University of Petroleum & Energy Studies

Final Project Report

On

IoT Smart Home Automation using Node MCU

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Executive Summary

An IoT-based home automation application and a Node MCU ESP8266 are used in this project. Home automation involves controlling lights, appliances, entertainment systems, and temperature without the use of a manual switch. Additionally, components for home security like access control and alarm systems could be included. A network of linked things, including home appliances, is known as the Internet of Things (IoT).

To control household devices like lightbulbs connected to relays in our home automation system, we will use an application. In order to wirelessly accept orders from a smartphone, the Node MCU ESP8266 Wi-Fi Module will access the internet. To encode the ON/OFF signal and send it to the server and ESP8266 Board, the best IoT platform is needed. As a result, we design our own application. Without internet access, it is impossible to finish this job.

Using our sensors, connections, platforms, and other end-to-end capabilities, we can build the "Home Automation" internet of things project. With capabilities like switch mode control, a means to check the devices' condition, and knowledge of the current humidity and temperature levels, the program is designed to run on mobile devices. The system was created using a microcontroller called the Node MCU, which helps with system control. Relay modules are then used to show and control the status of the appliances. Here, we may connect a variety of gadgets that the user can utilize and operate whatever they see fit.

 Once you've chosen whatever gadget you wish to use, you may turn it on using the buttons. Once it has acknowledged your instruction, it uses the program we have developed to send a signal to the circuit. The device's capacity to fulfill your request is aided by the relay module. The work is finished since the ON/OFF instruction was followed. The system, which is in charge of controlling the electrical equipment, can be used in households, small workplaces, and shopping centres. for online or intranet remote access to equipment. Internet is used to control the equipment in the environment outlined above. After selecting the device that you want to use, you can switch it on using the buttons. Once it has acknowledged your command, it sends a signal to the circuit using the program we have created. The relay module aids the device's ability to carry out your request. Since the ON/OFF command was followed, the work is complete. The system, which is in charge of managing the electrical apparatus, is applicable to homes, little offices, and shopping malls. for remote equipment access through the internet or an intranet. The equipment in the previously described setting is controlled over the internet.

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1. **Background**

1.1 Aim

The aim is to design a system that establishes wireless remote control over a network of home appliances. With the use of our sensors, connections, platforms, and other end-to-end capabilities, we can build an internet of things project called "Home Automation." The application is designed to run on mobile phone providing features like, switch mode control, a provision to view the status of the devices, current humidity and temperature status on the application itself. The system was developed with the use of the Node MCU, a microcontroller that facilitates in system control. Following this and relay module are used to show and control the status of appliances. We can connect a variety of gadgets here that can be utilized and operated anyway the user finds most convenient. The device you want to operate is chosen, and you may use the buttons to turn it ON or OFF. Once it acknowledges your command, it sends a signal to the circuit through the application we have created. Relay module helps in the device's ability to fulfil your request. The ON/OFF command is carried out and hence the task is completed. The system can be implemented in homes, small offices and malls as well, being in-charge of control of the electrical appliances. For remote access of appliances in internet or intranet. The appliances in the above-mentioned environment can be controlled in intra-network or can be accessed via internet

With the help this home automation system you would be able to control your home appliances such as Tv, Fan, Bulb, LED's, etc. with the help of your smartphone from anywhere around the globe. An Esp8266 Module (Node MCU) will accept the commands from your smartphone wirelessly through the internet.

1.2 Technologies

- Smart home appliances linked to the system are controlled by a mobile application
- Appliances are connected to wi-fi through ESP8266 Wi-Fi module
- The Node MCU is the primary microcontroller that oversees the entire system.
- Relay modules are electronic switches used to operate appliances. Using a relay module, we can turn on or off a device by sending a command through a mobile application.
- The DHT22 is a basic, low-cost digital temperature and humidity sensor. Using this, we can send the live room's temperature and humidity to the Cloud through Node MCU.
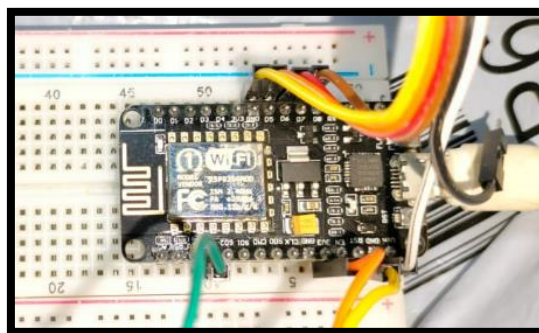
1.3 Hardware Architecture

Fig.1 Node MCU

• Node MCU: Node MCU is an open-source platform for creating embedded Wi-Fi systems, is based on the well-known ESP8266 Wi-Fi Module. The Node MCU Development Board comes equipped with serial communication protocols, analogue ports, and wi-fi functionality. The Node MCU ESP8266 Wi-fi Module will take commands wirelessly over the internet from the phone.
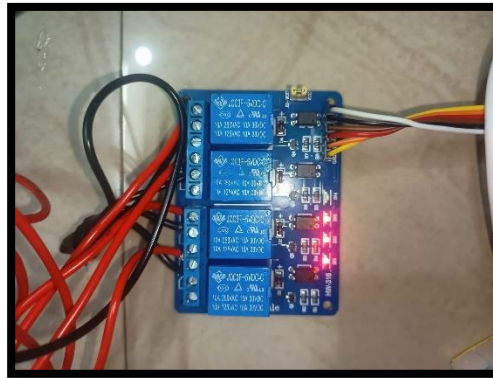
Fig.2 Relay Module

• 4-channel Relay Module (5V): Relay modules are used to regulate a variety of high current equipment and appliances. It has high-current relays that operate at either AC250V or DC30V 10A. It is meant to communicate with different microcontrollers such as node MCU. It also comes with an LED to indicate the status of relay. Using voltage and/or current considerably higher than what Node MCU could handle, a relay enables you to turn on or off a circuit. Relay offers total isolation between the high-voltage side managing the load and the low- voltage circuit on the Node MCU side. The Node MCU, which controls electrical equipment like fans, lights, and air conditioners, supplies 5V to activate it.
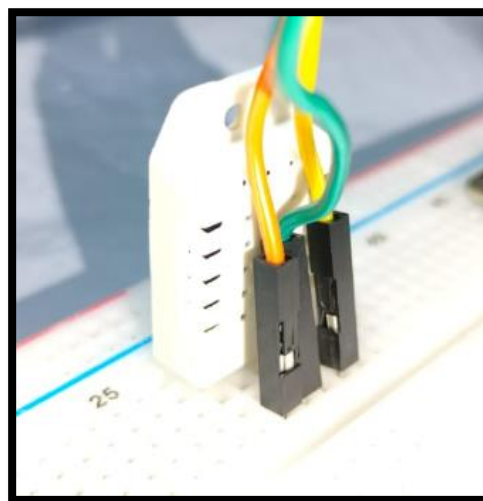

Fig.3 DHT22

• DHT22: A straightforward digital temperature and humidity sensor is the DHT22.It measures the humidity and temperature of the air around it using a thermistor and a capacitive humidity sensor, and it outputs a digital signal on the data pin without the requirement for analogue input pins. Both 3.3V and 5V can be used to power the sensor.

The Home Automation system is used to control home appliances from your Phone/Laptop. This system comprises of a NODE MCU board with an ESP8266 WI-FI Module, and a Relay Module, and a few appliances connected to it. The system's main microcontroller is the NODE MCU. The ESP8266 WI-FI Module is used to operate home appliances and conduct wireless communications with the phone. Relay module is an electrical switch that manages AC appliances. We use a Relay Module to turn the Device ON or OFF by sending commands like "ON" and "OFF" from the phone/laptop through the mobile application.
Smart home appliances linked to the system are controlled by a mobile application then Appliances are connected to wi-fi through ESP8266 Wi-Fi module and Node MCU is the

primary microcontroller that oversees the entire system.
Relay modules being an electronic switch is used to operate appliances. Using a relay module, we can turn on or off a device by sending a command through a mobile application. the DHT22 is a basic, low-cost digital temperature and humidity sensor. Using this, we can send the live room's temperature and humidity to the Cloud through Node MCU.

1.4 Software Architecture

A program has to be developed with an efficient logic to run and execute the designed wireless home automation system. The focus of this project is to automate the process of triggering the home appliances. We can easily turn on and off a variety of devices in this mobile application for the home automation project because we can see the device's status, which lets us know whether it's on or off. We can also use this application to control other devices, such as fans and bulbs, and we can check the temperature and humidity levels.

2. System

2.1 Requirements

2.1.1 Functional requirements:

Functional requirements denote the functions that a developer must build into the software to achieve use-cases. The functional requirements for automation system are thus, according to use-cases described in User Requirements section:

• Add device.

• Remove device.

• Display device status.

• Change device status.

These functions will be implemented such that they enable vendor independent system-to-system communication. The functionality of the automation system interface shall be implemented in such a way that it is homogeneous, based on standards, and convenient to use, according to the requirements stated in User Requirements section.

2.1.2 User requirements

• **Change the Status of a Device:** The person also wants to control devices included in automation system. This can be accomplished either by using the aforementioned "Device Dashboard" page. The "Device Dashboard" page shows information about the current status of a device. Updating a device goes as follows:
1. Open the mobile application.
2. Go to the dashboard.
3. Navigate to either the device through the registered device name.
4. Press the Slide Button to on/off the device. This sends the data through cloud and end to the ESP8266.
At last, the status of the device will change successfully.

• **See the Status of a Device:** When devices have been added, the person may want to see the status of the device(s) included in the system. This is accomplished through a page called "Device Dashboard," which shows an overview of all device status. If no devices have been added to automation system, the "Device Dashboard" explains this.

Checking the device status as follows:
1. Open the mobile application.
2. Go to the dashboard.
3. Navigate to either the device through the registered device name.
4. And you can check the device status through the status switch.

2.2 Design and Architecture

In this section, the conceptual design of a home automation system is described. The system is outlined in Fig 2. The user can connect to cloud-base server directly from their smart phone or tablet, depending on user's choice and the network connection.
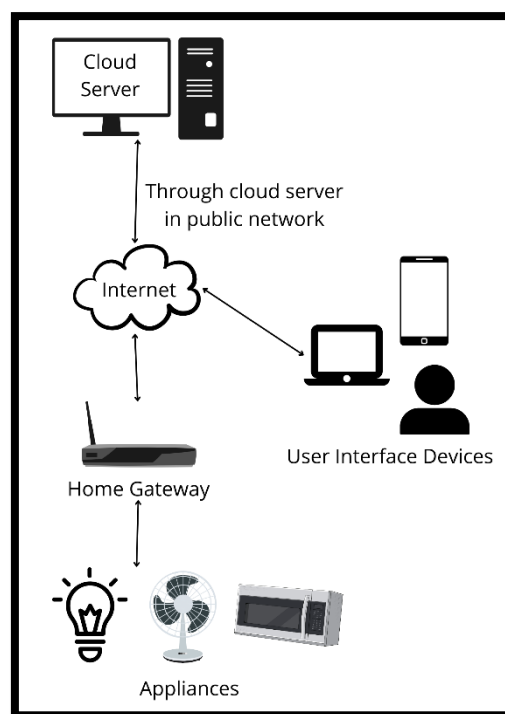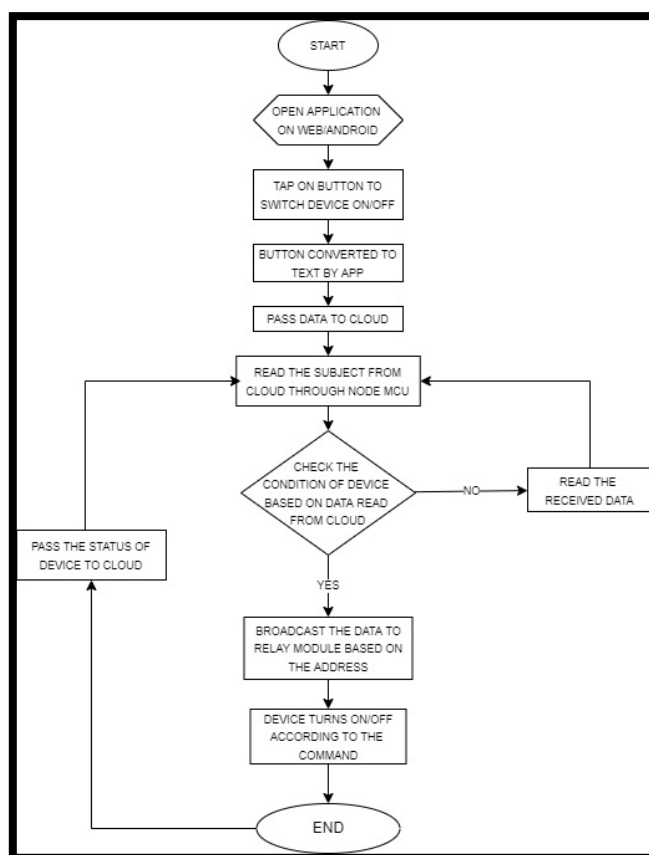

Fig.4 Home Automation Architecture

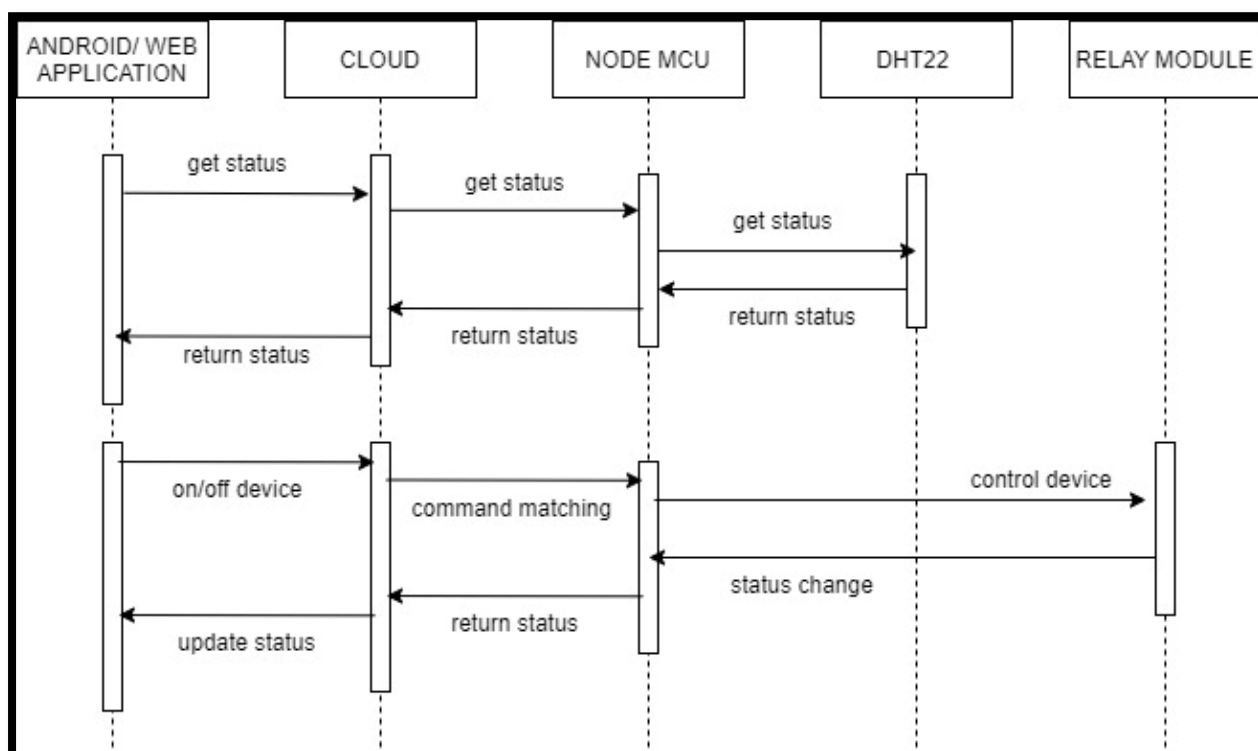Fig.5 Process-Flow Flowchart

Information Flow

Fig.6 Sequence Diagram

2.3 Implementation

Accessing the device through browser on phone/laptop:

Hardware Implementation:

The hardware requirements are- one Node MCU, one 5V relay with multiple channels, multiple Male to Male, and Male to Female jumper cables, one external power adapter and any home devices or appliances (Here, 3 bulbs are used). Figure shows the hardware setup.

Fig.7 - Hardware setup

The output of the relay will be connected to the 3 bulbs. The GPIO pins on relay will be connected to node MCU pins. This is how the node MCU will be able to send commands to relay to close or open the connection to the bulbs which will turn it ON/OFF. The GPIO pins are connected according to the node MCU as shown in figure.
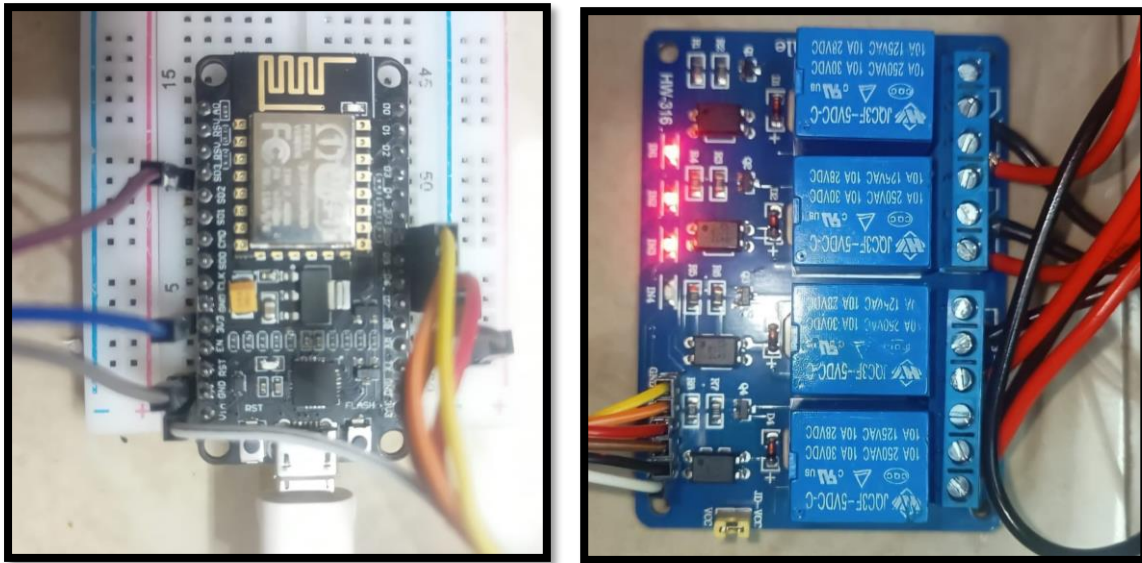
Fig.8 Node MCU Pinout Mapping Guide

Software implementation:

We have created a mobile application that we use to configure our home automation project and quickly turn on and off the various devices. Here we have added a temperature sensor through which we can easily get the room temperature. We can also include a variety of devices, such as fans, bulbs, TVs, and other items so that can be easily controlled by a mobile application. Through the mobile application, the data is transferred to the cloud. Assume that the information needed to turn on a device has been sent. As a result, data is now processed in accordance with the appliances and converted in such a way that the node can determine the name of the appliance and what to do with it. The data will be transferred to the node MCU after being converted. The data will be sent, the requested action will be carried out, and the response will be communicated to the cloud if the Node MCU is connected to the internet. Like this, the smart home appliances are linked to the system and are controlled by a mobile application where appliances are connected to wi-fi through ESP8266 Wi-Fi module.
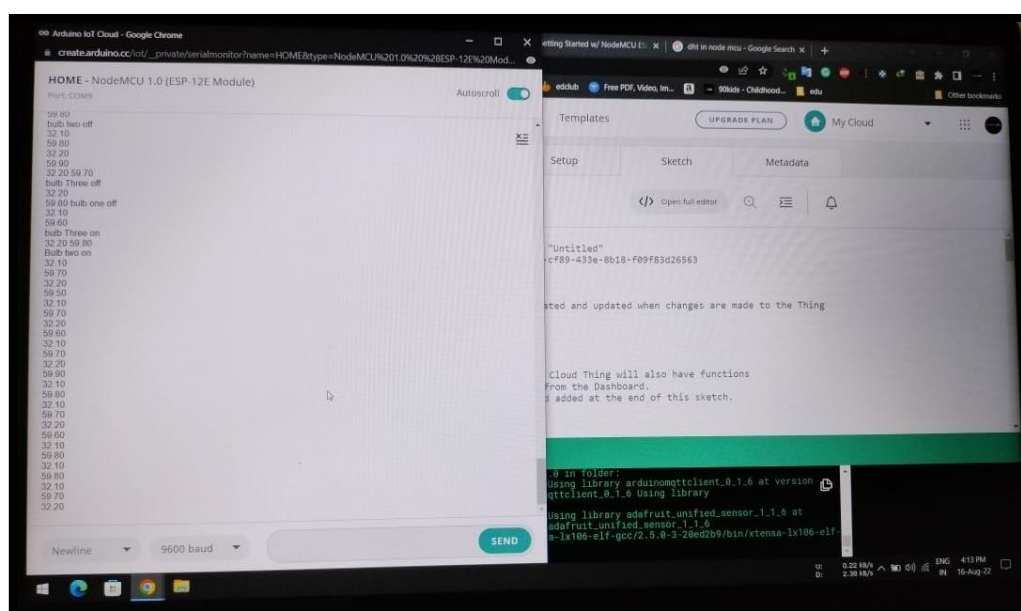

Fig.9 Serial Monitor

2.4 Testing

2.4.1 Test Plan Objectives

Testing is required so that we can determine whether or not errors have occurred. Avoiding errors at an early stage of development is one of the goals of testing hardware and software. Similar to home automation systems, mobile applications require user interaction in order to get the desired results. Therefore, it is imperative that our project be developed and tested often in order to obtain better results in the future.

Testing enables us to spot flaws in the system so that it can be fixed and the client's needs can be satisfied without the system failing to carry out the necessary task. Effective testing methods guarantee a complete decrease in the occurrence of software faults.

2.4.2 Test Strategy

Through the testing of our application's code and hardware, we have validated our project. Testing is crucial because we need to know whether our code is operating flawlessly or not. We gradually connected our devices in order to understand how they functioned and how they changed. We checked whether the humidity and temperature sensor are functioning properly and whether the bulbs(appliances) were turning on/off.
- We consider the following two factors to be crucial from a testing perspective: The device functions, and the bulb switches on/off.
- The room's temperature and humidity.

These two factors led us to conclude that our home automation project was successful.

2.4.3 Basic Test

Test Case ID:	Automation
Related UC/FR/NFR	System /Reliability, performance, reliability, maintainability.
Date:	19-08-2022
Purpose:	Testing the automation to check the errors
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection
Test Data:	Automation
Steps:	Steps to carry out the test. See step formatting rules below. 1. Open the mobile application 2. Further options like Control devices, Check temperature will open. 3. Check the status bar for condition of connection.
Status:	Pass

Test Case ID:	Automation
Related UC/FR/NFR	Temperature detection, receive message/Reliability, performance, availability, maintainability.
Date:	19-08-2022
Purpose:	Testing the automation to check the errors
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection, DHT22
Test Data:	Room Temperature

Steps:	Steps to carry out the test. See step formatting rules below. 1. Open the Application. 2. Further options like Control devices, Check temperature will open. 3. Check Temperature Graph and table Check Live graph to see the change.
Status:	Pass

Test Case ID:	Automation
Related UC/FR/NFR	Light on/off, receive message/Reliability, performance, availability, maintainability.
Date:	19-08-2022
Purpose:	Testing the automation to check the errors
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection, Device/Appliance
Test Data:	Light
Steps:	Steps to carry out the test. See step formatting rules below. 1.Press the automation button 2. Further options like Control devices, Check temperature will open. 3.Press the switch option and further test automation. 4.Press the Bulb ON option • Light 5.Press the Bulb OFF option • Light 6. The command sends to Esp8266 through RF transmitter and RF receiver receives the signal. 7.Relays are attached to Esp8266 and perform the function.
Status:	Pass

Test Case ID:	Automation
Related UC/FR/NFR	Light and fan on/off, gate open/close, temperature detection, smoke detection, IR security/performance, reliability, maintainability, availability, portability.
Date:	19-08-2022
Purpose:	Testing web-page automate home if in case of a mobile crash.
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection
Test Data:	Pressing buttons to perform on/off functions for home appliances.

Steps:	Steps to carry out the test. See the step formatting rules below. 1. Press the automation button 2. Further options Control devices from web Dashboard, Check temperature will open. 3. Press the switch option and further test automation. 4. Press the Bulb ON lounge option and further automation • Light 5. Press the Bulb OFF option and further automation • Light 6. The command sends to Esp8266 through RF transmitter and RF receiver receives the signal. 7. Relays are attached to Esp8266 and perform the function.
Status:	Pass

2.4.4 Recovery Test

Test Case ID:	Automation
Related UC/FR/NFR	Light and fan on/off, gate open/close, temperature detection, smoke detection, IR security/performance, reliability, maintainability, availability, portability.
Date:	19-08-2022
Purpose:	Testing the Esp8266 to automate the reconnection to cloud in case of an any crash.
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection
Test Data:	Portable Keypad by pressing slide buttons to perform on/off functions for home appliances.
Steps:	Steps to carry out the test. See the step formatting rules below: 1. Disconnecting the device from internet. 2. Check serial monitor for the action taken to reconnect. 3. Observe that the esp8266 return to connected state after internet return. 4. After restoring the connection with cloud check the all operations are working.
Status:	Pass

2.5 Graphical User Interface (GUI) Layout

Application design:

We have an application that we can use to configure our home automation project and quickly turn on and off the various devices. We added a status bar that informs us of a device's status, such as whether it's on or off, and we can include a variety of devices, such as fans, bulbs, TVs, and other items that can be easily controlled by our mobile application. We configured the status bar so that we can use it to check the temperature and humidity levels using this application.
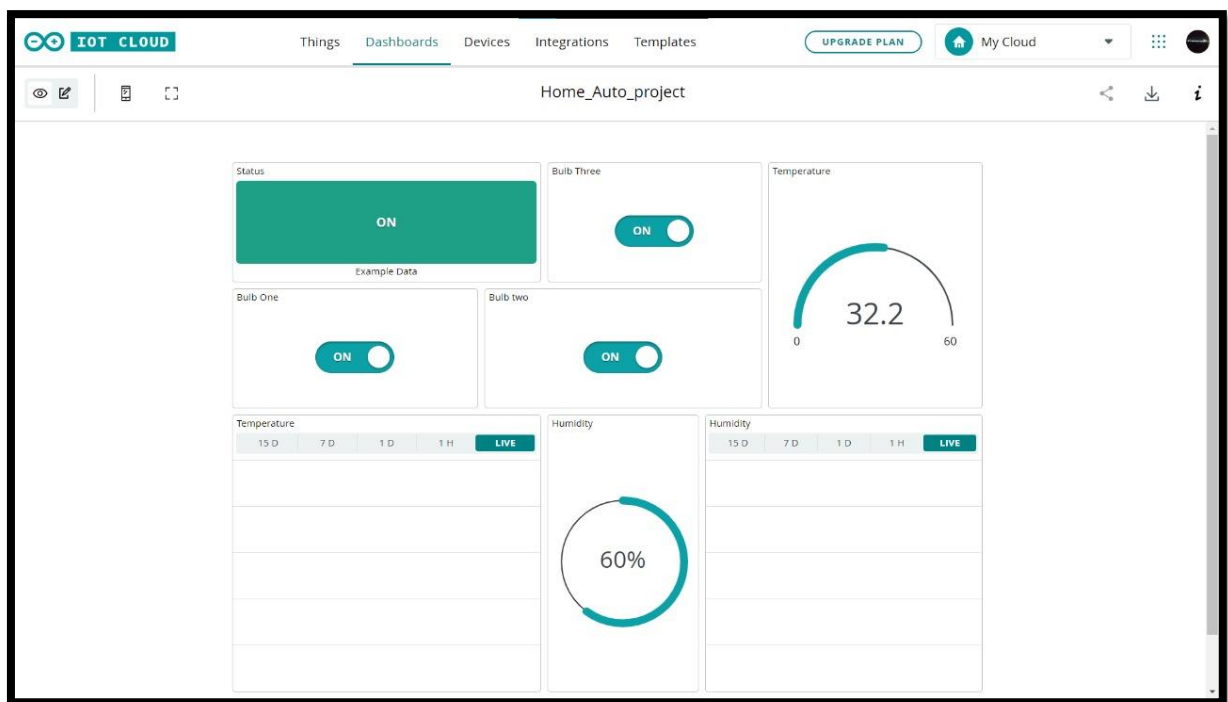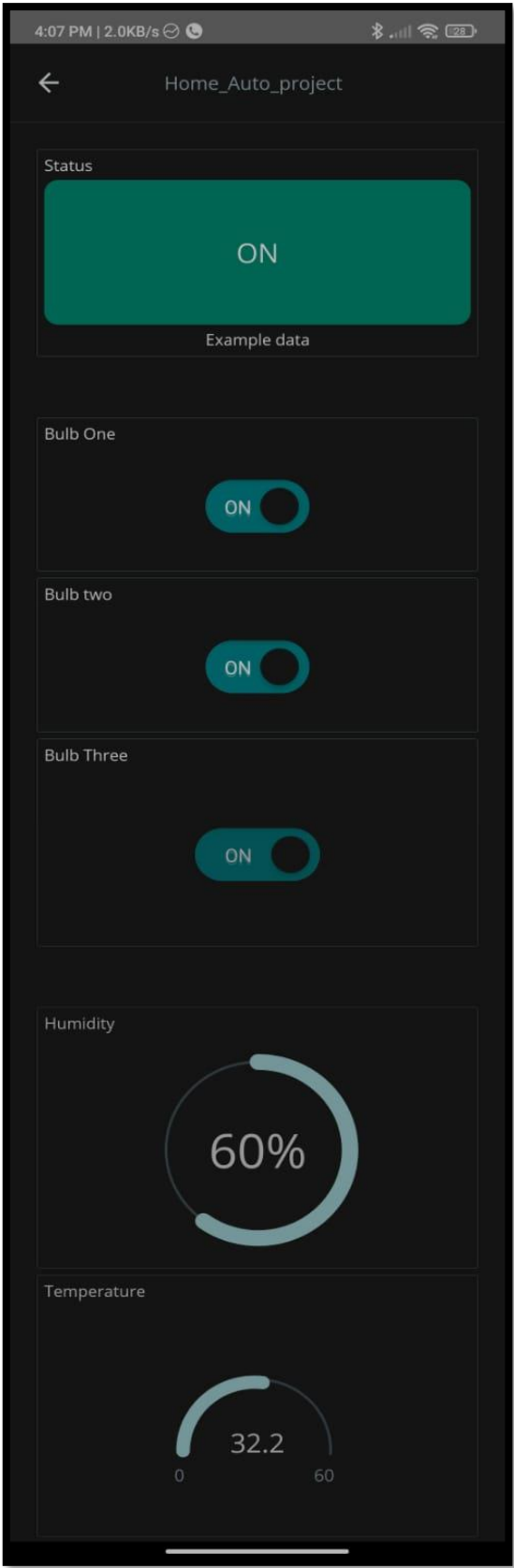

Fig.10 Laptop Dashboard

Fig.11 Mobile Dashboard

2.6 Customer testing

Test Case ID:	Login(customer)
Related UC/FR/NFR	Login /Reliability, performance, reliability, maintainability.
Date:	19-08-2022
Purpose:	Testing the customer login to check the errors
Pre-Req:	Using Node MCU, Mobile, Relay Module, Internet connection
Test Data:	Admin login(customer)
Steps:	Steps to carry out the test. See the step formatting rules below. 1. Visit the admin Login page. 2. Enter the correct and assigned login id and password to access the application.
Status:	Pass

3. Snapshots of the Project

Fig.12.2 Devices turned OFF

Fig.12.2 Devices turned ON

4. Conclusions

An architecture for low-cost, adaptable home management and monitoring system using Node MCU is suggested and put into practice in this final report. Numerous mobile and smart devices are used to operate household appliances. With such a design, a mobile phone can become a portable remote control for home automation. It should be emphasized that the suggested method is not limited to home automation; instead, it may be used to manage various industrial devices directly from a distance. The system can be expanded to include a variety of other options using this system as a foundation, such as home security features like open-door and motion detection, energy monitoring, or weather stations. The device only provides internet security at the moment via the Wi-Fi network to which it is linked, but more focused security implementation is required. Here are a few potential home automation features that remind us that there is a great need for new automated systems and that the level of integration grows yearly. As a result, fewer and smaller systems with many functions will be able to incorporate increasingly more functionalities. Automation must exist because it can affect how efficiently people use resources like time, energy, and space in buildings.

5. Further development and research

Future homes will supply most necessities, including communication, healthcare, energy, utilities, entertainment, and security. As we approach the next generation, more and more devices will be able to communicate with one another. A world without the need for manual byte input would be the optimum situation for data transmission between machines and people. Computers that can automatically mine data and then use that data to change aspects of the home environment are the ones who will rule the future. For instance, a smart thermostat that can detect a room's temperature automatically and change the central heating and cooling systems accordingly, or a washing machine that can automatically identify its load and schedule itself to finish washing at a certain time. All of

these objectives are being pursued by engineers and rely on developments in big data computing in addition to data mining technology. With the help of your smartphone, you can control, monitor, and secure your house with Pert, a new invention in home automation. The smart home will be viewed as an efficient method of providing remote healthcare services by the future healthcare provider, particularly for the elderly and disabled who do not require intense healthcare support. You can anticipate that the home of the future will be much more automated than the one we live in now as technology continue to improve.

6. References

Software used:

- **diagrams.net**: diagrams.net is a completely free diagram editor. diagrams.net for Chrome OS is a completely free, diagramming application custom built for Chrome OS. No registration, no limitations, no catches. Used to create flowchart and sequence diagram.
- **IOT cloud**: The IoT Cloud is an online platform that makes it easy for you to create, deploy and monitor IoT projects. Used to create the application UI.
- **Canva**: Canva is a free-to-use online graphic design tool. Use it to create social media posts, presentations, posters, videos, logos and more