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Internet of Things Based Smart Home System Using ESP32 Microcontroller

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Abstract: Nowadays, people tend to forget switching OFF their appliances especially heavy load at home causing their electricity bill to raise drastically. Apart from that, there is some people that are unable to walk to switch ON and OFF the appliances due to their health condition forcing them to either let it stay ON or ask others to help them but bear in mind they will not always be by their side. Additionally, in this current era toward the development of technologies, most of people are getting addicted to automatic devices which they believe can transform and ease their life especially in work. Internet of Things (IoT) manage to fulfil these criteria and give people a better quality of life. In this project, Internet of Things Based Smart Home System Using ESP32 Microcontroller is built to ease people especially in helping disable people. It can save their time if they are away from their home to turn on and off the electrical appliances and assist those in need to perform their daily task easily. This smart technique involves operating the switches through online server of a mobile or a computer. The project uses Ubidots STEM MQTT server and ESP32 to control ON and OFF of electrical appliances such as light. Instead, it can be control manually or online according to the user desire and will updates the status of appliances to the Ubidots STEM control panel.

Keywords: Esp32, Ubidots STEM, Smart Home System, Internet of Things

1. Introduction

Toward advance development of technologies in current scenario shows that, most of people in different ages are addicted to automatic devices which are often referred to a smart device. Smart home technology or home automation automation technology assigns security, comfort, convenience and energy efficiency to homeowners by enabling them to control smart home appliances and devices on their smartphone or laptops through smart home application or website control panel. Wi-Fi is often used for remote monitoring and control. Home appliances are considered as an essential component of Internet of Things when remotely monitored and managed over the internet

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Early home automation began with labour-saving machine. With the advent of electricity supply in the 1900s, self-contained electric and gas-powered home appliances became practical and led to the development of washing machine (1904), water heaters (1889), refrigerators, sewing machines, dishwasher and clothing dryers [1].

With the introduction of X10 which is an electronic device interaction protocol in 1975 by Pico Electronics of Glenrothes, Scotland [2]. X10 used signals to send command to desired devices, controlling how and when the operation will start. A home automation transmitter sends a signal along the electrical wiring of the house, informing a device to turn on at a certain time [3].

In 2005, INSTEON was introduced and deployed around the world to counter the X10 problems. The outdated X10 was too restrictive, unreliable and inflexible to be useful today as a home-control network infrastructure. While the company and factory X10 Ltd. are no longer in business, most legacy products are still in use [4].

The objectives and goals of this paper is to develop a safe home monitoring and home control system especially aimed to aid the elders and handicapped. Internet of Things Based Smart Home System Using ESP32 Microcontroller is a device used to control different appliances in the home such as lighting, socket etc over the internet as well as know the status of the appliances in ON or OFF condition that will allow people to know the Real Time Status of Appliances and also control it. Besides that, people also can control it in manual manner and at the same time will show the condition of the appliances.

2. Materials and Methods

This part will explain the concept of using ESP32 and MQTT in home automation controller and it list of materials that were used in completion of this project.

2.1 Properties Materials

a. Universal Switch Socket
   - Use to power up external appliances
   - 250 V
   - 13 A Rated Current

b. Switches
   - To switch ON lighting system
   - 1 Gang 1 Way
   - 1 A 250 V

c. Wire Cables
   - 1.5 mm is for lighting system
   - 2.5 mm is for universal switch socket

d. Relay Module
   - Triggering High Voltage Load
   - 5 VDC Trigger Voltage
   - 10 A Rated Current
   - 250 VAC/30VDC Max. Switching Voltage
   - 10 A Max Switching Current

e. Protection Device (Main Switch, RCCB, MCB)
   - Giving protection to the electrical circuit from any disturbances.
   - 63 A Main Switch
   - 40 A RCCB
   - 16 A & 6 A MCB

f. ESP32
   - Acts as brain of the system to control the behavior of the system

- Operating Voltage 3.3 V
- 30 I/O Pins

g. Rectifier (Hi-Link)

- Convert AC to DC to supply ESP32 and Relay
- 100-240 input voltage
- 5 VDC output voltage

2.2 Graphical Interface and Platform

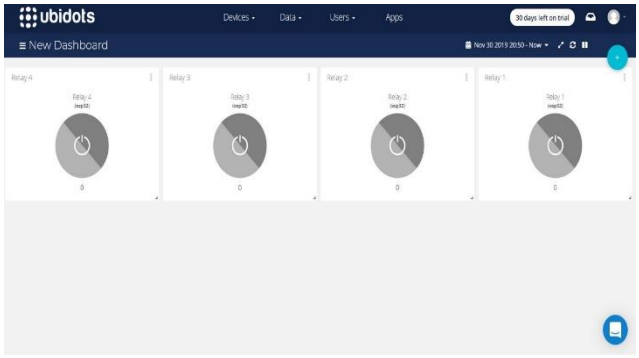

Figure 1: Ubidots Control Panel

Ubidots control panel as shown in Figure 1 is an online control system to control appliances through ubidots server. There are 4 variables was created which represent switches to control 4 loads in this project. Beside switching, the variables will also give feedback when there is a change happened to the appliances.

2.3 Methods

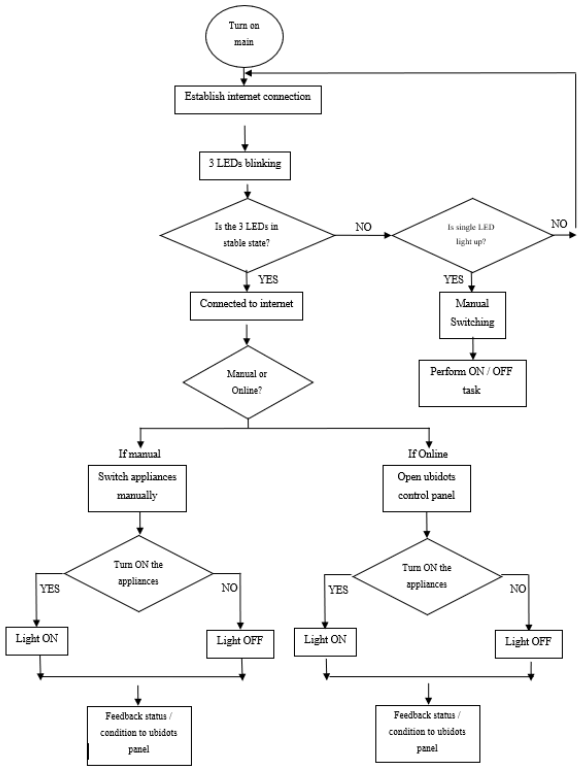

Figure 2: Project's Flowchart

Figure 2 shows project's flowchart as home appliances is the main things to be controlled in this project through online system using MQTT and ESP32. Relays are driven by ESP32 based IOT module to control high voltage devices and appliances. Ubidots MQTT server being used as heart of any publish or subscribe protocol for the system to fully online function. Web-based control panel buttons is created through ubidots so that the user can turn on/off lights or other electrical appliances online instead of manual switching as long as there is internet connectivity. Besides, this project is also managed to check the condition or state of appliances when there is a change happened to the appliances.

An MQTT broker (Ubidots) facilitates communication between the webpage and the ESP32. MQTT broker ease publishing and subscription to topics. The webpage publishes to and subscribes from topics based on user desire. ESP32 receives message published from the webpage and it trigger the relay for the appliances to turn on or off [5]. 3 LEDs attached for detecting the state of ESP32. It will be blinking to show it is trying to connect to the router and as it gets connected to the router and internet, all 3 LEDs will get stable. The user manages to control the appliances via internet or manual switches along with the real time feedback.

Nevertheless, if there is no internet access, it will automatically jump out from the loop and go into the manual automation function which is indicated by the single red light. In this condition, user able to control the appliances as they normally do with the help of manual switches. As soon as it gets internet connection back, it will automatically jump into ESP function which is again represented by these 3 LEDs light and the process goes on and on.

3. Results and Discussion

3.1 Manual Automation (Manual Mode)

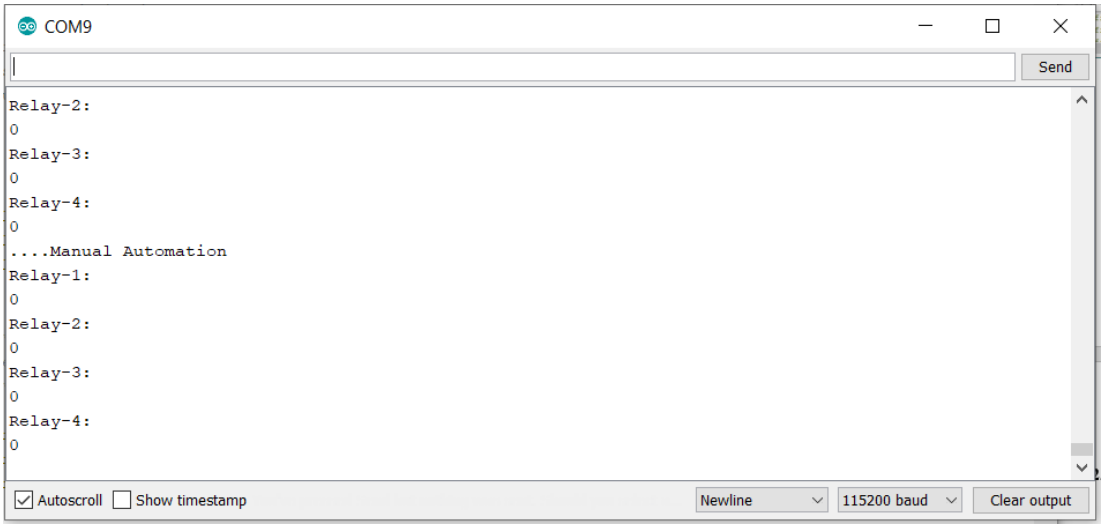

Figure 3: Manual Mode Serial Monitor

In this state, there will be no internet connectivity to be used. Serial monitor as shown in Figure 3 is used to indicate the behaviour of switching in controlling the load. In the terminal, it shows 4 relays that are used to controlled the load. Relay 1 and Relay 2 are used to control the socket outlets while Relay 3 and Relay 4 are used to control the lighting system which consist of downlight and fluorescent lamp. HIGH (1) and LOW (0) value represent ON and OFF condition of the load. As can be seen below, all 4 relays show 0, this mean the load is all in OFF condition

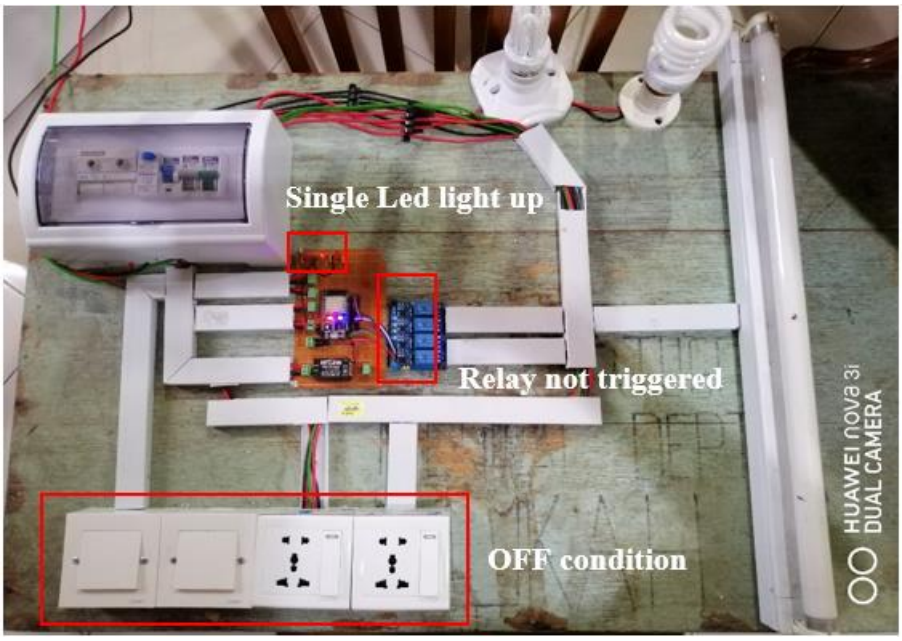

Figure 4: Manual Mode Overview

Single Led as shown in Figure 4 is light up to indicate it is in manual mode. Switches and sockets are proportional to the relay, as shown above, the switch and socket are switched OFF and these result in the relays did not triggered and its indicator did not light up as well which make the load did not take any action.

3.2 Online Mode

```
Wait for WiFi...
WiFi connected
IP address:
192.168.43.81
Relay1- ON
publishing to topic:
/v1.6/devices/esp32
Payload published:
{"r1":1}
Relay2 ON
publishing to topic:
/v1.6/devices/esp32
Payload published:
{"r2":1}
Relay3 ON
publishing to topic:
/v1.6/devices/esp32
Payload published:
{"r3":1}
Relay4 ON
publishing to topic:
/v1.6/devices/esp32
Payload published:
{"r4":1}
Attempting MQTT connection...
.connected
subscribing to topic:
/v1.6/devices/esp32/r1/lv
subscribing to topic:
/v1.6/devices/esp32/r2/lv
subscribing to topic:
/v1.6/devices/esp32/r3/lv
subscribing to topic:
/v1.6/devices/esp32/r4/lv
/v1.6/devices/esp32/r1/lv
r1
1.00

/v1.6/devices/esp32/r3/lv
r3
1.00
```

Figure 5: Successfully Connected

Online mode is a system that need internet connectivity in order for it to function well. The serial monitor shown in Figure 5 shows that the ESP32 is successfully connected to the WIFI and MQTT server (Ubidots STEM). For this system to fully function, WIFI or internet connectivity must be in stable state else it will jump into manual mode until the internet connection is stable again.

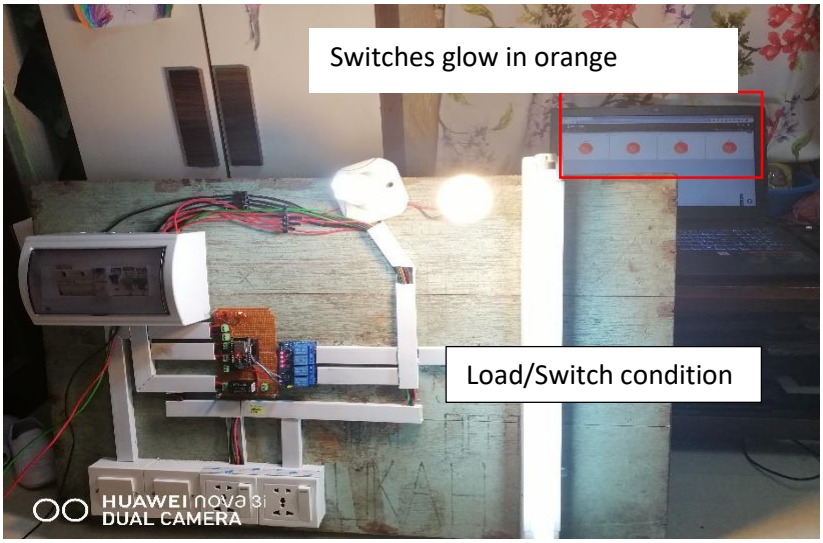

Figure 6: All load is ON

Figure 6 shows all lights and sockets are power up. The switches are glow in orange indicated that the load is in ON state. This also can be tell through the relay as shown in Figure 7 where all the relays' indicator are light up. Beside that, to tell the user if it is in online mode is through the 3 Leds, all the 3 Leds should be light up as it indicated that the system is connected to the internet but due to short circuited as shown in Figure 7, only the right Led is light up which still can also be used to indicate the system is connected to the internet.

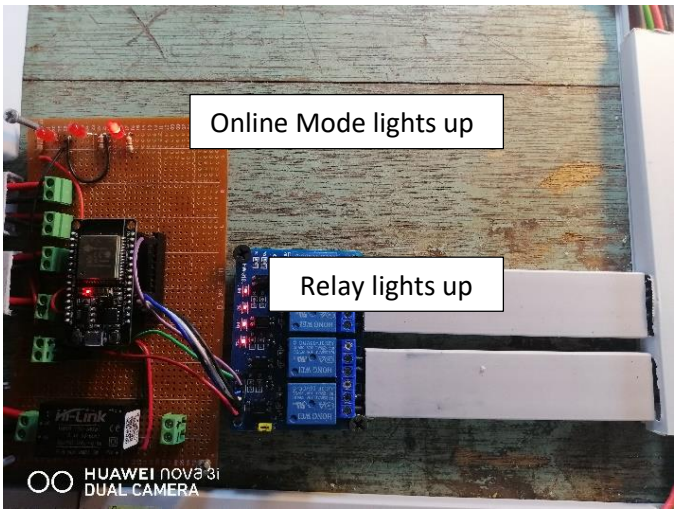

Figure 7: Relays and online mode indicator

The widgets or switches in the control panel can also be used to monitored and display any changes to the load as shown in Figure 8 where all load is in OFF state.

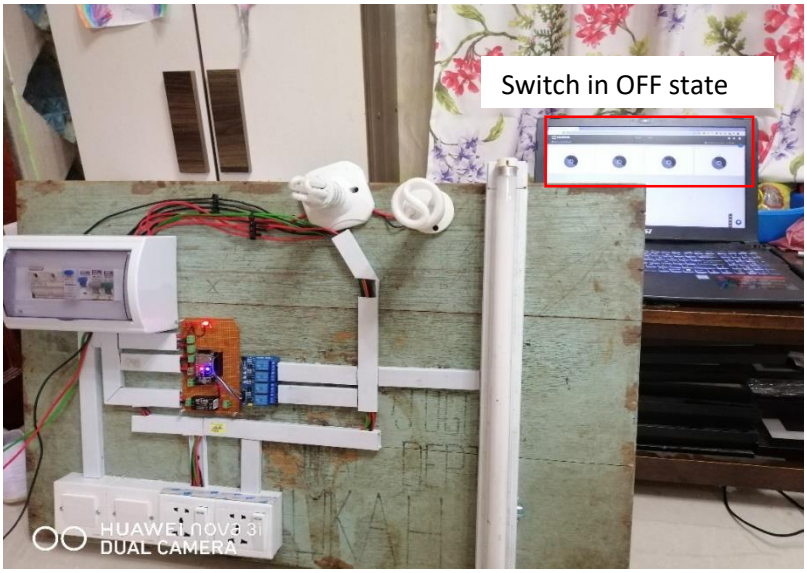

Figure 8: Condition changed

4. Conclusion

A system which can monitor and control multi devices at home using IoT based ESP32 microcontroller was presented. This system is built using embedded microcontroller with Wi-Fi module ESP32. The developed system is low cost, simple to operate and is easily embedded with home appliances. This proposed system is expected will improve the performance of various devices at home by controlling automatically and remotely. Additionally, the using of internet access that can control from far away can ease people in controlling appliances if they are absent from home and to ease disable people. Beside that, this system also can be access through smart phone and laptop as long as there is internet connection to be connected to the Ubidots STEM control panel. It also capable in controlling using two methods which is through online and manual mode.

Acknowledgement

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