Password Protected ESP32 Web Server Based Electrical Appliances Controlling System

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Abstract

The home automation system is mostly designed by using Bluetooth with the aid of MIT inventor app or Blynk app. In this research, a server is utilized instead of Bluetooth. The webserver home page is completed with HTML and CSS. The security of web server based home automation system is solved by using the password. ESP32 is feature-rich the system on the chip (SOC) with integrated Wi Fi and dual Bluetooth mode. It can be connected to the local Wi Fi. It can receive HTTP request from client and HTTP response to client. ESP32 is functioned as the web server. The user name and password is encoded by using Base64encoder.org. The password functionality can be added to any webserver of which wanted to be protected. 8-channel relay is used to control the home appliances via web server.

1. Introduction

Some home automation system is designed by using wireless system such as Wi Fi, Bluetooth,BLE (Bluetooth low energy). The microcontrollers which are attached to Bluetooth communicates the Android phone. Phone home pages are created by MIT inventor 2 app or Blynk app. In this research, ESP32 is chosen because ESP32 is a feature-rich microcontroller attached with Wi Fi and Bluetooth and it is compatible with Arduino IDE. So that, ESP32 is utilized in this research as both functions of microcontroller and Wi Fi. Webserver home page is developed by Arduino IDE with the help of HTML and CSS. HTTP messages are how data is exchanged between a server and a client. There are two types of messages: requests sent by the client to trigger an action on the server, and responses the server answers from the server. The client sends the hypertext transfer protocol (HTTP) request to a server and then, server responses to HTTP client. ESP32 is communicated to local router via Wi Fi while phone, PC, or tablets are connected to same router with Wi Fi or Ethernet cable. Client and server are on the same local area network. Base64 is a group of binary-to-text encoding schemes that represent binary data in an ASCII string format by translating it into a radix-64 representation. The term Base64 originates from a specific MIME content transfer encoding. Each Base64 digit represents exactly 6 bits of data. Three 8-bit bytes (i.e., a total of 24 bits) can therefore be represented by four 6-bit Base64 digits. Base64 encoder.org is commonly used password encoding. When there is a need to encode binary information that requirements be logged and transferred over media that are intended to manage textual data. This is to guarantee that the data stays flawless without alteration during transport. A number of applications including email, and storing complex data in Extensible Markup Language (XML) or JavaScript Object Notation (JSON) used Base64encoder.org commonly.[1]

2. Materials and Methods

Password protected home automation system is built up by using ESP32, 8-channel relay as hardware and base64encoder online tool, HTML, CSS as software. Eight GPIO pins of ESP32 are connected to inputs pins of relay to control the eight electrical appliances. Web server home page is used as the control console.

2.1. ESP32

(ESP32 is the product of Espressif systems. It is a cost effective system on a chip (SOC) series with Wi-Fi & dual-mode Bluetooth capabilities with low energy consumption. The features of ESP32 are as follows; Main Processors is Tensilica Xtena 32-bit dual core microprocessor. Clock speed can run up to 240 MHz and the performance is up to 600 DMIPS. In memory section, there are ROM 448KB, SRAM 510KB, RTC fast 8KB and RTC slow 8KB each. ESP32 possesses many peripheral connection:

1) Capacitance touch
2) ADC (analog-to-digital converter)
3) DAC (Digital-to-analog converter)
4) I2C (inter-integrated circuit)
5) UART (universal asynchronous receiver/transmitter)
6) CAN2.0 (controller area network)
7) SPI (controller asynchronous interface)
8) I2S (inter-integrated sound)
9) RMII (reduced media-independent interface)
10) PWM (pulse width modulation)

There are two built-in sensor; Hall effect sensor and temperature sensor. The pin assignments and their functions are illustrated in Figure 1. The blockdiagram of ESP32 is shown in Figure 2.[2]
2.2. 8-channel Relay

8-channel relay can be used with low voltage level so that it can be applied to Arduino and Raspberry Pi which works well with both 3.3V and 5V logic (Raspberry Pi, Arduino, ESP8266, ESP32……), requiring little current drive. Noise elimination diode and opto-coupler are attached to each relay. This 8-channel 5V relay has both optical and magnetic isolation, providing a lot of protection to the inputs from electrical faults on the outputs.

3. Operation

Two main preparations are required to implement the password protected web server electrical appliances controlling system; hardware preparation and software preparation.

3.1. Hardware Preparation

GPIO 33, GPIO 32, GPIO 25, GPIO 26, GPIO 27, GPIO 14, GPIO12 and GPIO13 of ESP32 are connected to the input pins of IN1, IN2, ……IN8 of 8-channel relay. The outputs of 8-channel relay are connected to the electric circuit of water pump, electric stove, air-conditioner, toilet/bath room, TV, bed room lighting, porch lighting and parlor lighting. The block circuit diagram of the working principle of the whole system is illustrated in Figure 4.

3.2. Software Preparation

Base64decode.org is use to protect the web server home page. It is free on-line tool. Base64 is originated from a multipurpose internet mail extensions (MIME) content encoding. Each Base64 digit represents exactly 6 bits (2^6=64) of data. Base64 encoder is also attached to system required when there is a need to encode binary data. Base64 is used commonly in a number of applications including email via MIME, and storing complex data in extensible markup language (XML) or json object notation (JSON). Figure 5 shows the window of Base64encode on-line tool.[3] The user name and password are typed in the Base64 window and encoded in the format of user:password. The encoded script “c3VzdTphdW5n” is obtained as shown in Figure 5.

Since ESP32 board is not included in Arduino IDE, ESP32 library and ESP32 board must be installed in Arduino IDE by inserting the link of...
https://dl.espressif.com/dl/package_esp32_index.json into the “Additional Board Manager URLs” Field as shown in the Figure 6. Using the board manager, ESP32 board can be installed as in Figure 7.

4. Results and Discussion

4.1. Results

The program is uploaded to ESP32 with pressing BOOT button. When the uploading sign dots are seen, the button is released. After loading is completed, the IP address is obtained on serial monitor by pressing the RST (reset) button. Figure 8 expresses the IP address on serial monitor. If the IP address 192.168.1.4 is pasted on browser, user/password box is appeared as shown in Figure 9. After the user name and password are logged in and run the system, the server home page is appeared as shown in Figure 10.

To connect local WiFi and get the IP address;
const char* ssid = "xxxxx";
const char* password = "xxxxxxxxx";
WiFiServerserver(80);
Serial.println(WiFi.localIP());

To protect the webserver, this code is inserted in the program as;
if(header.indexOf("c3VzdTphdW5n") >= 0)
{…………
}

To show the current status of switch and control “on” and “off".[4,5]

```
client.println("<p> Aircon-State " + output32State + "</p>");
if(output32State=="off") {
    client.println("<p><a href="/32/on"> <button class="button">ON</button></a></p>");
} else {
    client.println("<p><a href="/32/off"> <button class="button">OFF</button></a></p>");
}
```

All of eight control panels cannot fit in window of web server home page on both PC and phone. But it can visualize by the scrolling the page. The scrolling pages
of web server home page on window of PC and phone are illustrated in Figure 11 and Figure 12, respectively.

(a)

(b)

Figure 11.(a,b) Server home page on PC

(c)

Figure 12. Web server home page on phone

Figure 13.(a,b,c) Controlling the relay

By clicking the buttons on PC or touching the buttons on phone, the electrical appliances are well controlled remotely.

4.2. Discussion

Web server based controlling system is covered in the WiFi hot spot range about 150 ft in indoor and 300ft in outdoor area. The switching response time is reliably fast. The system will not work well in the out of WiFi accessing area. The external DC power supply should be used because the power supply of ESP32 is not enough for 8-channel relay. There is uploading problem- “Failed to connect to ESP32: Timed out Connecting...” is appeared. It needs the uploading mode. To be in uploading mode, “BOOT” button in which is already fit in ESP32 board is pressed. Just when seeing the “Connecting...” message in Arduino IDE, release the “BOOT” button. [8]

5. Conclusion

The differences between Web server appliances controlling system and conventional IR remote are as follows:
(1) IR remote use the infrared radiation and it can propagate the open air area. The solid obstacles can block the IR radiation so that it cannot work well. The web server appliances controlling system operates with electromagnetic radiation. It can used within 300 feet in no obstacles area and within 150 feet in building.
(2) IR remote cannot sense whether the switches are on or off. But the web server controlling system can sense the status of the switches.

(3) Any one can control the appliances using IR remote. The password coded webserver controlling system can be used by knowing the password for security.

The “delay ()” function is not used in the program because this function terminates the other process. As the timing “milli()” function is used in this code, the response time is reduced because the process is continued while the timer is counting. The time duration between the request and the response is 2 seconds. If 6000 mAh power bank is used, the system can control the appliances within a week.

The phone WiFi hotspot or fibre network can be used as internet service provider (ISP). IP address of the website is 192.168.1.4. Since it works under the local network, someone which is another local network cannot control the electrical components from their pc or phone. If it is used in public domain, it can solve that problem. Moreover if it runs with the help of ngrok software, the electrical appliances can be controlled from anywhere with internet access.

Future Enhancements

For future work, gas sensor, flame sensor, temperature sensor are fixed in home. Using the “telegram bot”, the notification message sends to the phone when the sensor reading is at or over the trigger value. The home appliances can be controlled via message of telegram bot from anywhere with internet access.

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References

[1] https://www.base64encode.org/
[3] https://www.base64decode.org/