 328PU Microcontroller

The AT mega Atmel 328PU is a low-power CMOS 8-bit chip based microcontroller which is based on the AVR improved RISC architecture system. Chip executes powerful instructions in a single clock cycle AT mega Atmel 328PU IC chip attains throughputs ranging up to 1 MIPS per MHz allowing the system designer to enhance power consumption against processing speed.

4. MQTT Protocol:

In this system, MQTT protocol has been used. This protocol gives faster response output. It has lower battery and bandwidth consumption. It works proficiently enterprise level applications which includes transfer data to server or to mobile application. It guarantees data transmission and efficient distribution. It is suitable for constrained environment. It is a light weight publish and subscribe protocol and runs on IP. It is open standard protocol.

3. RESULT AND CONCLUSION

Smart hospital has been successfully designed using IoT. This project is highly energy efficient as it uses Arduino board having AT mega chip Atmel 328PU microcontroller chip, which has low power utilization. It also uses MQTT networking standards. This protocol is a light weight protocol and helps in power saving. It is possible to control the electrical appliances from a webpage or from the mobile application. It is user friendly system. Maintenance of this project is not costly.

We have seen how we can build and implement IoT based system to assist in various functions of healthcare industry. The major advantages of operating and consuming Internet of Things technology in healthcare organizations include the following:

- Decreased 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.

- Enhanced Treatment Results

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

When patients are monitored on a continuous basis and health care providers are able to access real time data, diseases are treated before they get out of hand.

- Reduction in number of human errors

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**

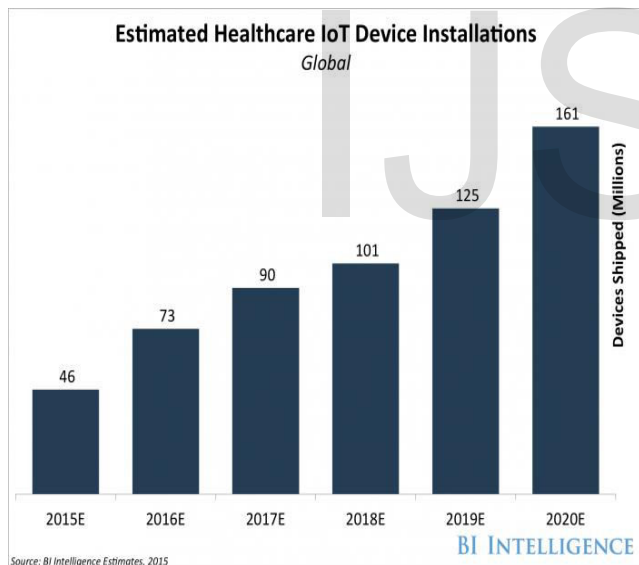
The connectivity of the health care system through the internet of things, places emphasis on the needs of the patient. Such as quick and responsive treatments, improved accuracy and efficiency when it comes to diagnosis, timely intervention by physicians and enhanced treatment outcomes result in accountable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

- **Drugs Management**

Creation as well as management of drugs is a major expense in the healthcare industry. Even then, with IoT processes and devices, it is possible to manage these costs better.

3.1 FUTURE OF IoT IN HEALTHCARE SOLUTION

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



Hospitals need to provide patients with efficient treatment with cost effective treatment. To meet these demands, hospitals are using IOT based solutions to capture obtain through various functions and examine that data to help hospitals to make smarter decisions that can help them in providing excellent and cost effective treatment to patients. There are number of things in a healthcare system that needs to be managed on a regular basis. It 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 care, time to service, and to provide care with less costs.

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