

Implementation of Home Automation System using MQTT Protocol and ESP32

V. Thirupathi, K. Sagar

ABSTRACT--- *In the era of Internet of Things (IOT) and digital technology automation of everything has become more popular. People are very smart, they want to control and monitor everything from working places. This paper explains a cloud based home automation system using MQTT protocol. It enable users to control and monitor home appliances using a mobile app or a web page. Using cloud technologies became cost effective because most cloud developers are offering their services freely.*

Keywords *IOT, Cloud, Mobile App, MQTT, ESP32*

I. INTRODUCTION

As technology developing faster, researchers are taking it as an advantage to implement new intelligent systems or enhancing the existing systems. Home automation system or smart home systems are getting more popularity in recent days. These home automation systems are enhancing by changing existing features like communication medium or features day to day.

Home automation systems enable users to control and monitor every home appliance from remote places. Many wireless technologies have introduced and enhanced in implementation of home automation systems in recent days. The available wireless technologies infrared, Bluetooth, ZigBee, Wi-Fi, RFID and GSM are used to develop a commercially viable smart home systems.

This paper explains design and development of a cloud based home automation system. Now a days many cloud vendors offering their services free of cost. So this system is cost effective, secure and reliable. MQTT protocol has in built security features so it provides security at Secure Socket Layer (SSL) level. A user can send relevant commands through cloud to control home appliances from remote places. This system is a combination of Wi-Fi, cloudMQTT, ESP32, relays and power supply unit. The remaining paper planned as follows: part II presents discussion on Home automation systems which were developed previously. Part III explains system design and implementation. Part IV presents evaluation. Conclusion discussed in part V.

II. RELATED WORK

Different home automation systems have developed by various authors. In this sections I will give a brief discussion on home automation system based on communication mediums.

A. Bluetooth enabled Home Automation systems.

Bluetooth is a wireless equipment for transmitting data between two devices that are in nearby propinquity; it is most appropriate for little timed transmissions. Bluetooth communication equipment does not need line of sight between the two connecting devices. It is a feasible alternative to develop home automation systems over the traditional remote control.

In [1], the authors explained about „PICONET“, which is used to create network in Bluetooth equipment. Authors explained master-slave communication among different devices. The Bluetooth device which is connected to microcontroller chip and serves as a master and other devices which are connected to different appliances are slaves. An Android mobile phone is used as a remote controller which sends appropriate commands through the Bluetooth device. These commands are collected by the microcontroller and necessary action would be taken. The microcontroller checks for new commands for every 500 milliseconds form android mobile phone. But it works with in short range of distance. In [2] and [27] authors explained a secure, low cost and flexible home automation system. Here Arduino microcontroller was used to receive commands from mobile phones. This system enables only the authorized users. Authentication has checked with passwords, if the password are correct then only the users are allowed to access the system. The ON/OFF signals sent through internet. [3] Explained home automation system using Bluetooth as communication medium. Android mobile phone was used as the remote controller, which has a user interface with ON/OFF buttons. When we press ON/OFF buttons appropriate command will be sent to the microcontroller through Bluetooth module. Microcontroller would take the decision i.e. which relay need to be enabled. Bluetooth has a major problem, which is not appropriate when user would like control appliance from a longer distances.

B. Home automation using ZigBee

Few authors implemented Home automation systems with ZigBee as a communication medium. It is an IEEE 802.15.4 [4] radio frequency (RF) based communication device. In [4] authors explained a home automation system with interoperability of home applications. Wi-Fi and ZigBee technologies have combined to create an integrated gateway which helps in controlling and monitoring home appliances remotely. These gateways are used to facilitate interoperability among networks.

Revised Manuscript Received on December 22, 2018.

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In [5], the authors implemented ZigBee based home automation system which enables to monitor and control home appliances by adding security. It is used to control and monitor electrical doors and gas system. Home owner will be intimated using SMS when intrusion has identified. Immediately owner closes all the doors and enables gas system by sending necessary commands. ZigBee devices are required less power in contrast from Bluetooth devices. A voice based Home automation system has explained in [6], [7]. It uses ZigBee device as a communication medium. In [8] authors explained ZigBee and GPRS based Home security system. This system has a host control system which was made by using PIR sensor, ZigBee device and GPRS device. Sub functional devices were connected to host control system. Sub functional devices acquire data through its acquisition devices and provides communication using ZigBee. In [9] authors presented a Home automation system which is energy efficient.

C. Home automation using GSM

Short Message Service (SMS) permits to send and receive text messages through mobile phones. The text consists of words or digit or group of words and digits (alphanumeric). Because easy use of SMS it is widely used in developing automation systems. Controlling and monitoring home appliances from remote places using different communication mediums such as Bluetooth, ZigBee, Wireless LAN and cellular networks. Cellular networks provide wide range of communications and cost effective compare to other communication mediums such as ZigBee and Bluetooth. Cellular networks uses GSM (Global System for communication). In [10] and [28] authors presented device to device communication using GSM. The authors presented a smart home system in [11] which enable users to control home appliances by sending text messages through GSM network. It provides simple and easy way to regulate the appliances in a reasonable cost. Microcontroller receives text messages from users, these will be processed and control signals sent to relays. Relays either switching ON/OFF the appliances. User gets a messages as feedback which explains the current state of appliances. In [12], the authors explained a home automation system using J2ME/J2EE framework. In [13] and [14]-[19] authors explained home automation systems using GSM technology. In this system home appliances controlled with help of text messages.

D. Internet based home automation system

The internet became more popular in 21st century. It grasps all other variations of wireless technologies by overcoming unlimited distance. Internet is strength for internet of things. In [20] author explained a home automation system which is IPbased. To reduce cost and complications of IPbased home automation system, authors proposed this system. In order to simplify the cost and complexity of IP-based system, the authors implemented a hardware/software structure called IPAcBox which permits home/office automation systems to be monitored and controlled over a direct connection right out of the box. This automation system is very cost effective to develop when we compare it with GSM automation systems. COAP

(Constrained application protocol) based automation system has explained in [21]. COAP is used to develop Machine-to-Machine sensor network applications. Paper [22] and [29] discussed home automation system for multifunctional appliances using internet. It explained implementation of low-cost, secure and flexible home automation system. [22] And [23] explained internet and email based home automation systems using Arduino microcontroller.

III. SYSTEM DESIGN AND IMPLEMENTATION

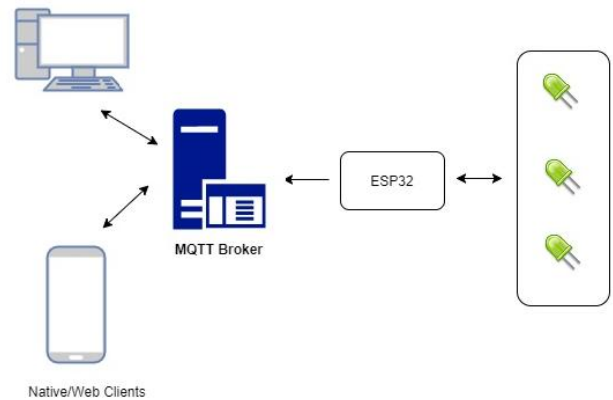


Fig-1 home automation system

Fig-1 explains the proposed system design. Users can send relevant commands to control the home appliances through MQTT broker. ESP32 receives these messages from MQTT broker and control appliances accordingly.

MQTT

Fig-2 explains MQTT architecture. IBM introduced a lightweight Message Queue telemetry Transport protocol to provide machine-to-machine (M2M) communications. MQTT works on top of TCP layer and provides publish/subscribe asynchronous communications. Publish/subscribe provides best IOT services than request/response protocols since clients do not require to wish updates so that it requires less bandwidth. In MQTT broker (server) [24] contains topics. Clients can be act as a publisher and send messages to the broker for a specific topic. Subscribers receive messages from brokers. MQTT is a low overhead protocol even it is running on top of TCP [25]. It also supports request/response of constrained application protocol (COAP). MQTT brokers need username and passwords to provide security which is controlled by Transport Layer Security and Secure Socket Layer (TLS/SSL). COAP has problem of packet loss because lack of TCPs retransmission procedure. In [25] author explained lower loss of packets but it can support less traffic to guarantee reliability. [26] explained MQTT protocol and broker architecture.



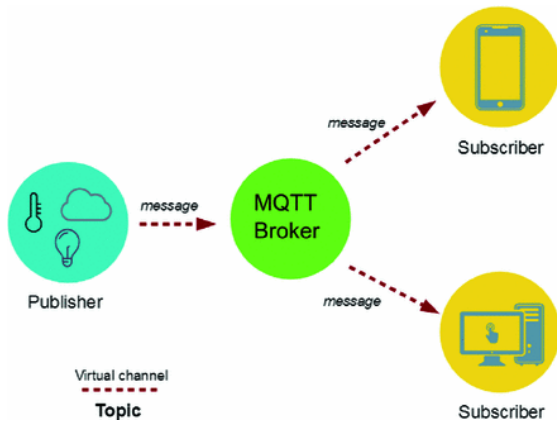


Fig-2 MQTT architecture

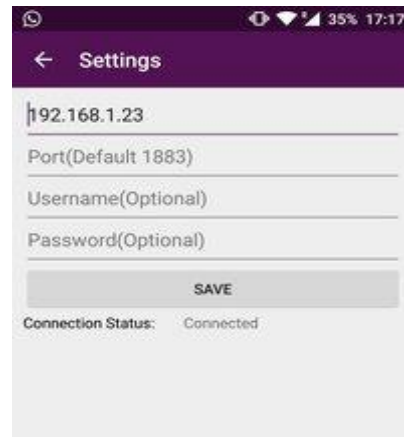


Fig-4 Android MQTT client

ESP32

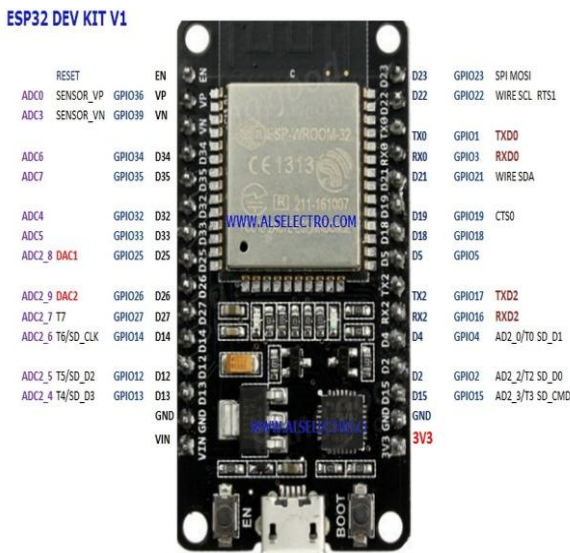


Fig-3 ESP32 development board

ESP32 is a system on chip microcontroller with inbuilt Bluetooth and Wi-Fi. It is a low cost and flexible to develop application for low powered systems. In this application ESP32 microcontroller accept messages from clients sends to respective relays to control the appliances. It has a CPU of Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS with 520 KiB SRAM

CloudMQTT

CloudMQTT is a universal known MQTT broker, used to implement “Internet of Things” (IOT) applications. To configure it, we require to provide server name, user name, password and port number.

IV. PERFORMANCE EVALUATION

Performance of the system evaluated using two different home appliance (Bulb and Fan”). They were connected ESP32 through relays. Free available android MQTT client used to send notifications to the MQTT broker (cloudMQTT).

V. CONCLUSION AND FUTURE WORK

In this I have discussed a home automation system using MQTT and ESP32. To test the system Android MQTT client pre available application has used. But it is not user friendly. As a future work one can develop an android or ios application with good user interface. It helps in controlling home appliances very easily.

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