ABSTRACT

”The Omni Remote project introduces an innovative multi-sensor smart remote system designed to seamlessly integrate with an Android application, enabling remote control of IoT appliances via the internet while also serving as a traditional remote controller when the user is nearby. This advanced system combines state-of-the-art sensor technologies with wireless communication capabilities, including infrared (IR) transmitters and receivers, radio frequency (RF) transmitters and receivers, an ESP32 microcontroller, humidity and temperature sensors, a light sensor, and an Inertial Measurement Unit (IMU) for gesture recognition. Through the ESP32 microcontroller, the smart remote communicates with the Android application over the internet, empowering users to remotely manage IoT appliances from anywhere with internet connectivity. Moreover, utilizing proximity detection capabilities, the device seamlessly transitions to function as a conventional remote controller when the user is in close proximity, providing a versatile and intuitive user experience. The project report details the integration process between the smart remote and the Android application, highlighting the harmonious relationship between hardware and software components. With the Omni Remote, users can effortlessly control their IoT ecosystem remotely and locally, facilitating a seamless and responsive smart home environment.

CONTENTS

LIST OF FIGURES

Chapter 1

INTRODUCTION TO THE PROJECT

As technology continues to advance, the demand for smart devices becomes increasingly integral to modern living. Today, it's rare to encounter a household lacking some form of home automation system. These systems range from basic remotes for controlling televisions, lights, and fans, to sophisticated security surveillance and automated climate control systems that maintain optimal temperatures.

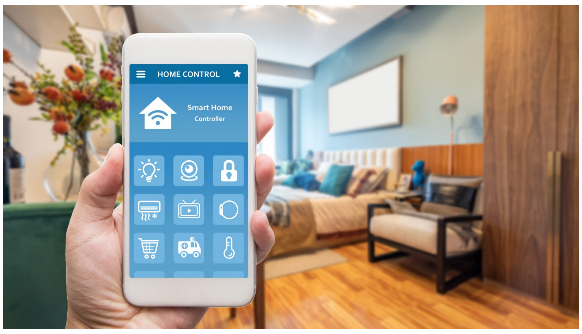

Figure 1.1: Smart Home.

This project aims to introduce a revolutionary device: a single remote controller that not only replaces traditional IR remotes but also extends its capabilities to RF and Wi-Fi remotes. Additionally, it integrates seamlessly with various home appliances such as lights and fans, allowing control from afar through a dedicated Android application. This innovation paves the way for a fully automated home, enhancing convenience and productivity in daily life.

Chapter 2

BASIC PRINCIPLE

Smart omni remote controller system integrates Infrared (IR), Radio Frequency (RF), and Wi-Fi technologies, along with an Android application, to offer seamless control over a wide range of devices. With support for IR, RF, and Wi-Fi protocols, users can effortlessly manage traditional appliances and smart devices alike. The accompanying Android application enables remote control from anywhere with internet access, enhancing convenience and flexibility. Additionally, integrated sensors monitor environmental conditions, allowing for intelligent automation of devices based on weather data. This comprehensive solution streamlines home management, offering users unparalleled convenience and efficiency in their daily lives.

The Smart Omni Remote Controller system operates through a seamless process involving various components. Initially, the ESP32 microcontroller reads sensor data from connected sensors and transmits it to a designated web server via HTTP POST requests. Upon receiving this data, the web server updates the Firebase Realtime Database, where it is stored for monitoring and processing. The web server continuously evaluates the sensor data against predefined automation rules, triggering actions when conditions are met. These actions are then updated in the database as command data. The ESP32 periodically retrieves these commands from the database through HTTP GET requests, executing the specified actions, such as transmitting infrared or radio frequency signals to control devices. Concurrently, the Android app interfaces with the Firebase Realtime Database to display sensor data and allow user configuration of automation rules. Through this coordinated process, the Smart Omni Remote Controller ensures efficient communication, data exchange, and automation for a seamless smart home experience.

Chapter 3

LITERATURE SURVEY

As technology propels us forward, our lives become increasingly intertwined with a multitude of devices, each controlled by its own unique remote. From the humble TV to the sophisticated smart home gadgets, we're surrounded by a cacophony of remotes, each speaking its own language—be it IR, RF, or Wi-Fi. But what if we could simplify this complexity? What if we could unite these disparate technologies into a single, elegant solution? Enter our vision: a revolutionary remote controller that transcends boundaries, seamlessly bridging the worlds of infrared, radio frequency, and Wi-Fi. No more fumbling through a sea of remotes—just one sleek device to rule them all. Welcome to the future of convenience and control. We begin by examining studies and articles that discuss the evolution of remote control technology, tracing its development from traditional infrared (IR) remotes to more advanced solutions incorporating radio frequency (RF), Wi-Fi and also home automation technologies that are currently available in the market. By delving into the historical context and technological advancements, we gain insights into the challenges and opportunities associated with remote control systems. To implement this project we referred following papers.

1. DESIGN AND RESEARCH OF INFRARED REMOTE CONTROL BASED ON ESP8266

School of Informatics Zhejiang Sci-Tech University Hangzhou, Zhejiang, China (Peer-Reviewed, Open Access, licensed under the Creative Commons Attribution International License (CC BY 4.0).) Published: April 29, 2021

Al-Sabri Akram Ali and Xianan Bao Designed an Infrared Remote Control Based on ESP8266.An android application was developed in 2021 to control the home appliances from anywhere. ESP8266 was used for dealing several function. Wireless communication Wi-Fi 802.11 b/g/n was used for the communication. Once the ESP8266 module is initialised the microcontroller is ready to accept commands from Wi-Fi. The android app will ask for the Wi-Fi network name and password for pairing process between mobile and remote controller. When commands given from the mobile the micro controller will act accordingly. Available online at https://doi.org/10.4236/oalib.1107314

2. PROTOTYPING DESIGN OF IR REMOTE CONTROLLER FOR SMART HOME APPLICATIONS

University Center of Excellence on Microelectronics, Institut Teknologi Bandung Tamansari Street, No. 126, Bandung, 40132, West Java, INDONESIA, Proc. of the 2017 IEEE Region 10 Conference (TENCON), Malaysia, November 5-8, 2017

They developed the smart remote to control the devices based IR to be turned ‘on’ with both the hardware as well as software in which the designed IR remote has a lightweight implementation concept. The system consists of indoor and outdoor subsystems where the indoor subsystem is consisting of the devices (nodes) that are at the house in which a host coordinates them. These devices communicate to each other via ZigBee® protocol and controlled by a Raspberry Pi host. And the outdoor subsystem is the outer part of the home consisting of users, cloud servers, and host. The users granted the full access to both of the system through an Android app that will be installed on the mobile phone device, and this is the main gateway that connects users to the whole system. The traditional remote is first used to read the signal. In addition to being a reference for signal emission, the reading result will be included into the Zigbee® network. Then, a 38 kHz carrier frequency signal will be applied to it. After being connected to the network, the remote control will begin to detect any interrupts or external signals that need to be sent to the device for control. Read aloud while pausing till the remote picks up a signal. A signal for logic processing and the start of IrDA modulation generation is sent when there is an interrupt.

3.JAVA-BASED HOME AUTOMATION SYSTEM

IEEE Transactions on Consumer Electronics (Volume: 50, Issue: 2, May 2004)

Al-Ali and Al-Rousan, 2004 developed Java based home automation system via World Wide Web. The home appliances were controlled from ports of embedded system board connected to PC based server at home. The control of devices was established, and their condition is monitored through the Internet, (Alkar and Buhur, 2005) implemented Internet based wireless flexible solution where home appliances are connected to slave node. The slave nodes 6 communicate with master node through RF and master node has serial RS232 link with PC server. The nodes are based on PIC 16F877 c. PC server is formed of a user interface component, the database and the web server components. An Internet page has been setup running on a Web server. The user interface and the Internet front end are connected to a backend data base server.

Available online at https://ieeexplore.ieee.org/document/1309414

4.INTERNET HOME AUTOMATION SYSTEM USING JAVA AND DYNAMIC DNS SERVICE

Sixth International Conference on Parallel and Distributed Computing Applications and Technologies (PDCAT'05)

According to the system developed by (Ximin et al., 2005), these designed and implemented an Internet home automation system. The design uses an embedded controller based on C8051F005 microcontroller which is connected to a PC-based home Web server via RS232 serial port. The home appliances are connected to the input/output ports and the sensors are connected to the analog/digital converter channels of the embedded controller. The software of the system is based on the combination of Keil C, Java Server Pages, and JavaBeans, and dynamic DNS service (DDNS) client. Password protection is used to block the unauthorized user from accessing to the server.

Available online at https://ieeexplore.ieee.org/document/1578974

5.DESIGN AND IMPLEMENTATION OF A BLUETOOTH BASED GENERAL PURPOSE CONTROLLING MODULE

Published in: 2008 4th International Conference on Information and Automation for Sustainability

According to (Wijetunge et al., 2008), these designed a general-purpose controlling module designed with the capability of controlling and sensing up to five devices simultaneously. The communication between the controlling module and the remote server is done using Bluetooth technology. The server can communicate with many such modules simultaneously. The controller is based on ATMega64 microcontroller and Bluetooth communication TDK Blu2i (Class 1) module which provides a serial interface for data communication. The designed controller was deployed in a home automation application for a selected set of electrical appliances.

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Chapter 4

DESIGN AND METHODOLOGY

This project used iterative software development. An iteration incorporates a loosely sequential set of activities in business modeling, 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.

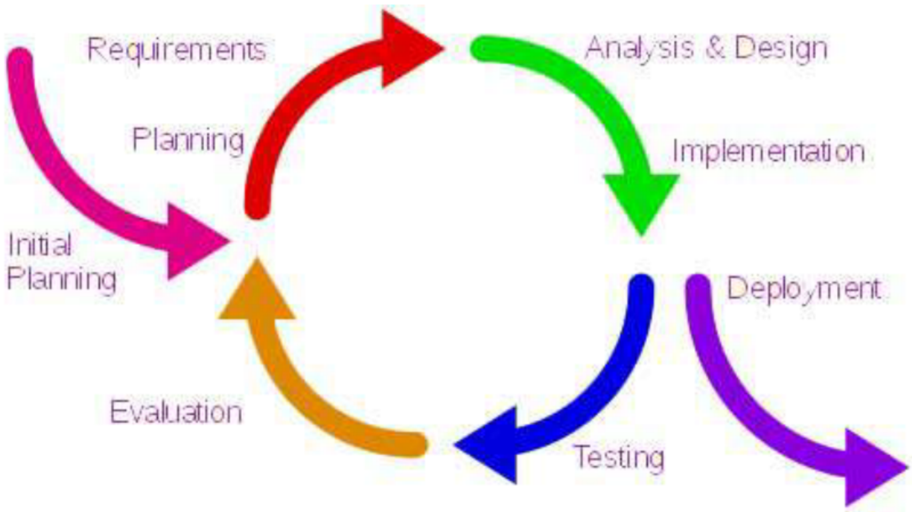

Figure 4.1: Methodology

4.1 PLANNING AND REQUIREMENT

After selecting the project topic, the team conducted a literature review for the technology selection, assessing both recent publications and older papers. A risk assessment was then conducted, considering technical challenges, resource constraints, and time limitations. Budget planning followed, estimating costs for hardware, software, and testing. With these analyses, a detailed project plan was developed, outlining tasks, milestones, timelines, and team responsibilities. This structured approach ensured efficient coordination and increased the likelihood of project success.

4.2 ANALYSIS AND DESIGN

Based on the insights gathered from online resources and academic papers, we finalized our design. Utilizing the draw.io platform, we created a block diagram as the initial step in the design process. Additionally, the circuit design was sketched out using Microsoft VISIO software.

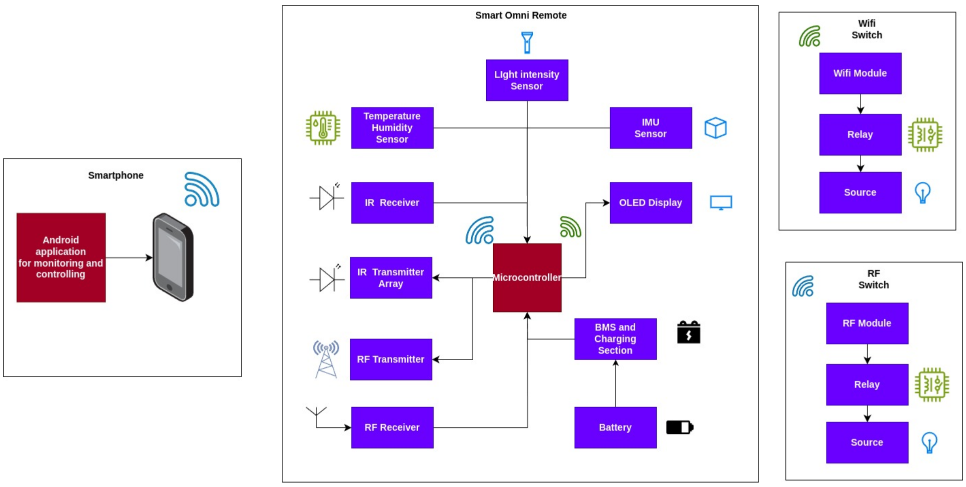

Figure 4.2: Block Diagram - Smart Omni Remote Controller

4.3 IMPLEMENTATION

For the hardware implementation, we begin by selecting a micro-controller platform ESP-WROOM-32 38-pin ESP32 Development Board integrating sensors and actuators such as IR transmitters/receivers etc. Moving on to Android application development using MIT App Inventor, we design the user interface visually with drag-and-drop elements. Then, using the blocks-based programming environment, we define logic for user interactions and communication with the hardware. After testing and debugging, the application is ready for deployment to Android devices, providing an intuitive interface for controlling the smart omni remote controller seamlessly.

4.4 TESTING AND EVALUATION

Testing and evaluation are critical stages in ensuring the functionality and reliability of the smart omni remote controller. Various tests are conducted to verify performance and gather feedback. After testing, identified issues are addressed through debugging, and updates are developed to implement fixes or improvements. These updates undergo thorough testing to ensure compatibility and reliability before deployment, ensuring that the remote controller meets user needs.

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.

Chapter 5

IMPLEMENTATION

5.1 SECTION WISE CIRCUIT AND EXPLANATION

5.2 HARDWARE

The proposed Remote Control can be implemented in a viable manner with reasonable cost and smart home meaning. The Remote Control basically contents of two major components: one hardware component and the other one is a software component. The ESP-WROOM-32 38-pin ESP32 Development Board serves as the central component of our system, playing a pivotal role as an intermediary module, or interfacing device, between hardware peripherals and software applications. Within this setup, every command and instruction is meticulously executed by the micro-controller ESP-WROOM-32. This micro-controller acts as the brain of the operation, processing commands and facilitating seamless communication between various hardware devices and the overarching software framework.

The ESP32 micro-controller is connected to the IR transmitter and receiver, RF transmitter, humidity and temperature sensor, and light intensity sensor. It reads data from these sensors and can transmit IR and RF signals to control various devices based on the sensor data and predefined automation rules.The ESP32 establishes a WiFi connection to the internet and connects to a Firebase Real-time Database, which acts as a central repository for storing sensor data and automation rules. A web server hosts a web application or API that serves as an intermediary between the ESP32 and the Firebase Database. Additionally, the web server

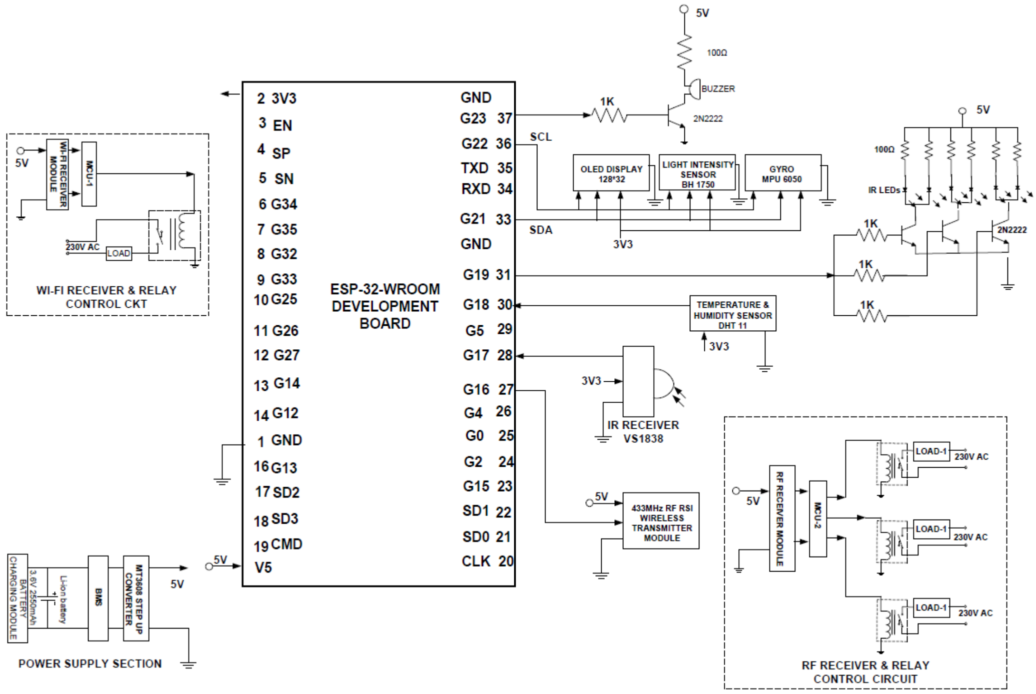

Figure 5.1: Circuit Diagram - Smart Omni Remote Controller

runs automation logic that processes the sensor data and triggers appropriate actions based on predefined rules.The ESP32 periodically sends sensor data (humidity, temperature, and light intensity) to the web server over the internet using HTTP POST requests. The web server receives this data and updates the corresponding values in the Firebase Real-time Database.The web server continuously monitors the sensor data in the Firebase Realtime Database. It compares the sensor data against predefined rules or automation scenarios set up by the user or administrator.For example, if the temperature exceeds a certain threshold, the automation logic might trigger an action to turn on an air conditioner or send a command to the ESP32 to control an IR or RF device accordingly. Similarly, if the light intensity drops below a certain level, the automation logic could send a command to the ESP32 to turn on smart lights or adjust their brightness. When the automation logic on the web server determines that an action needs to be taken based on the sensor data and predefined rules, it updates the corresponding command data in the Firebase Realtime

Database.The ESP32 periodically makes HTTP GET requests to the web server to retrieve any new command data from the Firebase Real-time Database. Upon receiving a new command, the ESP32 processes it and performs the appropriate action, such as transmitting an IR or RF signal to control a device.

5.3 SOFTWARE

The software section of the Smart Omni Remote Controller is the MIT App Inventor-based Android app can still be used for monitoring the sensor data and manually controlling devices if desired. However, its primary role in this scenario is to provide a user interface for configuring the automation rules and thresholds.The app interacts with the Firebase Real-time Database to retrieve the current sensor data and display it to the user. It also allows the user to set up or modify the automation rules, which are then stored in the Firebase Real-time Database and processed by the automation logic on the web server.

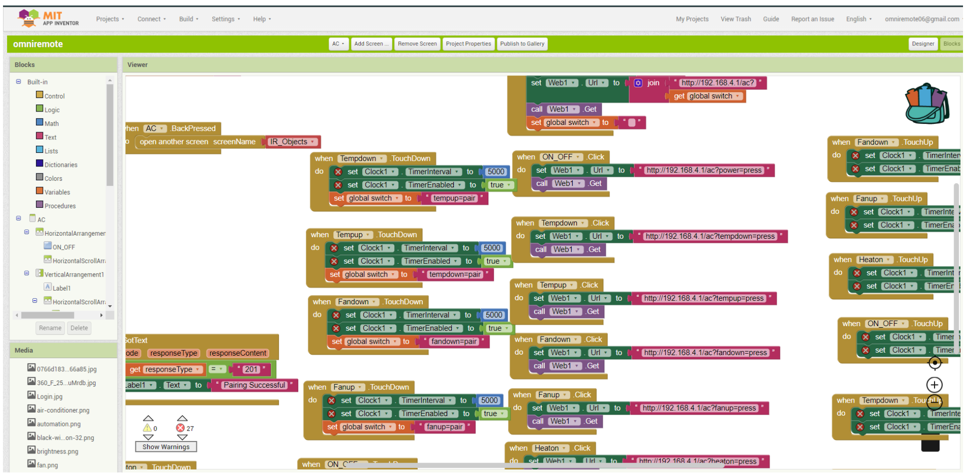

Figure 5.2: MIT App Inventor window

By leveraging the sensor data, automation logic on the web server, and the communication between the ESP32 and the web server, this system can automate various tasks or actions based on the environmental conditions (temperature, humidity, and light intensity) while still providing manual control capabilities through the Android app interface.

Chapter 6

HARDWARE/ SOFTWARE TOOLS USED

6.1 HARDWARE SECTION

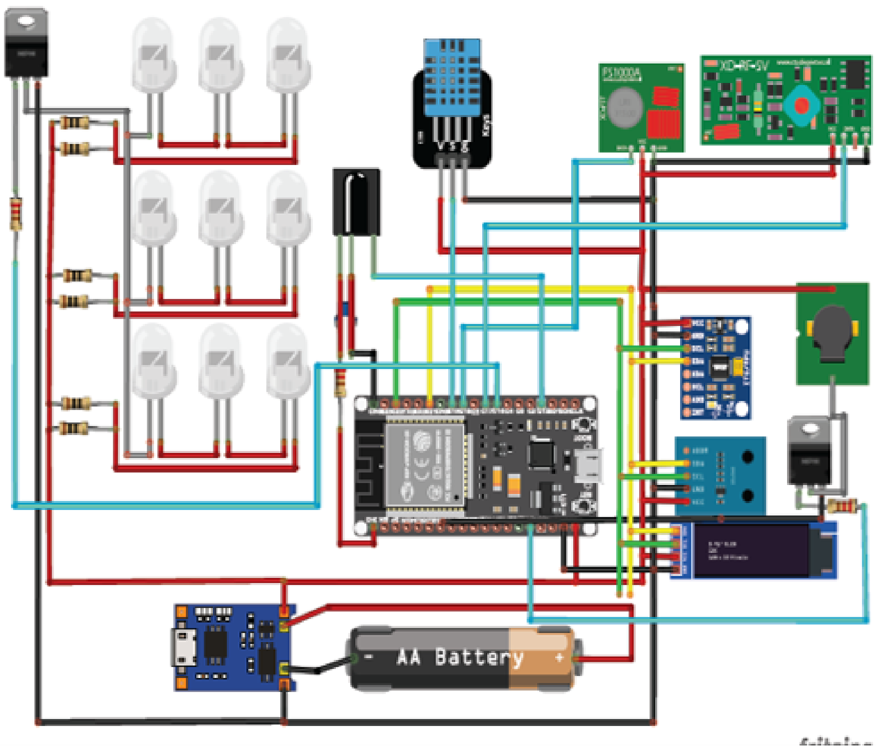

Figure 6.1: Hardware Components

- dual-core microcontroller
- GPIO – 38 Pins
- Built-in Wi-Fi and Bluetooth connectivity enable wireless communication, networking, and IoT connectivity.

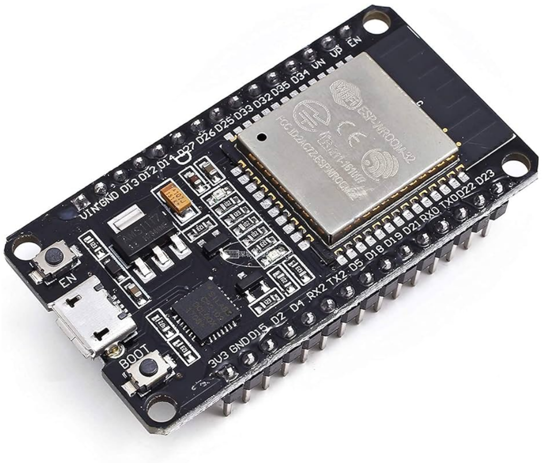

Figure 6.2: ESP-WROOM-32 38pin ESP32 Development Board

- Integrated Peripherals: Includes SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), UART (Universal Asynchronous Receiver-Transmitter), and ADC (Analog-to-Digital Converter) interfaces.
- Memory – RAM (520KB to 4MB), Flash Memory (4MB to 16MB)

DHT11 Temperature and Humidity Sensor Module: Capacitive humidity sensing element and thermistor for temperature sensing, Operating temperature range: 0°C to 50°C, humidity range: 20Digital output using a single wire (data line), Low power consumption and compact size, Relatively low cost and easy to interface with microcontrollers.

BH1750 Light Intensity Module: Based on the BH1750FVI digital ambient light sensor IC from ROHM, Measures illuminance in a wide range (1 lux to 65535 lux), Supports multiple resolution modes (up to 1 lux resolution), Communicates via I2C interface, Small form factor and low power consumption.

GY-302 VS1838 Infrared Receiver Module: Based on the VS1838B IR receiver IC from Vishay, Can receive and decode infrared signals in the 38 kHz frequency range, Supports multiple IR remote control protocols (NEC, Sony, Philips RC-5, etc.), Operates from a 2.7V to 5.5V power supply, Compact size and easy to interface with microcontrollers.

IR LED 5MM IR333C-A: A 5mm infrared LED with a peak wavelength of 940nm, Typical forward voltage: 1.5V, Radiant intensity: 40 mW/sr (typical), Suitable for remote control and infrared communication applications, Long life and high reliability.

TP4056 1A Li-ion Battery Charging Module: Based on the TP4056 constant current/constant voltage linear charger IC, Designed for single-cell lithium-ion batteries, Charging current: 1A (configurable via a resistor), Provides overcharge, over-discharge, and over-current protection, Compact size and easy to integrate into battery-powered projects.

Type C With Current Protection: Refers to a USB Type-C connector or port, Supports USB Power Delivery (PD) for higher power delivery, Includes overcurrent protection circuitry, Reversible plug orientation for ease of use, Supports data transfer (USB 2.0 or USB 3.x) in addition to power delivery.

1S 5A BMS Module: Battery Management System (BMS) module for a single lithium-ion cell, Maximum continuous charge/discharge current: 5A, Provides overcharge, overdischarge, overcurrent, and short-circuit protection, Includes a balancing function for lithium-ion battery packs, Helps extend the life and ensure safe operation of lithium-ion batteries.

3.7V Lithium Battery Protection Board: A protection circuit board specifically designed for 3.7V lithium-ion batteries, Provides overcharge, overdischarge, and overcurrent protection, Helps prevent damage to the battery and improves safety, Compact size and easy to integrate into battery-powered projects, Suitable for various lithium-ion battery chemistries (LCO, LMO, NMC, etc.).

18650 Single Battery Holder Case: A plastic case or holder designed to hold a single 18650 lithium-ion battery, Provides mechanical protection and insulation for the battery, Includes positive and negative terminals for electrical connections, Some holders may include a built-in protection circuit, Available in various sizes and designs to accommodate different battery dimensions.

BAK 3.6V 2550mAh 3C 18650 NMC Li-ion Battery: Manufactured by BAK, a reputable lithium-ion battery manufacturer, Nominal voltage: 3.6V (typical for lithium-ion batteries), Capacity: 2550mAh (milliampere-hours), Chemistry: NMC (Lithium Nickel Manganese Cobalt Oxide), Maximum continuous discharge rate: 3C (3 times the battery's capacity), Suitable for various applications requiring high energy density and power.

MT3608 2A DC-DC Step Up Converter Booster Module: Based on the MT3608 step-up converter IC from Aerosemi, Converts a lower input voltage to a higher output voltage, Maximum output current: 2A d. Adjustable output voltage range (typically 2V to 24V), High efficiency and low ripple output f. Includes protection features like overcurrent and short-circuit protection.

MPU6050 Gyro Accelerometer Sensor Module: Combines a 3-axis gyroscope and a 3-axis accelerometer, Based on the MPU-6050 motion tracking IC from InvenSense, Gyroscope sensitivity: up to 131 LSBs/°/s, Accelerometer sensitivity: up to 16384 LSB/g, Communicates via I2C interface, Suitable for motion tracking, orientation detection, and inertial measurement.

OLED 0.91 inch Blue 128X32 IIC 4PIN: A 0.91-inch OLED (Organic Light-Emitting Diode) display, Blue color with a resolution of 128x32 pixels, Communicates via the I2C (IIC) protocol, 4-pin interface (GND, VCC, SCL, SDA), High contrast, wide viewing angle, and low power consumption, Suitable for displaying text, graphics, and simple user interfaces.

6.2 SOFTWARE SECTION:

The front end and back end design of the Smart Omni Remote Controller application were both crafted using MIT App Inventor. The front end design is showcased in the second figure, illustrating the mobile screen layout, while the

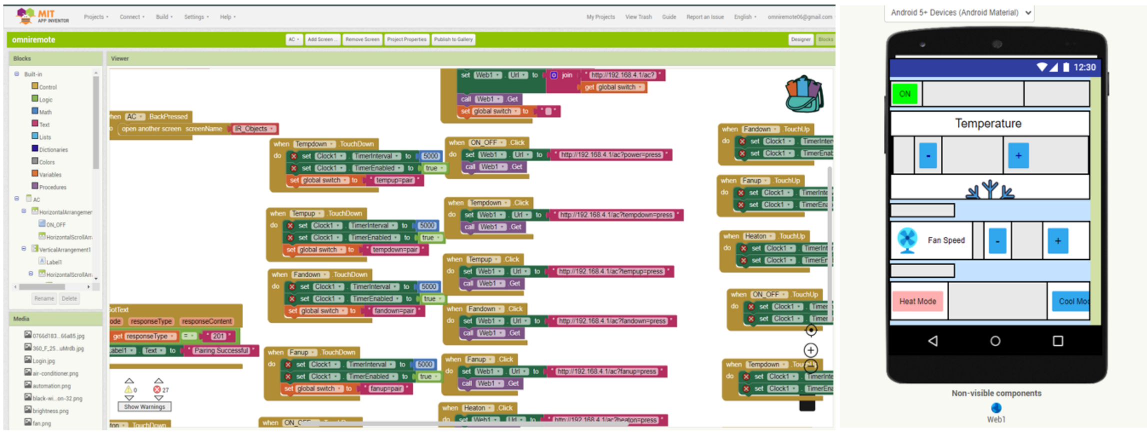

Figure 6.3: MIT App Inventor - Block codes and design

subsequent figure portrays the back end design of the application.

Chapter 7

RESULTS & DISCUSSION

The development and implementation of the Smart Omni Remote Controller have yielded promising results, showcasing a robust and versatile solution for home automation and device control. Through seamless integration of hardware and software components, the remote controller offers users unprecedented convenience and flexibility in managing their smart home ecosystem. The utilization of technologies such as IR, RF, and Wi-Fi, coupled with the implementation of the ESP-WROOM-32 38-pin ESP32 Development Board, has enabled reliable communication and control of various devices from a single interface. Furthermore, the Android application, developed using MIT App Inventor, enhances user experience by providing remote control capabilities from anywhere with an internet connection.

Figure 7.1: Android Application

The success of the Smart Omni Remote Controller project underscores the potential of integrating diverse technologies to create a cohesive and user-friendly solution for home automation. By consolidating control of IR, RF, and Wi-Fi devices into a single remote controller and accompanying Android application, the project addresses the fragmentation and complexity often associated with smart home setups. The utilization of the ESP-WROOM-32 Development Board as a central component ensures reliable communication between devices and the user interface, while the intuitive design of the Android application enhances accessibility and usability.

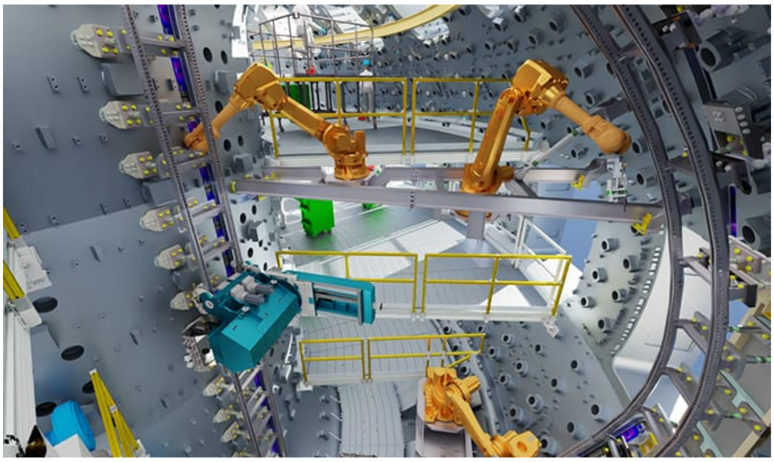

Figure 7.2: Final Product

Chapter 8

CONCLUSION

In conclusion, the development of the Smart Omni Remote Controller marks a significant advancement in the realm of home automation and device control. By integrating IR, RF, and Wi-Fi technologies into a single, user-friendly interface, the project offers users unprecedented convenience and flexibility in managing their smart home ecosystem.

8.1 SCOPE OF FURTHER WORK

- **Gesture Control Integration:** Incorporating gesture control capabilities into the Omni Remote will offer users an intuitive and hands-free way to interact with their smart home devices, enhancing convenience and accessibility in home automation.
- **Security:** Integration with security devices allowing users to control cameras, alarms and access control
- **Robotics:** Integration with sensors and cameras for remote operation and monitoring
- **Industrial Automation:** Remote monitoring and control of industrial equipment and machinery.

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