I-Home: Intelligent Home Controlling and Monitoring System using Cloud and Android

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Abstract— In this paper we will be discussing about a low cost and flexible home control and monitoring system using cloud networking for accessing and controlling devices and home appliances remotely using Android based Smart phone app. The framework of the monitoring system is based on combination of pervasive distributed sensing units and information system for data aggregation, interpretation and context awareness. Results are interesting as the reliability of sensing information transmission through the proposed integrated networking architecture is about 89%. The prototype was tested to generate real-time graphical information instead of test bed scenario.

Key words: IPMD (Intelligent power management device), ICMS (Intelligent Cloud management Server)

I. INTRODUCTION

As we are toward inside the era of advance automation where recent in electronic and communication technology have drastically lead to the miniaturization and improvement of the performance of computers, sensors and networking. Such changes in the society have given rise to the development of many home automation technologies and system, continuous increase in global energy consumption which gives rise to the current energy crisis and the environmental problem. Residential energy consumption accounted for 22% of US total energy consumption in 2009.

Homo-sapiens usually in the home environment interact within the home surrounding settings like light, air, etc., and regulate accordingly [2]. If in further use, the automation of home settings to act according to the inhabitant requirements is also called as intelligent home automation system. I-Home responds to the behavior of various facilities provided to them.

In our I-Home task will be working on the implements in the automation system using voice modulation, we will be able to control our home appliances through voice commands and also support manual and android functioning.

In general, intelligent home automation system consists of clusters of sensors, collecting different types of data, regarding the resident and utility consumption at home [1].These can automate the domestic utilizations effectively and also can support the inhabitant by reducing the costs and improving the standard of living.

II. RELATED WORK

There are many systems developed for controlling and monitoring home automation. (HEMS) is a Home Energy Management System is a part of smart grid on the consumption side , this system collect data from home appliances using smart meters and sensors, and then to optimize power supply and management by using this information [3]. This system helps in reducing the average total consumption by up to 7.3%. (iCHEMS) intelligent Cloud home energy management system assigns dynamic priority to a household appliance according with assigned priority, considering renewable energy [4]. RFID's are platform like cloud which serve as efficient backbone for achieving network of sensors and actuators for improving performance of day-to-day gadgets.

Cloud computing is a model for on-demand access to a shared pool of configurable resources (e.g. computers, networks, servers, storage, application, services, software) that can be easily provisioned as Infrastructure (IaaS), software and applications (SaaS) [8] . In this paper CDAC act as a cloud for IOT. CDAC's has rich expertise in sensor, networking, grid, and cloud technologies and scientific application development [8]. As HEMS is used to reduce and manage home energy use but it cannot able to figure out how efficient a home appliance is compared to others, so it is important to compare the energy usage of home appliances to that of same kind of home appliances thus GHEMS is introduced, GHEMS checks the relative energy efficiency of his home appliances into more energy efficient one or replace energy inefficient home appliance into an energy efficient one [4]. Pachube cloud network using mobile device, PC's or in home remote controlled, by this framework system can be expanded like home security such as open door and motion detection, energy monitoring, weather stations [7]. Pachube is a real time data infrastructure which allows management of millions of data points from thousands of individual, organizations, and companies. Pachube API was used to create home control user interfaces and monitoring graphs .Any Android based smart phone with built in support for Wi-Fi connection can be used to access and control the devices at home in case Wi-Fi connection is not available networks 3G or 4G can be used to access the system [5] .

III. PROPOSED SYSTEM

The system allows the user to control home appliances from a smart phones with the help of Wi-Fi and can also be controlled from anywhere in the world using an internet. This system has a capability to control their appliances within their home from a Android device. The smart phone has primary control over all the home appliances. The Smartphone and PC all were trying to control the system at the same time. The project was tested to switch appliances on and off such as: lights, fan, motor and AC. The system keeps on refreshing on the Smartphone and PC every time the user chooses an option to control or monitor a specific unit [10].

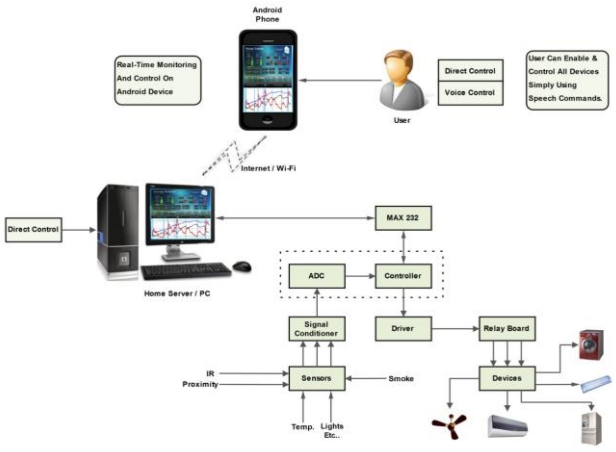

Fig. 1: A system diagram of home automation using Cloud network and Android mobile.

As well as this system can be directly controlled or with the help of voice control. User can enable and control all devices simply using Speech Commands to smart phone. Hence, Real Time Monitoring can be done on Android Device.

For direct control we can also use our PC where similarly home appliances can be controlled and monitored. As, we are using Wi-Fi we need to make our PC as a Home Server for controlling all our household electrical appliances [9].

In this system MAX 232 is used to convert TTL/CMOS logic levels to RS 232 logic levels during serial communication of microcontrollers with PC. The hardware circuit also includes ADC for analog to digital converter which is interfaced on microprocessor. It also includes connection of sensors like IR, Proximity, Gas, Temperature, Smoke etc.

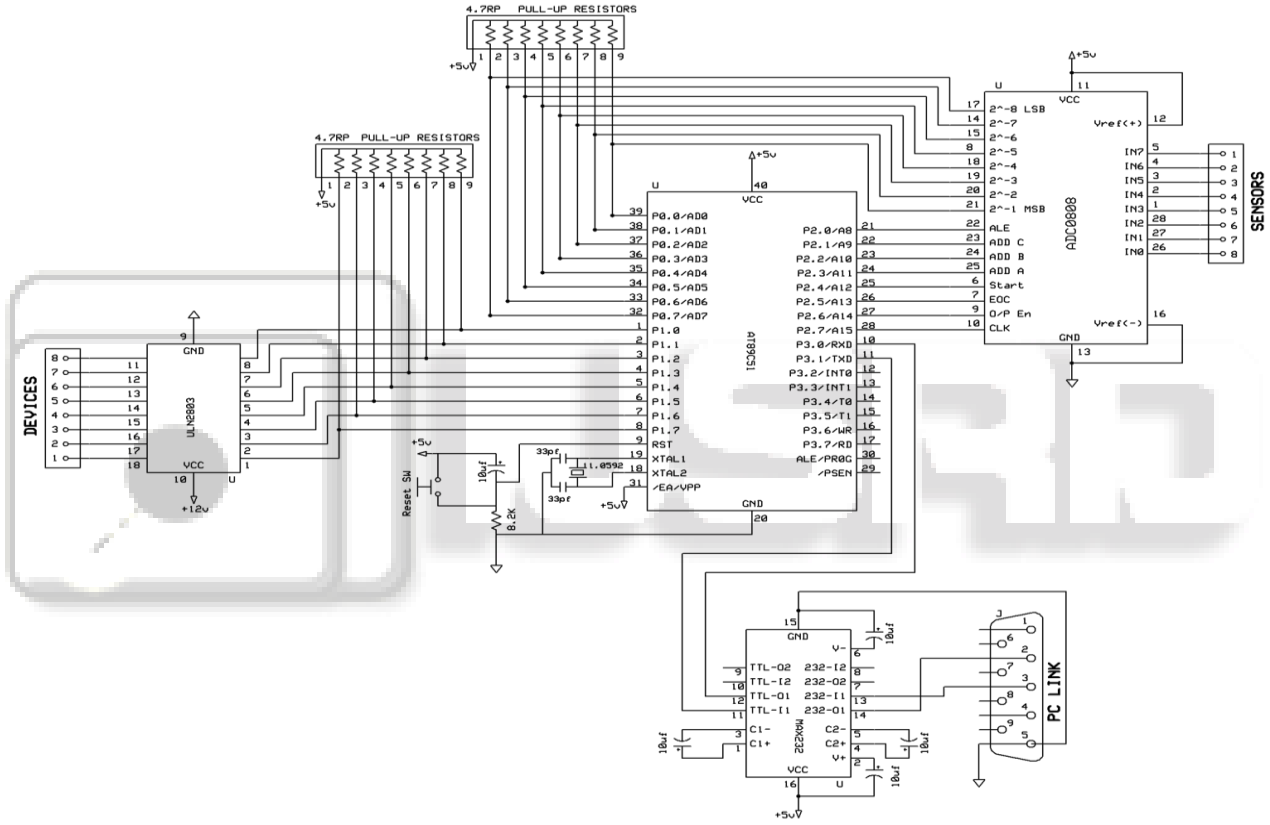

Fig. 2: Circuit diagram inside the in-home gateway controller.

In above fig 2, we have shown our hardware layout with the help of Express PCB software. It generally shows the communication between hardware components.

IV. HOUSEHOLD APPLIANCES PRIORITY BASED ALGORITHM

Home appliances are possible to be divided according to use pattern. For example, it is possible to divide them into devices decided for operation by user life/behavior pattern, 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 [4].

Utilization of renewable energy source can be maximized according to the priority-based scheduling of home appliances changing dynamically.

A. Classification of Household Appliance According to Operation Characteristics:

Household appliance is classified according to the factor that is related to its operation.

1) Resident Activity's patterns (Type A):

Behavior pattern of residents are closely related to operation of appliances. If resident's behavior is decided, then operating appliances can be decided accordingly. For example, if a resident wakes up in the morning and takes a shower, he will turn on the light in a bathroom. Also, if a resident prepares breakfast in the morning, he will turn on the light in dining room and use various electric cooking machines. Therefore, if user's behavior pattern is analyzed and can be predicted, operation of corresponding appliances also can be predicted. Table I shows devices decided their operation by various user behaviors. The time indicates the

main operation time of the day. This is modified in each house according to the lifestyle that is analyzed through energy consumption data gathered by the iPMD.

Behavior	Related appliance	Time
Bathing	Light in a shower room	5:00-6:00,20:00-22:00
Toileting	Light in a toilet	frequently
Cooking	Light in a dining room,	7:00~9:00
& dining	Electric cooking machine	17:00~20:00
Dish washing	Light in a dining room,	8:00~10:00,19:00~21:00

Table 1: Resident Behaviors, Related Appliances, and Operation Time

2) Environmental Factor (Type B):

Environmental factor also closely related to operation of I-Home appliances.

Surrounding brightness degree can be utilized for effective operation of a light system and temperature degree can be utilized for operation of a cooling or heating system.

B. Allocation Scheme Of Household Appliance Priority:

Operating the appliances in *type A* cannot be delayed. These appliances should work immediately if a resident

Operate them. In other words, the energy consumption of this type of home appliances cannot be scheduled. Therefore, this type of home appliances is allocated high priority.

On the other hand, operating the appliances in *type B* can be scheduled according to the environment factor. 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.

C. Priority based Scheduling Algorithm:

The objective of priority based scheduling algorithm is to enhance efficiency of renewable energy. That is, stored energy in ESS (especially, battery) is well utilized without wasting energy. Priority based scheduling algorithm is divided into two category, stand-alone and server-based architecture before priority based scheduling algorithm is performed, two preceding jobs are needed. First, priority of household appliance is continuously updated. Appliances are changed according to time, environment, battery's state. For example, if room temperature is lower than threshold value, priority of air conditioner is low but its priority set high if higher than threshold value. Since such environment changes are continuously occurred, the priority should be periodically updated. At second, how much energy is used to drive household appliances should be calculated. The priority change and the calculation of energy used for appliances are performed in iPMD.

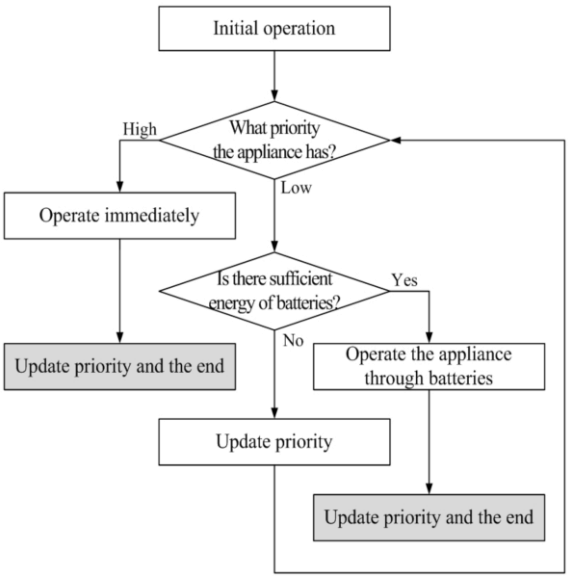

Fig. 3: Stand-alone type of priority based scheduling algorithm.

1) Stand-Alone Type:

Fig. 3 shows a flowchart of a priority based scheduling algorithm based on stand-alone structure. The stand-alone Structure means the proposed algorithm runs independently by iPMD not connected with the management server, i.e. iCMS. The procedures are composed of four steps

- Step 1: An appliance operates by residents through iPMD. Since all household appliances are connected to iPMDs, they are controlled by iPMDs. For this reason, operation time of home appliances is scheduled according to the appliance priority.
- Step 2: The iPMD that is received operation command signal is checked for the priority of connected appliance.
- Step 3-1: If the priority of connected appliance is high, it immediately operates through commercial electricity. After the operation is completed, the priority is updated and the process is completed.
- Step 3-2: If the priority of connected appliance is low, the battery storing energy generated by renewable energy are checked through iCMS. That is, iPMD confirms whether the battery has enough energy to operate corresponding appliances.
- Step 4-1: If the battery stores enough energy, iPMD operates this appliance.
- Step 4-2: If the battery stores not enough energy, the priority of appliance is updated and goes back to Step 2.

2) Server-Based Type:

Fig. 4 shows a flowchart of a priority based scheduling algorithm based on server-based structure. Not like standalone type, the server-based type manages overall operation scheduling of appliances through iCMS. That is, based on daily energy storage volume expected through weather information, appliance priority and the operation deadline of an appliance; daily appliance operation scheduling is managed in iCMS. The procedures also consist of four steps.

- Step 1: An appliance operates by residents through iPMD. Since all household appliances are connected to iPMDs, they are controlled by iPMDs.

- Step 2: The iPMD that is received operation command signal is checked for the priority of connected appliance.
- Step 3-1: If the priority of connected appliance is high, it immediately operates through commercial electricity. After the operation is completed, the priority is updated and the process is completed. Step 1, Step 2, and Step 3-1 have same process as the priority based scheduling algorithm of stand-alone type.
- Step 3-2: If the appliance priority is low, corresponding appliance profile is transmitted to iCMS. This profile includes identification of this appliance, operation deadline information, and status of this appliance. iCMS that received appliance profile updates operation schedule according to appliance operation deadline and daily expectation of energy in battery.

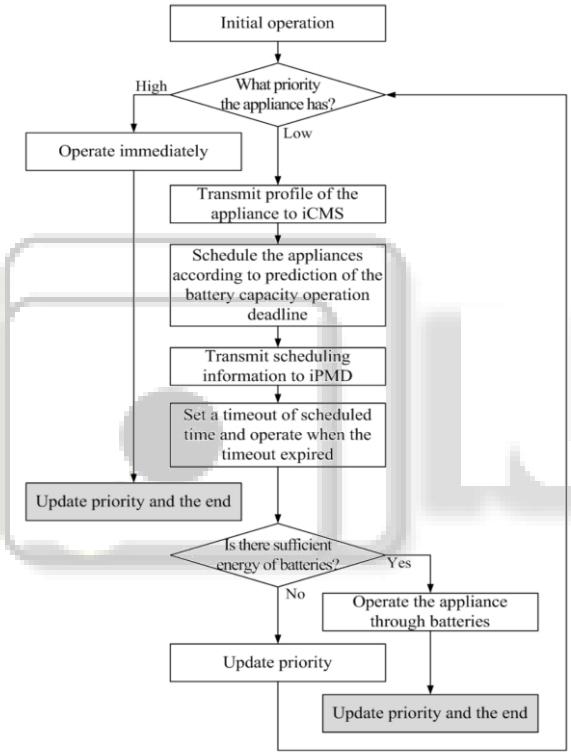

Fig. 4: Server-based type of Priority based scheduling algorithm.

That is, it decides when appliances up to now will be operated including corresponding appliance. Scheduled information is transmitted to respective iPMD again. The iPMD sets timeout based on this information and when timeout is expired, operation event of appliance occurs.

- Step 4-1: If the battery stores enough energy, iPMD operates this appliance.
- Step 4-2: If the battery stores not enough energy, the priority of appliance is updated and goes back to Step 2.

V. IMPLEMENTATION

A. *Software Development for Home Gateway:*

Software of the proposed home automation system is divided into two parts: server application software and microcontroller firmware [6]. The server application software is a library implementation of a micro Web-server running on cloud. To successfully communicate between the Home Appliances, configuration stage, sensor/actuator and Android Device control stage layers have been implemented on the microcontroller.

B. *Smartphone Application and Features:*

The Smart phone app for home control and monitoring applications provides the following functionalities to the user: 1) Remote connection to the Home Appliances. 2) Android Device control. 3) Android Device Monitoring. 4) Managing schedule. Below Screenshots shows the graphical user interface for controlling and managing the home environment using Smart phone [2] .

Fig. 5: Screenshots of iHome application for home automation using cloud; (a) The main menu where user needs to put server IP for connection.(b) User needs to insert its username and password for login into app

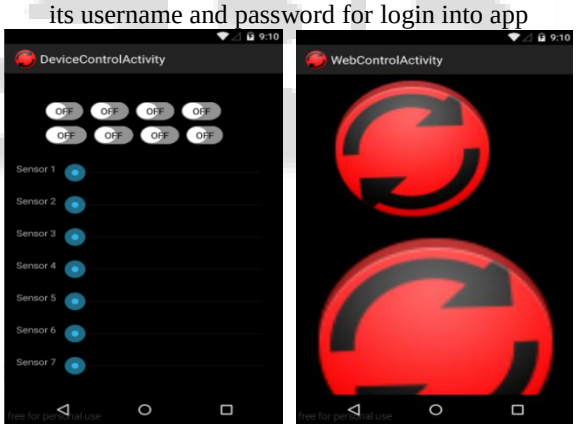

Fig. 5(b): The user interface for for monitoring each appliance status. Controlling appliances and (c) The user interface

VI. CONCLUSION AND FUTURE WORK

In this paper we are trying to present a module which should be of low cost with a good efficiency rate and which provides flexible home control and monitoring system using Android based smart phone will be preferred for the implementation. Any android based smart phone which supports the facility for Wi-Fi can be used to access and control the devices from home. If a Wi-Fi connection is not available, mobile networks such as 3G or 4G can be used to access the android system [6] . This will help the coming generations to save a huge amount of energy for the future use and make home a better place to live. The paper keeps some scope for the further progress for the working of the home automation system based on the voice modulation and

the senses to control the use of home appliances based on the gestures of the person. The paper can also be taken to another level if the work done on the scope for artificial handling, if any home appliance can measure and read the environment requirement and operates itself, this can be considered as a combining of home automation with artificial intelligence for the upcoming revolution.

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