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Central Hub For Home Automation

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Abstract— **This paper reports the designs of a 'Central Hub for Home Automation'. The important units of this system are a single board computer-orange pi zero, microcontroller -ESP32, web interface to envision the data dispense by orange pi and to send, receive and process the request. The system senses various information such as temperature, motion through temperature and humidity sensors, PIR motion sensor. The information and the status of controlling devices is sent to the cloud based MQTT broker which can be access by the user via mobile phone or laptop.**

Keywords— orange pi zero, ESP32, MQTT-Message queuing telemetry transport, temperature sensor, PIR sensor and RF sensor.

I. INTRODUCTION

The home automation system builds the operations of several home gadgets more appropriate, time saving and energy saving. Communication plays major task in home automation system for the remote access of those operations. Centralized authority of lighting apparatus, air conditioning and heating, security systems, and all other apparatus used in home systems is feasible with this system.

In this paper a central hub made up of automatic controlling the actions of relays by connecting all the sensors like temperature and humidity and motion detection for obstacle detection and different modules like RF receiver and IR receiver for remote controls the action of relays.This system uses Orange Pi zero single board computer as Central hub to which heterogeneous sensors such as temperature and humidity sensor, PIR motion sensor, RF Receiver for sensing inputs and are associate with the local server. All the sensors are connected to the Orange pi which is bridge to the ESP32 controller using a Wi-Fi module. The data transfer between Orange pi and ESP32 module is accomplished with the help MQTT (Message Queuing Telemetry Transport) protocol. All controlling devices (for eg. Light, Fan, AC etc.) Connected to ESP32 module. A cloud service (MQTT) is also used for centralized access to all products.

The idea of smart home is gaining importance in the present context due to their ability to automate home environments with great effectiveness. Smart systems are defined as miniaturized devices that incorporate functions of sensing, actuation and control. They are capable of describing and analyzing a situation, and taking decisions based on the available data in a predictive or adaptive manner, thereby performing smart actions.

II. PROBLEM STATEMENT

1. Design and development of subsystem using ESP32 module to control relay action.
2. Design and implement wireless interconnection between ESP32 controller and orange pi zero, interfacing of various sensors to orange pi zero, transmitting data to cloud based server.
3. Designing of user interface to visualize and control action of temperature and humidity sensor, PIR motion sensor and relays.

III. OBJECTIVE

1. To design and implement the wireless connection between ESP32 Controller and two channel relay.
2. To design the central hub using Orange pi zero and temperature and humidity sensor, PIR sensor which has capacity to sense various parameters such as temperature and humidity, motion.
3. Impose the wireless network using MQTT protocol to transfer data between orange pi zero, ESP32 controller and user.

IV. DESIGN IMPLEMENTATION

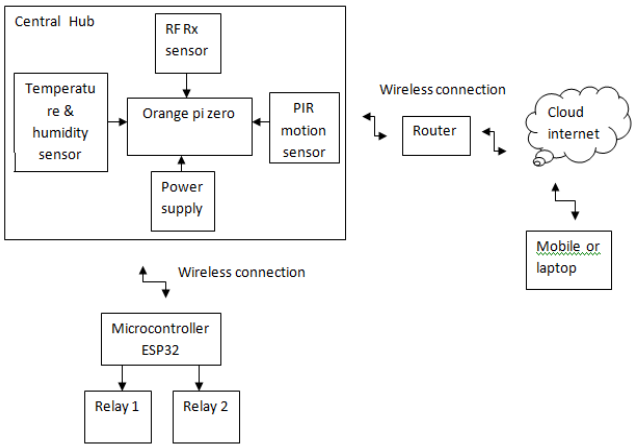

Fig1.Block diagram of system

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In this sytem, the ESP32 is use to control the two channel relay using MQTT protocol and and the relay action controls by using MQTT android application. The ststus of relay is displayed on the orange pi terminal which is central hub.

The central hub is formed by using diiferent sensors and modules. In system uses temeperature and humdity sensor, PIR motion detection sensor and RF module the output of this sensors displayed on orange pi terminal and also displayed on MQTT android application. Central hub maintain the ststus of relays action.

A. **Orange Pi zero**:

It's an open source single board computer. It can run android 4.4, ubuntu, debian. It uses the all winner H2 SOC and has 256MB/ 512MB DDR SDRAM used for wireless server, computer.

Name	Specification
CPU	H2 Quad- core cortex –A7 H. 256/HEVC 1080p.
Memory	256MB/512MB DDR SDRAM (256 standard version)
Onboard storage	TF card (Max 32 GB)/2MB spi flash
Onboard Wi –Fi	XR819,IEEE 802.11 b/g/n
Onboard network	10/100M Ethernet RJ45 POE is default off
Power source	USB OTG can supply power
Buttons	Power button
Low level peripherals	26 pins Header, with 2xUSB IR pin, AUDIO
Supported OS	Android, lubuntu, debian

Table1. Features of orange pi zero

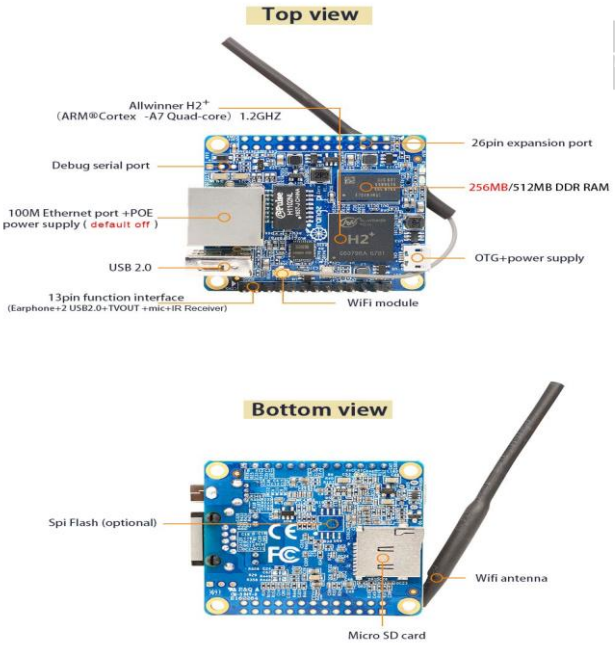

Fig 2. Orange pi zero

B. **ESP32**:

ESP32 is low power consuming arduino based microcontrollers with dual core Wi – Fi and dual mode Bluetooth SOC (Single On Chip) is single 2.4GHz Wi –Fi and Bluetooth combo chip designed for mobile, wearable electronics and Internet Of Things (IOT) applications.

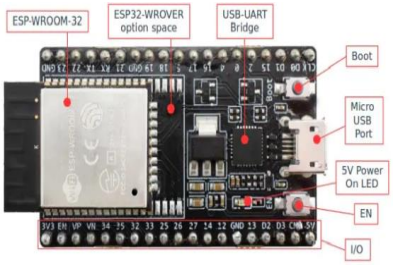

Fig 3. ESP32 module

Name	Specification
Processor	Xtensa single/dual-core 32bit LX6 microprocessor , 160MHz – 240 MHz, ultra low power co-processor, 448KB ROM, 520KB SRAM
Wireless connectivity	Wi -Fi : 802.11 b/g/n/e/I Bluetooth: V4.2 BR/EDR and BLE
Peripheral devices	12bit SAR ADC up to 18 channels 2x bit DACs
Software	Supports cloud server development/SDK for custom firmware development
Data rate	150mbps
Power	2.7V – 3.6v

Table2.Features of ESP32 module

C. **DHT22:**

The DHT22 is a fundamental digital temperature and humidity with more accuracy and low cost sensor. It uses a capacitive humidity sensor and thermistor to calculate the surrounding air and spot out a digital signal on the data pin, no analog inputs pins needed.

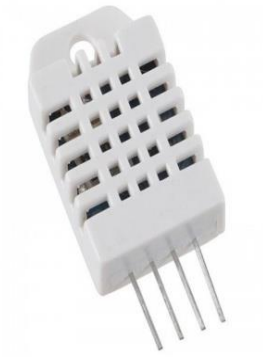

Fig 4.temperature and humidity sensor

Name	Specification
Power	3V-5V and I/O
Humidity	0% - 100% with 2% - 5% accuracy
Temperature	-40^{O} c - 80^{O}c with ± 0.5^{O}c accuracy
Current	2.5 mA (max)

Table3. Features of DHT22

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D. PIR motion sensor:

Passive Infrared sensor permits to sense motion, almost used to recognize whether a human has moved in one out of the sensor range. They are small, low power, easy to use that causes they are frequently used in home appliances and gadgets.

Fig 5. PIR motion sensor

Name	Specification
Wide working voltage range	DC 4.5V – 20V
Detection angle	< 140^{O}
Detection distance	3m – 7m (adjustable)
Work temperature	-20^{O}c - +80^{O}c

Table 4. Features of PIR motion sensor

E. RF Receiver module:

An RF (radio frequency) is a (usually) small electronic apparatus used to transfer or receive radio signals between two devices. In an embedded system it is frequently advantageous to interface with another device wirelessly. This wireless interface may be efficient through optical communication or through radio frequency (RF) communication.

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Fig 6. RF Receiver module

Name	Specification
Operating voltage	DC 5V
Static current	4mA
Receiving frequency	433MHz
Sensitivity	-105db
External antenna	32cm signal wire, spiral

Table 5. Features of RF Receiver module

F. Relay:

It is 5v two channel relay interface board and each channel needs a 15 -20 mA driver current. It can be used to control various appliance and equipment's with huge current. It is equipped with huge current relays that work under AC 250V 10A or DC 30V 10A. It has standard communication that can be controlled directly by microcontroller. Relay is a switch which controls electrically or electromagnetically. In this system, it is used to turn on and off the home appliances. Two channel relay module with optocoupler low level trigger evolution board, which is compatible with aurdino.

Fig 7. Two channel relay

Name	Specification
Relay max. output	DC 30V/10A AC 250V/10A
No. of relays	2
Each relay current (max)	20 mA
Operating voltage	5V

Table 6. Features of two channel relay

V. MQTT

MQTT protocol is used for data transfer between ESP32 module orange pi zero and other parameter available. This is more effectual as it is delicate and can be imposed on IOT appliances. It helps to keep the network traffic congestion level low from become inconvenience to others. MQTT server is configured on orange pi zero that responsible to receive all data and filter it and decided that who is fascinated in it and transmit the data to all subscribed clients. It has major role in IOT technique. This controls the data to and from numerous parameters that explicable for generate the status and controlling them. The server configured on orange pi zero is responsible for communication of local network. The ESP32 module is subscribed to specific topics in MQTT. When the designed data is published to the particular topic the analogous programmed function is executed declared in the data by the ESP32 modules which are subscribed to the same topic.

VI. FLOW CHART

In flowchart, initially connected to the MQTT server using servername, password and portname, if it is connected then subscribed to the required topic, the topic is relay. The status of relay is received from ESP32 which is controlled by using MQTT protocol.

The status of relay is displayed on orange pi terminal. The sensor which connected to the orange pi that transmits the data by using cloud MQTT server on orange pi terminal and depend on that data which is displayed on orange pi terminal there is change in current state of relay.

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Flowchart:-

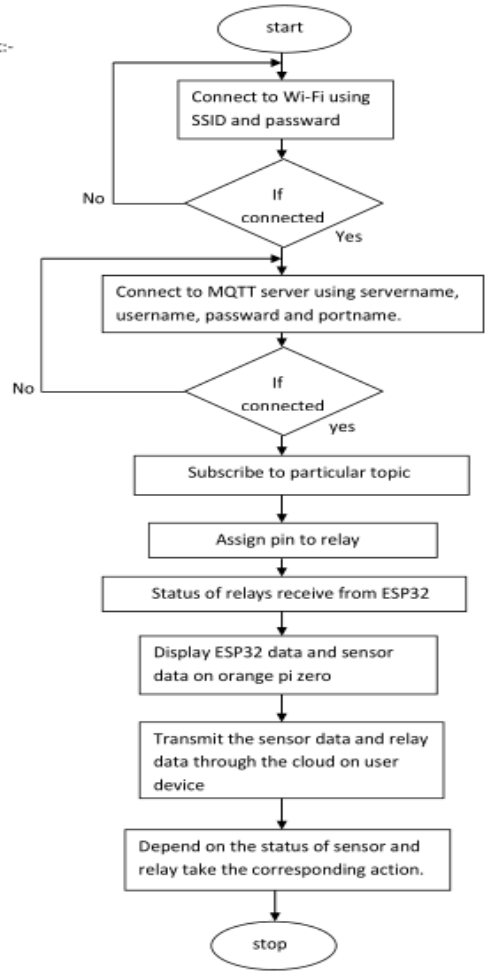

Fig 8. Flow chart

VII. RESULTS

The results shows the status of relays, different sensors which is displayed on orange pi terminal. On orange pi terminal displays the temperature and humidity in entire room and the gives the status of any human appearance in the room.

If any human enters in room then it gives the status by using PIR motion sensor on orange pi terminal then the relay is automatically operate which turns light automatically on otherwise it will off. And also controls the actions of relays manually by using MQTT android application..

Fig 9. Circuit connection of the system

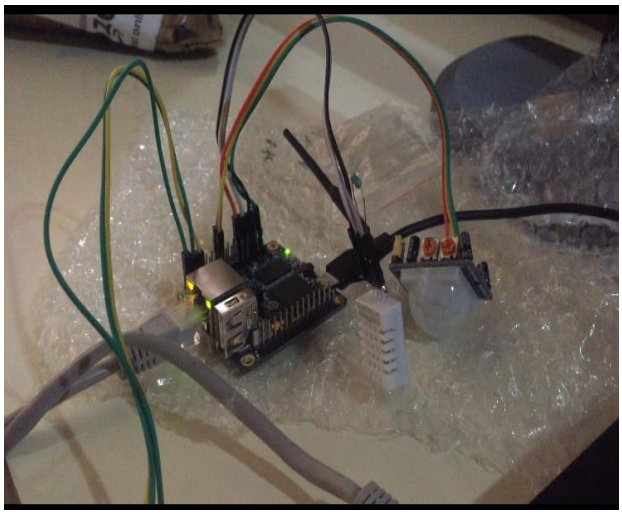

Fig 10. Circuit connection of the system

1.The result is displayed on MQTT application dashboard. This gives the current status of relay and sensors. User can control the functioning of relays and sensors by sending the corresponding commands.

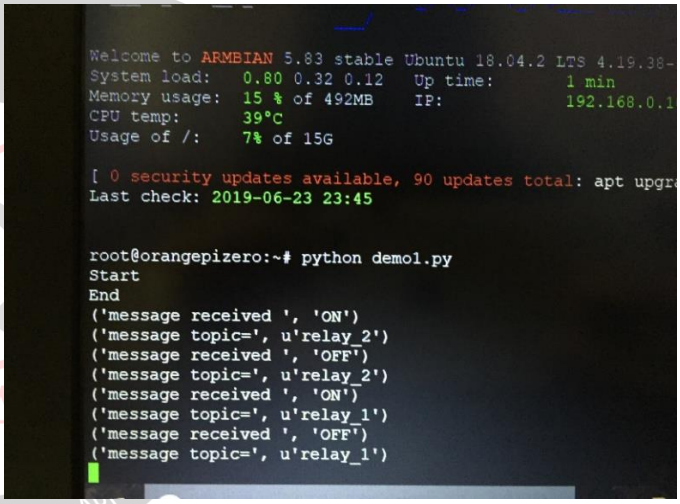

Fig 10. Status of relay on orange pi terminal

2.Status of the relays from ESP32 is displayed on the orange pi terminal screen. The status of which are configured with orange pi are displayed and control through MQTT application

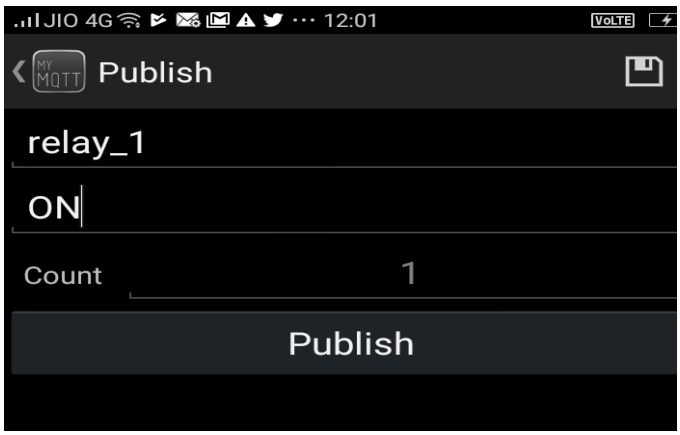

Fig 11.Controlling of relays from MQTT mobile application

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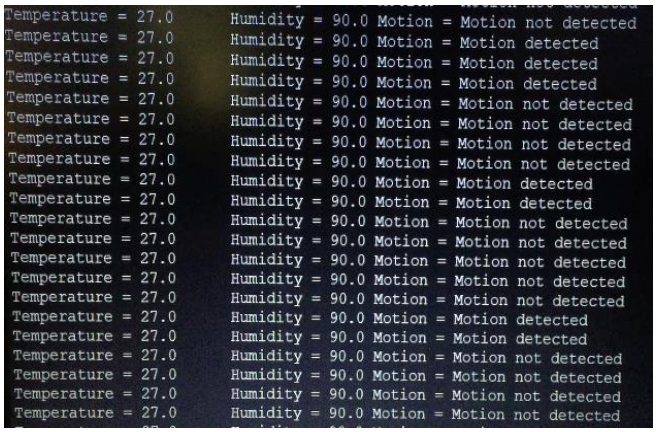

Fig 12. Status of temperature, humidity and motion display on orange pi terminal

3. Status of the DHT22 temperature and humidity sensor, PIR Motion sensor from orange pi zero is displayed on the orange pi terminal screen. The status of which are configured with orange pi are displayed on MQTT Dashboard.

VIII. FUTURE SCOPE

We can improve the system by adding voice command for controlling function of relay.

IX. CONCLUSION

In this project, we have developed and design the central hub for home automation using orange pi zero and different sensors and ESP32 module. This system shows status of relay and controls the functions of relay with the help of the MQTT protocol. Using this system we can centralize all the network.

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