

# Smart Home Automation Deployment on Third Party Cloud using Internet of Things

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**ABSTRACT**- In this era of evolution of technologies, bringing smartness in home is a center of attractions for researchers. Home automation is gone prevalent across the world because of its flexibility to be adopted by human being for their convenience. Till now, there are many approaches which have been proposed by researchers to provide the practical solutions to control and monitor home appliances locally or remotely. Due to the advent of Internet of things and Cloud Computing technology, Smart Homes become more feasible over the internet. By using these two technologies, the authors proposed a new architecture to deliver intelligent services to user. Internet of things makes an ordinary device as smart device and cloud computing provide the third party server to access, monitor, and control smart devices over public network. Author demonstrated the implementation of this approach using real environment.

**Keywords:** Cloud Computing, Internet of Things, Smart, Internet.

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## 1. INTRODUCTION

Cloud computing is new paradigm that provide computing as a service to consumer with ease of utilization. These services are provided as ordinary services such as electricity, water and gas in pay as you go model. This provides facility to run number of resources with minimum effort by simply clicking on provider's portal. It not only provides the resources but also provides the supplementary services such as value-added services, development support and security over the consumer required infrastructure. Cloud is most reliable model for shared pool of resource that is adopted by many of the organization. According to survey, till now there are 71% of consumer utilizes QuickBooks for accounting purpose, 70 % vendor adopt Google Analytics to provide best solution for their business, 59% consumer use Salesforce.com to provide customer management relationship services with new way to connect to costumers, 39% vendor use Dropbox to store data over cloud for backup [1].

The Internet of Things paradigm is collaboration of internet and ordinary things. The ordinary real-world things are acting as smart and intelligent device that can communicate to each other or to central system over internet. Due to use of IPv6 ever things over the World Wide Web are uniquely identify. According to survey, 5 million of things are connected and their information

is flow over internet. This number will boost up to 50 million in 2020 as per the researcher prediction [2]. Internet of Things provide new platform for researcher to make amendments in smart home concept by embedding intelligence into the appliance which make ordinary devices as intelligent and their information is flow over the internet.

Cloud Computing and Internet of Things are two different worlds of technology. However, their integration is required to facilitate some new concept such as Smart Home. The integration of these technologies provides the two-way benefits to the world of technologies. Generally, the intelligent devices in Internet of Things have small memory and cannot store the data the produced. The cloud provides storage for that data in such a way so that it is easy to access. Moreover, it provides additional operation so that viable information can be extracted from that data with minimum effort. In spite of this, Cloud is multi tenancy model provide platform for secure access of things by multiple user over internet.

Smart Home is new paradigm that gives a power to user to control the home according to its need. Generally, Smart Homes are used to control home condition and control the appliances to address the problem of resource wastage. The user can access their home from anywhere over the public network and able to control the condition at home.

The remainder of the paper is organized as follows. Section II provides the related work of Home Automation based on Internet of Things. Section III formulates the problem based on the loop holes found in the existing works as given Section II. Sections V provided the way how this approach works with real scenario implementation. Finally, Section VI compares this work with the existing works to draw valuable conclusions in Section VII.

## 2. RELATED WORK

Many approaches had been proposed by many researchers. Some of these approaches are based on local access or some based on both local and remote access to home. Coskun [3] described the approach for home and office automation system. This approach was based on telephone system which acted as normal telephone. The commands to central controller were sent through the telephone by dialing any tone. The tone was further processed by central controller and control devices according to command. For security shake user identification number was used by the system. The feedback signal was also sent back to the user to tell whether the command failed or got executed. Whole system was developed by microprocessors and PLD's with the minimum effort and with slight modification. This system is also used for vehicles. This system is used to control the home appliances remotely moreover, to send additional information such as message and video calls. Neng et al [4] present a software level architecture for smart home which uses agent technology for space, function and personal preference agent.

Author used personal computer-based environment for integration of home appliances with home automation system. However, this technique is implemented for local scenario there is no connectivity to public network. Nunes et al [5] present internet application for home automation system. This application is based on object-oriented approach where each devices represented by objects. The application runs on system with web server with html as a front end. It connected to home hardware controller through computer standard interface such as usb or serial port. However, there is no hardware implementation for home automation system. Sriskanthan et al [6] proposed architecture for home automation system using Bluetooth technology. Personal area network is used to operate various devices through single controller. They develop a Home Automation Protocol to monitor and access home appliances through Bluetooth technology. This system reduced the cost of wiring as Bluetooth is wireless technology. However, all the devices used single Bluetooth channel which cause delay in the system. Al-Ali et al [7] present java-based home automation system over the public network. The java application is connected to embedded system to which all the devices are connected. Application sends code to embedded system which controls the devices accordingly. This technique provides provision to user to access home locally or remotely over internet. This system is cost effective and adds scalability to the system. Gill et al [8] presented a home automation architecture based on wireless technology. They used ZigBee technology to communicate with home appliances in local environment. This system provides the facility to access home devices locally and remotely.

Home controller is used to connect heterogeneous home appliances to the internet. Evaluation shows that this system is fast and scalable as compared to previous ones. However, the device which supports Java can only able to access the system. Han et al [9] proposed architecture for room based on ZigBee technology. The appliances in the room are controlled by the remote working on infrared technology to save energy

consumption. Users can user remote to dimming the lights and control power outlets to cut off and on. The outlets monitored the power for period and set threshold point for power. If the power is below that threshold point it cut the power supply to eliminate the standby power consumption. Every appliance has this outlet and can be configured according to particular device. Parwekar [10] address the need of integration of IoT to Cloud Computing. The integration of any technology with another is such that the information can be shared and processed by each resource efficiently. On the development of cloud computing made big difference to those resources which have limited processing power. Author explained the application of integration of cloud computing to IoT. It also specified the services offered by cloud computing to IoT. Felix et al [11] proposed an approach for home automation system using GSM. It is new technology that helped to control the home system from remote location. This home architecture could access through mobile system and other devices which had network connectivity system. The command to microcontroller was sent via SMS to the home controller which interpreted the command and on and off the devices accordingly.

Authors also discussed the reasons for not adaptation of this home automation system. This approach reduced the complexity and cost of the system so that it can be easily adopted by the people. Soliman et al [12] proposed an approach for smart home by integrating internet of things with cloud computing. The embedded intelligence into sensors and these sensors communicated with central controller through ZigBee network. The devices were controlled and accessed by cloud application. This approach provided facility for monitoring and controlling. However, there is interference between external wifi network and internal ZigBee network. Moreover, there is no implementation is done to test this approach

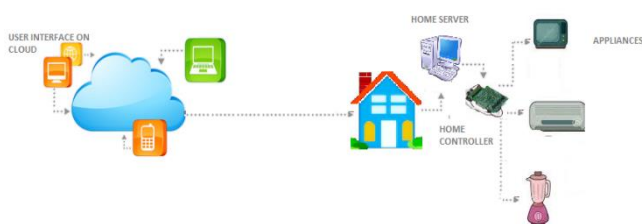
## 3. PROBLEM FORMULATION

From thorough related work, it was found that many techniques were used to implement this Smart Home concept. Some of these techniques did not have internet access or some used complex methods, such as, reorganization pattern and knowledge driven approach. Moreover, the sensors or devices that used, produced large amount of data and there was no such technique used to handle that data. In spite of this, there was little control of user over the functionality of appliances. By dint of this, there was need to build such system by which user can control the appliance through simple interface that can be accessed from anywhere. In proposed approach, the authors developed a smart home architecture by integrating third party cloud services with Internet of Things.

## 4. PROPOSED WORK

The proposed work sets the enhancement over existing techniques those deal with controlling the home appliances from the remote location that have minimum control over the appliance functionality. In this approach user have full control over the devices and user also able to scale up the system according to their need. It consisted of simple interface that have two type of user first one is administrator and second is ordinary user. The admin can scale up the system by adding

devices and rooms to the system and also control the devices. Moreover, admin can also add user to the system. While ordinary user is only control the status of the appliances. The web interface is connected to home controller that consists of two things server at home location and home controller to which appliances are connected. When user switch 'on' and 'off' the appliances it send code from cloud interface to home server using IP address then home server forward that code to home controller. The home controller is embedded circuit has programmed that process the code accordingly and executes command to relay circuit for switch 'on' and 'off' particular appliance.



**Figure 1:** Overall scenario of the system

After any command execution the current status of that appliance is store on database so that in future user know what is the status of their appliance.

As shown in *figure 1* user can access the web interface anywhere on cloud and send commands to home server. Once home server received command it forwards it to home controller which is connected to end appliances. Home controller interprets the command and controls the appliances accordingly.

## 5. IMPLEMENTATION

To show achievability of architecture, authors implement smart home system with three appliances. Authors developed hardware and software that is required for the system. Following are the various step that author follows to develop the system:

Interface development: firstly, author develops the interface for user in Don net framework. For this they use Microsoft Azure cloud infrastructure as a service. This provides infrastructure to develop and deploy interface on cloud. The interface has two types of user named as admin or ordinary user. Admin have privileges to add user, room and devices to the system while ordinary user only accesses the information and status and also able to control devices. The interface is connected to back-end database to store user information and status of the devices connected to the system. If any alteration is done in the status of devices will also be trigged in the database. After designing interface, it is deployed on Azure platform by creating website there. It gives uniform resource locator to access that one can interface from any device at anytime from anywhere only need is internet connection. This interface is totally platform independent that is it runs on any operating system that support browser.

Home controller: home controller is basically a microcontroller embedded circuit to which all the devices are connected. There are varieties of microcontroller available but authors used Atmel AT89S52. This microcontroller is 8052 based Full Static CMOS controller with Three-Level Program Memory Lock, 32 I/O lines, 3 Timers/Counters, 8 Interrupts Sources, Watchdog Timer, 2 DPTRs, 8K Flash Memory, 256 Bytes On-chip RAM. A programming was done through Keil MDK Version 5 software development environment for embedded system. Moreover, it also provides debugging and testing of the system. After debugging and testing of program the file was converted into hex file so that it can burn to microcontroller. The burning process is done through Proteus 8 professional tool for design and testing the embedded circuits. After burning the program the demonstration circuit is design for testing weather it works accordingly or not. After testing demonstration circuit actual circuit was made. Three appliances are connected to the home controller to check whether it is working or not.

Integration of home controller to cloud interface: For this approach integrating of cloud with Internet of things is main prospective. For this author used cloud third party virtual server. The virtual server was integrated to home server by Hybrid connection and BizTalk service. The home server is up for all the time. The interface was deployed on that virtual server so that when user trigger any command it send data to that virtual server. From this virtual server the data generated after execution of command was reflected to home server. Home server forwards this data to home controller which interprets the data and controls the devices accordingly.

## 6. COMPARATIVE STUDY AND RESULTS

There are many approaches till now that provide the architecture for home automation system. However, they lack in providing some kind of facility and unable to cop up with the new technology standards.

**Table 1: Comparison of proposed technique to existed techniques**

Parameters	Remote access	User control	Ability to handle big data	Security	Cost effective	Easy scalability
Technique software level home architecture	✗	✓	✗	✗	✓	✗
object oriented approach	✓	✓	✗	✗	✓	✗
Bluetooth wireless technology	✗	✓	✗	✗	✗	✗
ZigBee wireless technology	✓	✓	✗	✗	✗	✗
Internet of Things with Cloud Computing using ZigBee	✓	✗	✓	✓	✗	✗
Proposed approach	✓	✓	✓	✓	✓	✓

Authors compared these techniques with each other by many parameters as shown in *table 1*. Due to the migration of all the

things over internet, remote access is main objective that the researcher wants to achieve. In software level architecture and Bluetooth based architecture remote access is not available and can be accessed locally only. Zigbee wireless technology, integration of Internet of Things using Zigbee and proposed approach is able to access the system from both remote and home location. All these techniques have full control over the system in spite of integration of internet of things with cloud computing using ZigBee because the system is fully based on sensor. If one of the sensors fail then whole system is affected and user have no manual control over the system. Using of sensor and intelligent equipment produced large amount of data. There are no techniques to handle these data and to take out valuable information from that in these techniques instead of integration of internet of things with cloud computing using ZigBee and proposed approach. Third party cloud is responsible to handle these big data and provides technique to process these data to take out valuable information. Security is also embedded in these techniques only. Cloud is responsible to secure communication between the home and to the cloud web interface. Moreover, encrypted data is stored on third party cloud and provide backup of database. Cost is main concern to user that revokes the customer to adopt that home automation system. Proposed approach is simple and having less cost of overall system. The hardware that used as home controller is not too much costly. Moreover, the third-party cloud provide the facility to access the system from any device so, there is no need to buy new dedicated devices as in the other approaches. However, in other approaches researches used the costly sensors and wireless equipment's that add the cost to the system. This approach is also providing scalability that one can add new appliance of any vendors with the nominal changes to the system. However, in integrating internet of things with cloud computing using ZigBee technique special sensor are needed to add different vendor device and need much more complex changes to the system. Moreover, by using third party cloud it provides the 99.99% up time of system that is not possible in other techniques

## 7. CONCLUSION AND FUTURE WORK

This approach develops the concept of Smart Home through integrating Internet of Things with Web application and Cloud Computing. Smart Home promotes the combination of the traditional construction industry and the emerging information industries. The vision of Smart Home is to gratify the requirement of the congenial and convenient living and fundamentally ameliorate the living standard of the humans. It is contemporary and simple technique to lodge the smartness in the homes. This approach consisted of embedding intelligence into home appliance by uncomplicated microcontroller circuit that controls the various appliances in the home, networking smart things via internet technology by integrating it with the Cloud, facilitating interactions with smart things using Cloud services for easy access at different locations. The approach was successfully used for evidence services for monitoring home appliances and controlling home access. Moreover, it also provides the potential to change the status of the various

appliances in the home scenario. The infrastructure can be arrogating for smart controlling of the appliances anywhere and anytime. The main prospective of this approach is to reduce the cost of Smart Home in the aspect of hardware and provides the reliable and high quality of service via Cloud Computing.

The future work is to embed sensors to sense the environment and report to user accordingly. In future that system can be developed in which microcontroller circuit wirelessly connected to the various appliances. Moreover, it needs home server in future the home

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