

SIMPLE WEB CONTROLLED HOME AUTOMATION SYSTEM WITH FAULT DETECTION

*M. N. Ismanto, E. Abbas

Department of Electrical Engineering,
Nilai University, Malaysia

*Corresponding author's email: mamad_mni@yahoo.co.id

Submission date: 15 July 2017 Accepted date: 30 Sept 2017 Published date: 30 Nov 2017

Abstract

This paper reports an ongoing project related to the development of Web Controlled Home Automation System. The system contains three (3) main functional blocks which are (i) webpage to provide Graphical User Interface (GUI), (ii) Controller Bridge consists of Arduino UNO and Arduino Ethernet Shield, and (iii) switching unit as a task executor. The project focuses on creating a simple and easy system to control home appliances using user-friendly GUI which is a website page. There is also a built-in fault detection module. This project has two (2) main tasks. There are (i) building simple system for web controlled home automation system with a system fault feedback reporting, and (ii) developing the system programming and creating user-friendly website page with interesting GUI. The system is connected to the Internet through the Arduino Ethernet Shield using RJ45 cable.

1.0 INTRODUCTION

Home automation system is also called as a smart home. Home automation system may contain centralized control of lighting, electronics devices, electrical switch, appliances, and security system to provide better accessibility, comfort, energy saving, and security. Home automation system is suitable for the elderly and disabled, as it can provide a better quality of life.

The popularity of home automation system has grown significantly in recent years due to the increase in the number of Internet users and the ease of Internet surfing through smartphones and tablets. The advancement of Internet of Things (IOT) recently, is also one of the major reasons on the increment popularities of home automation system (Alaa et al., 2017).

Currently, there are varieties of home automation system available and are applied around the world (Jacobsson, 2016). The range is from low cost up to the very expensive system with different features and functions. Some of the home automation system companies are competing among each other in providing features that are useful, practical, and could give maximum impact to the society (Hui, 2017).

The conflict is most of the available home automation systems that contain a lot of features are usually expensive and beyond the means of general users. However, if the home automation system only consists of basic features, then the usefulness of the system will diminish and be less attractive to the users. More importantly, as innovation should be based on ethics, the system should not present a negative impact to the society and environment. Also, the use of recycle components should be avoided or limited.

Previous study on home automation system was carried out by (Mahesh, 2016) applied Global System Messaging (GSM) which able to be controlled through android application. This android application can simplify the programming of the user interface (Mahesh, 2016). Meanwhile, a study conducted by (Naresh et al., 2013) come out with a bluetooth-based home automation system using ARM9 board which utilized ARM7 LPC2148 and ARM 9 S3C2440A boards as the main device. The main aim is to produce less modification of core components at low cost.

Besides, there are also designs and implementation of a Wifi based home automation system (Ahmed & Karim, 2012). The system consists of two main components. There are (i) web server which manages, controls, and monitors user's home and (ii) hardware interface module, which provides appropriate interface to sensors and actuator of home automation system. This system is scalable and flexible because one server able to manage many hardware as long as the Wifi network coverage exists. Each of the previous project, creates their own connection with unique specifications and applications.

There are also a lot of projects related to the development of home automation system that utilizes Arduino and Ethernet shield boards as the basis (Prima, 2017). However, most of them do not employ fault detection. Also, most of the interfaces are less user-friendly. This study overcomes the problems by proposing a Web Controlled Home Automation System with Fault Detection. The system consists of three main modules which are (i) user interface controller which is a website, (ii) the main controller which acts as a bridging device between the first and third modules, and (iii) executing device which acts as a switching unit to control the lights, fan, and other home appliances. The bridging device consists of Arduino Uno, Arduino Ethernet Shield and ACS712 current detector. There are reasonably priced and easily available. The next section discusses in detail each of the components in the proposed system.

2.0 MODULES OF WEB CONTROLLED HOME AUTOMATION SYSTEM

The proposed Web Controlled Home Automation System consists of three main modules which are (i) website controller (user interface), (ii) hardware controller system (main controller), and (iii) fault detection system.

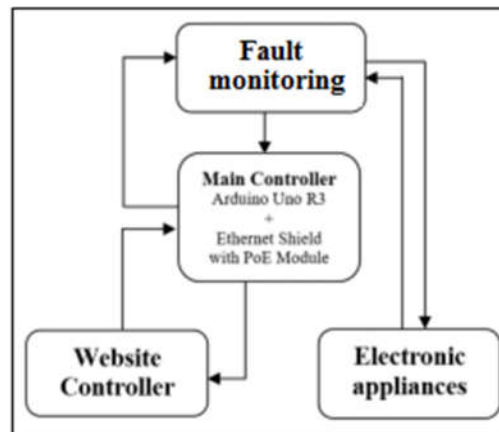


Figure 1 System block diagram

The hardware controller system involves the configuration of the main controller, Arduino Uno R3 interfacing with the Arduino Ethernet Shield with PoE module to connect to the main controller to the Internet. The programming of the interface devices could be performed by utilizing the Arduino IDE

software. The fault detection system or fault monitoring module, ACS712 works by detecting the feedback current from the home appliances and provides the data measurement to the main controller to be displayed on the website page. Website controller system starts by setting off the IP address by uploading programming codes to the Ethernet shield using the Arduino IDE software. Figure 1 shows the block diagram of the system.

The Web Controlled Home Automation System involves the primary and secondary controllers. The primary controller is the main controller unit, and the secondary controller is the website controller. The fault monitoring or fault detection is monitored by the ACS712. It receives feedback current from the home appliances and forwards it to the main controller as an input signal. Status of the appliances will be notified to the users through the website page. Figure 2 exhibits the details of working flow on controlling and monitoring processes of Web Controlled Home Automation System.

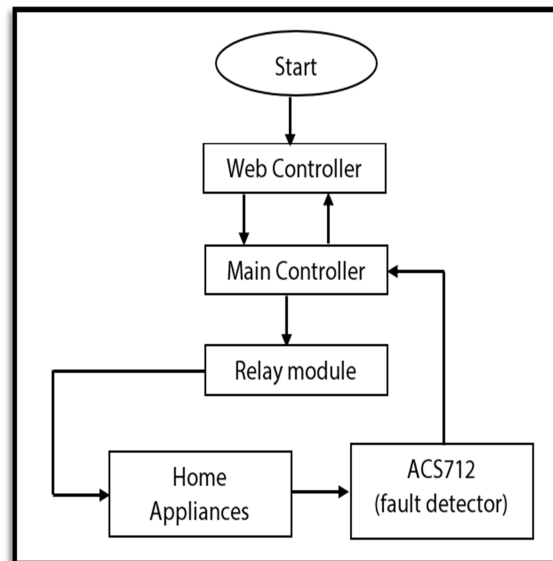


Figure 2 Working flow

Feedback current from home appliances is analysed by ACS712 for any faults. If there is no current, it means that there is a fault from the home appliances. However, if there is a feedback current from the home appliances, it means that there is no fault, and the relevant information on the status of the appliances will be displayed on the website controller page.

3.0 SYSTEM DESCRIPTION AND CONFIGURATION

Web Controlled Home Automation System is a system which able to control home appliances and monitor for faults in the system simultaneously. The monitoring of fault uses ACS712 through the current detection technique. ACS712 is an AC or DC current sensor that allows easy implementation. The data measured by ACS712 is forwarded to Arduino Uno R3 as the main controller unit and a feedback report will be displayed on the controller website page.

With the ability of fault monitoring and ease of controlling through the website, this system could help the user to control and monitor their house via any devices which are connected to the Internet such as smartphone, computer, and tablet. Figure 3 demonstrates the block diagram of the system flow.

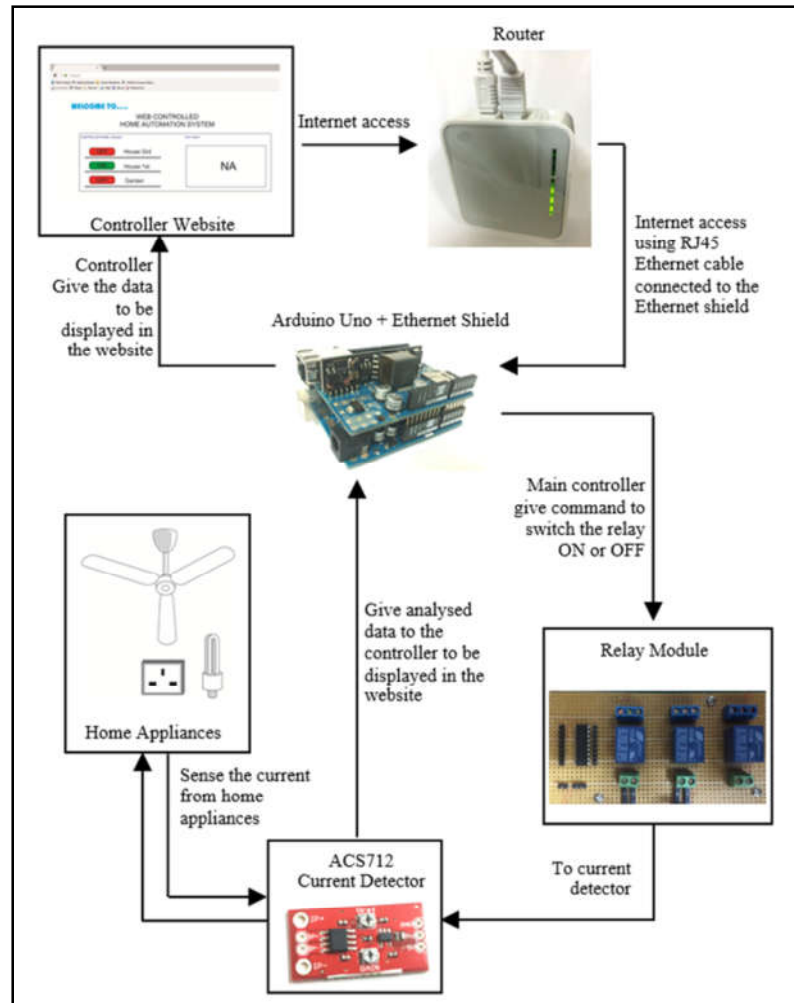


Figure 3 System flow

The command starts from the website controller page which is a user-friendly interface. The command is received by the main controller through the Internet connection using router. The main controller gives command to the relay that acts as a switching unit to the home appliances through the ACS712 current sensor. The ACS712 detects any current feedback from the home appliances. The current sensor collects the data by analysing feedback current and provides the current feedback information to the main controller as an input data. The data from ACS712 is displayed on the website by the main controller.

Web Controlled Home Automation System contains four major components which are (i) main controller board, (ii) Ethernet Shield board, (iii) current sensor, and (iv) switching module.

The configuration of the system consists of the hardware configuration of the controller, software configuration of the programming, and the user interface design. The first configuration is hardware controller, which is to test the connection from the router to the Arduino Uno R3 through the Ethernet Shield. If the connections are correct, the indicator on the Arduino Uno board and the Arduino Ethernet Shield will turn on. Figure 4 demonstrates the connection testing on the controller board.



Figure 4 Controller connection test

The next configuration is webserver for the controller. Configuring webserver for the main controller is performed through Arduino IDE software. To create a web controller page, the main controller hardware must be connected to the webserver.

The first step of configuring the webserver is determining the IP address of the Ethernet Shield. Setting the IP address requires (i) Arduino webserver programming code, (ii) IP address from the router, and (iii) MAC address from the Ethernet Shield. The IP address must be configured based on the IPv4 address from the local network connection details as demonstrated in Figure 5.

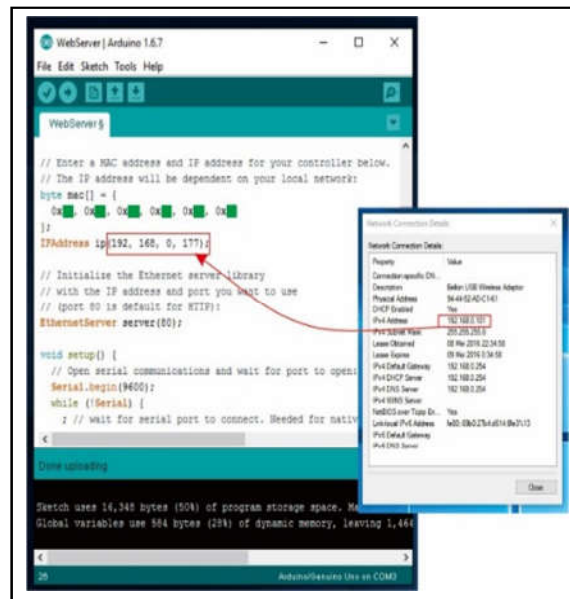


Figure 5 Configuring the IP address

For the system IP address changes the last digits of the local IP address that is unused by other devices. As example the local IP address is 192.168.0.101 and the last two digits change becomes 192.168.0.177 because the address is unused by other devices in the local network.

MAC address is the address for the Ethernet Shield to be known by the Arduino Uno. The MAC address for the webserver programming code can be found at the back of the Ethernet Shield board as demonstrated in Figure 6.

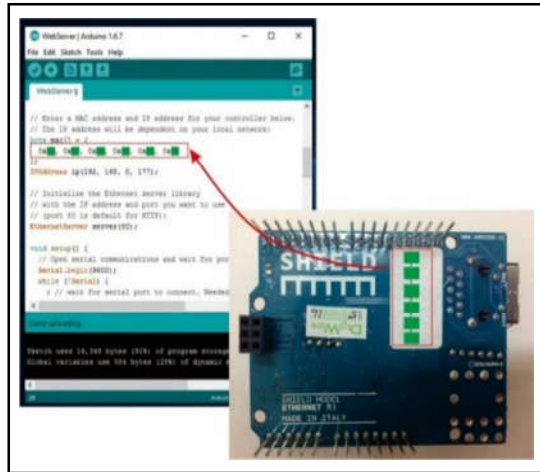


Figure 6 Configuring the MAC address

After completing initialization and testing of the relay ports, the next step is to verify and upload the code to the Arduino Uno R3 using the Arduino IDE software, followed by testing the IP address for the webserver online in the browser. The webserver testing code shows the input details of the online main controller and keeps refreshing the page every second to monitor the input. Figure 7 demonstrate the webserver page testing.

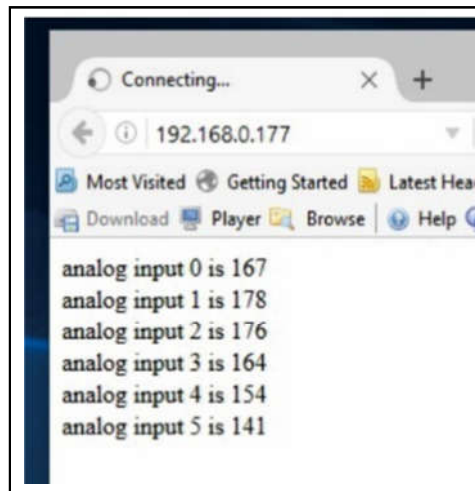


Figure 7 Webserver testing

4.0 SYSTEM TESTING RESULT

The full system will be tested after the hardware configuration is complete. The full system testing consists of:

- i) Testing the switching unit connection to avoid the short circuit when controlling the AC current on the relay ports as demonstrated in Figure 8.

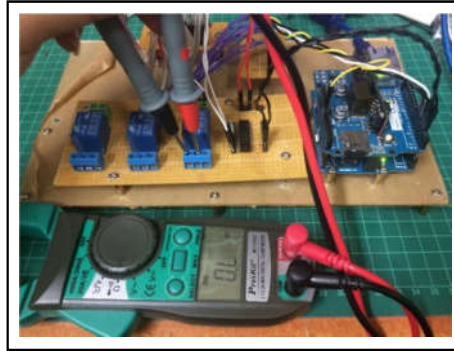


Figure 8 Testing the relay ports

- ii) Testing the current sensor unit, to read the feedback current from home appliances and to check for faults (Figure 9).

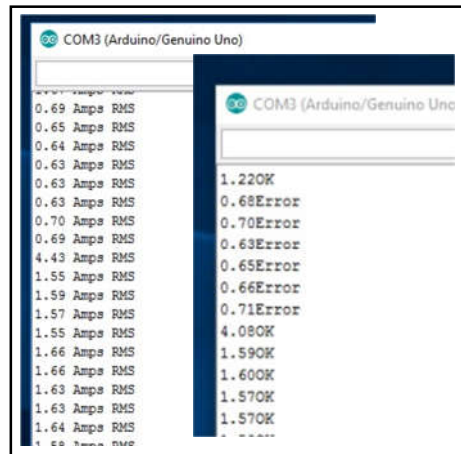


Figure 9 Testing the current sensor unit

5.0 WEBSITE CONTROLLER PAGE DESIGN

The previous webserver page only shows the input details. To customize the webserver page as to be able to control the system and showing the input information, the coding of HTML pages inside the webserver programming code must be modified. To modify the HTML code, Macromedia Dreamweaver software can be used to create a new design user-friendly website page to replace the original HTML code. Below is the original HTML code of the webserver page (Figure 10).

The modified controller website page consists of controller panel and reporting area. The website should display controlling indicator which is either ON or OFF, and display the fault report as detected by the sensor. To design the website background, text, and button, CorelDraw X7 is used. The reason of customizing the website page is to provide a user-friendly interface to control the home appliances. The modified website page is as displayed in Figure 11.

```

client.println("HTTP/1.1 200 OK");
client.println("Content-Type: text/html");
client.println("Connection: close"); // the connection will be closed
client.println("Refresh: 5"); // refresh the page automatically every 5 seconds
client.println();
client.println("<!DOCTYPE HTML>");
client.println("<html>");
// output the value of each analog input pin
for (int analogChannel = 0; analogChannel < 6; analogChannel++) {
  int sensorReading = analogRead(analogChannel);
  client.print("analog input: ");
  client.print(analogChannel);
  client.print(" is ");
  client.print(sensorReading);
  client.println("<br />");
}
client.println("</html>");
break;

```

Figure 10 Original webserver HTML

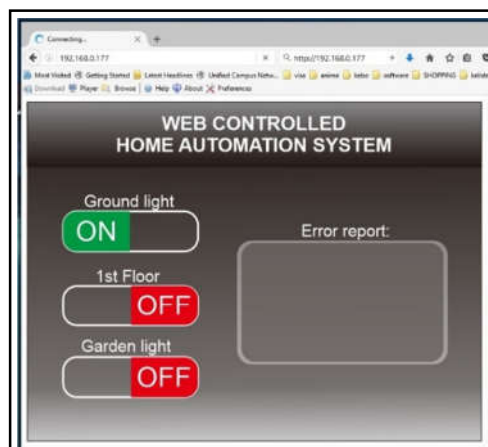


Figure 11 Friendly website user interface

6.0 CONCLUSION

This paper presents the design, configuration, fault detection, and the website customization of the Web Controlled Home Automation System in order to achieve a new and easy way to implement a web controlled smart home system using inexpensive and easily available components that are easy to install for better performances and features.

This system could detect faulty appliances through the current detection technique using the ACS712 current sensor and displays it on the website page to inform the user of the fault. It is envisaged that a control panel for the website page that allows the user to customize the website page on their own could be developed in the near future.

References

Ahmed, E. & Karim, A.H. (2012) Design and implementation of a WiFi based home automation system. *International Journal of Computer, Electrical, Automation, Control and Information Engineering*, 6(8), pp. 1074-1080.

- Alaa, M., Zaidan, A.A., Zaidan, B.B., Talal, M., & Kiah, M.L.M (2017). A Review of Smart Home Applications Based on Internet of Things. *Journal of Network and Computer Applications*, 97, pp. 48-65.
- Hui, T.K.L., Sherratt, R.S., & Sanchez, D.D. (2017) Major Requirements for Building Smart Homes in Smart Cities Based on Internet of Things Technologies. *Future Generation Computer Systems*, 76, pp. 358-369.
- Jacobsson, A., Boldt, M., & Carlsson, B. (2016). A Risk Analysis of a Smart Home Automation System. *Future Generation Computer Systems*, 56, pp. 719-733.
- Mahesh, N. J. (2016). GSM based home automation system using app-inventor for android mobile phone. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 3(9), pp. 12121-12128.
- Naresh, D., Chakradhar, B., & Krishnaveni, S. (2013). Bluetooth based home automation and security system using ARM9. *International Journal of Engineering Trends and Technology*, 4(9), pp 4052-4058.
- Prima, E.C., Munifaha, S.S., Salam, R., Aziz, M.H., & Suryani, A.T. (2017). Automatic water tank filling system controlled using Arduino based sensor for home application. *Procedia Engineering*, 170, pp. 373-377.