

Enhanced intelligent home automation security system using IoT and cloud computing security on android platform

Sumit Gupta [§]

Department of Electronics and Communication

SR University

Warangal 506371

Telangana

India

Dheresh Soni [†]

School of Computing Science & Engineering

VIT Bhopal University

Bhopal 466114

Madhya Pradesh

India

Ankur Goyal ^{*}

Department of Computer Science & Engineering

Symbiosis International Deemed University

Symbiosis Institute of Technology

Pune 411016

Maharashtra

India

Arpita Baronia [‡]

School of Computer Science and AI

SR University

Warangal 506371

Telangana

India

[§] E-mail: Sumit.g@gmail.com

[†] E-mail: research.dheresh@gmail.com

^{*} E-mail: ankur_gg5781@yahoo.co.in (Corresponding Author)

[‡] E-mail: arpita.baronia@gmail.com

Shivkant Kaushik[@]

Department of Computer Science & Engineering (AI & DS)

Greater Noida Institute of Technology (GNIoT)

Greater Noida 201310

Delhi/NCR

India

Abstract

With the aid of cutting-edge technology that makes life easier and more accessible, the world has changed through time to become a better place. With home automation, a number of the home's components may be controlled remotely. The primary goal of building a wireless, low-cost home automation smart control system was to provide the security, reduce power consumption and enable automated control from a distance. Home automation is a useful concept and offers a number of advantages, including improved comfort and quality of life as well as security in every house by enabling users to manage electrical devices with their fingers within its range. It makes use of the microcontroller, and Wi-Fi is utilized for connection with the application. The paper is exploring the cloud connectivity with embedded board to perform the home automation system along with security based on the basic protocols of IOT. This manuscript proposed a home automation system for intelligent lighting, gas detection, plant watering system, water tank monitoring and password-based home security system. Developed system includes ready-to-deploy software and real-time HTTP and MQTT protocols monitoring through smartphones or PCs.

Subject Classification: *Primary 68M12, Secondary 90B18.*

Keywords: *Security, Network, IOT, Cloud security, ESP32 board, Hyper text transfer protocol (HTTP), Message queuing telemetry transport (MQTT), Wi-Fi Connectivity.*

1. Introduction

The "Internet of Things" is abbreviated as "IOT." It is a network of real-world physical objects, including automobiles, household appliances, and other things, that are equipped with electronics, software, sensors, and network connectivity [1]. At the core of home automation, there are various IOT protocols that enable communication between the connected devices and the cloud network. Popular protocols include Zigbee, Z-Wave, Bluetooth, and Wi-Fi. Each protocol has different features and capabilities, so it is important to choose the right one for the application. Once the IOT protocols are set up, the user can then access the cloud network to control and monitor their home appliances and systems [2]. The cloud network is

[@] E-mail: kaushikshivkant@gmail.com

the bridge between the user and the connected devices. It is responsible for collecting and sending data between the devices and the user. It also serves as the platform for storing and managing data [3].

1.1 Integration of Cloud Computing with IoT

Integrating cloud computing with IoT creates a powerful combination that enhances the capabilities of IoT devices and provides a centralized platform for data collection, data processing, managing, analyzing, and controlling IoT-related data. Cloud providers implement security measures, encryption, and authentication to ensure the confidentiality and integrity of IoT data [4]. Overall, integrating cloud computing with IoT enables more efficient data management, advanced analytics, improved user experience, and streamlined device control for home automation, security, and a wide range of other applications [5].

This paper is going to demonstrate the various home automation system using IoT system where physical devices and objects that are embedded with software, sensors, and electronics that enable them to collect and exchange data. These devices are connected to the internet, allowing them to be remotely monitored, managed, and controlled. They can also be used to monitor the environment, track assets, and provide real-time data to help inform decisions and improve efficiency. Finally, the article explains the process of sending commands from the web application to the ESP32 board for controlling the light and buzzer. Overall, this paper provides an in-depth analysis of the cloud based embedded system for IOT network.

The paper is divided in 5 sections. The first section explained about the IOT and cloud computing with its features and problem statement. The second section described about the recent work which has been done in the field of security and home automation. Third section explained about the different integrated IOT, Cloud security & home automation system. In fourth section implementation and results in the tabular form were discussed and in the fifth and last section is ended with the discussion about the future work and conclusion of this research work.

2. Related Work

Researchers described about IOT based smart home automation system in 2022, which is operated through web page [6]. They discussed about remote device, but limitation of remotely operated device can

perform operation in a specific range. They introduce the implementation of remote access this through a webpage by providing an easier interface in web. Authors discussed about a new technique of home automation through voice control system. Author discussed about a Google assistant voice command to control home automation system [7]. Household items are controlling with the help of Amazon Alexa device. This system can operate household things like AC, Freeze, Light and fans. All the applications are handled online or manually using a timer.

Authors discussed about home automation smart control power outlet through GSM for low costing and wireless technique [8]. Researchers explained about the solution that can preserve the natural resources and increase the comfort and quality of life. Proposed system can be handled through any android smartphone and make device controlling simpler and user friendly with low cost design and installation. In 2023, authors discussed about transformation of home system through smart home automation with Google assistant voice recognition system. In proposed system they introduced a Node MCU microcontroller for making a communication between device and Wi-Fi [9].

Authors proposed a system which is based on Arduino UNO micro controller and performing dual operation of configuring and engineering to alert the house owner with home security. For ensuring house security, if any unwanted activity is sensed by sensor, then it immediately turn on led and start buzzer to ring [10].

2.1 *Problem statement*

This paper discusses about the security issues in home and provide a solution for home automation. These issues can be solved by using microcontroller Node MCU, sensor and other hardware's along with software.

3. **Proposed Designed**

This section explains the home automation system along with the hardware and software used in the development of system. The Work consists of the following hardware, software, protocols and Apps.

3.1 *Embedded System (ESP32)*

The ESP32 is a low-cost, low-power, highly-integrated system-on-chip microcontroller with Wi-Fi and Bluetooth capabilities. It is connected

to the cloud using HTTP and MQTT protocols, thus allowing them to be remotely monitored and controlled [13]. It can be used to create powerful and secure IoT applications. Cloud services allow for secure data storage, analytics, and machine learning [12]. The ESP32 can also be used to develop applications that can be used to monitor and control devices in a distributed manner [14-15]. The software comprises of a user interface, a controller for monitoring and controlling the system, and a web-based database for storing sensor data. The communication protocol is based on an HTTP protocol, allowing for real-time monitoring of the system from anywhere in the world [11].

3.2 MQTT & Blynk App

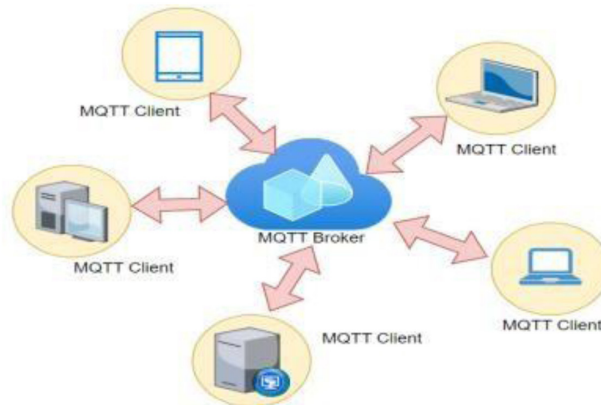


Figure 1

Connection by MQTT protocols

MQTT is a lightweight messaging protocol designed for low-bandwidth, high-latency networks such as Machine-to-Machine (M2M) and Internet of Things (IoT) networks. Figure 1 shows the various connections by MQTT protocol. The protocol provides a secure, reliable, and efficient communication method for IoT devices and networks. MQTT is based on two main protocols: the MQTT Control Packet Protocol (MQTT-CP) and the MQTT Publish/Subscribe Protocol (MQTT-PS) [16]. Blynk is an app that allows users to create and control hardware projects from their smartphone. Blynk provides a library of widgets that can be used to control various aspects of your project including sensors, motors, lights, and more [17-18].

The protocol is designed to be lightweight and efficient, and uses a combination of TCP and UDP protocols to communicate [9].

4. Experimental Setup and Results

4.1 Home Automation 1 - Smart watering system

The system is based on watering the plants using ESP32, relay module, and other basic components. The model is created to control the watering of plants through mobile network from anywhere. The microcontroller is connected to the Blynk mobile app which allows the user to control the water pump remotely as shown in Figure 2.

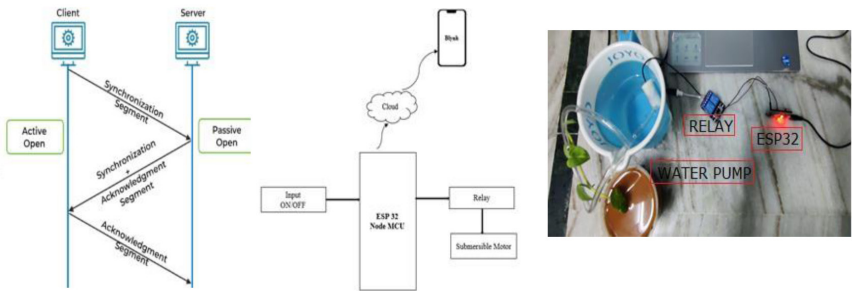


Figure 2

TCP/IP (a) communication pattern (b) Node MCU communication (c) Working diagram of Plant watering system

4.2 Home Automation 2 - Smart Kitchen System

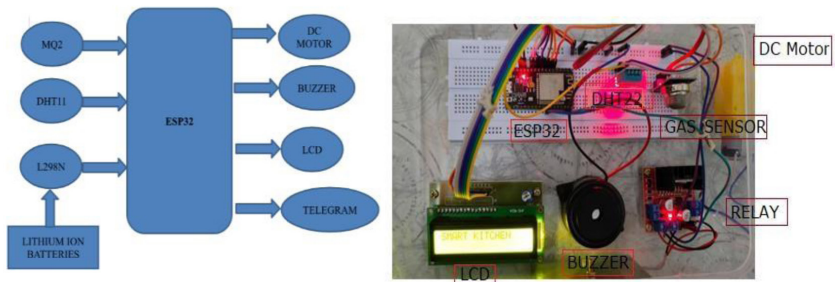


Figure 3

Basic Block Structure & Implementation of Kitchen automation system

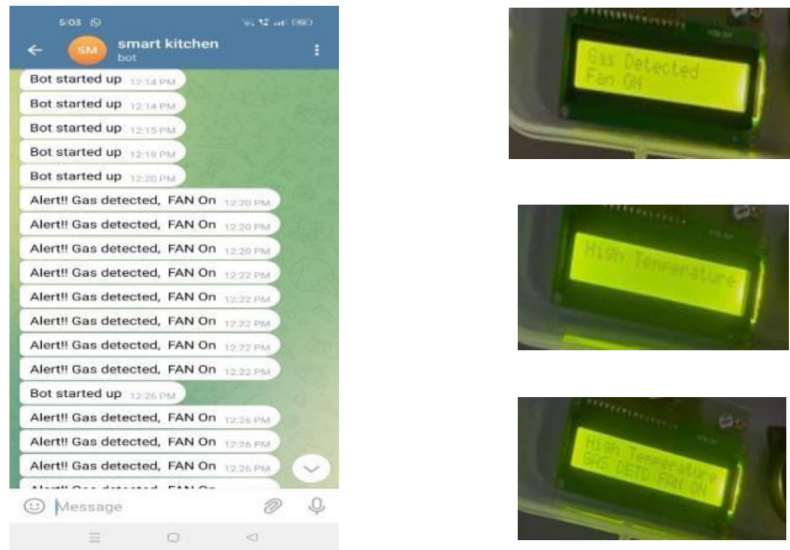


Figure 4

Alerts messaging on Telegram and LCD display for automation of Kitchen

The system consists of a gas detector, an alert system, an exhaust fan, and a temperature sensor. The gas detector is used to detect the presence of gas in the environment. When the gas detector detects the presence of gas, it sends a signal to the alert system. Figure 3 shows the implementation of kitchen automation system with block structure. The alert system then sends a telegram notification to the authorized user to inform them of the gas leakage. The exhaust fan is then activated to reduce the concentration of gas in the environment. The temperature sensor is used to detect any increase in temperature in the kitchen. When the temperature sensor detects a high temperature, it sends a signal to the alert system, which then sends a buzzer sound to the user. The user can then take the necessary action to prevent a fire from starting.

Hardware is arranged as shown in figure 3 for gas detection and user will receive notification on telegram and output message will be shown in display as shown in Figure 4.

4.3 Home Automation 3 - OTP Based Smart Wireless Locking System

In OTP Based Smart Wireless Locking System, we use ESP 32, OLED Display, 4x4 Keypad, Buzzer, LED, Jumper Wires and Servo motor and boot app as shown in Figure 5. When a person switches on the button then

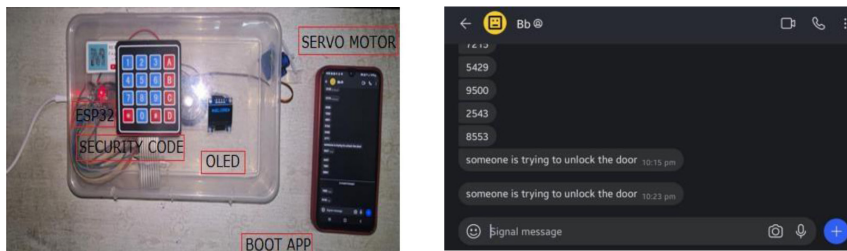


Figure 5

Hardware Setup of OTP based smart wireless locking system & Display system

it sends OTP to the particular person who ever opening the door. When we type that OTP on the keypad the doors will open for 5 seconds. After 5 seconds the door will close. When someone type incorrect OTP then it sends an alert message to the house owner. This makes the people to secure their things safely without any problems.

4.4 Home Automation 4 - Home Lighting Using Local Wi-Fi

“Home Automation,” means employing a system that is connected to the Internet to control lighting and appliances instead of using a manual switch. To operate the home appliances when linked to the Internet, a local web server will be used and generate IP address as shown in Figure 6.

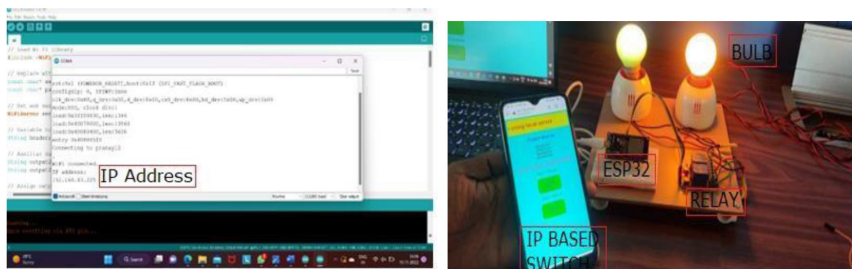


Figure 6

IP Address Generation Real time demonstration of Control of Electric device

4.5 Home Automation 5 - Water Monitoring System

An IOT water tank monitoring system is a technology solution that utilizes sensors; connectivity and data processing capabilities to remotely monitored and manage the water level and other relevant parameter of

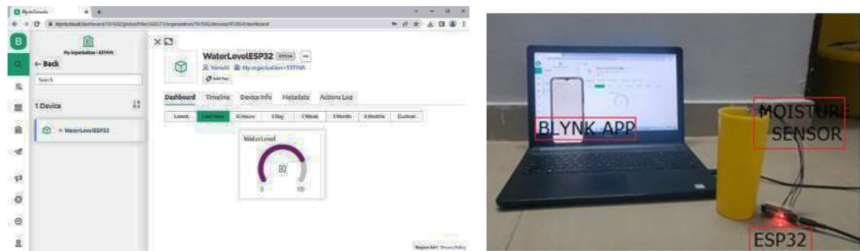


Figure 7

Implementation of water tank monitoring

water tank as shown in Figure 7. This type of system is commonly used in various applications, such as residential, agricultural, industrial, and municipal setting to ensure efficient water usage prevent overflow and optimize water supply management.

Table 1 and 2 give the overall details of the result of all home automation system, which are developed through microcontroller and other hardware devices in this research.

Table 1
Result Matrices

Sr. No.	Developed System	Define matrices	Tested cases	Data collection	Comparative analysis	Accuracy measurement
1	Wi-Fi Based smart watering system for plants	Execution Time Success rate Response time	30	[16, 17]	Better performance Low cost Easy to use	100%
2	Smart Kitching system(gas detection)	Execution Time Success rate Response time	60	[18, 19]	Low cost Early detection Easy operation	100%
3	OTP Based Smart Wireless Locking System	Execution Time Success rate Response time	50	[20, 21]	Improved performance Secure & giving alert Low cost	100%

Contd...

4	HOME lighting USING LOCAL WIFI	Execution Time Success rate Response time	40	[21, 22]	Low cost Manage power usage	100%
5	Water tank water level monitoring System	Execution Time Success rate Response time	30	[22 23]	Easy to use Power Saving Stopping water wastage	99.9%

Table 2
Quantitative Analysis

Sr. No.	Developed System	Quantitative analysis			Error analysis	Visual representation
		Success rate	Response time	Energy saving		
1	Wi-Fi Based smart watering system for plants	99.75%	06 sec	Yes	0.25%	Shown in Figure 2
2	Smart Kitching system	99.6%	10 sec	Yes	0.04%	Shown in Figure 4, 3
3	OTP Based Smart WirelessLocking System	100%	5 sec	Yes	0.01%	Shown in Figure 5
4	HOME lighting USING LOCAL WIFI	100%	3 sec	Yes	0.01%	Shown in Figure 6
5	Water tank water level monitoring System	98.9%	7 sec	Yes	1.1%	Shown in Figure 7

5. Conclusion

This research paper presents a solution for home automation using embedded board and cloud connectivity and provides the security. The system is designed for intelligent lighting and employs basic IOT protocols such as HTTP and MQTT for real-time monitoring of the system. The system allows users to monitor, control as well as access real-time sensor data stored on a cloud server. Overall, this paper provides a practical

approach for implementing a cloud-connected embedded system for home automation and security system. Incorporating AI and ML into home automation can transform our living space, making the more efficient, comfortable and personalized. These techniques predict the human appliance usage behaviour, increase electrical efficiency, security and surveillance, Predictive maintenance etc. As these technologies mature, they have the potential to make our living space smarter, more connected and more responsive to our needs and preference. But it is also important to consider the data security and privacy are major concern while implementing these technologies.

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