CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTION ABOUT THE PROJECT: A smart home incorpates sensors, actuators, middleware,and a network and has two major interacting components which is a smart network and a smart load. The Smart home known as House automation or Home Automation, with the use of new technology, to make the domestic activities more convenient, comfortable, secure and economical. The Internet of things can be defined as connecting the various types of objects like smart phones, personal computer and Tablets to internet, which brings in very newfangled type of communication between things and people and also between things. With the introduction of IoTs, the research and development of home automation are becoming popular in the recent days. Many of the devices are controlled and monitored for helps the human being. Additionally various wireless technologies help in connecting from remote places to improve the intelligence of home environment. An advanced network of IoT is being formed when a human being is in need of connecting with other things. IoTs technology is used to come in with innovative idea and great growth for smart homes to improve the living standards of life. Internet helps us to bring in with immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption.

1.2 PROBLEM STATEMENT: Nowadays, people with the hectic daily life routine sometimes makes them forgetful to switch off the devices at home. As a human being we can't run from the clumsiness attitude plus with our packed daily routine life that sometimes makes ourselves such in hurry situation that sometimes makes us forgot to switch off the lamps. It will cause the electricity bill rose sharply. Besides, it is one of the electricity wastages that will lead the earth to become an unhealthy one. Besides, the elderly and the handicapped user faced problem to manually access control of devices like light, fan etc. instead of automation process. Lastly, no one is aware of luxurious property before lost. If there is a CCTV installed, they can see the footage after lost but cannot inform or notify before lost or at the time of occurrence. This means we think we have a high security. But it is a low security one.

1.3 OBJECTIVES OF THE PROJECT: The main objective of this project is to control the devices such as lamp, fan, door etc. at home using smartphone.

- ✓ To design one system that is related with home appliances using NODEMCU which can be control using mobile application from anywhere around the world and that can be installed at every home and office at lowest possible cost.
- ✓ To implement a home appliance that can help user to control the devices at home.
- ✓ To develop a good condition of house area that will prevent any loss and damage to the property of any organization.
- ✓ To view the status of home appliances on the application.
- ✓ To save the electricity, there is a timer mode for a device by selecting the time. After the time is over, that device will be auto off.
- ✓ To get the notification of a sensor data. For example, notification will be sent to the user if -
  - someone enters to his/her private area.
  - his/her room temperature is high or low.
  - there is a leakage in gas and many more.

1.4 PROJECT FOCUS: Project has focus on two main area of home which are electricity and security, and come up with two solutions: -

I. Smart Switch with timer based.
II. Notification based on Sensor's values.

1.5 ORGANIZATION OF REPORT: The entire Project is composed of five chapters. each covering a section of work as summarized below:

• Chapter one introduces automation as a whole and the different types of automation. And define project objectives and problem statements.

• Chapter two covers an extensive background overview of project working and which technology are involved in development with establishment of standards and protocols and benefits.

• Chapter three highlights the project methodology, and comprehensive details on project development timeline.

• Chapter four is on the system design with DFD, ERD, Circuit Diagram, Flow Chart and Block Diagram.
• Chapter five is on the project testing and implementation with clear practical details of the project design, construction, testing, microcontroller coding and debugging. Special emphasis is also made on the flexibility and scalability of the project work with real life illustration.
• Last chapter is on the conclusion and recommendations based on the project work with emphasis on the reliability, maintainability, and flexibility of the design. Also, recommendations based on the challenges encountered and further possible development of the project work.

CHAPTER 2 – BACKGROUND MATERIAL

2.1 CONCEPTUAL VIEW OF HOMIE APP:

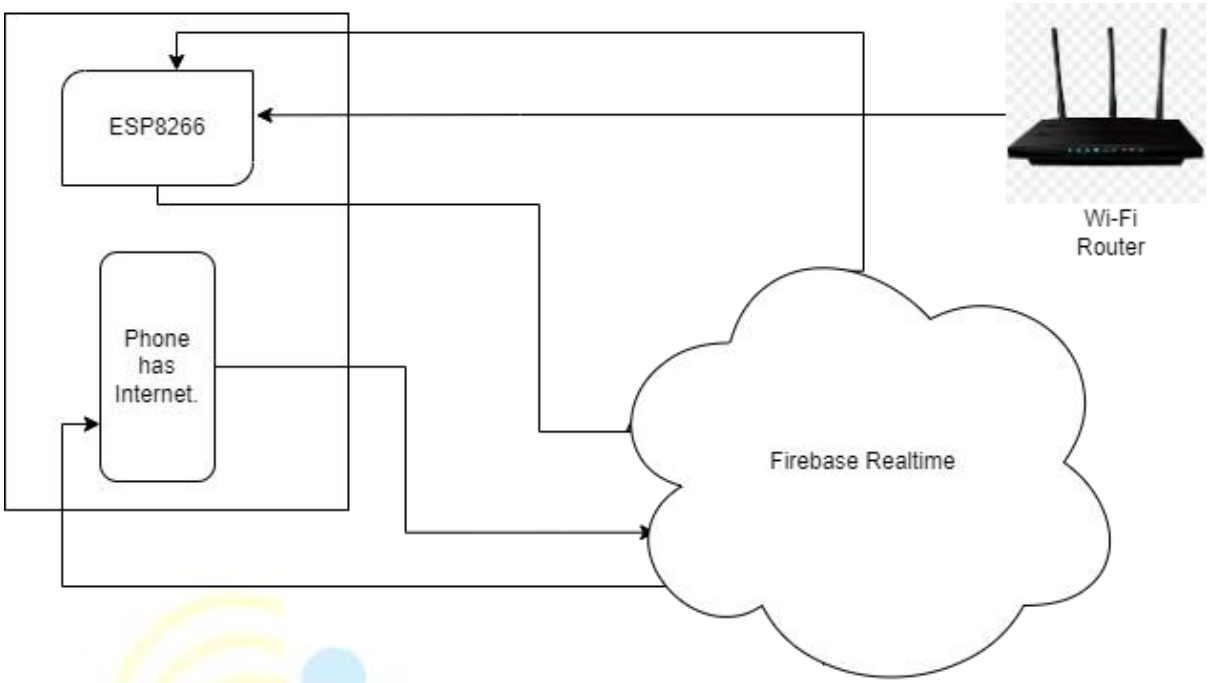


Figure: Conceptual View of the app

2.2 TECHNOLOGIES INVOLVED IN THE PROJECT:

Hardware Requirement Specifications

- ✓ Node-MCU ESP8266 Wi-Fi Module
  - Type - 32-bit micro-controller
  - CPU - 160MHz
  - GPIO -16 pin
  - Memory - 4MB
- ✓ Cables and Connectors
- ✓ 5v 1amp micro–USB Adapter
- ✓ 5v DC Single Channel Relay
- ✓ DHT-11 Sensor
- ✓ LDR sensor
- ✓ 9W Bulb
- ✓ Wire and Sockets
- ✓ Jumper Wires
- ✓ Ultrasonic Sensor
- ✓ Emulator

Software Requirement Specifications

- ✓ Arduino IDE 2.1.0 using C++.
- ✓ Flutter Framework 3.10.5 on VS Code IDE 1.79.2
- ✓ Dart 3.0.5
- ✓ Java 17.0.2
- ✓ Google Firebase Realtime Database

IOT (Internet of Things) as a term has evolved long way because of convergence of multiple technologies, machine learning, embedded systems and commodity sensors. IOT is a system of

interconnected devices assigned a UIDS, enabling data transfer and control of devices over a network. It reduced the necessity of actual interaction to control a device. IOT is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. The Arduino IDE 2.0 is an improvement of the classic IDE, with increased performance, improved user interface and many new features, such as autocompletion, a built-in debugger and syncing sketches with Arduino Cloud.

Flutter is a mobile app development platform created by Google. It allows developers to create web, desktop, and cross-platform apps that run on Android and iOS devices. Flutter uses a reactive programming language called Dart, making development faster and easier than traditional methods.

C++ is an object-oriented programming language which gives a clear structure to programs and allows code to be reused, lowering development costs. C++ is portable and can be used to develop applications that can be adapted to multiple platforms.

Node-MCU (Node Microcontroller Unit) is an open-source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. When purchased at bulk, the ESP8266 chip costs only Rs 370 apiece. That makes it an excellent choice for this project. Figures 4 and 5 show the Node-MCU ESP8266 Wi-Fi module.

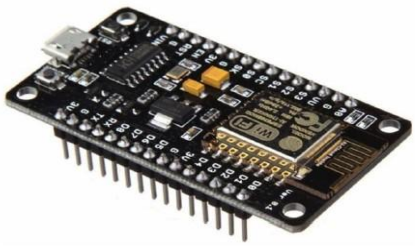


Figure 4. Node MCU Development Board.

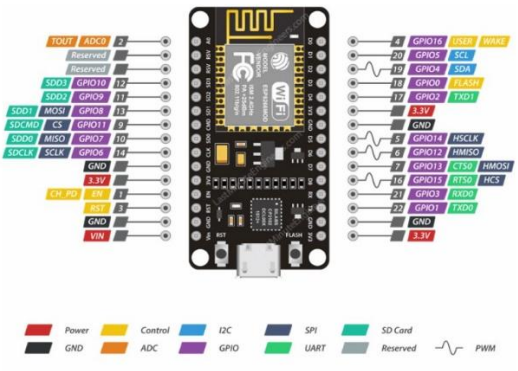


Figure 5. ESP8266 Node MCU pinout.

Bulb is used for real home appliances.

Relay is an electrical device which is generally used to control high voltages using very low voltage as an Input.

Figure: Relay Single Channel

Three inputs:

- VCC = 5V is needed
- GND = Common Ground, 0V
- IN = Control signal need to be ~~5V~~ 0V to activate the Relay (Active Low)

DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low-cost humidity and temperature sensor which provides high reliability and long-term stability. Only three connections are required to be made to use the sensor – Voltage, Ground and Output.

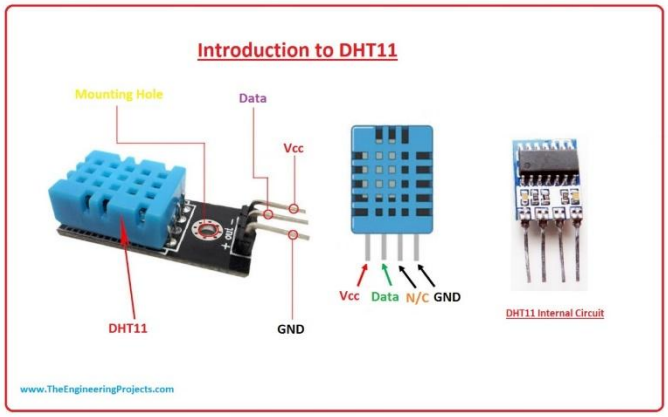


Figure: DHT-11

Packages used in the project: Some packages will be installed but I don't mention the names. These are some packages that I used. They are given below:

cupertino_icons: ^1.0.2
google_fonts: ^4.0.4
firebase_core: ^2.9.0
firebase_database: ^10.1.0
simple_animations: ^5.0.0+3
flutter_svg: ^2.0.4
lottie: ^2.3.1
cloud_firestore: ^4.5.0
firebase_auth: ^4.4.0
google_sign_in: ^6.1.0
animated_text_kit: ^4.2.2
shared_preferences: ^2.1.0
provider: ^6.0.5
searchbar_animation: ^0.0.4
easy_loading_button: ^0.3.2
flutter_loadingindicator: ^1.0.1
awesome_dialog: ^3.0.2
syncfusion_flutter_charts: ^21.1.39
multi_dropdown: ^1.0.9
slide_countdown: ^0.5.0

liquid_pull_to_refresh: ^3.0.1
flutter_staggered_animations: ^1.1.1
shimmer: ^2.0.0
connectivity_plus: ^4.0.1
anim_search_bar: ^2.0.3
animated_splash_screen: ^1.3.0
flutter_launcher_icons: ^0.13.1
flutter_native_splash: ^2.2.19

CHAPTER 3 – METHODOLOGY

3.1 DETAILED METHODOLOGY THAT WILL BE ADOPTED: This section represents which development cycle project used and how it is implemented.

Software development cycle:

This project used iterative software development. An iteration incorporates a loosely sequential set of activities in business modelling, requirements, analysis and design, implementation, test, and deployment, in various proportions depending on where in the development cycle the iteration is located. Iterations in the inception and elaboration phases focus on management, requirements, and design activities; iterations in the construction phase focus on design, implementation, and test; and iterations in the transition phase focus on test and deployment.

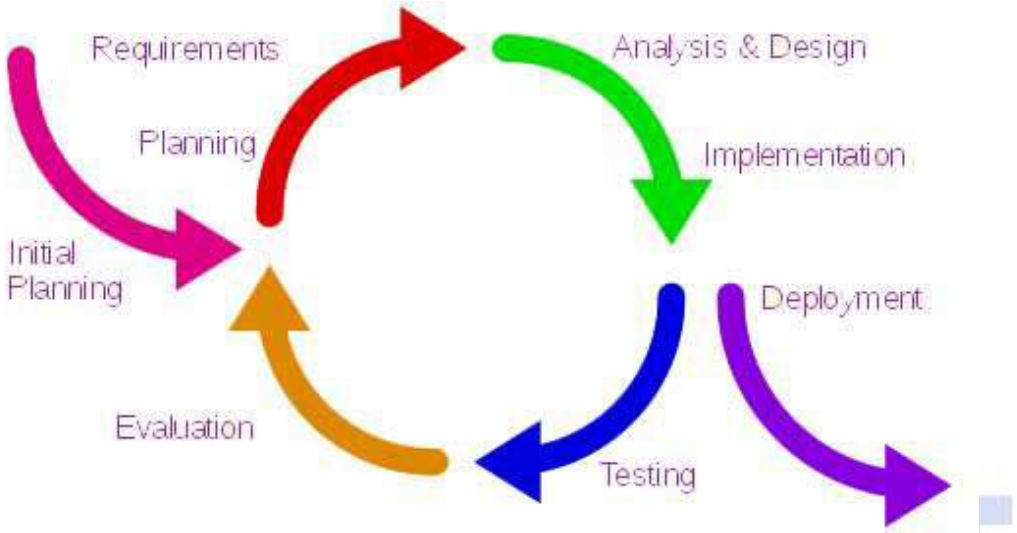


Figure 3.1 Software Development Cycle

Project benefits using **Iterative implementation**:

An iterative approach is generally superior to a linear or waterfall approach for many different reasons.

- Risks are mitigated earlier because elements are integrated progressively.
- Changing requirements and tactics are accommodated.
- Improving and refining the product is facilitated, resulting in a more robust product.
- Organizations can learn from this approach and improve their process.
- Reusability is increased.

3.2 OVERALL PROJECT TIMELINE:

Development of Application:

This development required high amount of time to develop due to two different platform. Total six Iterative cycles were required to refine the device into perfect working condition.

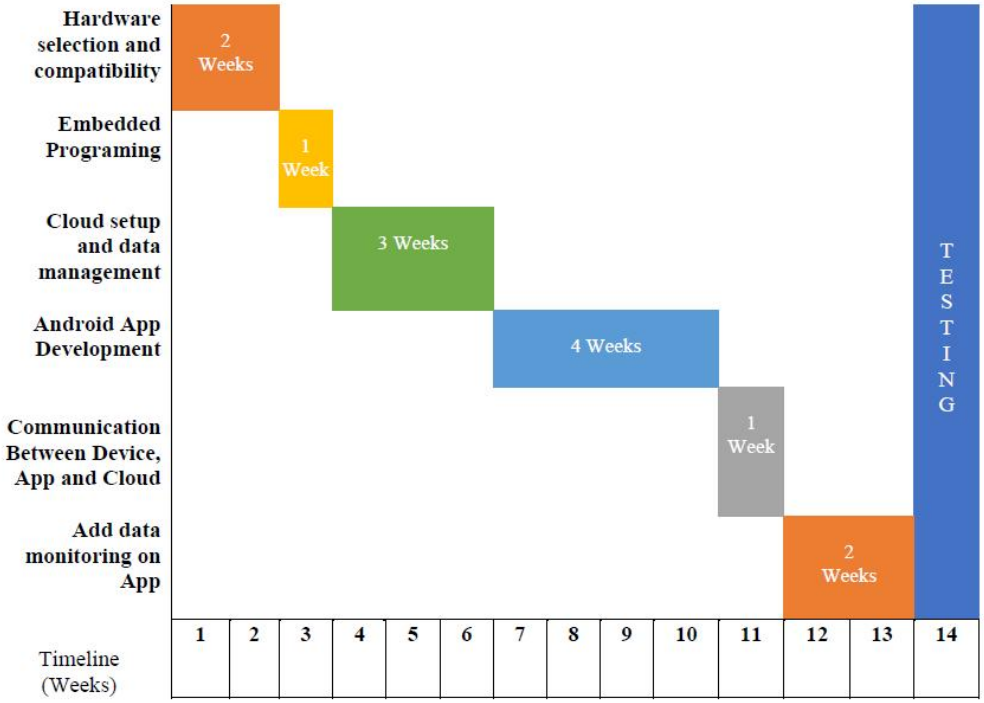


Figure: Project Timeline

CHAPTER 4 – SYSTEM DESIGN

4.1 DATA FLOW DIAGRAM: A data flow diagram (DFD) maps out the flow of information for any process or system.

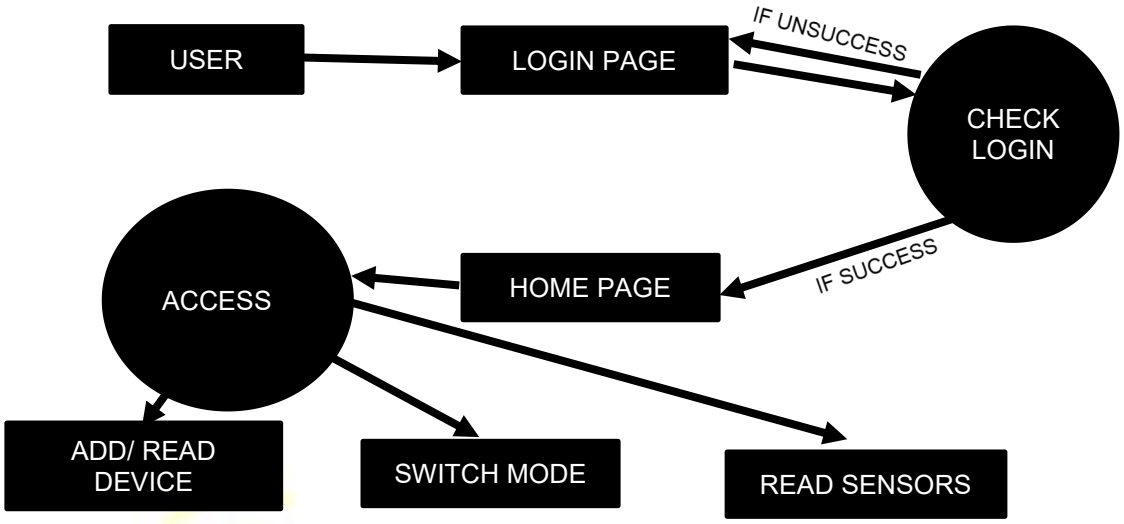


Figure: DFD for User

4.2 ENTITY RELATIONSHIP (ER) DIAGRAM: An ER diagram show the relationship of entity sets stored in a database. It is visualizing how the information produced is related.

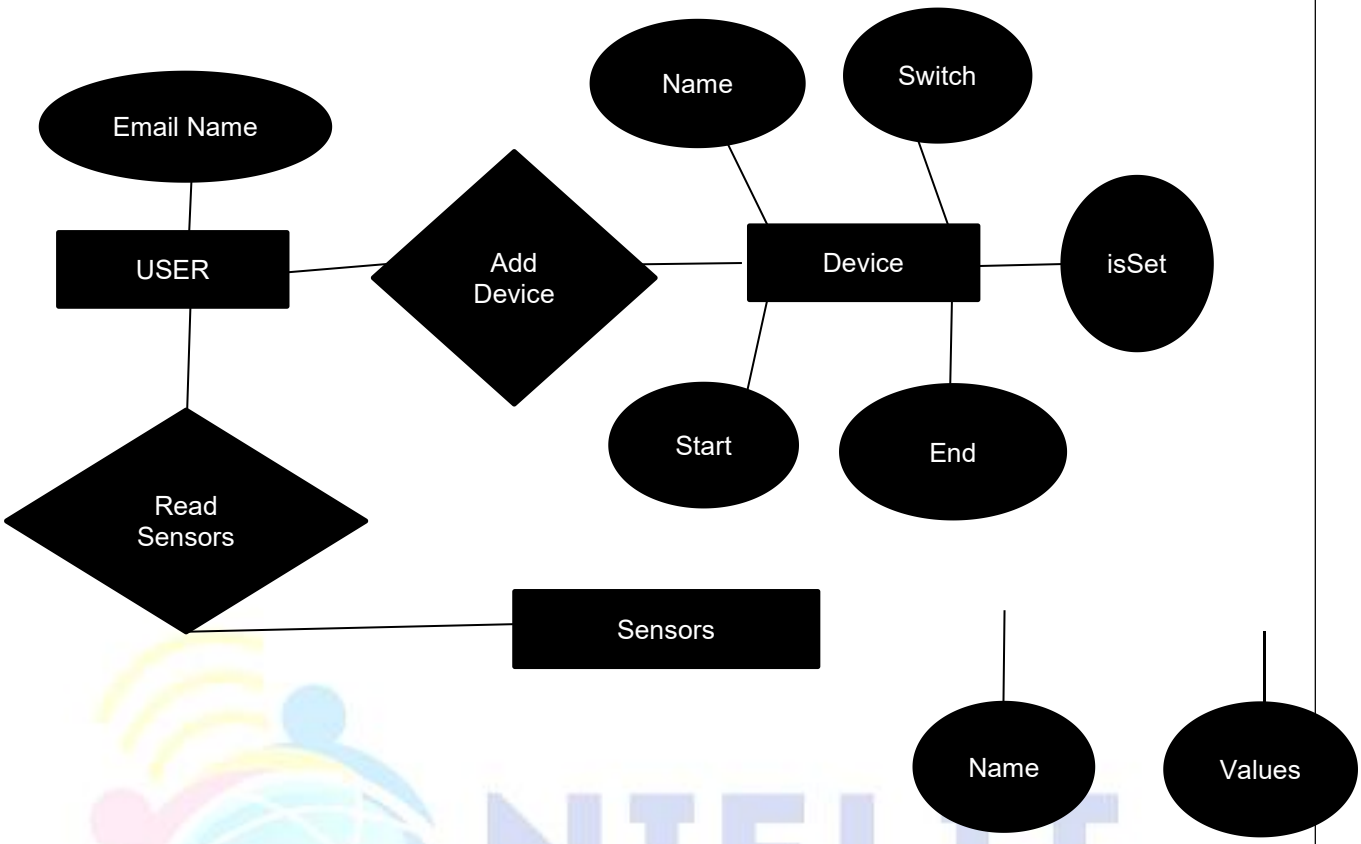


Figure: ER Diagram for User

4.3 FLOWCHART: A flowchart is a graphical representation of a process or system, illustrating the sequence of steps or actions involved in achieving a specific objective. It uses various shapes and symbols to depict different elements of the process, making it easier to understand and communicate complex procedures visually. Flowcharts are commonly used in various fields, including software development, business processes, engineering, and education.

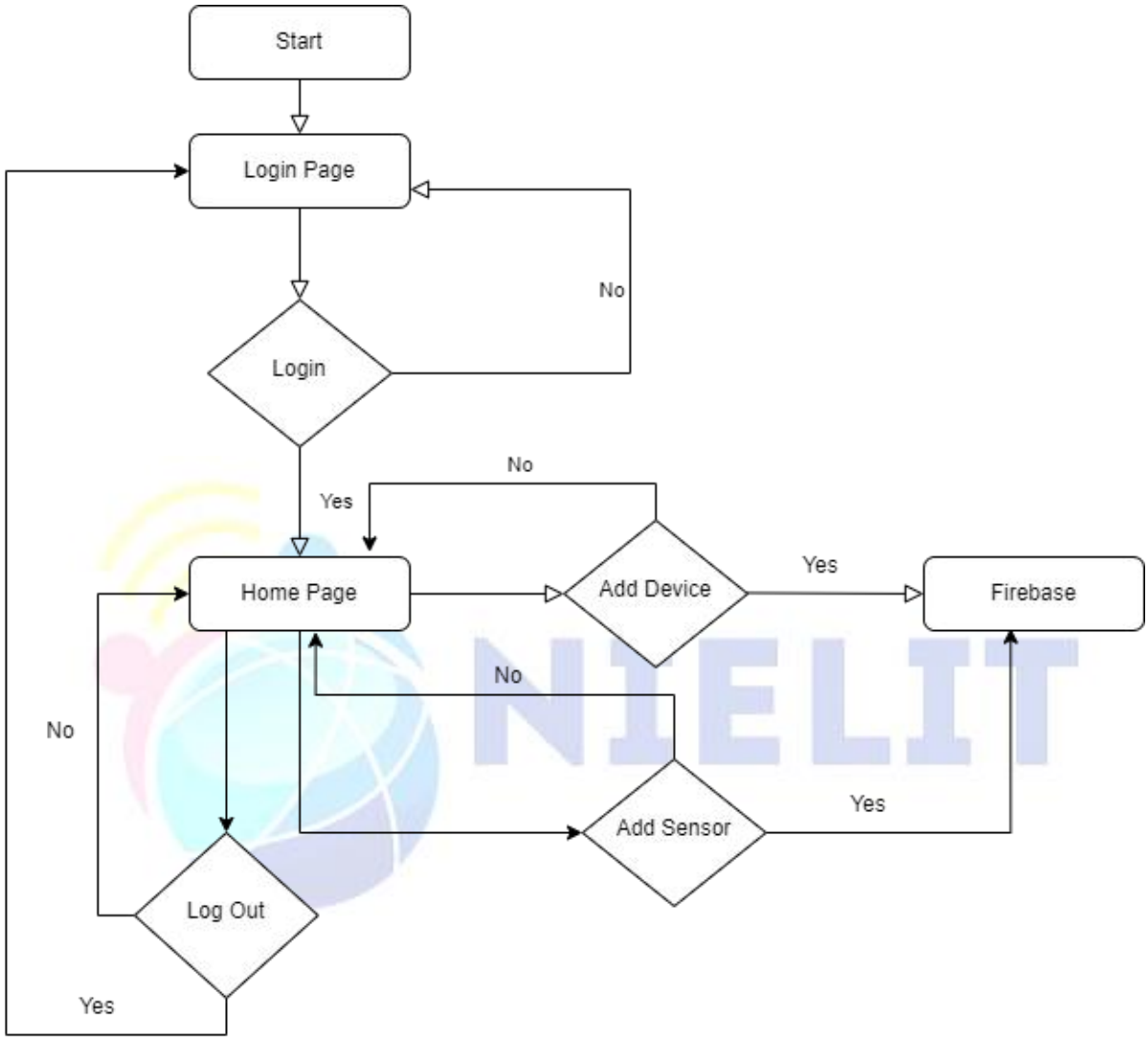


Figure: Flowchart for the Homie

4.4 BLOCK DIAGRAM: A block diagram is a type of graphical representation that illustrates the components or stages of a system, process, or concept using blocks or rectangles connected by lines. Each block represents a specific function, element, or subsystem, and the lines connecting them indicate the flow of information, data, or signals between these blocks. Block diagrams are commonly used in various fields, including engineering, electronics, computer science, and system design, to provide a high-level overview of complex systems or processes.

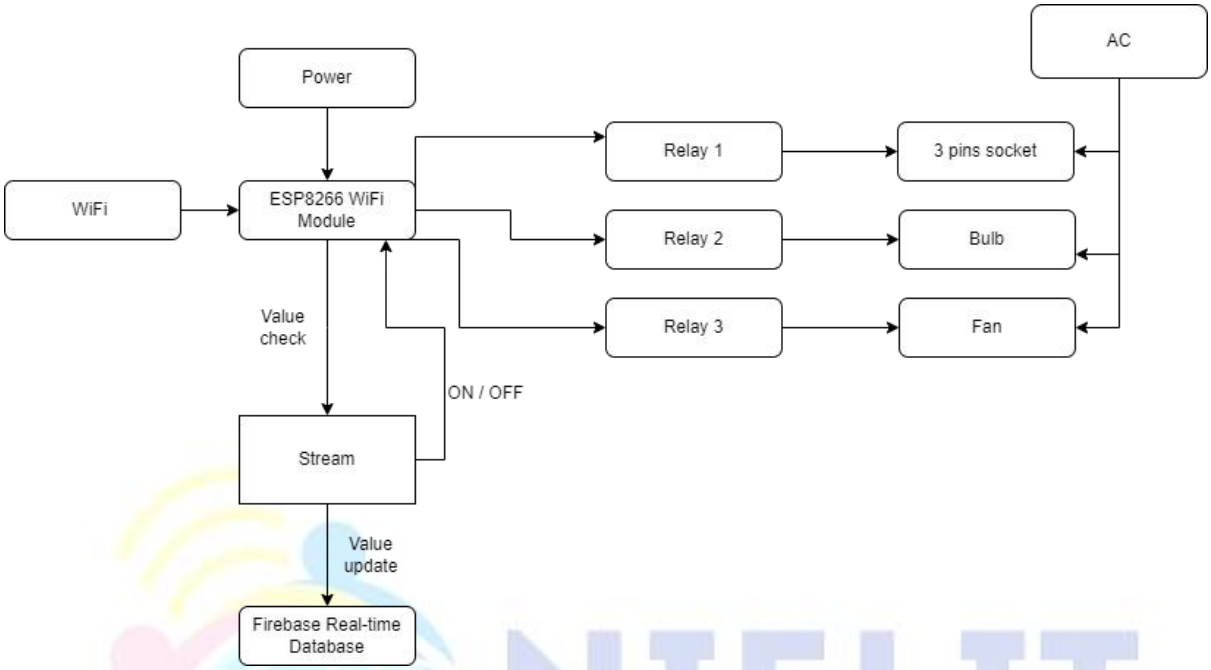


Figure: Block Diagram for ESP8266

4.5 HARDWARE CIRCUIT DIAGRAM:

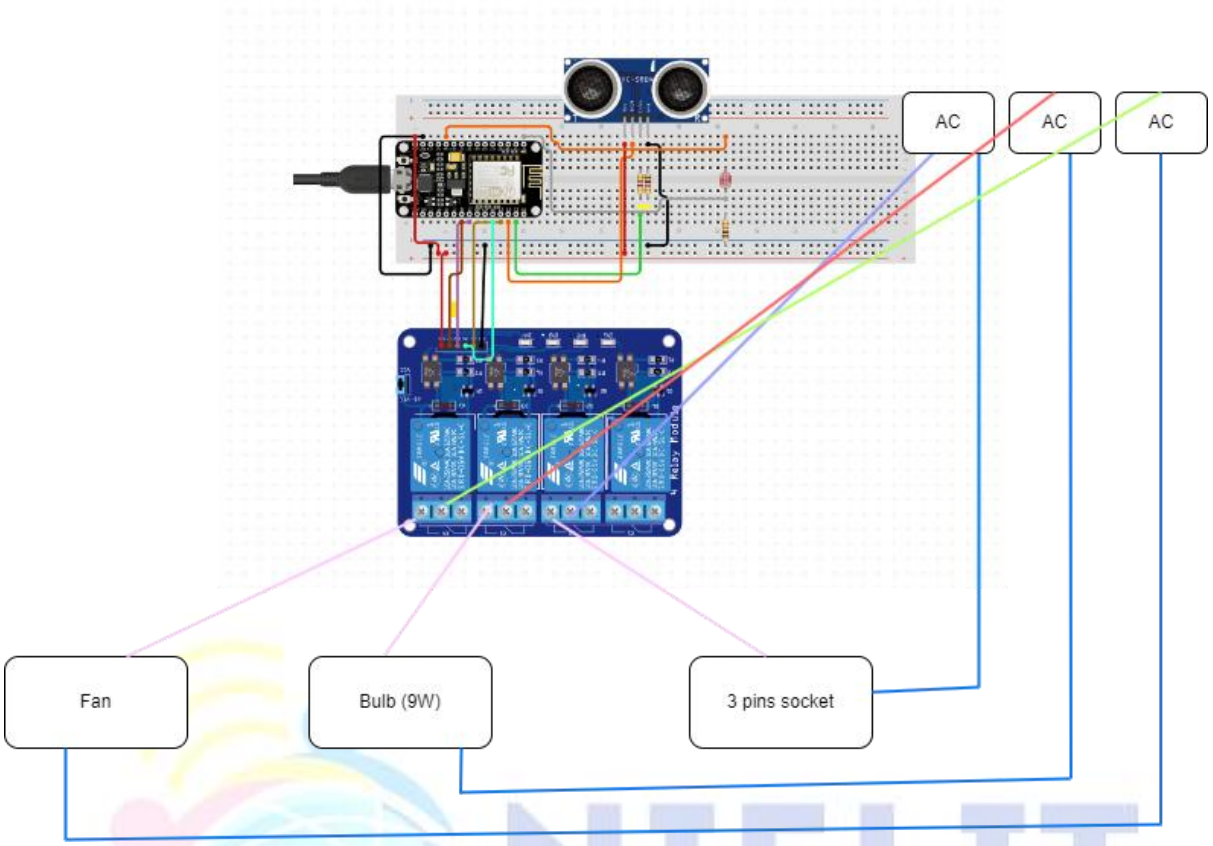


Figure: Hardware Circuit Diagram

CHAPTER 5 – IMPLEMENTATION

5.1 SYSTEM TESTING: The Homie App underwent rigorous system testing to ensure its reliability and performance. The testing phases included unit testing, integration testing, functional testing, usability testing, performance testing, security testing, and compatibility testing. The systematic testing process identified and resolved bugs, optimized performance, and confirmed the app's compatibility across multiple devices and platforms.

a. **Unit Testing**: Individual components of the Homie App were tested in isolation to ensure their proper functioning. This included testing various modules for device control, user interface, IoT device connectivity, and data handling.

b. **Integration Testing**: Integration testing was conducted to validate the seamless communication and cooperation between different modules of the app. Data flow and interactions between components were thoroughly examined to ensure a cohesive system.

c. **Functional Testing**: Functional testing aimed to verify that the Homie App met all specified functional requirements. The team ensured that users could control IoT devices, adjust settings, and receive feedback as expected.

d. **Usability Testing**: Usability testing was performed to evaluate the app's user interface and user experience. Feedback from users helped identify areas for improvement, leading to a more intuitive and user-friendly interface.

e. **Performance Testing**: Performance testing assessed the app's responsiveness and speed under various scenarios. Resource consumption was analyzed to ensure optimal performance, even under heavy user loads.

f. **Security Testing**: Security testing was of utmost importance, considering the app's control over physical devices. Potential vulnerabilities were identified and addressed to safeguard user data and ensure secure communication.

5.2 IMPLEMENTATION:

a. **Mobile App Development**: The HOMIE App's mobile application is developed using the Flutter SDK, ensuring a native-like user experience on both Android and iOS devices. The app development process involves the following steps:

UI Design: User-friendly and intuitive UI/UX design is created to ensure easy navigation and seamless control of room devices.

Flutter Widgets: A wide range of Flutter widgets, including Material Design and Cupertino widgets, is utilized to implement various UI elements, such as buttons, sliders, and text fields.

Networking and Communication: The app integrates secure communication protocols (HTTPS) and RESTful APIs to establish a connection with the ESP8266 microcontroller, enabling real-time data exchange.

b. **ESP8266 Firmware Development**: The ESP8266 firmware is programmed using the Arduino IDE, following these steps:

Wi-Fi Configuration: The ESP8266 is configured to connect to the user's home Wi-Fi network, allowing communication with the HOMIE App.

FirebaseEsp8266: It is a library that enables ESP8266 microcontrollers to communicate with Google's Firebase Realtime Database and Firebase Authentication. Firebase is a powerful cloud-

based platform provided by Google, offering various services for building, and managing mobile and web applications. The FirebaseESP8266 library allows ESP8266-based devices to interact with Firebase's real-time database, store and retrieve data, and authenticate users securely.

Multipath Stream: Multipath stream refers to the capability of the ESP8266 to establish multiple concurrent network connections with remote servers or devices. The ESP8266's multipath stream feature allows it to handle multiple communication streams simultaneously, enhancing its ability to manage various tasks efficiently.

Device Control: The firmware is designed to receive commands from the HOMIE App and execute appropriate actions on the connected room devices.

5.3 USER FEEDBACK: Feedback from early users of the Homie App was collected and analyzed to gauge its usability and identify potential areas for improvement. Overall, users appreciated the app's user-friendly interface and its ability to effectively control room devices. Some users suggested additional customization options for scheduling and scene management, which could enhance the app's functionality further.

5.4 SYSTEM MAINTENANCE: Continuous system maintenance is vital to keep the Homie App operating efficiently. Regular bug fixes, security updates, hardware compatibility checks, and performance optimizations have been implemented to ensure a seamless user experience. Data backups and recovery mechanisms were also set up to protect against data loss.

5.5 PROTOTYPE: A prototype is built and used. The prototype is working as expected. The one with 3 pin socket and bulb is used for devices controlling with timer mode and the other is used for measuring room like temperature and humidity by DHT11, detecting the distance of a particle or whatever moves by Ultrasonic sensor where it is placed, reading light density by LDR and a buzzer for entering the protected area. Figures are given below:

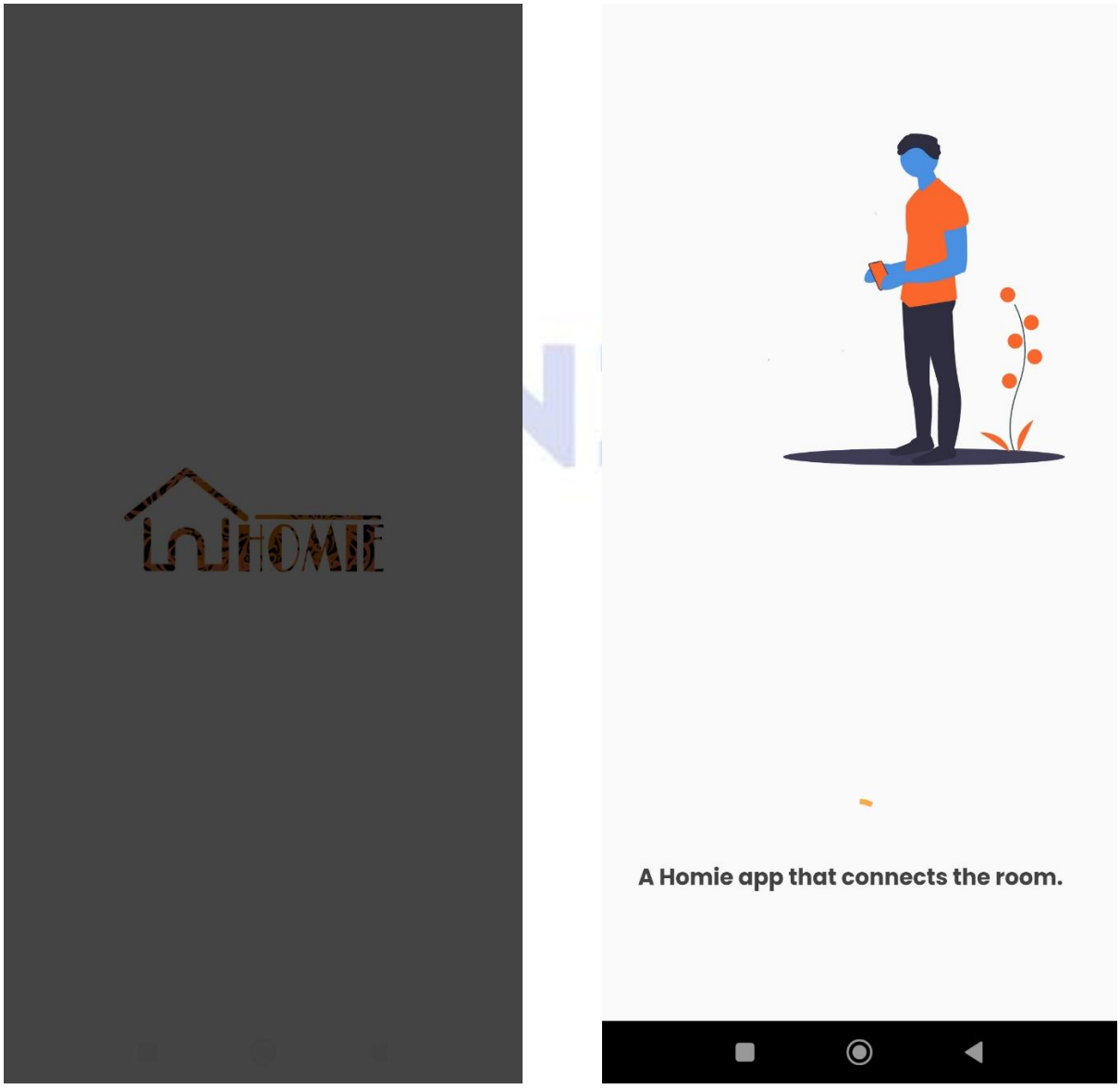
Figure: Prototype of HOMIE app

5.6 WORKING: After setting up all the necessary connections, upload the code to Node-MCU ESP8266 Wi-Fi Module Board and provide the power supply of 5V. Once the system is powered ON, ESP8266 scans the Wi-Fi and connects to the defined Wi-Fi SSID. After it is connected, Firebase shall begin to perform stream. If any changes in the Firebase, it will be shown in the Serial monitor and perform action according to the data changed.

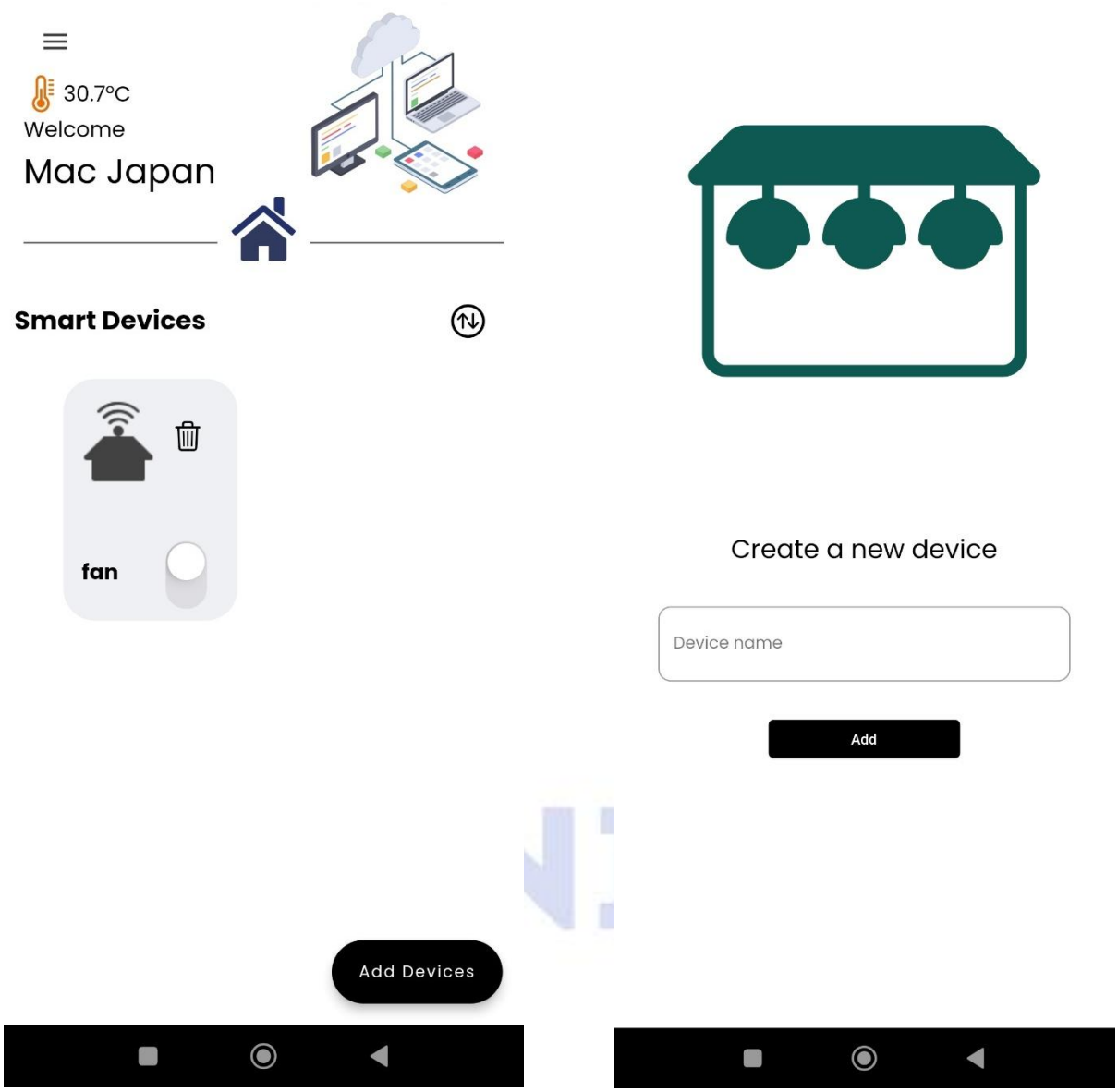
In another board, Code is uploaded to perform some action. After it is powered ON and connected to Wi-Fi, values of temperature and humidity of a room and distance of a moving body in entering the protected area are uploaded in Firebase. If he /she enters a distance like 5cm in value, the buzzer will automatically set to true that means sound of buzzer is on. And the notification like Gmail or SMS also will be sent to know the updates. Finally, all are worked perfectly as the project desired.

5.6 SCREENS OF THE APP:

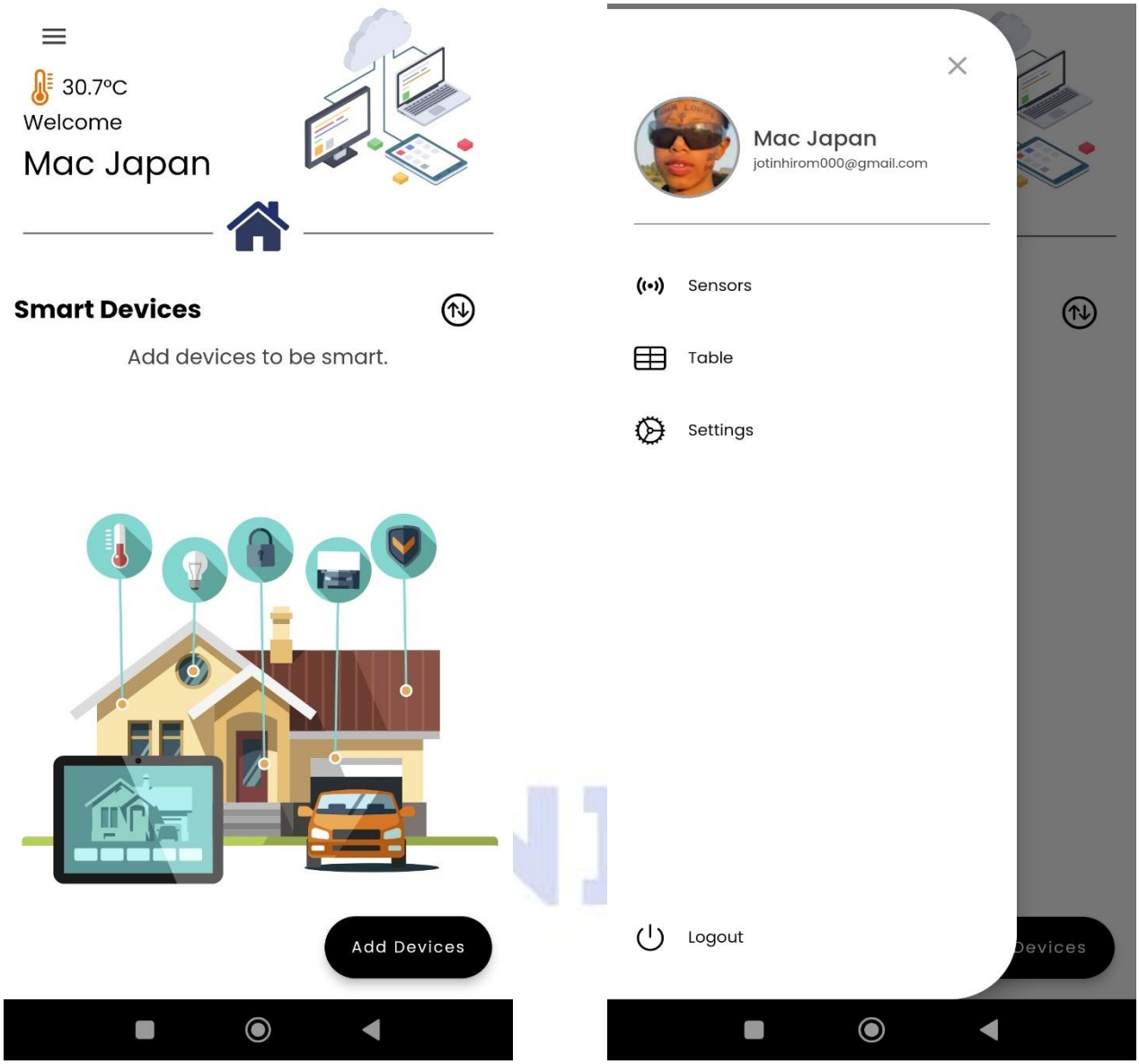
A) With Internet Connectivity-



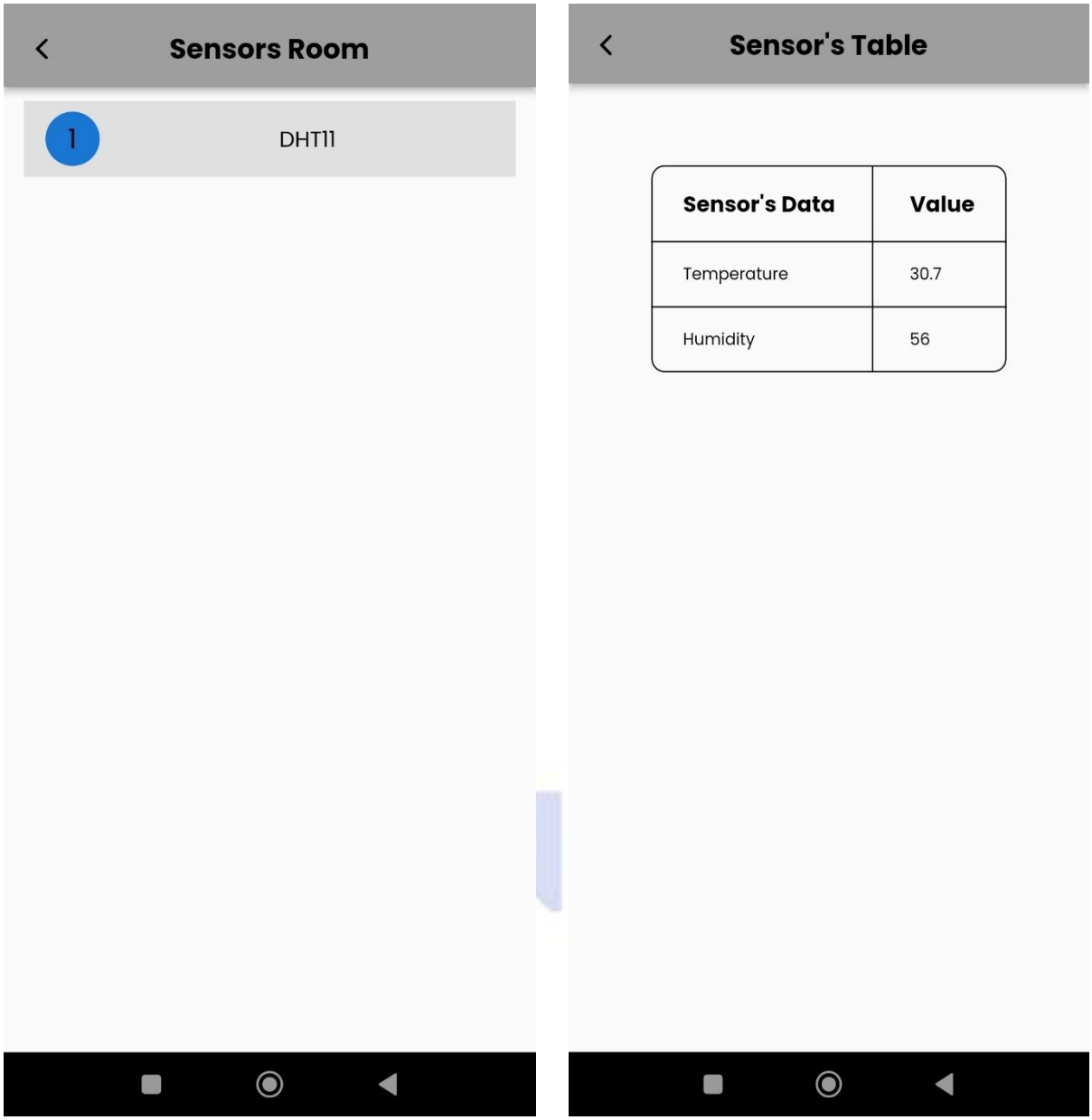
Screens of Splash and Loading



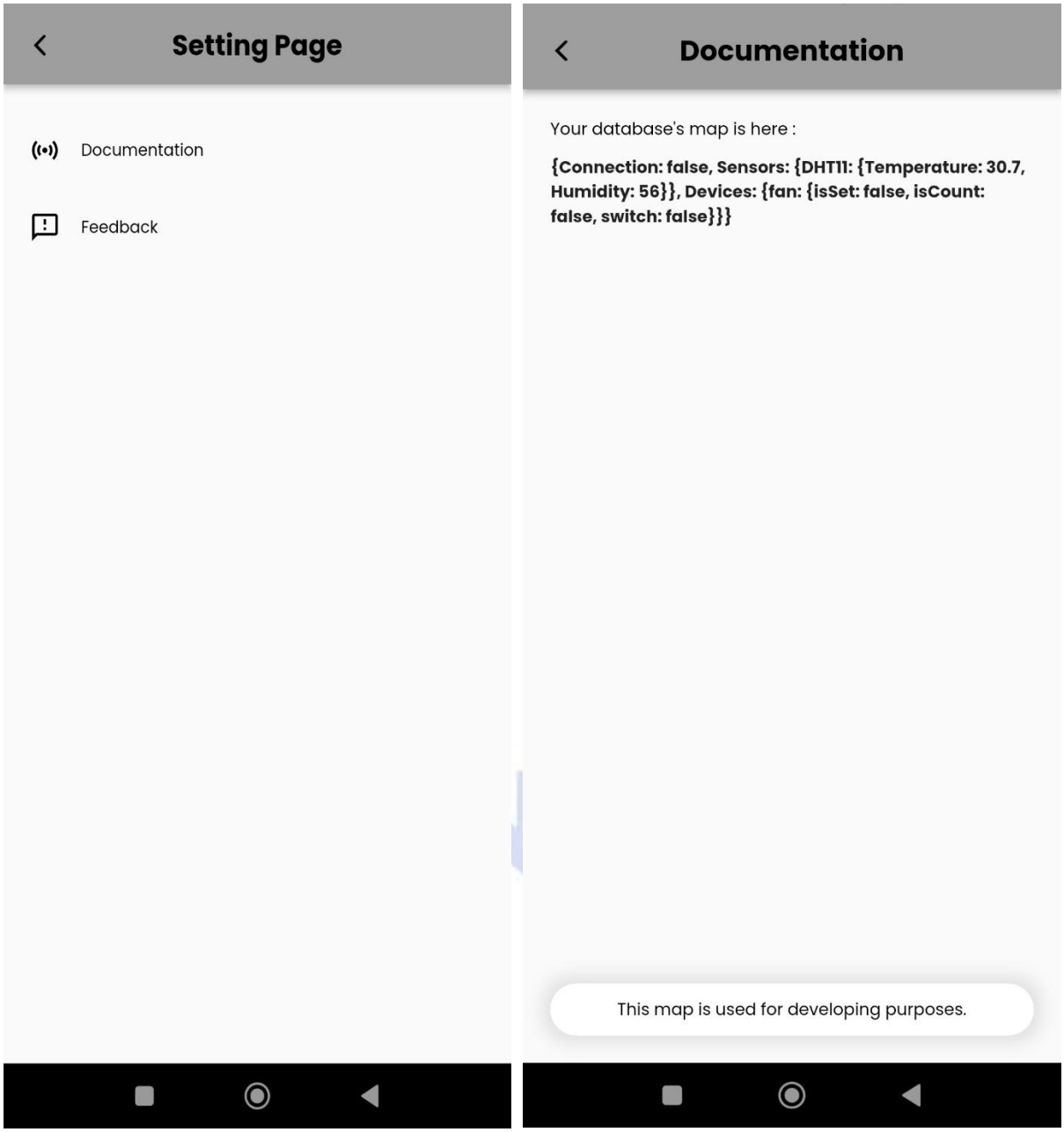
Screens of Home and Adding Device



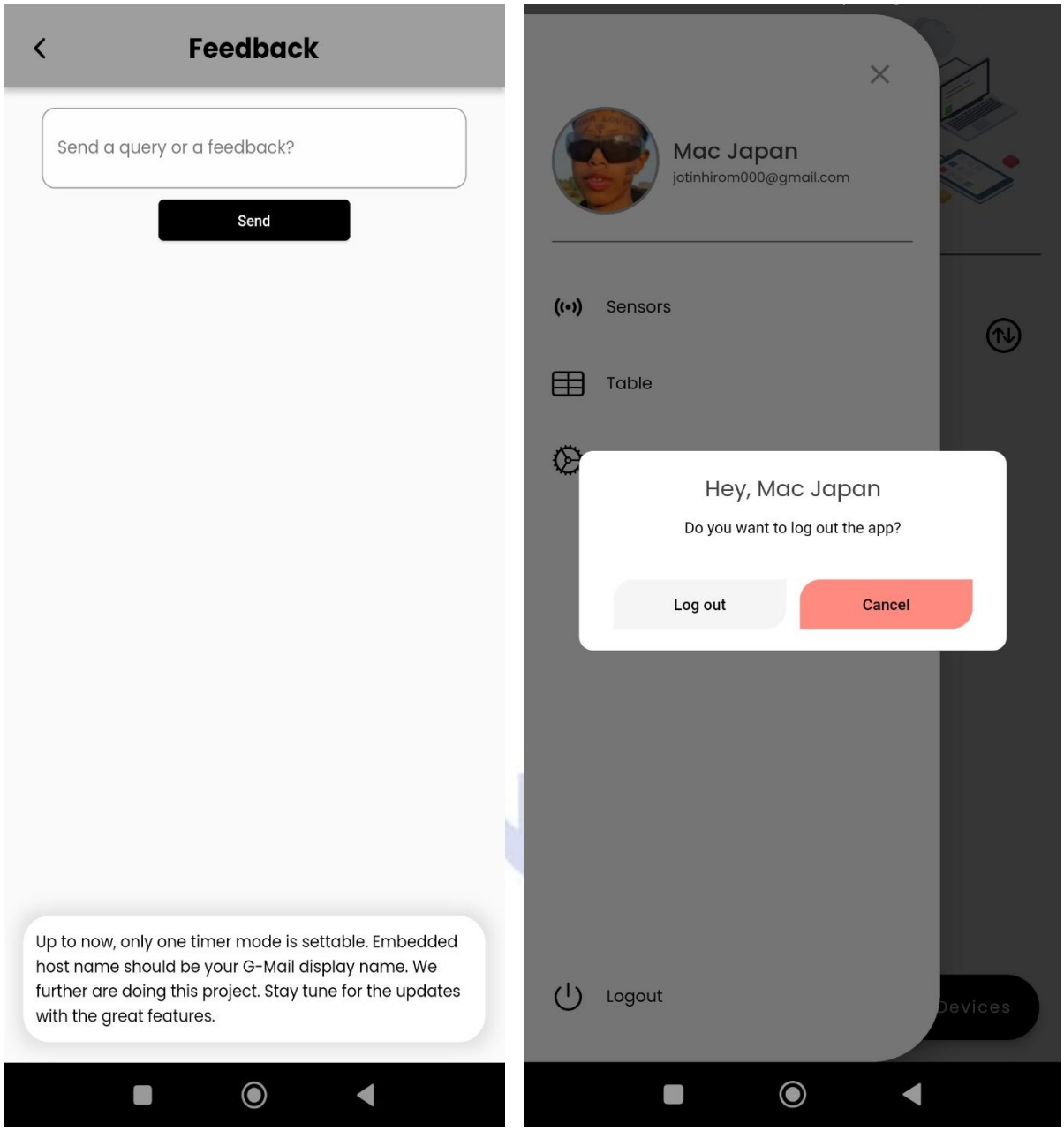
Screens of No Device and Drawer



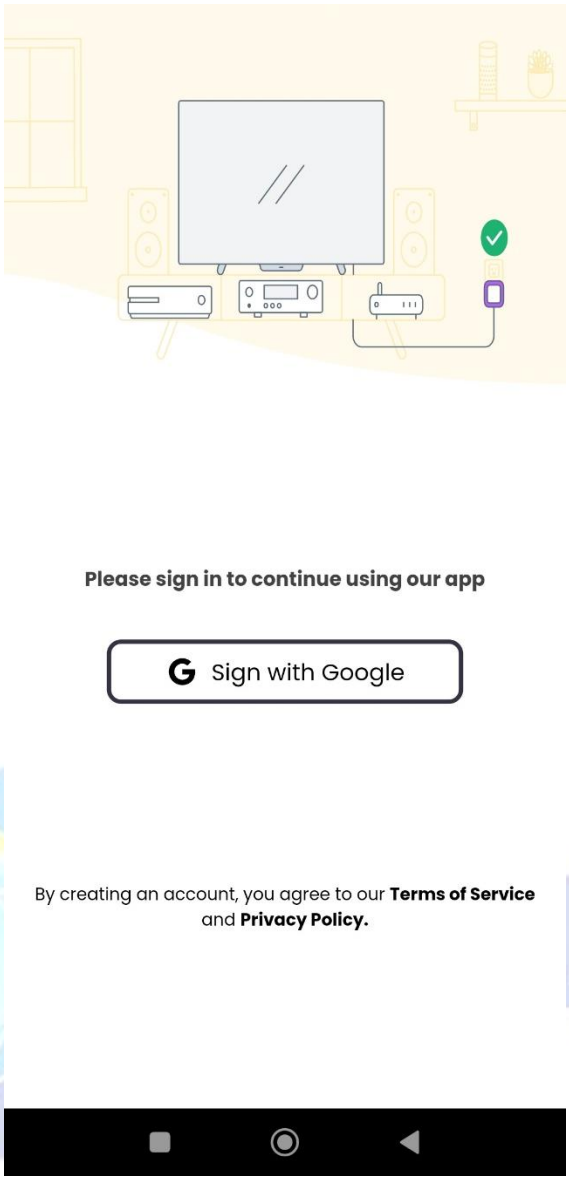
Screens of Sensor Room and Sensor Table



Screens for Setting and Documentation

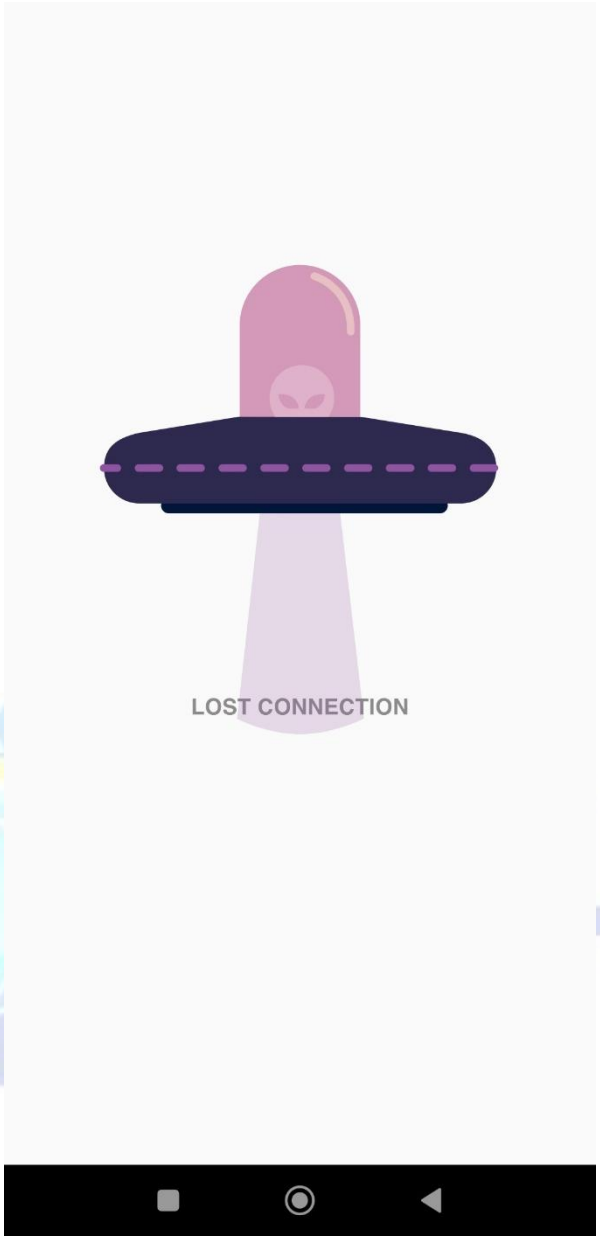


Screens for Feedback and Log Out



Screen for Login

B) Without Internet Connectivity:



Screen for No Internet Connectivity

CHAPTER 6 – CONCLUSION AND FUTURE WORK

6.1 CONCLUSION: The prime objective of our project is to use the Smartphone to control the home appliances effectively. The switch modes are used to control the home appliances. This project is based on the Android platform Flutter, Node-MCU and C++. These platforms are Free Open-Source Software. So, the overall implementation cost is low and can be easily configured. User can easily interact with the android phone/tablet. The user can send commands via the mobile application. The data are being analyzed by the application and are sent over a network. The Node-MCU acts as a hardware, analyses the data, and activates the GPIO (General Purpose Input Output) Pins. The GPIO Pins are connected to the relays switch which activated the required home appliances. In this way, automation process is carried out.

This system is designed to assist and provide support to fulfil the needs of elderly and disabled in home. Household appliances can be easily controlled via a Mobile/Tablet. Status of light, fan and other electrical appliances can be known. This helps to provide security.

6.2 FUTURE WORK:

I. To install IP camera to microcontroller, video of rooms or certain area of a house can be recorded.
II. To install Text-To-Speech to Mobile App for a blind person.
III. To install an alternative mode like a voice mode.
IV. To control the speed of the devices like fans, vacuum cleaner etc.
V. To develop the app for iOS user.
VI. To make an individual room control by adding room data in the database which make possible to control with devices effectively in the room.
VII. To set the timer for all devices individually (Timer mode can set only one device till now).

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