Design of Home Automation Framework With Social Network Integration

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***ABSTRACT*:** *In present days, home devices with network capabilities are widely used and augmented for delivering several Home Services (HS) to more end users. The technology integration offers new and exciting opportunities to increase the device connectivity within a home for many proposals of home automation. This paper is designed and implemented for a cost effective, flexible, manageable home automation system. The proposed system consists of three main components: a device control using a microcontroller (e.g., Raspberry PI with control circuit), a notification system (Social network integration) and a user control from anywhere, any time and any device. This system can support a wide range of home appliances connecting through the network as the Internet of Things (IoT) concept. A user is able to easily control home automation system by several ubiquitous devices. Air conditioners and fans are sample devices to be controlled by our system in order to demonstrate the simplicity and effectiveness that will save usage energy.*

Keywords: Home Automation Framework, Sensor Devices, Raspberry Pi, Social Network

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1. Introduction

With the growth of the Internet, many homes usually have network connections as one of the mandatory things in daily life. Home equipment such as television sets, refrigerators, doors, light controllers, fans and air conditioners come with embedded network capabilities for creating a home automation and connecting to other ubiquitous devices (e.g., digital camera, mobile phones). Once several appliances are connected, the solution of management these devices are required to be effectively controlled. Generally home automation is concerning on four main challenges [1]. These are (1) high cost of ownership, (2) inflexibility, (3) poor manageability and (4) difficulty achieving security. Several technologies are used to implement a home automation concept to solve home automation issues by different short range communication technologies. The authors in [2] proposed to remote control home automation via Bluetooth network which is generally used for point to point communication. Their hardware and software are described to perform home automation via test bed. Remote and local controls are useful to support the elderly and the disabled people. Another solution, a Zigbee-based home automation system [3], is integrated through a common home gateway which provides network interoperability. Zigbee and Bluetooth-based home automation systems have the low installation and running costs. Cellular technology, however, such as SMS based home automation system [4] also has been used to implement home automation with various capabilities to monitor alarms (power, temperature,

motion, fire and door alarms, etc.). Several sensors are directly connected to a microcontroller through appropriate interface as a sensor host. The advantages of GSM based control system is the mobile network and battery powered which have less problems of power failure. On the other hand, the controlling cost per SMS is more expensive than the other local short range wireless technologies. Our proposed system is another alternative home automation framework that aims to easily manage and control home appliances which can be done locally or remotely. The system has many advantages such as energy saving, simplicity to use, flexibility, and low cost. In addition, the notification system is incorporated with well-known social networks from any device while other previously proposed systems are lagged.

The remaining of this paper is organized as follows. Section 2 provides technical background. Section 3 shows our proposed system architecture through the selected experimental scenario and implementation. The discussion is given in Section 4. Finally, the conclusion and future works are given in Section 5.

2. Technical Background

Technical background is required to understand how the framework works. Home automation concept is introduced following by several required major components such as Raspberry PI, Responsive Web design and a notification system.

2.1 Home Automation

Home automation concept has been described in many definitions from many researchers. However, the main idea of home automation is to automate home devices, house works or activities. Home automation may include control of light, air conditioner, fan and appliances etc. This will provide energy management efficiency, convenience and security. Presently, research and development in the context of home automation is the trend since ubiquitous devices are increasingly quick and cheap. There are many proposed research concepts in home automation e.g., a framework for cloud-based smart home [5] in order to control home appliances through web services and links with cloud system which is easy to control them. The authors in [6] propose an intelligent self-adjusting sensor to provide smart home services based on Zigbee communications. Moreover, IEEE 802.15.4 and Zigbee are proposed in [7] to create smart home energy management system.

2.2 Raspberry PI Interfacing

Raspberry PI [8] is a single board computer that is chosen for the system since it is cheap, small, and has a good performance compared to cost ratio and large supported communities. Linux operating system is used in Raspberry PI with ARM CPU operates at 700 Mhz and LAN connectivity. The peak power requirements are low: 700 mA at 5V. Raspberry PI has GPIO (General-Purpose Input/Output) to interface with various sensors. It is able to provide a web server and a database server like a computer desktop which is easier to deploy and also consumes less energy. Raspberry PI has been recently used in many researches as experimental test bed e.g., interface with secure sensor node for elderly people [9], remote control of domestic appliances to balance demand in the context of smart grid [10] and data integrity for energy management of sensor nodes as home services [11].

2.3 Responsive Web Design

Responsive web design is an approach to design web site with optimal viewing in different screen sizes since many vendors release several sizes of ubiquitous devices or desktop PCs. It will bring a user to read or navigate easily by dynamically adapting to different browser and device views which allow users to easily control from any devices.

2.4 Notification System

Notification system is a method to notify users for some predefined events. There are many methods that have been used for notification such as SMS, Email, Social network etc. Most notification systems are used in the context of health care or monitoring patient. e.g., XMPP protocol is used to implement instant notification system in heterogeneous sensor network [12]. However, they are rarely implemented with social network capability. In our experimental scenario, we will implement it with social network which can be reached to related users immediately.

3. The Proposed System Architecture

3.1 Experimental Scenario

Air conditioners and fans controlling are chosen as an experimental scenario in order to illustrate how the system works. This scenario is attractive to us since it can gain benefits by high energy saving with the effective control and monitoring is

implemented with notification system. In addition, to make the system more flexible, this is not only limit to those two devices but also extend to various home appliances connecting to a control circuit box.

3.2 System Architecture

The proposed system is designed, developed and tested, to evaluate the prototype system. The experiment of a circuit part has been setup and connected between home devices and Raspberry PI in order to control home devices e.g., an air conditioner, a fan, and a microwave oven, etc. from mobile phones or tablets anytime and anywhere. This framework is a proof of concept and has been tested at home and the laboratory of Department of Computer Engineering, Prince of Songkla University, Phuket Campus.

Figure 1 shows the home automation architecture framework. It consists of 3 parts: (1) a device control, (2) a notification system (Cacti project [13] and Facebook integration) and (3) a user control.

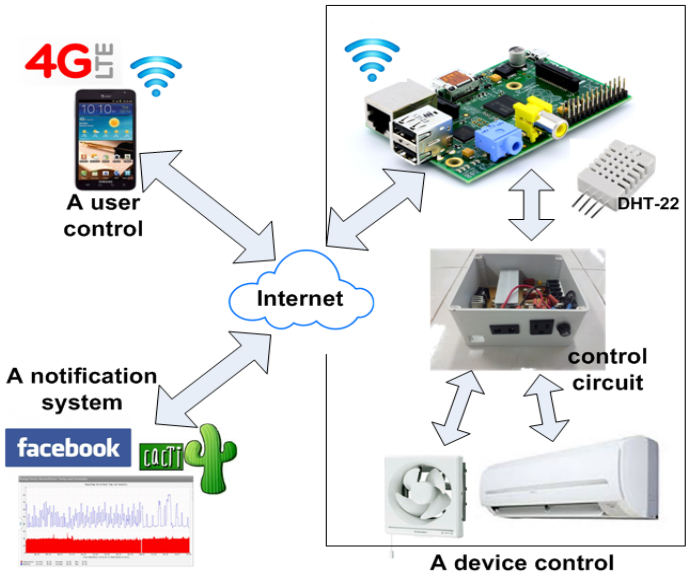

Figure 1. The Home Automation Architecture Framework

3.2.1 A Device Control

This part can be divided in 3 sub-parts:

• Raspberry PI: It is a microcontroller to interface with various sensors and home devices via our control circuit. Raspberry PI uses GPIO to read various sensor data (e.g., temperature and humidity sensor: DHT-22) and sends control status to command connected sensors or home devices. These processes are implemented by Python programming language. In addition, Raspberry PI stores sensor data in the database (e.g., mySQL) periodically. Figure 2 (as implemented on the responsive web based) shows that the temperature in a server room is recorded in every 5-10 minutes (this value can be reconfigured). In the case that a temperature is higher than a pre-defined threshold, the system will automatically trigger a notification system in part 2. Moreover, Raspberry PI provides WiFi/LAN to connect to the Internet. It is always connected to related users.

• Control circuit: It is a circuit that helps to handle home devices with low or high current by connecting between Raspberry PI and home devices as shown in Figure 3. It consists of several electronic components e.g., transistors, optos, relays, varistors and resistors, etc. The control circuit is designed with high flexibility. Various home appliances are supported to associate with it.

• Home devices: These are common electrical devices or home appliances that are needed to manage effectively.

3.2.2 A Notification System

A notification system runs on Raspberry PI by Cacti project. Cacti is a front-end RRDtool that gets the data from a database server and generates graphs of temperature or ping latency as shown in Figure 4. This data can be used to help a system administrator to monitor the devices and link to any social network (e.g., Facebook or Twitter). In our test bed, Facebook is

chosen as a notification system since Facebook allows us to create a custom group and adds responsible members to receive alert or notification. It is added and linked to the notification system by Cacti using a custom email (temperature-report@groups.facebook.com, for example). The Cacti is capable of sending notification via email by a polling service in a specific pre-defined time and a configured condition. When an email is trigged, Facebook will alert users immediately and automatically. In a similar manner, Twitter and Google plus provide application programming interfaces that can post notification messages to users directly.

Figure 2. The home automation architecture framework

3.2.3 A User Control

This part is implemented as a responsive-web based in order to support multiple screen sizes of mobile devices or tablets. The system can be controlled by users as a client side from anywhere, anytime and any device that has the Internet access. A client side interface device is just a portable device such as mobile phone with WiFi or 3G/4G connecting to the Internet. Thus, users can easily manage home devices effectively.

A user has to login to the system, then configure the device on/off timer, monitor device status, add or delete more devices. As a result, a user can control and monitor home devices as home automation concept for future life.

4. Discussion

The main contribution of this work is to propose a new design of home automation framework with a notification system. This system is cheap, simple, flexible and manageable. One of our main interests is to link the system with the well-known social network, thus a person or a group of related people can manage devices easily. Figure 4 shows the graph of temperature and ping

Figure 3. Control circuit to interface home appliances

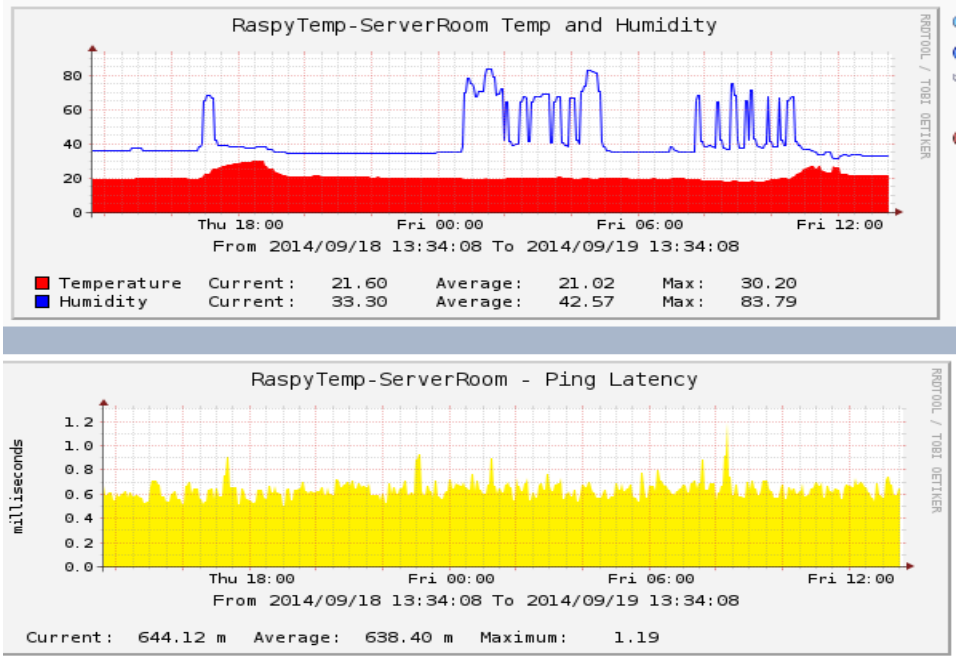

Figure 4. The sensor data as graphs generated by Cacti

latency that an administrator can easily see the peak period of the graph. Moreover, these data can be kept in history which can be viewed later. This can be used to analyze the problems and to notify though the social network that can help officers from several situations:

• There are four or five air conditioners in a server room. If one or two devices are un-operated from any reasons, the other air conditioners remaining may work too hard and will be damaged soon. Therefore, if an administrator knows the situation from notification system, then he can solve the problem immediately. This is because the administrator and most people usually stay connected to social networks by their ubiquitous devices. In contrast, if some air conditioners are un-operable since the mentioned air conditioners are damaged. The government process to replace a new one is not simple and may not be quick enough to keep other servers to operate.

• In another situation, if some air conditions are turned on without any need, then an officer who has authority can login to the system and shutdown these devices remotely. This process will save the consumed energy.

After the system is tested with air conditioners and fans regarding to our experimental scenario, users can control these devices easily and effectively.

5. Conclusion and future work

In this paper, we introduced the concept of home automation through the real-life experiment. The proposed system is designed to manage and monitor home devices over network in a home or an office environment. The main benefit of the system is a way of managing home devices more effectively. This leads to many advantages (1) energy saving since there are rarely cases that home devices are running without the need, and (2) protecting the device from damages since a system administrator is notified by social network and the problem can be handled rapidly. Furthermore, the system is flexible and low cost. The total price of the system is less than 100U$. Additional home appliances can be integrated into the system. In future work, this system will mainly be improved in the security issue since home devices at homes or offices directly affect privacy and people life.

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