The development of IoT Smart House Automation System controlled wirelessly via OpenHab central server

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Abstract. Smart home technology, also often referred to as home automation, provides homeowners security, comfort, convenience, and energy efficiency by allowing them to control smart devices, often by a smart home app on their smartphone or another networked device. A part of the internet of things (IoT), smart home systems and devices often operate together, sharing consumer usage data among themselves and automating actions based on the homeowners' preferences. This smart home automation system will be a server-based system using the OpenHab central server that can connect and control the house appliances by using an application that can be installed on the smartphone. By using this smart house system, the user can control their home appliances from distance. It can reduce the cost and provide better time management of the household.

1. Introduction

Nowadays, technology becomes a vital part of our daily life. It is included in most life aspects. One of the emerging technologies is smart home technology. This technology will influence the structure of the houses in the coming ten years. Smart homes promote comfort, luxury, entertainment, security, and world peace. Altering an existing home to accommodate changing needs can cost up to three times more than including the same features in the initial design. Current existing smart homes need special kinds of appliances to deal with. These appliances should be equipped with a network adapter since they should connect to a wired network. Smart homes also should contain a pre-installed wired infrastructure to provide a means of communication between the appliances. Smart home technology originally depends on the wired network infrastructure but after the huge improvements in that technology, it also supports wireless communication over multiple frequencies to control the system [1-3].

Several researchers studied and developed the home automation system using any technologies. The researchers in [4] reported that the home automation system that has been built by them is controlled via based on the Android app communicating with the micro-web server providing more than the switching functionalities. The Arduino Ethernet is used to eliminate the use of a personal computer (PC) keeping the cost of the overall system to a minimum while voice activation is incorporated for switching functionalities.

The Arduino Ethernet is used to eliminate the use of a personal computer (PC) keeping the cost of the overall system to a minimum while voice activation is incorporated for switching functionalities [5]. The studies in [6-8] have presented Bluetooth based home automation systems using Android Smartphones without Internet controllability. The devices are physically connected to a Bluetooth sub-
controller which is then accessed and controlled by the Smartphone using built-in Bluetooth connectivity. However, due to the limited range of operation (maximum up to 100 m), the system is unable to cope with mobility and can only be controlled within the vicinity. The paper in [9] mentioned that the smart home automation system can also be controlled using Android Application on the smartphone via Wi-Fi connectivity.

This project proposed a smart home automation system that can control household devices wirelessly through the smartphone via the OpenHab server. This Openhab server helps to give the command wirelessly to the home appliances. This smart home system is user friendly to people even the kids starting at the age of six years and above can also know how to use it correctly.

The smart home automation system is mainly focused on maintaining the security of the house when the household is away from home, for example going for a long holiday or go back to hometown for a long term. This system will keep the security of the house from thieves and the users can monitor their home security by observing it through their smartphone.

Other than that, this system also can help to control the home appliance whether to turning it off condition or it on condition. This can be controlled also by using a smartphone via IoT technology compared to the conventional way where the users need to press the switch button.

2. The methodology of IoT Smart Home Automation System

2.1. Overall System Flow Chart

Figure 1 shows the overall flowchart of the smart home automation and security system controlled via OpenHab server directly to the user’s smartphone and any communication devices. According to this flowchart, the main microcontroller of the system is Raspberry Pi and connected to the Node MCU as the second main component. The function of Node MCU is to act as the open-source firmware and development kit that helps to develop the IoT product. It includes firmware that runs on the ESP8266 Wi-Fi and to the OpenHab server. The command from the users will goes to the server and receiving at the Node MCU and then, it is will wirelessly control the home appliance such as fan, lamp, and other home appliances.
Figure 1. Flow chart of the overall process of the smart home automation system
From the system architecture shown in figure 2, the system consists of two main parts: the wireless control system and the home automation network system. The smartphone and laptop or computer act as the wireless controllers, and it is connected wirelessly to the network directly or via the Internet enabling the remote control of home appliances. The Raspberry Pi used in this project and act as the microcontroller and connect to the OpenHab server. This OpenHab acts as the central server for the system. The function of the modem router can log the IP address of the different devices connected to it and besides, it can be operated as the central connection point for all the devices and appliances in the house. The NodeMCU wifi module is used to communicate the signal wirelessly from the router to the OpenHab central server.

The user can access this central server with an email address and a password registered to it. The connection can be made via two methods either from the web interface or any smartphone applications such as Android or IoS. The users can make the command to the server after gaining access. The receptiveness of the designed architecture was necessary because, in smart homes, appliances must respond to either switching commands or voice commands.

2.2. Block Diagram of the IoT Home System

Figure 3 below represents the block diagram of this IoT home system. Based on the figure, there are three main parts in this block diagram where the left-hand side is the input process, the center part is the main microcontroller (Raspberry Pi) that act as the brain of the system and give the command to the devices. And the right-hand side is the outputs obtained in this system to control the home appliances for security and electrical energy reduction purposes.
2.3. Schematic Diagram

![Figure 4. The schematic diagram simulated on fritzing circuit simulation software](image)

Figure 4 represents the sample of the schematic diagram and one of the outputs that can be controlled wirelessly using this smart home system. In this schematic diagram, the main “brain” of the component is the Raspberry Pi and connected to the NodeMCU. As cannot be seen in this figure is the server that connects the signal wirelessly and is called as OpenHabian or OpenHab.

2.4. User Interface of the System

The user interface of the home automation system developed using the OpenHab server is presented in figure 5. The OpenHab is chosen compared to others server like SmartThings, Blynks Application and ThingsSpeak are due to the user-friendliness of its interface; it offers the user the capability to modify the interface based on their preference [10], low-security issues, more compatible with any devices; it is open-source and can be integrated with smart devices and NodeMCU based sensors, and reasonable cost.

![Figure 5. The user interface of the OpenHab server.](image)
2.5. Circuit Testing and Troubleshooting
This kind of project will reduce the cost of the household due to that they can monitor their home appliances away from their home. It also can help the household to decrease their electric bill accordingly because they can switch off their fan and lamp wirelessly through the mobile devices. Figure 6 shows the schematic diagram of the IoT Smart Home System. This circuit has been designed using the Proteus simulation software tools. Then, this schematic diagram has been converted to a Printed Circuit Board (PCB) layout to proceed with the fabrication process as shown in figure 7.

![Figure 6. Schematic diagram of IoT Smart Home System designed with Proteus simulation software.](image)

![Figure 7. Printed Circuit Board Layout on Proteus ARES](image)

![Figure 8. The circuit was fabricated on the Printed Circuit Board (PCB) through the etching process.](image)

Figure 8 shows the final fabricated circuit printed on the PCB board through the etching process. As can be seen, all the components have been arranged according to the PCB layout. The middle component is NodeMCU that will connect the signal from Raspberry Pi to the OpenHab server wirelessly through the same internet connection.
The Raspberry Pi is used in this project to host a lightweight distribution with OpenHab. It is installed with the Mosquitto MQTT broker and it can be communicated with the network by connecting either via Ethernet cable or wirelessly connected to the router.

3. Results and Discussion

3.1. Software Simulation Test
The simulation for this system is constructed and simulated using Proteus Professional 8 software. To simulate the circuit, first, the library of the software must be added with the Arduino Library. After that, the simulation can be done by picking all the components and the script for the circuit was loaded to the Arduino board in the Proteus.

3.2. Hardware Implementation Test
In this project, the real standard hardware of the AC fluorescent lamp (220 V to 240 V) is used to verify the results. The condition of this lamp can be controlled wirelessly through the OpenHab server either in the ON state or OFF state. The OpenHab server has been installed on the laptop and also the smartphone. The list of outputs obtained according to the OpenHab server is demonstrated in figure 9 to 12. As can be seen in figure 9, the command on the OpenHab server is set to OFF conditions in controlling the switching of the AC fluorescent lamp and the value of MQTT is set to ‘1’. Then, the result of the lamp is shown in figure 10, where the lamp is turned OFF following the command encoded from the OpenHab server.

Figure 9. The command on the OpenHab server in controlling the switching of the home appliances (OFF conditions).
Figure 10. The AC fluorescent lamp is turn OFF according to the command set in the OpenHab.

Figure 11 shows the command on the OpenHab server in controlling the AC fluorescent lamp is in ON conditions and figure 12 shows the lamp is turned ON according to the command set in the OpebHab server that has been connected wirelessly through the same network via NodeMCU. It can be seen that, the value of MQTT is set to ‘0’ value to indicate the ON state condition for the command in the OpenHab central server.

Figure 11. The command on the OpenHab server in controlling the switching of the home appliances (ON conditions)
Figure 12. The AC fluorescent lamp is turned ON according to the command set in the OpenHab.

3.3. Notification results on the smartphone

Figure 13. Alert notifications are received on the smartphone via the OpenHab Apps.

Figure 13 shows the alert notification received on the user smartphone via the OpenHab application that have been installed in the Android Operating System smartphone. The message and command from the OpenHab central server will be sent directly and wirelessly using the OpenHab application. The message then will be appeared on the user's smartphone and stated the condition of the lamp either in ON state or OFF state.
4. Conclusion
In conclusion, this project will make some changes to the daily life and perspective to the people how important the maintain the security and controlling the condition of the home appliances. This system could provide homeowners security, comfort, convenience, and energy efficiency. These home appliances can be controlled control via the smart devices such as using smart home applications on their smartphone or other networked devices. Besides, this smart house will be a server-based system that connects and control the house appliances by using OpenHab application that can be installed in the user’s smartphone. In the nutshell, this project can help users to control their home appliances far from distance and thus reduce the electricity and the electrical energy consumptions.

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