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### Home Energy Management System Using Cloud Computing

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#### Abstract

Nothing runs without electricity at home or in industry. So providing a reliable supply of electrical power on demand is the important task of power generation plant. Growing populations are using increasing amounts of power, which is putting a strain on existing supplies. To overcome the problem of power distribution this system provides a cloud networking based home power management system. We will developed a Home Energy Management system that employs the integration of multi-touch mobile devices, cloud networking, wireless communication, to provide the user with remote control of various lights and appliances within their home. A home energy management system is an integral part of a smart grid system that can potentially enable demand power response applications for residential customers. This system include home energy management algorithm for managing high power consumption household appliances with consideration of demanded power limit analysis using the cloud computing technique. The proposed algorithm manages household loads according to their preset priority and guarantees the total household power consumption below demanded power limit levels. This proposed system will result in reduction of the average total power consumption by up to 7.3 percent.

**Keyword:** home automation; cloud networking; Internet; household appliances.

#### Introduction

Home automation is an umbrella term used to describe the use of specific automation techniques in private homes for enhanced convenience, comfort, energy efficiency and security of the residents. Prevalent techniques used in home automation include control of lighting, heating, ventilation, air conditioning, appliances, multi-media home entertainment, security surveillance and other systems. Home Automation using cloud networking can simplify this scenario by connecting each sub-system of a home automation system directly to the cloud, and thus not only reduce the setup and maintenance cost by eliminating the need of specialized gateway and web server in each household [1], but also enable home automation service providers to deliver advanced automation services to the system. Multi-user system must be necessarily based on the standard cloud computing model, in which services are made available to the general public over the Internet as long as they use the specified web application programming interface

(API). Cloud networking and data infrastructure allow the individuals, to monitor, manage, and control their personal data points through the Internet [5-7]. It is a real time data infrastructure allowing the management of millions of data points from thousands of individuals, organizations, and companies.

Considering our living environment, almost every place, e.g., office, school, and dwelling house, are all equipped with computers, air conditioners, lights and other high-power consumption devices. People usually forgot to turn off the power devices after they are not in use. Therefore, how to make efficient use of the limited energy resources to avoid the wasting of power energy has become a major problem to be conquered. Recently, the idea of central power management is also proposed in this system. However most of the central power management system just perform on and off operation on the power switch in a room space, control on every single or individual appliance is hard to attain. To maximize the benefits of distributed energy resource, the system assigns dynamic priority to a household appliance according to the type of appliance and their current status depending on their power consumption. In accordance with the assigned priority, the use of household appliances is scheduled by considering energy consumption capability of the individuals.

#### Cloud Networking Based Home Automation System

Home Automation is the residential extension of "building automation". It is automation of the home or household activity. Home automation may include

centralized control of lighting, heating, ventilation and air conditioning, appliances, and other systems, which provides improved convenience, comfort, energy efficiency and security<sup>[7]</sup>. Gill *et al* <sup>[3]</sup> proposed ZigBee based home automation system which controls and monitors home appliances. The proposed system is composed of a household appliances and a home server. As an essential part of the system, the home server supports interoperability between the external networks and home networks. Agarwal *et al* <sup>[4]</sup> presented the design and implementation of a sensor platform that can be used for accurate occupancy detection for building energy management.

Home appliances are possible to be divided according to use pattern. For example, it is possible to divide them into the devices decided for operation by environmental information such as temperature, and devices decided for operation by battery state. And it is possible to decide priority according to appliance characteristics classified by such a manner. Utilization of energy resource can be maximized according to the priority-based scheduling of home appliances. Operation of the appliances which cannot be delayed i.e. these appliances should work immediately if a resident operate them, in other words, the energy consumption of this type of appliances cannot be scheduled. Therefore, this type of appliances is allocated high priority. On the other hand, operation of some appliances can be scheduled according to the environment factor <sup>[1]</sup>. For example; an air conditioner can be scheduled according to indoor air temperature. That is, if the indoor air temperature is lower than threshold value, operation of air conditioner is delayed through a resident operates it. However, if this delay time (i.e. how long does air conditioner wait) is too long, the resident feels uncomfortable. Thus, this delay time is well determined. Other appliances controlled according to the temperature such as water and air heater, and according to the humidity such as humidifier/dehumidifier are included in this category.

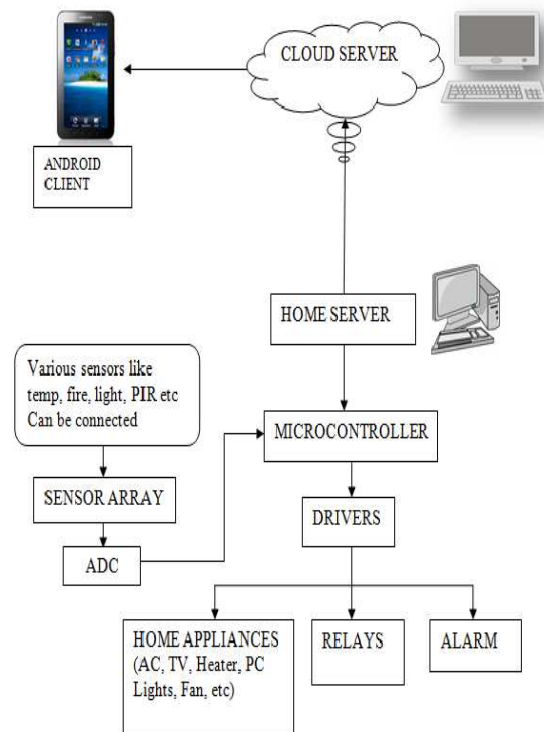


Fig.1 overview of home automation system

As discussed earlier we are developing Android based energy management application. The application consists of main function like Light controlling, Temperature sensing. When the application starts user is first authenticated, if user is authorized he will be navigated to main screen. The main screen has a list of all functions like which appliances want to make on/off ,etc. among which user can select any one function which he want to control. After selecting a function he would be able to see a current status of a particular device<sup>[2]</sup>. If user wishes, he can enable or disable intended device from the EMM.

#### a. Energy Management module(EMM):

In the energy management module (shown in Fig), relays, loads and sensors viz. PIR, temperature sensor, light sensor are connected to controller. In this case, the home server is acting as input as well as output. Here, the LCD will display the power consumed by the loads. The energy management module switches the loads, and continuously sends the power consumed by loads to the controller. The loads can be fan, bulbs, air conditioner, Heater, television, personal computer, etc. These loads are given the priorities such that higher priority given to the fan, bulbs, PC and lower priorities given to A/C, TV, etc. depending on the users comfort level.

#### b. Home Server:

The database home server here is used to record the status or power consumption of individual electrical appliances. Here, we use MySQL, powerful and free software, as our database home server. To bridge the user, i.e., the browser, and the database server, a web server is required<sup>[3]</sup>. The control commands from the server in the Cloud are first sent to the home gateway and then transmitted to the appliance. The home gateway is a server which is used to receive the user command from the far-end place on the Internet, and to transmit the status as well as the power consumption information of appliances back to the database server.

#### c. Cloud Server:

Cloud Computing is a technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. In our system we are going to use the SaaS model. In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. The clients do not manage the cloud infrastructure and platform on which the application is running. This eliminates the need to install and run the application on the cloud user's own computers simplifying maintenance and support. Cloud client can be android phones, tabs, Pcs.

## Conclusion

The system allows the user to control appliances and lights in their home from an android and PC from anywhere in the world through an internet connection. It also allows the user to control their units within their home from a wireless remote. The wireless remote has primary control over the system; therefore if the remote is active neither the android nor PC will be able to control the units in the home. This design prevents from the android, PC, and wireless remote all trying to control the system at the same time.

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