IOT base Smart Home Appliances by using Cloud Intelligent Tetris Switch

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Abstract— **To enhance the convenience of life, Internet of things today is a famous research topic. However, different home appliances provide different functions and services. Hence, in this research, the IOT base Smart Home Appliances by using Cloud Intelligent Tetris Switch is proposed which including the *Cloud Intelligent Tetris Switch, Cloud Home as a Service (HaaS) Server,* and *IOT based Appliances*. The *Cloud Intelligent Tetris Switch* is proposed to achieve the power control and local data exchanging. In addition, the dynamic extendable module is embedded. The *IOT based Appliances* provide the service of identification. Similar to the EPC network, the corresponding home appliance description data with RFID unique number can be obtained from the Internet and manufacture. The *Cloud Home as a Service* (HaaS*) Server* is proposed to provide the user interface for client users, storage all the information or data corresponding to the specific house, and query the function information of individual home appliance.**

Keywords— **Cloud, Internet of Things (IOT), Home Appliance, Smart Home, Switch**

I. INTRODUCTION

Internet of things [6] today is a famous research topic. To enhance the convenience of life, connecting most sensors and appliances can be a good solution. By using the central home server, people can use the Wi-Fi or Bluetooth connection to control the home appliances. Suppose that all the home appliances are connected to the network and already on-demand identified by the central home server, all the states of the appliances can be monitored remotely. However, not all current home appliances can be connected to the network. Most of the appliances are turn on/off based on the mechanical switch. In addition, different home appliances provide different functions and services. Hence, how to connect these different home appliances to the network for remote control becomes an important issue.

Currently, the extension cord with manual switches (or sockets) is popular and generally used. In addition to the mechanical switch of individual home appliance, the manual mechanical switch can be used to enable the specific socket for home appliance using. In other words, there are two phases for appliance controlling:

1) the switch of extension power cord for power providing,

2) the switch for function activation of the appliance.

If the home appliance is controlled and monitored, it means that the appliance is powered on and already connected to the network. In opposition, to save the power and reduce the cost, the appliance should be turn off if it is not used. Since most of current appliances today are not equipped the intelligent power module, to directly turn on or power on the appliance via using wire or wireless signal is too difficult.

In addition to the power, different appliances provide different services. In the other hand, the corresponding function commands will be needed for each appliance. Considering the current appliances used, to query the service functions from these appliances is almost impossible. These appliances cannot reply the queries to the central home server automatically. In other words, for the home central server, to dynamically identify each home appliance for executing the specific function or service is not possible. Hence, how to identify different appliances automatically becomes an important issue.

Today, Internet of Things (IOT) is proposed to make all the things connected by network. Suppose that the devices equip the Internet connection module for information exchanging based on network. All the powered devices will be treated as the network devices and exchange the data between device and controller. In addition, based on IOT concept, the control server or the management system can automatically identify each individual device. However, until now, most home appliances are not the “Home IOT " type devices. Therefore, how to establish a home IOT environment for the existed home appliances should be considered.

The rest of this paper is organized as follows. Section 2 presents the related technologies. Section 3 shows the proposed system structure of IOT based Smart Home Appliances by using Cloud Intelligent Tetris Switch. In the section 4, the real implementation is presented. The conclusion is given in section 5.

II. RELATED TECHNOLOGIES

A. Internet of Thing

Internet of Things (IOT) is famous today. An IOT device which equips the network module can connect to the network (or Internet) as a network device [8]. The information can be exchanged via network (such as home network). By using the

network module, each device can be identified according to its address of network interface card (NIC) and the corresponding device data. Then, each sensor or device can passively or actively exchange the information with each other. [5]

B. Universal Serial Bus -- USB

Universal Serial Bus, also called USB, is a famous standard used in information industry [2]. The standard is defined and designed for the electronic devices to achieve the communication and power supply between the personal main information devices and the plug-in devices. By exchanging the device description data, the main device can identify and active the plug-in removable device.

C. Cloud

Cloud computing now is generally used in different applications [9][7][4]. Based on the virtualization technology and resource pool, the cloud platform can provide the huge computing resource for rapid using. Via IaaS, PaaS, and Saas, all the services can be obtained by network. Users can give the on demand required conditions, such as CPU speed, memory size, storage space, etc., to the cloud platform for specific virtual machine (VM) establishment. Furthermore, by on demand configuration, the configured VM can be rapidly used for different users. Each user can be assigned an individual VM. The remote client users can use any devices such as mobile phone, Raspberry Pi, pad, laptop, etc., with Internet connection to control the VM on cloud.

Hence, based on the virtualization technology, the services manager can configure the corresponding VM once for repeatedly used.

D. EPC RFID

EPCGlobal is an organization to define the standard of electric product code (EPC)[1]. Based on the standard and definition, each radio frequency identification (RFID) tag will be assigned a unique identification number (UID). A unique ID (UID) will consist of the EPC manager number, object class number, and the serial number. EPC manager number is used and assigned to a registered company. The object class number is defined by the company. A serial number is used to indicate the individual trade item (object). Hence, each RFID tag with the unique ID can be used to indicate the specific trade item. In addition, based on the EPCGlobal network, by querying the RFID UID, the remote system can search the specific server to obtain the information corresponding to the RFID UID. Therefore, the corresponding information of the specific trade item with the RFID tag can be obtained via network information exchanging.

III. PROPOSED SYSTEM

To identify different home appliances and active the corresponding functions, the proposed system including the *Cloud Intelligent Tetris Switch, Cloud Home as a Service (HaaS) Server,* and IOT based Appliances is presented.

A. Cloud Intelligent Tetris Switch

In this research, the *Cloud Intelligent Tetris Switch* is proposed [3] to achieve the power control and local data exchanging. The *Cloud Intelligent Tetris Switch* is the extension of the original power line. Based on the embedded system module, each socket of the *Cloud Intelligent Tetris Switch* can be individually controlled. In addition to the manual operation, users can use their own mobile (via APP) or browser to remotely control each socket. It means that each home appliance can be powered on/off remotely according to the command given by the user.

Moreover, the *Cloud Intelligent Tetris Switch* with the embedded system module should connect to Internet. The Bluetooth, Zigbee, or Wi-Fi is available for communication between *Cloud Intelligent Tetris Switch* and home appliances / remote home service server. In other words, the communication and data exchanging is achieved.

However, there are different rooms in a house. There are many different home appliances located in different rooms. Considering the real implementation, to on demand define the function of individual room is difficult and impossible. In this research, the dynamic extendable module is embedded in the *Cloud Intelligent Tetris Switch*. The sockets of the switch can be extended from total three to nine. The direction of the switch extension can also be different. Hence, by using one *Cloud Intelligent Tetris Switch*, the extension of the sockets can still be controlled by the remote server or users.

In addition, to locate and identify each *Cloud Intelligent Tetris Switch* is needed. Fortunately, since each *Cloud Intelligent Tetris Switch* equips the wireless communication module, the MAC address of each module can be used to differentiate individual *Cloud Intelligent Tetris Switch*. Similar to configuring the router of network, client users can add any valid MAC address to the remote HaaS server with the corresponding location (room) information. Then, the HaaS server can send the command to the corresponding (correct) home appliances according to the added location (room) information.

B. IOT based Appliances

To identify each home appliance for further control is important for client users. However, most home appliances don't equip the USB or Wi-Fi connection today. Hence, additional identification method for home appliances is required. Suppose that all the home appliances equip the electronic product code (EPC), such as binary code, QR code, or RFID tag. By using the additional socket structure with the RFID reader or scanner, each home appliance can be simple indentified. In other words, similar to EPCIS and EPC network, based on the obtained identification information of the home appliance, the remote home server can query the corresponding device description data from the Internet and manufacture. Then, even the home appliances today can be controlled according to the corresponding functions.

C. Cloud Home as a Service (HaaS) Server

To provide the remote control by the client users anytime anywhere, using the server based on the cloud is needed. In this research, the *Cloud Home as a Service* (HaaS*) Server* is

proposed to provide the user interface for client users, storage all the information or data corresponding to the specific house, and query the function information of individual home appliance.

Similar to the EPCIS and EPC network, the server can obtain the corresponding function information of individual home appliance via the electric product code. In addition, since the HaaS server will deal with the control of individual home appliance, to establish a independent server for each house will be needed. In this research, the HaaS server is implemented as the service of the virtual machine (VM). Hence, the managers deploy the VMs for different houses with the same IOT based smart home appliance service. In other words, via account and password, different users can login to the corresponding VM for their own appliances control and management. Moreover, the IOT based smart home appliances and the cloud intelligent tetris switch can register in the database of each *Cloud Home as a Service* (HaaS*)* VM. Hence, even the same type of home appliances located in different houses can be identified according to the registration in individual database of *Cloud Home as a Service* (HaaS*)* VM. Therefore, each user can only control the home appliances which are registered in the corresponding *Cloud Home as a Service* (HaaS*)* VM. The security can be maintained.

IV. Real Implementation

By using the Arduino GPIO connection and Wi-Fi module, each socket of the Tetris switch can be controlled remotely. The remote command given by the users via *Cloud Home as a Service* (HaaS*)* VM or APP will be sent to the corresponding *Cloud Intelligent Tetris Switch*. The *Cloud Intelligent Tetris Switch* can be dynamically extended. Figure 1 presents the dynamic extension of *Cloud Intelligent Tetris Switch.* Not only manual operation but also Wi-Fi remote control are available.

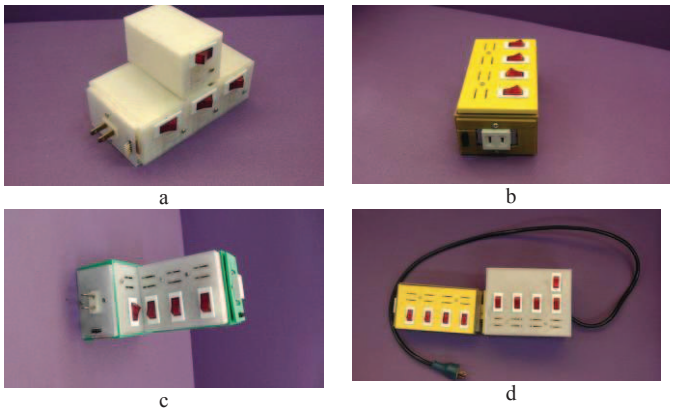

Figure 1. The dynamic extension of *Cloud Intelligent Tetris Switch.*
a. T type extension; b. I type extension; c. L type extension; d. The connection of the *Cloud Intelligent Tetris Switch.*

Then, based on the cloud environment, the *Cloud Home as a Service* (HaaS) is established on the virtual machine. System users only need to access the user interface via browser and give the command. Finally, Figure 2 presents the home appliances can be managed and turned on/off by the *Cloud Intelligent Tetris Switch*.

Figure 2. The home appliances can be managed and turned on/off by the *Cloud Intelligent Tetris Switch*.

V. Conclusions

In this research, based on the *Cloud Intelligent Tetris Switch* and *Cloud Home as a Service* (HaaS*)* server, the most home appliances with IOT embedded can be managed and controlled remotely. In addition, considering the implementation, the intelligent Tetris switch can be dynamically extended to different direction. The extension of switch or sockets can still be controlled by the remote cloud server. The corresponding functions of appliances can be also managed by the IOT module and switch. Hence, the life at home can be smart and intelligent.

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