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Implementation of Smart Home using Wi-Fi to IR through MQTT

K Shivaraj, K Kalyana Srinivas, P Sampath Reddy

Abstract*: As there is an advancement in wireless communication there is a wide development in embedding all the devices together and controlling them through a single device. Home automation is a smart system that has been becoming more popular in the present era, where all the devices related to the home are controlled remotely through a Smart Hub. The aim of the project is to develop a Smart Hub and to control multiple IR devices through a Smart Hub using Wi-Fi to IR through MQTT, because it is inconvenient to use multiple remotes for multiple IR devices. Smart Hub consists of peripherals ESP-WROOM-32D (Microcontroller), RT400, IR transmitter, IR receiver, LDR(Light Dependent Resistor) and LM35 as Temperature sensor. All the controlling of these integrated devices can be controlled through a smart phone or tablet. This technology uses ESP-WROOM-32D and web server using mobile phone or tablet having a specific application, one can control the smart system from anywhere or with in a home remotely. This paper describes about the automation of home for a specific electronic devices having IR Transceiver like Television, Air conditioner, Dish box, DVD player and many more. This paper also describes how MQTT protocol is used for the implementation of the present prototype using ESP-WROOM-32D. The other scenario is when we don't have the IR Transceiver devices like light, fan etc and the devices which are manually operated through electrical switches also can be controlled through IR Transceiver, Arduino and Relays.

Keywords- MQTT, ESP-WROOM-32D, Arduino, LM35, LDR, IR Transmitter, IR Receiver, RT400, Relay, Wi-Fi Internet.

I. INTRODUCTION

In the present era as there is a vast increase in the technology there are high expectations by a human for a security, comforts and user friendly nature. In these days smart home automation plays a vital role across the world, as the technology is increasing widely there are various developments that has been going on the smart home automation. The various applications for a smart home such as smart home appliances, smart switches, smart locks, gardening management, light controlling, air and water quality controlling, improved security and safety. All these plays a major role in human life and these can be controlled through a smart devices such as smart phones and laptops[1].

As it is discussed that there are various applications in the smart home automation, a small short circuits that may lead to the fire breakouts and that sometimes results in the accidents, so that the switches can be replaced in the home. There are many such issues that we can overcome through the smart home automation.

As there is an enormous increase in the home appliances many of them are controlled through the IR signals in the wireless technologies [2].

The remote that is used to control one device is unique such that the same cannot be used to control the other devices as they are having its own frequency. So there are many devices that we use in our home and it is very inconvenient to have an individual remote to control different devices and in order to avoid such inconvenience, it is preferable to have a single remote that has a capability of controlling all the devices. The remote may be like a smart universal remote that can control Television, Dish box, Air conditioner etc. This is the condition where we can control through the IR signals that have a IR receiver in any device but when there is no IR receiver for devices then the scenario is different. This paper discusses about both the statements how the smart home is controlled when there is a IR receiver electronic devices (Television, Air conditioner, DVD player) and in the absence of IR Receiver electronic devices (Light, Fan and etc).

One can control the devices using a universal remote controller with the help of IR Transmitter to control a various devices from a constant place. Due to the various complexities it has become very critical to read and store all the values related to remote control of various devices of various manufactures. In order to overcome such type of issues, as there is a much advancements in the mobile technology and everyone in the present life is using it essentially through connecting it from one end to anywhere in the world. By using this mobile communication technology people can connect to various devices and their applications as mobile phones are having many capabilities to do very interesting things. There are many features that supports mobile phone such as Bluetooth, Wi-Fi that can be used to enable and disable the devices. Mobile phones alone cannot control the devices directly, there is a specific hardware that is needed along with the devices having IR transmitter, IR receiver and Wi-Fi module that will be used to connect mobile phone to control the devices for smart home automation. In this paper ESP-WROOM-32D is used as a Wi-Fi module that is used for the connection of smart mobile and devices in controlling the home appliances.

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The previous work done related to the present project is shown in literature survey that is described in section II. And the methodology, components that are used in the present project are described in block diagram, hardware description and software description are included in section III.The results are shown in the section IV. Conclusion of the project is described in the section V.

II. LITERATURE SURVEY

N.V.K Ramesh et al in 2017 have been discussed about the performance and implementation of ESP8266. And also described how the wireless universal remote performs, when the client and server are connected to the same hotspot using protocols. At first maintaining the data that would be required by the IR remotes and then storing it in the protocols and libraries are also required for the implementation. To perform Home Automation we also required a hardware which will be a specific hardware through which the IR devices can be controlled and enabled. The methodology of this paper was to reduce the usage of battery and remotes [1].

B.S.S Tejesh in implementing an efficient Smart home system using MQTT has been discussed about the efficient Smart home. And how the manual labor is reduced and also the system providing the services to the users through the electronic gadgets .This paper discusses about the comparison of the HTTP and MQTT protocol based on their data traffic, energy, power consumption and latency. Here the smart home automation services are implemented using MQTT protocol and HTTP protocol as they are used to transfer the data which is based on the type of location based data [2].

YAN Wembo et al in Smart home implementation based on internet and Wi-Fi technology have been discussed about the home automation based on both the Wi-Fi and internet with low cost and flexibility. This paper deals with the concept of home proxy and smart units, here XMPP has been used for the remote control with home proxy and remote server. It describes how to solve the problem that occurred due to synchronization. In order to support the multi users the home proxy is used and the system is enabled through a particular platform, an application in the mobile phone is developed in order to control more than one smart home by using a single remote [3].

Jeetendra Joshi et al in performance enhancement and IOT based controlling for smart home discussed about the achievement of the complete integrated home automation system and integration of the location based services along with cloud based services, comparison of latency due to the data traffic in HTTP and MQTT architecture. And this paper describes how to operate home automation easily and implementation of the low cost system to control the multiple devices from anywhere. The technology used here is the Raspberry Pi along with web server and enough models are used to control home appliances that are integrated with Raspberry Pi and Arduino. Any issues regarding the transferring of commands, the alarm is send to the mobile through the web server [5].

Jagadeesh Thati et al in controlling of home appliances through internet described about home appliance that are widely used in various environment with high flexibility and reliability that has real time response. The main purpose of this paper is to design a prototype that can be used to control electronic devices from anywhere using smartphone with voice controlled either ON or OFF. ESP 32 is used as a Wi-Fi module that acts as an interface between the home devices and client. The major part of this prototype is to have a system with cost effective and low power [6].

III. METHODOLOGY

In this methodology, it has been discussed about both the scenarios where the electronic devices with and without IR receivers have been used, and explained in detailed with the help of block diagrams, hardware and software description.

1.Block diagram:

The block diagram of implementing smart home using Wi-Fi to IR using MQTT is shown in Fig. 1.The components that have been used are LDR, ESP-WROOM-32D, RT400, LM35 as a temperature sensor, IR Transmitter (Tx) and IR Receiver (Rx).

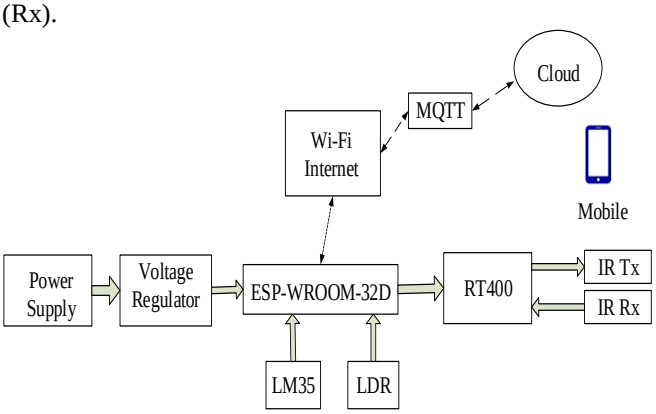

Fig. 1. Block diagram of smart home using Wi-Fi to IR using MQTT.

A. ESP-WROOM-32D:

ESP-WROOM- 32D is a Wi-Fi +BT+BLE MCU module that is used for targeting various applications. The applications that ranges from low power networking sensors to application specific tasks like a speech enhancement, voice encoding and decoding, music.

ESP32-DOWDQ6 is a chip that is the core of the ESP-WROOM-32D module. The designing of a chip is embedded in such a way that it provides adaptability and scalability. ESP32 is integrated with a large number of peripherals that consists of capacitive touch sensors, SD card interface, SPI, I2S and I2C, Ethernet and UART. This chip has two CPU cores that are independent and the clock frequency of CPU is controlled from 80mhz to 240mhz.

Free RTOS with LWIP is the operating system for module ESP32. Secure over the air(OTA) is available to support the users to upgrade their respective projects at minimum cost ever they are released.

This ESP-WROOM-32D module is integrated with a Bluetooth, Bluetooth Low Energy and Wi-Fi to target a variety and wide ranged applications. Direct connection to the internet is provided with the help of Wi-Fi, through a Wi-Fi router and the range of Wi-Fi is large. ESP32 module has a sleep current less than 5 micro amps that are useful in making various battery-powered and wearable smart electronic applications. Hence this ESP32 module offers best performance, range and less connectivity and power consumption [16].

B. Voltage Regulator:

Voltage regulator is an electronic device that maintains the voltage within the limits that are accepted. In other words voltage regulator keeps the prescribed range of the voltages as required for the applications. It is designed in such a way that it automatically maintains the level of constant voltage. It is used to regulate DC voltages based on the design build and it uses electromechanical mechanism.

Voltage regulators are used in devices such as power supply devices like computer in which processor uses a stabilized DC voltage. The voltage regulator is a three terminal device and it is an integrated circuit that will provide constant voltage at output irrespective of changes in the input voltage and regulates the voltage. The application of voltage regulator is that it is used in electronic circuits to provide a precise amount of voltage to electronic gadgets so that it can save from the damages. Voltage regulator are different from the voltage stabilizer because voltage regulator step down the voltages to a required level while stabilizers are used for stabilizing and it is used in AC and voltage regulator is used in DC[17].

C. IR Transmitter:

IR Transmitter and IR Receiver are widely used in wireless communications to control devices wirelessly.IR receiver that senses the IR pulses and then it is converted by the IR receiver to an electrical signal. In the present project IR LED is used as an IR Transmitter and for IR Receiver TSOP1738 is used [18].

D. IR Receiver:

IR(Infrared Receiver) is a hardware device that is used to receive the IR pulse from the remote control. It decodes the signal that has received.

E. LED Indicator:

LED Indicator is used for indicating when power is ON/OFF. In this project we are using LED indicator to know whether the device is ON/OFF and it is also used for warning purpose [19].

F. LDR:

LDR is a Light Dependent Resistor and it is a photo resistor device or cadmium sulfide cell. The functioning of the LDR is based on electromagnetic radiation. LDR devices are also called as photoconductive cells or photo cells as they are sensitive to light.

The working principle of LDR devices is photo conductivity. In photoconductivity the conductivity of the materials increases as the light on the material is absorbed with the light intensity.

LDR is used in applications as it detects the intensity of light. The resistance of LDR varies with respective to the light intensity. When the intensity is more such that when light falling on the LDR, its resistance is low and when the intensity of light is less that is in dark the resistance is increased. The resistance of LDR is very high at dark hence this resistance is called Dark resistance.

The advantage of LDR is they are cheap and available in market with different sizes and shapes. The required operation power and voltage is very small and the disadvantage is the response time is inaccurate with few milliseconds. The application of LDR is as a light sensor they are often used in various applications like Streetlights, Alarm clocks and many more [20].

G. LM35:

LM35 is a temperature sensor that is used for measuring different temperatures at the surroundings. As per the applications required the resistance current or voltage output is measured. It is an integrated temperature sensor that takes analog inputs and provides the output electrically in degree centigrade, it has a linear output and low impedance. The advantage of LM35 is its linearity and it is called linear because for every rise in temperature the output voltage of LM35 also will be increased or raised linearly. As it is an integrated circuit it doesn't require any extra component to be interfaced that provides the digital output like ADC. LM35 temperature sensor is a three terminal sensor VCC , GND and OUT .It measures the temperature that ranges from -55 degree centigrade to 150 degree centigrade. VCC is a terminal for supply voltage from 4V to 30V. OUT terminal is to provide analog output voltage, GND is ground and the temperature output of LM35 is more precious than thermostat [21].

H. RT400:

It is a 8-bit microcontroller and flash based, low power, integrated based on turbo 8051. The aim of RT400 is that instead of traditional remote control, it provides universal remote control and also provides the interface to the host system by utilizing a UART protocol. It is designed for IR remotes.

I. MQTT:

MQTT(Message Queuing Telemetry Transport) is a simple messaging protocol and it provides a communication between multiple devices. MQTT reads and publish data from sensor node, it allows controlling output by sending commands. The concept of MQTT is to publish and subscribe on a topic. A device can publish a message and it is subscribed to a topic so that it can receive a message. Through topic one can publish/subscribe a message and the representation of topic is followed by a string separated with forward slash [22].

Broker is responsible to filter the messages and to receive the messages. And also decides the interested one to publish the messages, diagram of working of MQTT is shown in Fig. 2.

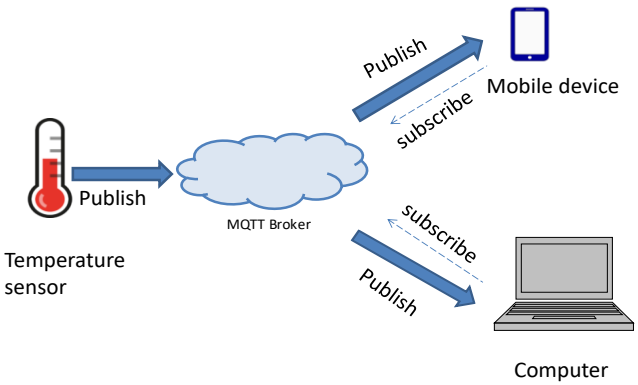

Fig. 2. Working of MQTT.

2. Controlling of Electronic Devices through IR Remote: The other scenario is that when the devices does not have the IR Receiver then these devices are controlled through IR Receiver, Arduino and Relays as shown in the block diagram Fig. 3.

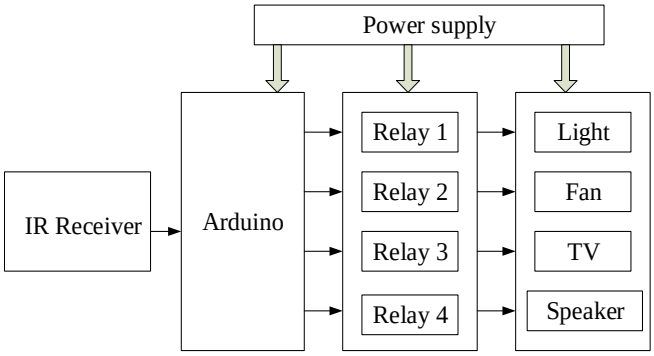

Fig. 3. Block diagram of remote controlling devices.

This block diagram represents the scenario in the absence of IR Receiver for the devices like Light, Fan, TV, Speaker. Here the model is controlled using the IR receiver, Arduino, Relays and power supply. Here the Arduino acts as a microcontroller that is the heart of a device and relay acts as switch.

3. Initialization of Wi-Fi to IR using MQTT:

Initially create a task to Reset a board and erase the memory. If GPIO pin 5 is kept high for 10sec then in ESP the memory will be erased and the board will restart. The main program will start to access the memory location where SSID(service set identifier) and password is stored, If SSID and password is not available then the Wi-Fi is initialized and it is in soft Access point (AP) mode. Then TCP Server task is created and the client will be connected to ESP Wi-Fi. The availability of Wi-Fi scan list data will be send to client by a ESP chip. The client selects one among the available Wi-Fi list and the SSID and password is given by the client and it is stored in the nvs(non volatile storage) flash memory.

When SSID and password is available then Wi-Fi is initialized in station mode and then ESP32 is connected to the internet through Wi-Fi. After connecting to internet ESP32 will initialize UART 1. ESP32 connects to MQTT server through a broker URL and ESP creates a topic to publish/subscribe in the name of MAC ID to read the data/send the data. Based on the payload data the ESP takes an action. The complete procedure is shown in below flowchart Fig. 4.

If the payload data is new_key then ESP sends data to RT400 that receives the IR data that is manually pressed key in the remote through IR Rx. Then the ESP32 sends the data to server through MQTT publish. The procedure is shown in below flowchart Fig. 5.

If the data is OTA (Over the air) the ESP will executes a OTA function call. ESP is connected to the server through URL and downloads the bin file and then flash the bin file to ESP32 module and restart.

If the data is change AP (access point) then it will erase old SSID and password, save new SSID and password in nvs_flash memory, board will restart and ESP is connected to the new Wi-Fi network.

If the data is Temperature/ LDR then ESP reads the value from temperature and LDR sensors, send the values from temperature and LDR sensors to the server through MQTT publish. If the data is restart then the ESP module will restart.

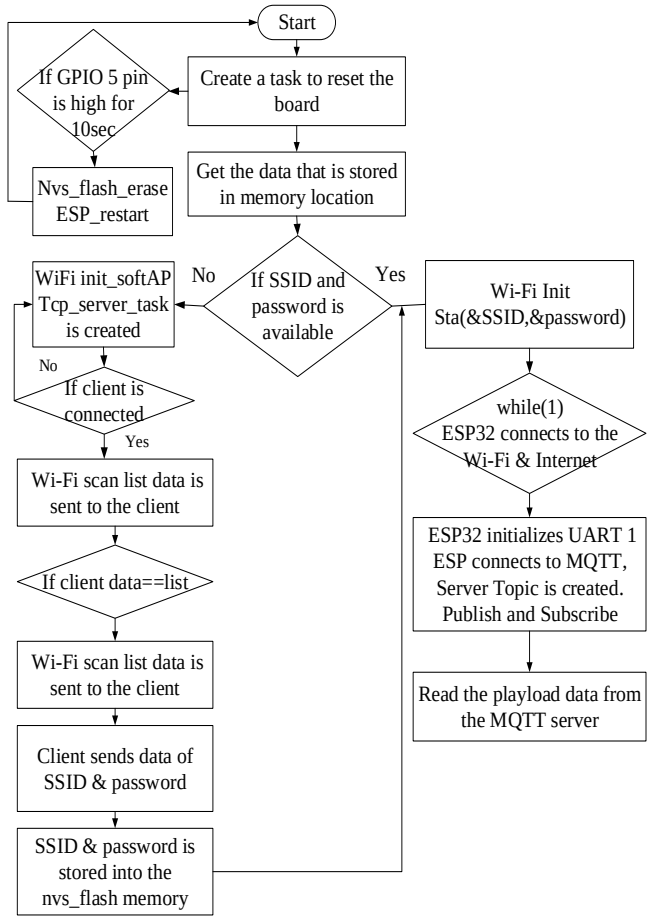

Fig. 4. Flow chart of Wi-Fi to IR using MQTT.

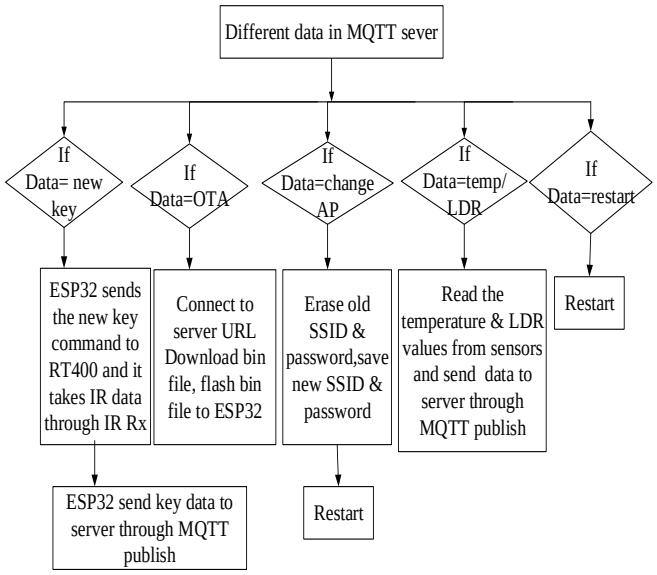

Fig. 5. Flowchart of Publish/Subscribe data in MQTT.

4. Hardware Description:

The pin configuration of hardware ESP-WROOM-32D is shown in the Fig. 6.

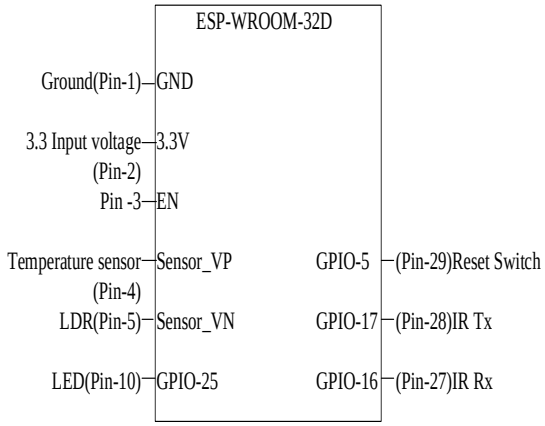

Fig .6. Hardware Pin Configuration of ESP-WROOM-32D.

As per the temperature data collected from MQTT the temperature in the home can be controlled. It is like if temperature in the room is low then the AC remote key is set to increase the temperature and if temperature in the room is high then AC remote key is set to decrease the temperature. Similarly through the LDR data from MQTT by observing the intensity of light in room the lights are turned in to ON/OFF. If the intensity is high the lights are turned OFF and if the intensity is low the lights are turned ON.

The hardware description for controlling the devices that does not have IR receivers as shown in Fig. 7, in this scenario Arduino, Relays, IR receiver is used.

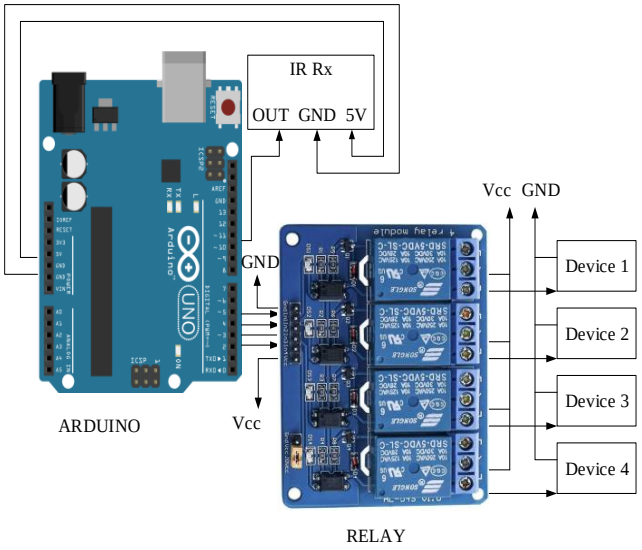

Fig. 7. Hardware Pin Configuration of Arduino-Relay and output devices.

GND(Ground) pin of IR Receiver is connected to the Arduino ground and the power for IR receiver is supplied through Arduino. OUT pin of IR Receiver is connected to the Arduino pin 11. Relay acts as a switch and it has three terminals, in the present prototype 4 Relays are used having IN1,IN2,IN3,IN4 are connected to Arduino pin 2,3,4,5 and Vcc is 9V.Pin 2 of each relay is connected to the Vcc and pin 1 is connected to output devices. The output devices can be Light, Fan, Speaker. In this project 4 LED are used and IR remote is used to turn ON/OFF the devices.

5. Software Description:

The software IDE used in the present project is Eclipse. Eclipse provides a good integrated development environment that is esp-idf (Espressif IOT development framework) for faster prototype to Build and Flash. This is a development framework for all the chips of ESP32. And the version used is esp-idf V4.0.It has a default build system that is CMake-based build system and it makes the work environment quite simple. As it provides a way that a developer can develop an application without making any modifications in esp-idf files. The application directory is different from esp-idf files as the updating of esp core files is independent of application.

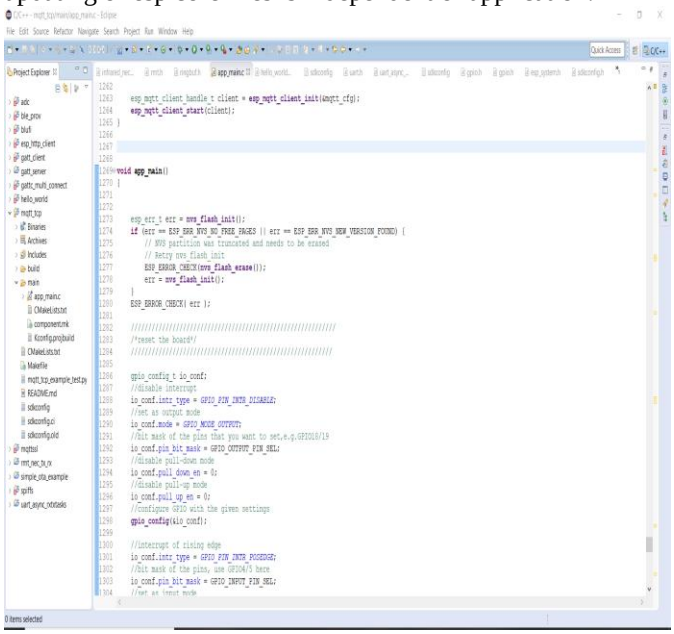

Fig. 8. Eclipse IDE window.

IV. RESULTS AND DISCUSSIONS

The results for both the scenarios having the electronic devices with IR Receiver and another one is the electronic devices without IR Receiver has been shown in Fig. 9 and Fig. 18.

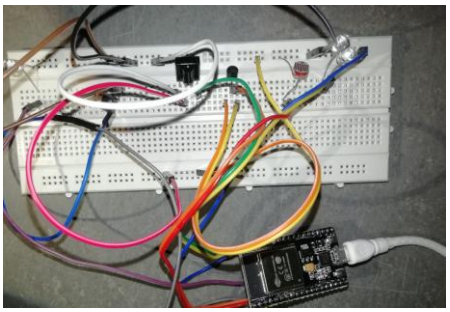

Fig. 9. Hardware circuit of Wi-Fi to IR using MQTT.

After making the hardware connections, initially power is supplied to the ESP module then ESP is ON and it checks for SSID and password in its nvs_flash memory storage. If SSID and password is not available in flash storage ESP will be in access point (AP) mode as shown in Fig. 10.And also in TCP socket listening mode. When client is connected to TCP, then ESP send the Wi-Fi scan list data to the client that is shown in Fig. 11 and client sends the required SSID and password data to the ESP. Then ESP scans the scan list data and connects to the Wi-Fi that can be seen in the debugging tool as shown in Fig. 12. Then ESP connects to internet through Wi-Fi and it is connected to MQTT server through URL and connection established between MQTT and ESP.ESP creates a topic (publish/ subscribe) in the name of MAC ID.

ESP waits for MQTT event to occur based on the payload data such as new _key, temp_ldr, ChangeAp, OTA and remote key data.

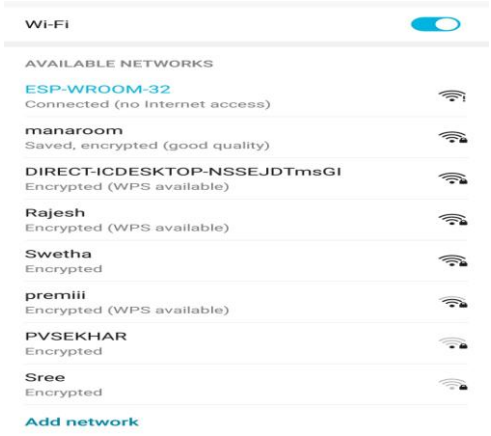

Fig. 10. Connecting ESP Wi-Fi through mobile.

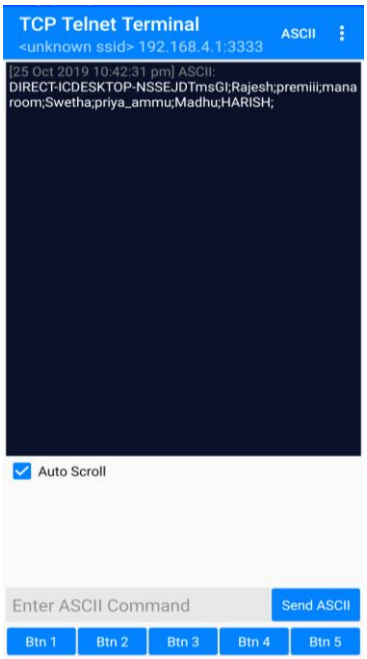

Fig. 11. TCP terminal.

```
SCAN LIST-1
mywifi;JioNet@VNR_Institute;JioPrivateNet;JioNet@VNR_Institute;JioPrivateNet;
ivateNet;JioNet@VNR_Institute;
SCAN LIST-2
LIST2-mywifi;JioNet@VNR_Institute;JioPrivateNet;JioNet@VNR_Institute;JioPriva
;JioPrivateNet;JioNet@VNR_Institute;I (529754) EASY TAG: sta scan done
I (646144) EASY TAG: Received 20 bytes from 192.168.4.3:
I (646144) EASY TAG: mywifi;8142428383;


SSID is :mywifi

PASSWORD is :8142428383
```

Fig. 12. Output for scan list in debug tool.

If the data is new_key then ESP sends the new keyword to RT400 through IR Rx and ESP sends key data to the server through MQTT publish as shown in below Fig. 13.

When data is temp_ldr then it reads the data from sensors and sends through MQTT server as shown in Fig. 14 and Fig. 15, if the data is changeAp then erase old SSID and password, saves the new SSID and password in nvs_flash memory and then ESP will restart as shown in Fig. 16 and Fig. 17.

If the data is OTA, ESP connects to the server URL and downloads the bin file from the server, flash bin file to ESP-WROOM-32D.If the data is Restart then ESP module will Restart.

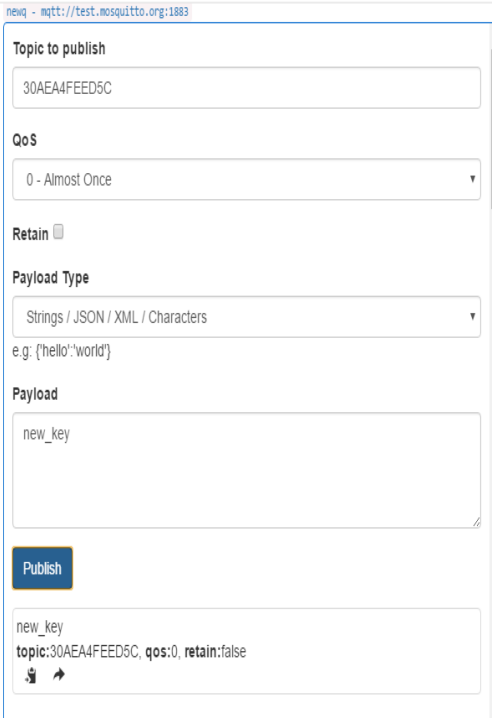

Fig. 13. Publishing new_key data in MQTT.

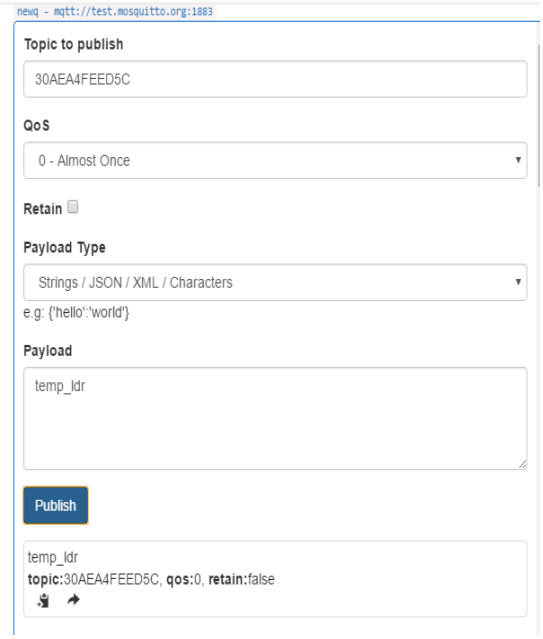

Fig. 14. Publishing temp_ldr data in MQTT.

```
TOPIC=30AEA4FEED5C
DATA=temp_ldr
Characterized using eFuse Vref
Raw: 964        Voltage: 19.08C
Raw: 4159       Voltage7: 1026mV
I (1863264) EASY TAG: sent publish successful, msg_id=20905
send templdr data to mqtt
I (1863564) EASY TAG: MQTT_EVENT_PUBLISHED, msg_id=20905
I (1871754) EASY TAG: MQTT EVENT DATA
```

Fig. 15. Output data of temp_ldr in debug tool.

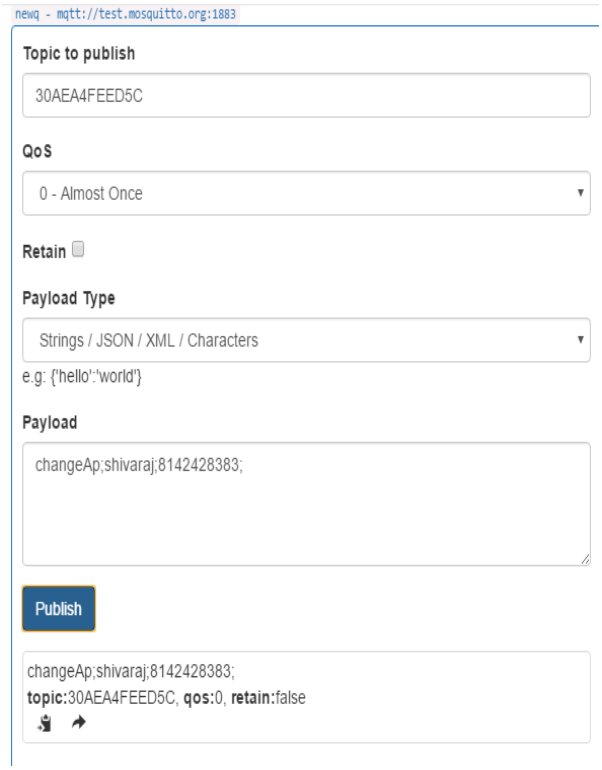

Fig. 16. Changing Wi-Fi network.

```
TOPIC=30AEA4FEED5C
DATA=changeAp;shivaraj;8142428383;
SSID is :shivaraj

PASSWORD is :8142428383
```

Fig. 17. Change of ssid and password.

The connections for the electronic devices that does not have IR Receiver is shown in Fig. 18.

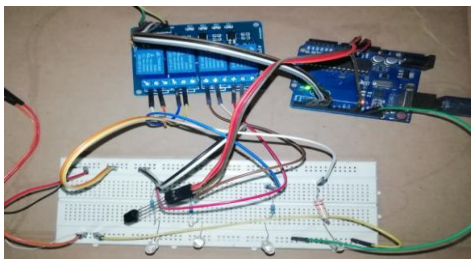

Fig. 18. Hardware circuit of relays controlling through IR receiver.

Here IR remote is used to turn ON/OFF the devices. In remote if key is pressed once then device is turned ON and if key is pressed twice then the device is turned OFF.All the devices can be turned ON/OFF when required. Here Four LEDs are used that indicates as devices.

V. CONCLUSION

In the present paper it has been discussed about the ESP-WROOM-32D and its performance and implementation in smart home using Wi-Fi to IR through MQTT.It is described how smart hub is implemented to control multiple IR devices through internet using MQTT, how the keys are generated, how the SSID and password is stored. Here it is discussed about both the scenarios where devices with IR Receiver and without IR Receiver are controlled. It has been also discussed about how IR protocols are used for universal remote wirelessly and establishment of the connection between client and server using MQTT. Controlling of home appliances through temperature and LDR sensor values are also explained. The ideology of this paper is that how the data that is required for the remote is stored and flashed in to memory. In the scenario where electronic devices does not have IR Receiver the Arduino, Relays, IR receiver are used along with remote control that is used to turn ON/OFF the devices, the devices may be speaker, light, fan and any other electronic devices.

REFERENCES

1. N. V. K. Ramesh, S. V. Tejesh Kumar, V. Vamsi and S. Akarsh, "WI-FI Controlled Universal Remote Using ESP8266",In ARPN Journal of Engineering and Applied Sciences ©, VOL. 12, NO. 24, December 2017.
2. B.S.S.Tejesh, S. Neeraja, "Implementation of an Efficient Smart Home System using MQTT", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 03, Mar -2017.
3. YAN Wenbo, WANG Quanyu, "Smart Home Implementation based on Internet and WI-FI", In Proceedings of the 34th Chinese Control Conference , July 28-30, 2015, Hangzhou, China.
4. Rashida Shujaee, "Optimization of A Smart IOT Gateway", In International Journal on Recent and Innovation Trends in Computing and Communication, Volume: 5 Issue: 7. July 2017.
5. Jetendra Joshi, Vishal Rajapriya, Rahul,Pranith Kumar,"Performance Enhancement and IoT Based Controling for Smart Home", IEEE 2017.
6. Jagadeesh thati , P.Venu Kumari "Controlling of Home Appliances through Internet",In International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS-2017).
7. Gomez, C.Paradells, "Wireless home automation networks: A survey of architectures and technologies", IEEE Communications Magazine, vol.48, no.6, pp.92,101, June 2010.
8. J. Byun, I. Hong, B. Lee, and S. Park,Intelligent household LED lighting system considering energy efficiency and user satisfaction, IEEE Transactions on Consumer Electronics, vol. 59, no. 1, pp. 70C76, Feb. 2013.
9. B.M. Van Der Werff, X. GUI and W.L. Xu "A mobile based home automation system", 2nd International conference on mobile technology,Applications and systems, 2005.
10. Ruicong, Qian, Z. C Yan, "IoT gateway: bridging wireless sensor networks into internet of things", In 2010 IEEE IFIP 8th International Conference on the Embedded and Ubiquitous Computing (EUC'2010).
11. Zhi-yong Bai, Chin-Hwa Kuo, Tzu-Chia Wang,"Design and implementation of an IoT multi-interface gateway for establishing a digital art interactive system",IEEE Vol. 21, No. 3, 2016.
12. K. Bromley, M. Perry, and G. Webb,"Trends in Smart Home Systems, Connectivity and Services", www.nextwave.org.uk, 2003.
13. Pandey, Rajasekhara Babu, Manasa K., Avinash J,"Mobile Based Home Automation and Security System",Indian Journal of Science and Technology in 2015 Jan 8(S2).
14. Sindhuja P, Balamurugan Ms ,"Smart Power Controling and Control System through Internet of Things Using Cloud Data Storage",Indian Journal of Science and Technology in 2015 Aug 8.
15. Yunjung Park, Minho Lee, "Cost Effective Smart Remote Controller Based On Invisible Ir Led Using Image Processing", In 2013 IEEE International Conference on Consumer Electronics.

16. empa.com/empaiot/esp-wroom-32d_esp32-wroom-32u_datasheet_en.pdf.
17. http://www.circuitstoday.com/voltage-regulators.
18. https://circuitdigest.com/electronic-circuits/ir-transmitter-and-receiver-circuit.
19. https://en.wikipedia.org/wiki/Light-emitting_diode.
20. https://www.electronics-notes.com/articles/electronic_components/resistors/light-dependent-resistor-ldr.php.
21. https://www.electronicwings.com/components/lm35-temperature-sensor.
22. https://randomnerdtutorials.com/what-is-mqtt-and-how-it-works.

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