Scheduler and Voice Recognition on Home Automation Control System

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***Abstract*— Automated home or home automation or smart home can be described as a product to provide ease of doing homework. One of the simplest task is turning on or off light or any other electrical equipment at home remotely and or automatically. There are issues on building a house that could efficiently use electricity in a comfort way. Current development of technology enable production of cheaper and smaller size of computer. Raspberry known as a Single Board Computer (SBC) proposed in this paper to achieve those goal. Current development shows that home automation could be managed by the means of website or smartphone application such android or IOS application which required resident to access computer or smartphone. This paper proposed better seamless communication between automated home and it's resident. To achieve that goal, this paper proposed voice command function to control any electrical device while still keeping web based application to control detailed instruction or configuration. Raspberry equipped with microphone, relay and internet access will deployed a house that will have function of monitoring the state of electronic devices, scheduling, and web remote control. In addition, electrical devices could also be controlled using voice commands to provide its resident a new experience in controlling their house. Cloud-based API, Wolfram Alpha, will be deployed to record voice command sound which in turn convert it into text to be processed by Raspberry Pi. Therefore, for the system to work, it is compulsory to be connected to the Internet.**

Keywords—home automation; control; voice command; scheduler; web-based

I. INTRODUCTION

Currently, working people tend to be more busy than before causing them to manage their recklessly. Such a way that they often forget to turn off their electrical prior leaving the house for work. Those device will use the electricity available whole day. These lead to huge amount of energy wasted [1]. If only there is a way for people to monitor any electrical usage remotely, they could aware how many times they waste energy [2][3][4]. But again, there is a need for them to remotely control their electrical devices back in their house in the case they turn it off. Web is multi-platform technology thus could be accessed from many kind of devices[5][6][7]. Therefore in this paper web is proposed as services in controlling remotely. To encourage people to adopt this kind of technology, it need to provide new experience in house electrical management [8][9]. One function that could be added would be voice command [10][11][12][13].

Home automation is relatively new technology and they quite expensive making people to think twice before having it in their house [14][15]. Alternatively, those system could be develop a using open source software and multipurpose Single Board Computer (SBC)[16] like Raspberry Pi [17]. Open source software allow people to participate in the development of those devices. It will also encourage people to share any resource they got which in turn rapidly increased adoption and development of the system [18]. It also relatively has a lower cost compared to built-in commercial products on the market such as x10 Home automation [19][20].

Recent developments on computer and electrical devices making them relatively cheaper than before [21]. It also lead to the development of even smaller devices. Computer is getting cheaper and smaller in sizes. SBC is one example of low price and small size computers that could be used in Home automation system. Raspberry is an example of SBC that is quite popular and could easily found on the market. It will be used as central system that controls electrical devices. Relay is a device that works as a switch that could be controlled by raspberry [22]. The switch will be closed or open, or on and off based on controller signal. Raspberry pi is a credit card-sized computer that is equipped with a 700 MHz ARM1176JZF-S. It use SD card as the storage, and equipped with USB port, HDMI, RJ45. With those specifications and sizes, Raspberry Pi will be able to provide as a controller in automated home [13].

II. PROPOSED METHOD

The method used in the development of the system includes several stages of the following:

A. Requirement Analysis

At this stage, whatever requirement and equipment to build home automation system is identified. Those included function, Hardware and Software analysis.

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This system will have functions like:

1. Monitoring the state of the electrical devices (ON/OFF)
2. Scheduling the state of the electrical devices[23][24].
3. Voice command control
4. Web Management control.

Hardware needed in the home automation system according to the input requirements analysis, the following list of components used:

a) Raspberry Pi (See Fig. 1)

Fig. 1. Raspberry Pi Model B

b) Microphone

c) Relay (See Fig. 2)

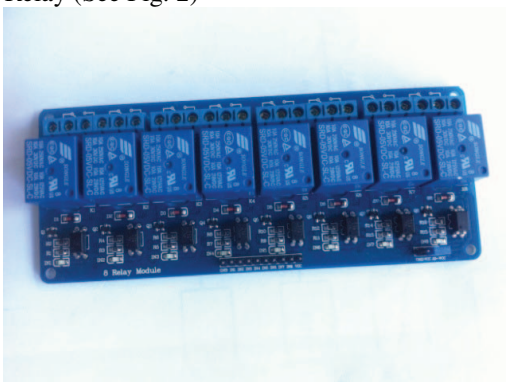

Fig. 2. Relay 8 Channel

d) USB Sound Card (See Fig. 3)

Fig. 3. USB Sound Card

e) Speaker

Software required to develop home automation system based on the function analysis requirement are as follows:

f) Operating System Raspbian (Debian Wheezy).
Raspbian would be the operating system (based on Linux kernel Debian Wheezy) of Raspberry Pi.

g) MySQL
MySQL would be the database application to store all information and the state of the equipment.

h) Apache
Apache would be the web server to serve the HTTP request where the web interface control enabled.

i) Voice Command
Voice Command is an application to connect to API Wolfram Alpha. It was cloud base API thus Raspberry must connect to Internet for this service to work. Wolfram Alpha API will take recorded sound captured by Raspberry Pi and convert it into text to be processed by Raspberry Pi.

j) Python
Python is a programming language used by Raspberry including execution of GPIO command GPIO.

B. Planning and Design

At this stage, the whole design of the system is defined. Those included Overall System, Software, Hardware and Interface Design.

C. Implementation

This was the stage where the process of planning, analysis and design that have been made in the previous stages are implemented according to scenario made based on the user need identified on requirement analysis stage.

D. Testing

At this stage, performance test was conducted to identify any design and implementation flaw that might affect system goals achievement. Therefore, we could decide if the system work as designed and could be implemented on the field.

III. System Design

This section consist of two part which are overall system and software design. The other part system like hardware and interface design would be explained on the next section. This section will emphasized on how the process and software designed to support the proposed system.

A. Overal System Design

Home automation control system has three different way to control electrical equipment in automated home which are automatic control system using a schedule, manual button click on its web interface and, voice commands. To illustrate the workflow and relationships between each components in this system. (See Fig. 4).

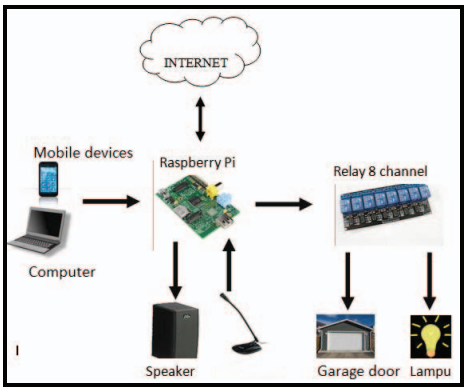

Fig. 4. Overall System Design

B. *Software Design*

There are several processes that have separate flowchart in Fig. 5 which are scheduler, manual switch button and a voice command. All the needs of the function will be summarized into a complete program that can be used on this system. (See Fig. 5)

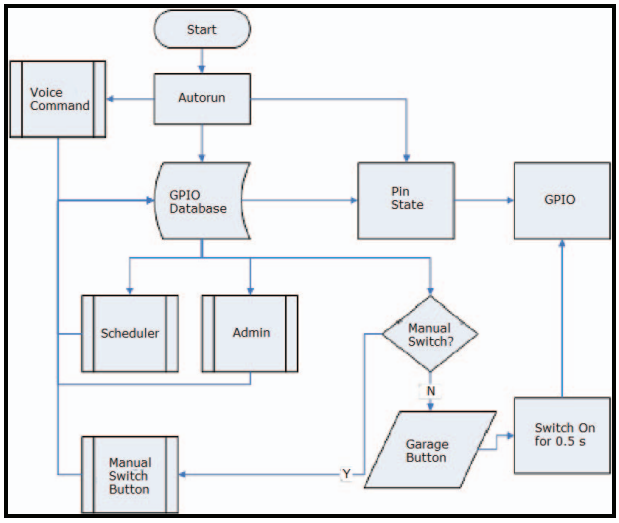

Fig. 5. Software Design

IV. Hardware Implementation

Raspberry Pi comes with GPIO pin that serves as connector to other electronic devices such as Arduino microcontroller, sensor and actuator. It act as central processing unit for the whole system. Raspberry Pi is not equipped with audio input. However, for the system to have voice command function, Raspberry Pi need to be equipped with external sound card on with USB connector (There are two available USB slot in Raspberry Pi). Thereafter, microphone could be used for audio input. Last but not least, to get confirmation from audio input, speaker is needed.

Hardware assembly consist of four main phases which are:

1. Interconnection between Raspberry Pi and Relay
   In this phase, Raspberry is connected through relay (See Fig. 6)

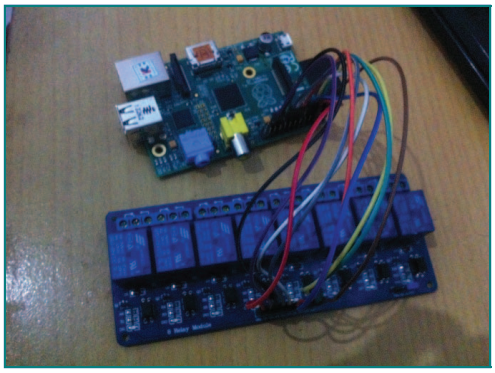

Fig. 6. Raspberry and Relay Interconnection

Table 1 shows schematic installation of Raspberry Pi pin and relay pin.

TABLE I. Raspberry Pi Schematic Pin Installation

***Raspberry Pi* Pin**	**Relay Pin**
5v	VCC
GND	GND
GPIO2	IN1
GPIO3	IN2
GPIO4	IN3
GPIO17	IN4
GPIO27	IN5
GPIO22	IN6
GPIO10	IN7
GPIO9	IN8

2. USB Soundcard installation
   In this phase, USB soundcard was installed in raspberry pi. This phase is necessary as Raspberry to enable Raspberry with audio input from microphone that will be installed on the next phase. (see Fig. 7)

Fig. 7. USB Soundcard installation

3. Microphone installation
Microphone was installed on the sound card already installed previously. This microphone would later captured the voice commands. (See Fig. 8)

Fig. 8. Microphone Installation

4. Speaker installation
Speakers was installed to give respond to voice commands. Speaker was installed on the sound card already installed previously. (See Fig. 9)

Fig. 9. Speaker installation

V. System Implementation

Upon completing System Design and Hardware Implementation, system was implemented by providing web based user interface and voice command.

The interface of the web controller is user main interface. I will be concise providing simplicity on it use. It contains information about the state of the electrical equipment on 7 rooms. Those information was in the form of button that could easily understand the meaning and operate. At the bottom, there is an image of garage door that simply means button to open and shut garage door. There were also a timer that will lead to scheduler menu. (See Fig. 10)

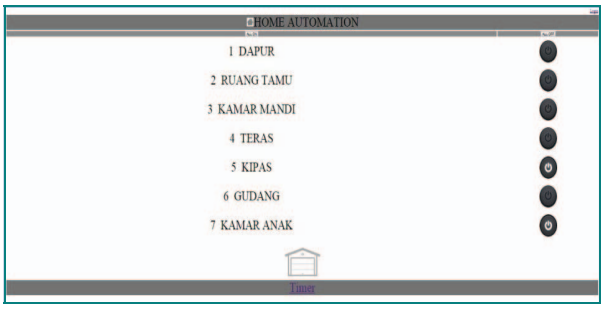

Fig. 10. User Main Interface

The next interface would be admin main menu. It has menu such as changing the room name, relay switch port number, Raspberry Pi GPIO pin number, switch state information, change password and logout. (See Fig. 11)

Fig. 11. Admin Main Menu

Last interface would be scheduler interface that was created to create, view, modify, and delete schedule of electrical device operation time. (See Fig. 12)

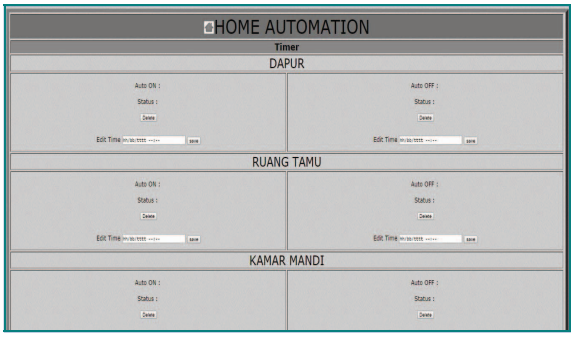

Fig. 12. Scheduler Menu

VI. Performance Test

Once the system implemented, it was tested to measure the system performance based on predefined functional which are:

1. Web-based electrical equipment state monitoring
1. Switch scheduler
2. Ability to switch electrical equipment on/off
3. Voice command to control electrical equipment state

Due to lack of equipment, garage door functionality will only tested by led simulation.

Based on predefined testing scenario on proposed method section, analysis on system has been conducted to identify system pros and con. Result of those analyses on this system of home automation were:

1. Pros
   a) The state of the switch directly attached to relay could be monitored.
   b) Scheduling function to turn on and turn off electrical device worked as planned.
   c) Database used on Raspberry Pi could maintain the last state of the switch. Thus, in a case of system failure, whole system will be restored to prior condition before the failure occurred.
   d) Web based interface could be deployed to control electrical device remotely. Those would work on any platform that support web browser.
   e) Voice command could be used to manage the state of electrical device.
2. Cons
   a) The system could only monitor digital state of the switch. Thus, this system could not manage ambient device.
   b) Voice command controller performance is relied on internet connection therefore it is expected to have a noticeably delay on poor internet connection area. Obviously could not be used without internet connection.
   c) Scheduling system activated approximately 1 minute after raspberry activated.

VII. Conclusion

This paper shows that the automated home could be build using relatively cheap and widely available SBC like Raspberry Pi. This main contribution of this research is providing automated home or smart home with seamless operation of the system by the means of voice command, offering new experience in their home. However, detailed configurations of the system could be performed remotely via web. User could use computer, laptop, table or even smartphone as long as it has web browser.

There are limitless application could be build based on SBC like Raspberry Pi. Current rapid development on microcontroller, SBC, sensor and actuator will surely reduce the cost of smart home deployment while providing seamless operation of the whole system.

VIII. Further works

Regardless of achievement on this development, there still many things to improve this system. One of which will be controlling ambient device with analog input such as HVAC temperature control [25][26][27] and ambient light [28][29]. Another useful improvement would be voice recognition module on Raspberry Pi instead of cloud based voice recognition. This will provide home resident it's functionality in the case of internet connection loss, making the system more reliable than before.

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