

# A CLOUD BASED MONITORING SYSTEM IMPLEMENTATION OF ROOM AUTOMATION

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## ABSTRACT

Home automation and the Internet of Things are important fields of research which are thought to gain a lot more public attention in the years to come. Cloud computing has the potential to provide easy access to home automation for the general public by providing easy to use online services. Open and standardised protocols for home automation devices further increase the convenience by offering more choice and freedom to the customer. The "IOT based Interactive Controlling and Monitoring System for home automation" is a new technological advancement which can control and monitor devices not only for home automation but any real life appliances remotely. Any automation project using embedded system like PIC Microcontroller provides an intelligent, low cost, energy preserving system for homes, schools, hospitals. Electrical appliances will turn on only when there is presence detected by the PIR sensors. Workable room environment such as light intensity and room temperature are maintained and monitored by using lux sensor and temperature sensor respectively. The room automation system based on IoT consists of sensors (temperature sensor, lux sensor), arm controller board, multifunction energy meter, ESP8266 Wi-Fi module and Wi-Fi router.

## 1. INTRODUCTION

In recent years, the price for small electronic devices has dropped significantly. This development towards cheap embedded devices drives forward the idea of ubiquitous computing, where humans are surrounded by a multitude of such devices to make their lives easier. Naturally, this also includes the living space of humans, mainly their homes. These can be extended by electronics to automate certain routines (e.g. making coffee in the morning) or just to enable some services to be remotely controlled by the owner (e.g. moving sunblinds via a smartphone). The term smart home has taken hold in conjunction with such automated households. There are already a lot of vendors offering such services and devices, but a large problem so far has been the heterogeneity of the different systems offered by the vendors. Of course, every company wants to promote their own product, but the difference between the technologies often leaves the owner no choice but to buy additional devices directly from the original vendor or risk

wasting money/time on an incompatible device. The lack of a global standard for home automation devices and the eventual need to create such a standard lead to technologies which are already established standards in today's world. IP based networks seem the most promising when trying to interconnect a lot of devices.

The main objective of this home automation project using embedded system that uses PIC Microcontroller which provides intelligent energy preserving system, "IOT based INTERACTIVE CONTROLLING AND MONITORING SYSTEM (ICMS) for home automation" which is capable of controlling and automating most of the home appliances through an easy manageable Smart phone based android interface. The proposed system has a great flexibility which uses Wi-Fi technology to interconnect its distributed sensors to home automation server. This will reduce the deployment cost and will increase the ability of upgrading, and system reconfiguration. Our proposed IOT based automation system not only reduces overall cost because of PIC Controller which when used in distributed environment drastically reduces project cost because of cheaper components used, also it upgrades and does auto-system reconfiguration. The use of embedded system using PIC Microcontroller reduces project cost because it is cheaper in cost compared to other embedded systems controlling IOT. Already developed IOT based projects systems, faces four main challenges; these are high cost of ownership, inflexibility, poor manageability, and difficulty in achieving authorization security. In earlier IOT based projects, energy consumption reduction is also not considered as criteria [2]. This proposed system presents a low cost and flexible ICMS using an embedded PIC microcontroller web server, with IP connectivity for accessing and controlling devices and appliances remotely using Android based Smart phone application.

Over the most recent couple of years innovation has advanced immensely and is still developing itself rapidly. With the development of new technologies human life is also at urge to become more tech savvy [1]. Room automation provides automatic control and monitoring of various electrical and electronic appliance without much human intervention. Energy efficient home automation provides the same service but with less consumption of energy [2]. Expanding energy efficiency frequently increase the cost, however,

this capital expenditure will be paid back as reduced energy cost [3]. Automation for residential and non-domestic buildings mainly focuses on controlling of HVAC, lighting, fan and other domestic electrical appliances [4]. Intelligent buildings thus become more energy efficient, human-friendly, convenient and flexible using optimal combination of various intelligent building energy efficient technologies [5]. With the advancement of Internet of Things (IoT) all these physically controlled electrical and electronic appliances can be automatically controlled, monitored and analyzed wirelessly [6].

Generally, room automation consisting of sensing elements which collects different kind of data like environmental parameters along with electrical parameters. A controlling unit to control appliances by analyzing the collected data. It also transmits this data to a network [7]. This framework automates the room appliances with increase in human comfort and energy efficiency. In this paper the main focus is on office room automation of National Institute of Technical Teachers Training and Research, Chandigarh. As the workspace of an office is the area where most of time spend by the occupants. The room automation system is major factor in creating a comfortable work environment in an energy efficient way by controlling room lights and room temperature.

## 2. LITERATURE REVIEW

The "IOT based Interactive Controlling and Monitoring System for home automation" is a new technological advancement which can control and monitor devices not only for home automation but any real life appliances remotely. Any automation project using embedded system like PIC Microcontroller provides an intelligent, low cost, energy preserving system for homes, schools, hospitals. The main objective of this paper is to design and provide implementation details of IOT based ICMS for home as well as for any real life applications to automatically switch on/off lights, fans, gas, curtains, gates using sensors, which is capable of controlling and automating most of the real life appliances through an easy manageable android based interface. The same project can be scaled up in distributed systems for any real life application.

Consumers' interest in smart home concepts has been increasing due to the rapidly expanding home appliances industry that introduces Wi-Fi enabled appliances. Manufacturers provide firmware that allows users to control appliances using smartphones from anywhere. Smart appliances, firmware, and smartphones connected to a cloud server for data storage to form a simple smart home automation system (SHAS). This paper reviews how SHAS is implemented and its recent progress. The authors' observation found that there is a growing interest among researchers and

developers to study software defined network, web services, and end-user development tools within 2016 and 2018. This progress caused by researchers' and developers' interest to mitigate heterogeneity issues in SHAS.

As the time spent inside the office and comfort level is rising, the office room is altered for automatic control and observation of various parameters. Internet of things (IoT) system proposed in this paper based on ARM controller and Thingspeak cloud provide solution for automatic control of office room appliances such as light, fan, AC by considering human comfort. Various office room parameters like temperature, light intensity, connected load, energy consumption, voltage and current consumption can also be monitored and analyzed from anywhere over the internet. Electrical appliances will turn on only when their presence is detected by the PIR sensors. Workable room environment such as light intensity and room temperature are maintained and monitored by using lux sensor and temperature sensor respectively. The room automation system based on IoT consists of sensors (temperature sensor, lux sensor), ARM controller board, multifunction energy meter, ESP8266 Wi-Fi module and Wi-Fi router.

Home automation and the Internet of Things are important fields of research which are thought to gain a lot more public attention in the years to come. Cloud computing has the potential to provide easy access to home automation for the general public by providing easy to use online services. Open and standardised protocols for home automation devices further increase the convenience by offering more choice and freedom to the customer.

In the course of this thesis, state-of-the-art communication technologies and cloud services in this field are presented and compared based on their features. Furthermore, benefits and drawbacks of cloud-based home automation are discussed and evaluated with regard to cost and security. To show the basic concept of cloud-based home automation, an API is presented that can be integrated into the AppScale Platform as a Service. The API is able to communicate with remote devices via CoAP and oBIX and can be used like any existing API in AppScale.

## 3. SYSTEM OVERVIEW

### A. Internet of Things

The association of physical things to the internet enhancing HEMS to get sensor data and to control the physical world wirelessly in real time creating more scalable and flexible system for the physical world with computer-based systems, resulting in improved efficiency, accuracy, reduction in installation cost along with reduced human intervention [8]. As per NASSCOM 2016 future of internet India is becoming a growing landscape as various market powers like analytics, cloud

computing, and development of various embedded control systems are driving India towards adoption and development of IoT based systems. The main goal of using IoT is to provide analytics, controlling and tracking capabilities to a system, so that users would be able to control and monitor their use and performance in real time. These devices establish a communication network over the internet to provide information what they collect from the sensors or to allow other systems to act on it. With the increasing number of smart devices and rising customer expectations in India, the adoption of IoT brings the evolution of a smart lifestyle, adoption of energy efficient smart building devices and technologies, improved healthcare facilities, remote monitoring and controlling. Essential elements that driving India towards IoT as energy efficient building automation are (i) Real time decision making (ii) Increasing usability of smart devices and internet (iii) Changing lifestyle and human comfort level (iv) Cost effectiveness and high rate of interest (v) Development of new technologies and sustainable living. (vi) Need to keep up a secure and safe workplace to avoid cyber

threats. Current trend of IoT concentrates on use of cloud platform for storing and analyzing data. Through cloud computing authentic person can analyze the stored information from anywhere over the internet. Building automation with IoT thus provides remote controlling and data analyzing feature. The proposed system uses Thingspeak cloud platform and ESP8266 Wi-Fi module to send data to internet through router.

### B. IoT Components

IoT is divided into three basic components devices, gateways and cloud as shown in Fig. 1. Devices include user interface devices, sensors, and actuators. These devices also include hardware and software to interact with the internet. Devices communicate with other devices or, a control unit to act accordingly. Gateway provides device connectivity to the internet to reach cloud services. It also enables device security features and provides end to end data security. The data from each device is transferred to a cloud platform, where it is analyzed and joined with data from other devices to perform..

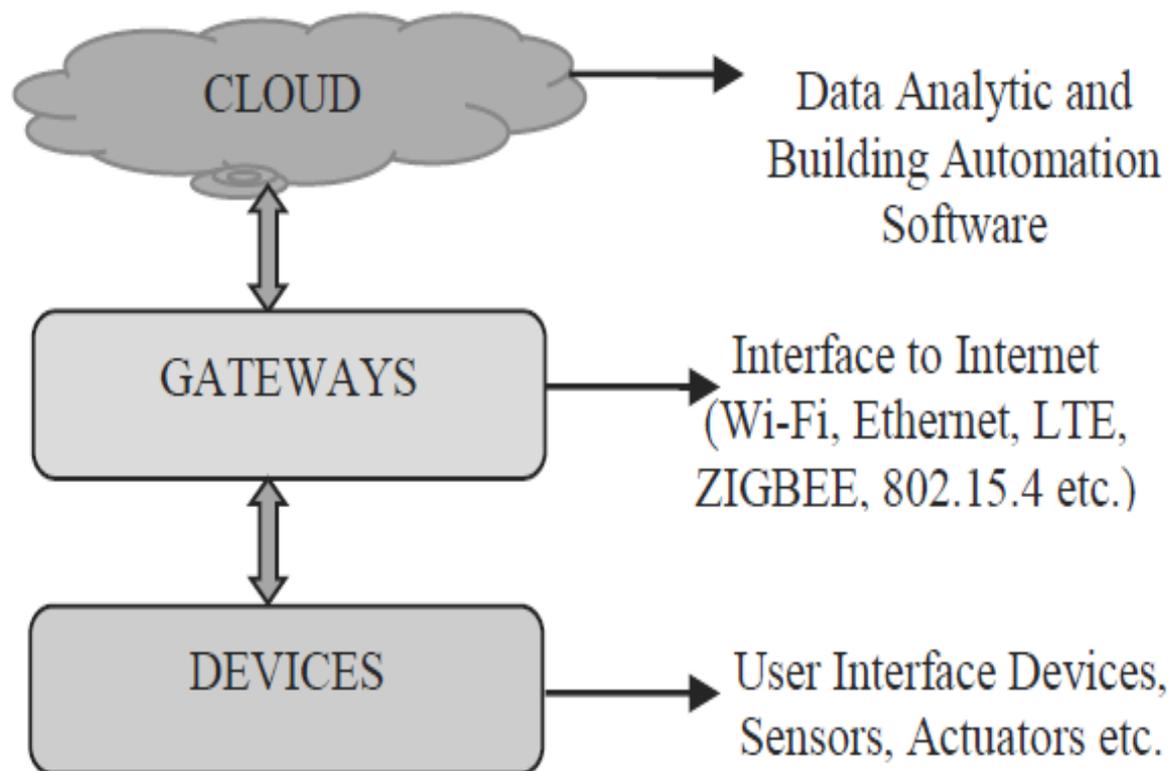


Fig. 1. Main IoT Components

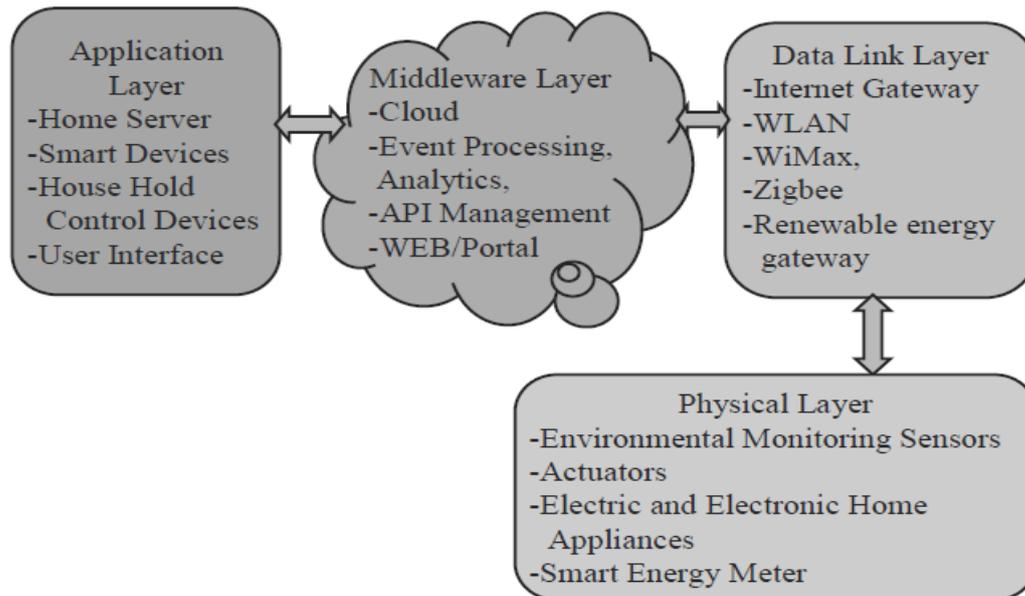


Fig. 2. Overall Architecture of Smart Room Automation



Fig. 3. Common wireless communication technology for home appliances

**C. Architecture of Room Automation With IoT**

IoT based room automation architecture provides flexibility in the connectivity, communication, device management, data analysis. Fig. 2 represents the architecture of smart room automation system. The general design of smart room architecture includes a Physical layer, Data link layer, Middleware layer and Application layer. Physical layer comprises of appliance node i.e. electric home appliances, sensors, actuators and a physical network node for creating, accepting or transmitting data. Data link layer to act as an interface between the physical layer and the application layer. It will store, recover, process and register the data along with computational analysis. Middleware provides various communication protocols through which application program and

data link layer communicate. Application software layer is responsible for the end user with monitoring modules and control functionalities based on home communication network. Smart home system architecture in view of IoT technologies coordinating home appliances into an intelligent system was proposed.

**4. IMPLEMENTATION OF SMART HOME AUTOMATION**

Developments in both ICT and electrical hardware industry have made smart homes easier to be implemented as compared to the past two decades. Today, various electrical appliances have been designed with the capability of connecting to wireless network, Wi-Fi. It makes the electrical appliances smarter as it can be controlled remotely using a smartphone. As compared to the past two

decades, some of the home electrical appliances like TV, fan and air-conditioning units can only be controlled using the remote control units provided by manufacturers. Today, many manufacturers still supply the remote control units. However, they come with the additional firmware that allows consumers to control the appliances through mobile applications on their smartphones. This situation supports the implementation of the smart home system easily. There are various definitions of smart home given according to their respective areas; covering from construction, engineering, energy, to ICT. In terms of construction and engineering, smart home is more likely to be defined through the use of modern materials to produce energy-efficient homes. On the other hand, the use of software and hardware for controlling home appliances is the major focus of ICT for the smart home. Horálek et al. [8] defined a smart home as a home built using modern materials with low-energy consumption, and it uses hardware and software tools for general task automation which enhances the comfort of living and provides a cost-effective operation to the residents. In this paper, smart home refers to a home or

living environment that uses technology to allow electrical appliances and systems to be controlled automatically. In particular, it uses ICT to control homes including the electrical appliances and home automation such as windows and lights. Mittal et al. [4] proposed a SHAS, a residential space that provides comfort to residents, facilitates the operation of electrical appliances all the time regardless of whether they are at home or away. Appliances can be controlled remotely using applications on smartphones that are connected via Wi-Fi and the Internet. Communication to SHAS is simple and affordable using the existing network infrastructure. Smartphones affordability has been significantly increasing the demand for home automation.

Also, the emerging of Internet of Thing (IoT) where electronic appliances, sensors, and software are connected to home network [1] has catalysed the SHAS. Home automation has undergone a revolution by witnessing a wide range of electrical appliances that can be controlled remotely. In the beginning, only fans, TVs, and air-conditioning units can be controlled using remote controllers.

TABLE I. WIRELESS COMMUNICATION TECHNOLOGY FOR REMOTELY CONTROLLED HOME APPLIANCES

<b>Wireless communication technology</b>	<b>Description</b>
Infrared (IR)	A wireless communication technology used for device communication over short ranges. line-of-sight, unable to penetrate walls
Radio frequency (RF)	A wireless communication technology that uses radio waves in the range of 3 kHz to 300 GHz
Bluetooth	A wireless technology standard that is used to exchange data over short distances (less than 30 feet).
Wi-Fi	A wireless network technology used for connecting mobile devices to the Internet using the microwaves frequencies of 2.4Ghz or 5Ghz.

Then the gate and garage can also be controlled remotely. Infrared (IR), radio frequency (RF) or Bluetooth technology have been used extensively for the wireless communication between the electrical appliances and the remote controllers. However, today, various electrical appliances can be controlled remotely using Wi-Fi technology, including refrigerators, washers, lamps, rice cookers, ovens, and dishwashers. Consequently, the word "smart" has always been used together for marketing of these appliances to differentiate them with the old technology. For example, smart TVs, smart refrigerators, and smart lights, to name a few. Fig. 3 shows four common remote controllers for wireless technology used by the manufacturers on

their electrical appliances. The description of the wireless technology as defined by Techopedia is presented in Table I.

#### **CONCLUSION**

The concept of the smart home received high attention from consumers lately due to fast-growing development of smart electrical appliances in the market. Various Wi-Fi enabled appliances are available to enable consumers to build a SHAS at lower costs. The use of Wi-Fi enabled appliances has introduced the cloud-based SHAS where control of these appliances is made over an Internet connection and data is stored on a cloud server. This paper represents the implementation of real time office room automation by using Internet of

things. It has been found that LPC2148 ARM-7 controller provides low power consumption, efficient controlling and analyzing operation effectively and efficiently i.e., turn ON/OFF electrical and electronics appliances without much human intervention along with taking care about room temperature and light intensity. When a person enters into the room the lights of the specific section will get automatically turned ON/OFF.

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