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DESIGN AND IMPLEMENTATION OF A SMART HOME AUTOMATION SYSTEM BASED ON THE INTERNET OF THINGS

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NEAR EAST UNIVERSITY
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M.Sc. THESIS

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Approval

We certify that we have read the thesis submitted by Abdimalik Salad Hussein titled **"DESIGN AND IMPLEMENTATION OF A SMART HOME AUTOMATION SYSTEM BASED ON THE INTERNET OF THINGS"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science in Computer Information Systems.

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All information in this document has been obtained and presented by academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

DESIGN AND IMPLEMENTATION OF A SMART HOME AUTOMATION SYSTEM BASED ON THE INTERNET OF THINGS

ABDIMALIK SALAD HUSSEIN

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Many of today's aspects of our daily lives have been impacted due to the immense growth of technology, whereby home automated systems have proved to be one of the significant aspects. This research will focus on designing and implementing an IoT-based smart home automation system based on the Arduino Uno R4 Wi-Fi board and the Blynk application. The system aims to facilitate remote control and monitoring of various home-based devices, such as lights, fans, and security systems, through a mobile application. Its architecture includes multiple sensors for temperature, humidity, and flame sensing to monitor environmental conditions and improve the safety of the home. What makes this system very unique is its ability to auto-fight fire outbreaks, provide CCTV surveillance in real-time, and send out notifications and emails in times of emergencies like fire outbreaks. All these are put together to enhance the user experience regarding home security. IoT devices such as Arduino Uno R4 Wi-Fi are used for developing communications between devices and a mobile application for providing real-time control and monitoring. The Blynk platform offers a user-friendly interface for managing one's home environment. The results obtained from the implementation proved the system's reliability in remote access and control of devices at home. These include switching lights and fans on and off and monitoring temperature and humidity. Its real-time alerting feature increases its practical utility by responding quickly to hazards. This smart home automation system developed in the research work is a considerable improvement in technologies associated with home management since it brings about quality of life through convenience and security, setting a trend for future enhancements in IoT-based home automation solutions.

Keywords: Smart technology, systems, smart home automation, internet of things, home automation, designs, and implementation.

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CHAPTER 1

INTRODUCTION

This chapter presents an overview of the study on the Internet of Things (IoTs), including the introduction, thesis problem, aims, and relevance. Smart home automation systems.

The Internet of Things transformed smart home automation. IoT devices have changed how dwellings are designed and used. (Rose et al., .). (Vijayaraja et al., 2023) Emphasize the need to understand and assess IoT-based smart home system expertise, which prompted our systematic literature review. Current discussions focus on security, communication protocols, interoperability standards, edge computing, and artificial intelligence. (Tayef et al., 2021). As the smart home ecosystem evolves rapidly, the assessment seeks to reveal patterns, difficulties, and information gaps from abundant data. The literature evaluation anticipates and addresses IoT integration difficulties in smart homes, not just as a postmortem analysis. According to (Sisavath & Yu, 2021) The emerging narrative of smart home technology prioritizes privacy, security, and user experience. The study addresses these topics to inform future research and industry practices. Crisan et al. (2021) emphasize the complexity of embedding IoT into smart homes and the necessity of critical assessment to uncover research gaps and development opportunities. So, the review strives to further the conversation, guiding future studies, industry practices, and responsible smart home technology use.

IoT accelerates smart home automation. This landscape has significant technical advances, say (Froiz-Miguez et al., 2023) . First, IoT-enabled smart homes need better data security. Improved protocols increase home device communication. Better IoT interoperability simplifies smart homes. AI and edge computing enable smart house modification and real-

time decision-making. As smart home technology advances swiftly, every data must be assessed. (Nur-A-Alam et al., 2021) recommend reviewing trends, barriers, and information gaps to adapt to changing conditions. Scholars, industry experts, and politicians must comprehend these achievements to understand the situation and prepare for future changes. Understanding smart home IoT applications through the knowledge base fosters creativity, development, and problem-solving in this dynamic technology.

Privacy, security, and user experience in IoT-based smart home automation are examined in our literature review. Increasing IoT adoption has made these concerns more critical, say, (Arif et al., 2020a) Ownership, consent, and abuse issues arise when smart home devices retain sensitive personal data. Protecting networked systems from hackers and smart home data is vital. User experience issues emphasize intuitive, fluid, and user-friendly interfaces to encourage adoption and enjoyment. The literature analysis shows smart home automation's complex privacy, security, and UX issues. Reviewing these topics improves comprehension and guides future study. Addressing these issues is necessary to build the smart home firm responsibly. Ethical smart home technology reviews boost user trust, data protection, and experience. This dual focus on obstacles and solutions makes the literature review proactive for IoT-based smart home technology development.

This study develops a mobile application that enables users to manage a smart home through their mobile devices remotely. The system takes orders using a mobile application and carries them out using Arduino, which controls the hardware. The proposed solution enables users to exert control over and monitor a smart home system. The user has the ability to both open and close the doors, as well as activate or deactivate a fan and regulate the lights. The user can view the current temperature and humidity levels. Additionally, the user has the capability to access or secure the door by utilizing RFID technology.

The system can activate the alarm. In the event of a fire, it simultaneously sends a notification and an email. The user performs the manipulation of the system through a web-based mobile application. A mobile application gives input to the user about various scenarios by the system.

1.1. Problem statement

Different researchers have developed various home automation systems to manage smart homes. However, more things need to be updated, This system is made with Arduino Uno R4 Wi-Fi, managed by Blynk. It can solve many problems because of its use of the latest Arduino Uno R4, which can do many things in parallel, like controlling fans, lights, and sensors through sending notifications on the mobile application and Email.

1.2. The aim of the study

This study aims to design and implement an IoT-based smart home automation system using Arduino Uno R4 Wi-Fi and the Blynk application. This system shall be able to control the user over several devices at home, including lights, fans, doors, and security systems, through a mobile application. It also aims to enhance the security aspect in homes by providing automated firefighting, CCTV surveillance, and real-time notification through email and mobile alerts. Wi-Fi will be used to connect the Arduino Uno with the mobile application on the smartphone.

1.3. Significance of the study

This Study is helpful because it helps people control their devices from afar without physical presence. It does this by using a mobile app to connect to the devices. It will also help other experts who want to learn more about IoT and smart houses. The created system uses sensors to gather information, and sometimes it makes decisions independently without help from a person.

when it detects a fire, the fire sensors will notify Both the mobile application and Email.

The originality of this system is that the user can manage his home on any device, whether IOS or Android. It also sends notifications to the mobile application and Email.

is integrated with various sensors, such as temperature, humidity, and flame sensors, to improve safety at home. Its unique ability to auto-fight fire outbreaks and provide CCTV surveillance in real-time is much needed in enhancing the security standards of smart home systems.

The system provides robust remote control and monitoring using the Arduino Uno R4 Wi-Fi board and the Blynk application. Light, fan, and security systems can be controlled, and environmental conditions monitored in real time.

1.4. Study Overview

This study has six chapters: introduction, attached research, theoretical framework, systems development, system implementation, and conclusions and recommendations.

- Chapter One thoroughly examines IoT and automation, including the thesis issue, research purpose, study significance, and study framework.
- Chapter Two summarizes the research undertaken in the same area.
- Chapter Three outlines the theoretical basis.
- Chapter Four focuses on system development and architecture.
- Chapter Five detailed the system's implementation.
- Chapter Six summarizes the study's results, makes suggestions for the thesis, and recommends more research.

CHAPTER 2

RELATED RESEARCH

In this chapter contains related work on Smart technology, systems, Smart Home automation, the Internet of Things, home automation, designs, and implementation. and controlled by many methods such as mobile applications, and Bluetooth.

2.1. Controlling Smart Home

(Stolojescu-Crisan et al., 2021) Developed a mobile application for smartphones known as qToggle, which gives customers the ability to manage several sensors and household appliances. The qToggle system is not only user-friendly and adaptable, but it also has the potential to be further extended by using a variety of added-ons and gadgets.

(Singh et al., 2022) developed Smart home control unit around AVR microcontroller Atmega 2650, Wi-Fi IoT module ESP 8266, RN-42 Bluetooth module with Serial Port Profile (SPP), DS3231 Real Time Clock (RTC) module, sensors for light, temperature, humidity, PIR motion detection, soil moisture sensor, relay board, 3.5-inch touch screen display and electrical loads.

(Isyanto et al., 2020) Designed an Internet of Things (IoT) smart house app with a voice-activated remote control for disabled people. Smart home control systems let disabled people use speech orders to handle their home's electrical devices, like TV lights and fans, so they don't have to move to turn them on or off. The Google Assistant app on smartphones is used for voice recognition on electronics. If you say the words correctly, the Google Assistant tool will follow your instructions. Voice prompts are easier to use

on an IoT-based smart home because you don't have to type text messages. Users find it easier to use than texting. The Internet link signal strength can be used to make a useful performance tool for the Response Time of Google Assistant, the Response Time of System Processing, and turning on and off electrical equipment. To help handicapped people connect with their surroundings, we think this gadget could be more useful if it used IoT technology.

(Sun et al., 2021) developed several IoT technology standard protocols, including OneM2M. Although smart houses are quickly expanding, they do not yet have standardized standards or full-scale home systems. Based on this, it is recommended that the public service entity (CSE) in the oneM2M standard be tiered management, with MN-CSE serving as the core node for threshold detection and forwarding values to IN-CSE for in-AE data operation of the smart home deployment scheme. Experiments have shown that the method may greatly decrease the device needs of the home core node MN-CSE while also lowering the cost of intelligent home deployment maintenance.

2.2. The Summary of the Related Research.

The table below summarizes the linked research articles by the writers and the methods they used. This will directly show the gaps that need to be filled, and I then chose my criteria based on the table, Table 1 shows the summary of the related research.

Table 1 *Summary of the related research*

Home Automation System	Communication	Controller	User Interface	Applications

(Stolojescu-Crisan et al., 2021)	Wi-Fi	Raspberry PI, ESP 8266	web-based, mobile app	multiple home automation indoor and outdoor, irrigations, security, monitoring, power, and energy management (including solar energy), Google Assistant compatible
(Singh et al., 2022)	WiFi/ Blueto oth	ESP 8266,	Mobile application	indoor and outdoor control short range
(Irugalbandara et al., 2023)	Wi-Fi	Raspberry PI, ESP 8266	Web Based	Indoor control
(Isyanto et al., 2020)	Wi-Fi	ESP8266	Mobile application	Controlling TV, light, and fan using the Google assistance application
(Sun et al., 2021)	Zigbee	OneM2M	Mobile Application	control of indoor appliances
(Umer et al., 2023)	Wifi, GSM	Raspberry PI	Mobile Application	Control indoor and outdoor with short-range
(Sivagami et al., 2021)	Ethernet , WI-FI, GSM	Arduino	Mobile App / Web-based	Indoor/outdoor Control
(Hussien et al., 2022)	Wi-Fi	ESP 8266	Mobile application	Indoor/outdoor control with Google assistance

(Sisavath & Yu, 2021)	Ethernet	LPC 1769	Web-based	Indoor control
(Zharikov et al., 2022)	Wi-Fi	STM32, ESP8266	Unspecified	control home appliances, surveillance
(Tayef et al., 2021)	Wi-Fi	ESP 8266	Mobile application / Web Based	Control indoor and outdoor
(Midul et al., 2023)	Wi-Fi, GSM	ESP8266	Mobile application	Control indoor and outdoor
(R Sivapriyan et al., 2020)	Wi-Fi, Bluetooth, GSM	Arduino	Mobile application	Control indoor /outdoor with short-range
(Vijayaraja et al., 2023)	Wi-Fi	Arduino	Web server	Control indoor
(Hassan et al., 2022)	Wi-Fi	ESP32, Arduino	Mobile application	Controls indoor and outdoor
(Ahmed et al., 2021)	Wi-Fi	Arduino, ESP8266	Mobile Application, Web Application	control indoor appliances
(Nur-A-Alam et al., 2021)	Wi-Fi	ESP32	Mobile application	Controls indoor and out door

CHAPTER 3

THEORETICAL FRAMEWORK

In this chapter introduces the theoretical framework to be used for this study by explaining the Internet of Things (IOT), the introduction to Home Automation Systems, a brief history of the Internet of Things IOT, Automation of smart homes. Application and technologies, and Protection of Smart Homes.

3.1. Internet of Things

The Internet of Things is often described by scholars as a network of devices equipped with sensors and actuators that make use of sensor data (Rose et al.,.).(Rose et al.,.) define the Internet of Things as a wireless network and self-configuring system that connects various objects, such as those found in a home. Cisco Systems, Inc. defines IoT as a concept that imagines a future in which ordinary objects are linked to the Internet and have the ability to recognize and communicate with other devices. The term is commonly linked with RFID communication, although it can also encompass other sensor technologies.

Below, we will describe the three primary constituents of the Internet of Things that facilitate pervasive computing across networked devices:

- ***Hardware:*** This category encompasses a collection of integrated communication tools, sensors, and actuators.
- ***Middleware***: refers to data analytics tools and on-demand storage services.
- ***Presentation:*** The resultant should be displayed in a clear and comprehensible manner, facilitating visualization, comprehension, and interpretation.

(Rose et al.,.) Stated that in order for the Internet of Things (IoT) to operate effectively and accomplish desired outcomes, it is essential to establish the following technologies:

- Radio Frequency Identification, or RFID, is an essential technology for implanted communication because it provides the facility to produce microchips for wireless data transfer. Application technologies enabling access control and ticketing replacement can also be employed in transportation facilities.
- The sophisticated sensors within the Wireless Sensor Networks (WSN) collect and analyze data from varied contexts. The data from sensors is relayed to several nodes, where it is disseminated and forwarded for further utilization.
- Effective communication between IoT devices relies on the proper addressing schemes. A system has to be capable of detecting or locating these devices and understand their diverse functions.
- Data analytics and storage: By design, it is reported that IoT results in data production. There is a need for careful analysis of such data and its appropriate preservation. There are algorithms widely used in designing artificial intelligence systems to accelerate this process, with data either kept centralized or distributed depending on needs.
- Visualization is a crucial feature of the Internet of Things, as it enables users to come in touch with the environment. Therefore, device interfaces have to be pleasant and easy to navigate.

3.2.Introduction of a Smart Home

Smart homes are popular because owners can remotely operate appliances such as refrigerators, washing machines, air conditioners, and other similar electronic devices that utilize sensors ((Khan et al., 2020) Wi-Fi provides the backbone for increased bandwidth and sample rates, which improves home control and energy efficiency. Smart homes can improve security and sustainability by using sensors and web technology to make

more informed decisions, such as air conditioners connected to the Internet of Things. (Arif et al., 2020b).

Based on stored history, the Smart air conditioning systems may estimate home occupancy periods and automatically turn on to achieve the desired outcomes when the residents arrive. (Nurlan et al., 2022) According to the study, smart homes that help seniors with everyday duties like cleaning, cooking, shopping, and washing may improve comfort. Intelligent home systems may also remind patients of their regular medication intake. These devices monitor patients and alert caregivers so they may act quickly to save hospitalization expenditures. Before deploying smart home technologies, they must be secure and trustworthy.

3.3.Automation of smart homes

Smart home automation is a new technology that makes life easier, more pleasant, conserving energy, and safer. (Narayanan et al., 2022) Said intelligent systems in homes may improve the Standard of living.

3.4. Technologies and Applications

(Franco et al., 2021) Describes innovative house applications and technology. Figure 1 shows how different technologies work together to get outcomes. The shown components are described below:

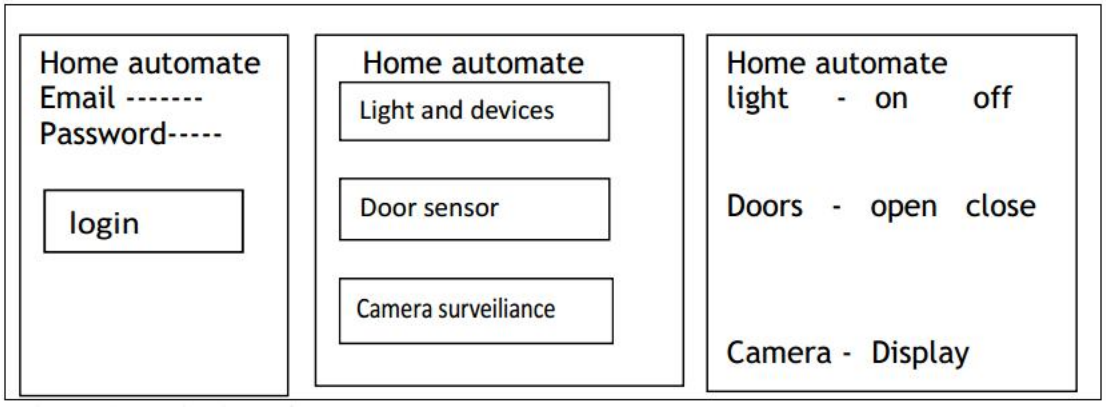

Figure 1

Applications of the Internet

- ***Light and Devices:*** The house occupant can remotely monitor the status of the exterior light and shut it off without having to leave the bed. These devices provide a benefit to older individuals and anyone with limited mobility by enabling them to remotely operate equipment and switches without having to physically move.

- ***Webcam surveillance*** refers to the real-time streaming of video captured by a webcam to monitor activities in a specific location. The camera records photographs in real-time, which can be stored, examined, or transmitted across the network via email attachments.

- • ***Magnetic Door Sensors*** are in a position to determine an open door from a closed door. Some of the magnets are encased in plastic housing for weather protection. The reed switch shuts automatically when the magnet is less than 0.5 inches.

3.5. Securing smart homes

Several scholars in the literature have underlined the necessity of home security, and the use of technology has resulted in even more guarded residential homes than previously. Homeowners are increasingly investing in security systems to guarantee their houses are fully protected. Thermostats, energy meters, lighting systems, irrigation systems, pool management systems, and video streaming boxes are all examples of technological devices. These are among the gadgets and appliances that may be controlled over the internet. These gadgets are linked to cell phones, allowing owners to remotely control and manage them. Figure 2 depicts a house outfitted with Internet of Things technology, which allows the homeowner to connect to and control it remotely.

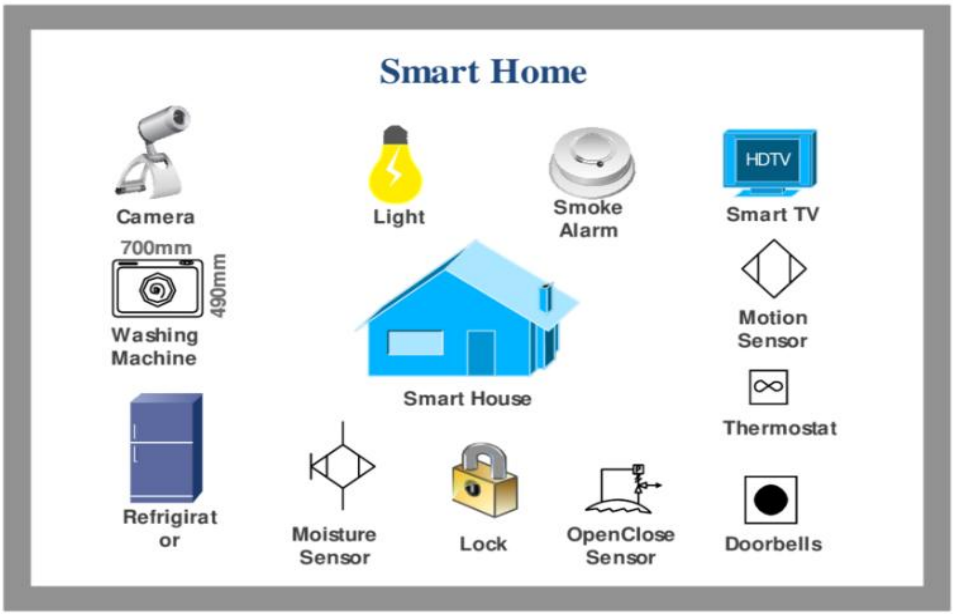

Figure 2

IoT smart home connected

CHAPTER 4

SYSTEM DEVELOPMENT

4.1. System Architecture

The suggested system consists of both hardware and software components. The Arduino board serves as the central processing unit of the project. The microcontroller processes incoming commands by comparing them to the preestablished ones. Once the signal is detected, the microcontroller will initiate the operation of a connected relay by transmitting a 5V electrical current. The microcontroller will transmit a 0V signal to the corresponding relay to deactivate the appliance. A mobile application can manipulate the lighting system. The mobile application operates on a portable electronic device. Both the Android and iOS operating systems. The system establishes a connection to the internet. As Shown in Figure 3.

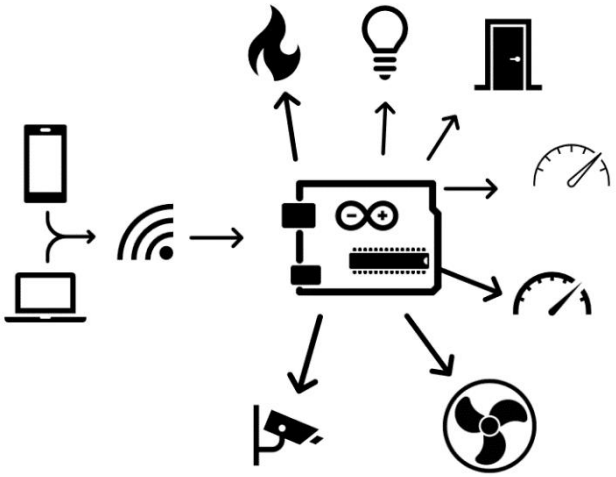

Figure 3

System Architecture

4.2. System Technology

In this study, some systems offer many tasks for building a smart home application controlled by a mobile application.

4.2.1. Arduino technology

Arduino, an open-source electronics platform, was founded in 2005 at the Ivrea Interaction Design Institute. It was designed as a quick prototyping tool, using simple hardware and software that students can readily understand (Abdullah et al., 2016). The origins of Arduino technology involve the creation of programs that receive input data, illuminate a sensor, engage a motor, and turn on an LED (Kim et al., 2020). At these points, the instructions are relayed to the microcontroller, which may then determine the next practical action. Arduino boards have undergone advancements as a result of the growing challenges and impediments. These advances have been seen in a variety of dimensions, including applications such as IoT, 3D printing, and general embedded systems (Lopez-Belmonte et al., 2020). It has been used for communication and regulation, and it is now being expanded to serve as the basis for many complicated concerns.

4.3. Programming Language for Arduino

C Programming language was created in 1973 to design compiler architectures and operating systems. The C programming language is relatively lost and of direct low-level memory access, and it carries a small number of keywords, as witnessed by Tupac-Yupanqui et al. (2022). Most computer languages applied in the modern age are borrowed from the C programming language's syntax. C is a high-level programming language and has served as the base for many other languages like Java, PHP, JavaScript, and so forth. C programming language hosts several platforms ranging from

microcontrollers to supercomputers to desktop computers. Microcontroller can be programmed in the C programming language.

4.4. Use Case Diagrams

A use-case diagram shows how a system was built. This is an effective technique for comprehending system behaviors. It also demonstrates system utilization and user-system interaction as Shown in Figure 4 Use case diagrams typically portray the interaction between a user—actor—with a system to model the functional requirements of a system. This study probably intends to show how the user will interact with the smart home system in controlling and monitoring a variety of components that involve doors, sensors, and other devices in homes.

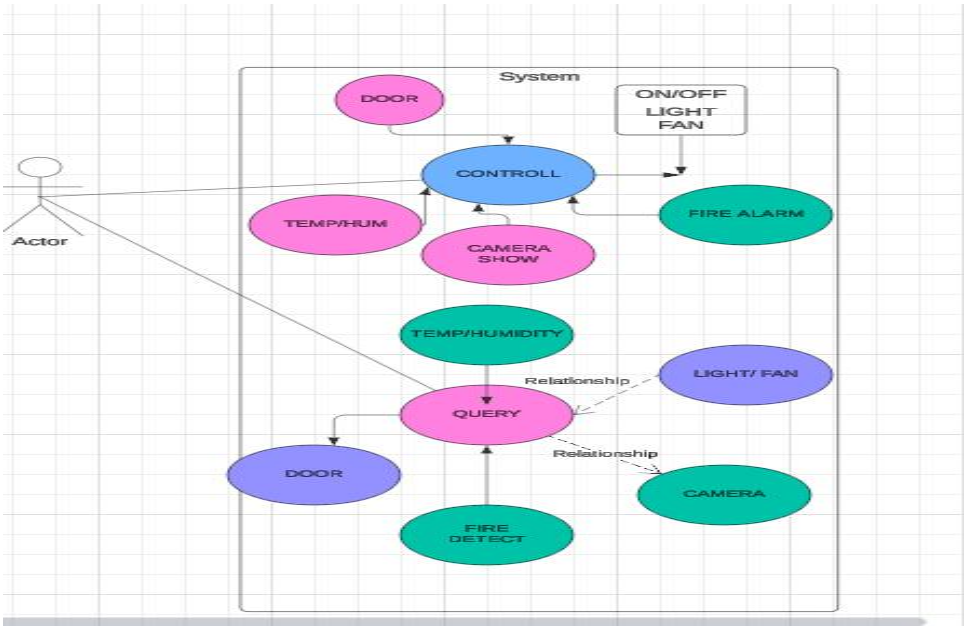

Figure 4

Showcase diagram.

4.5 System User

The system comes equipped with a user who can operate the hardware component of the System. The mobile application user role said the following:

Control: The system lets the user control physical components such as opening and closing doors.

Monitor: The system enables the user to monitor sensors such as temperature and humidity levels.

4.6. System Requirements

The system requires hardware and software tools like Arduino parts, sensors,

Mobile devices, and the Blynk Platform.

4.7. Hardware components

Below are some components in the hardware part:

4.7.1 Arduino Uno R4 Wi-Fi

The Arduino® UNO R4 Wi-Fi features the first UNO board with a 32-bit microcontroller and an ESP32-S3 Wi-Fi® module (ESP32-S3-MINI-1-N8). It features an RA4M1 series microcontroller from Renesas (R7FA4M1AB3CFM#AA0), based on a 48 MHz Arm® Cortex®- M4 microprocessor. Memory in UNO R4 Wi-Fi increases to 256 kB, which surpasses that of its predecessors flash, 32 KB SRAM, and 8 KB of EEPROM. The RA4M1's operating voltage is fixed at 5V, whereas the ESP32-S3 module is 3.3 V. Communication among these two MCUs is achieved through a logic-level translator (TXB0108DQSR) (Arduino® UNO Wi-Fi, . Figure 5 shows Arduino uno R4.

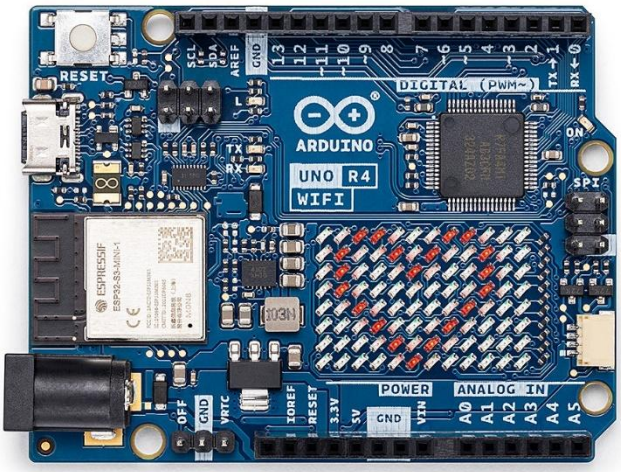

Figure 5

Arduino Uno R4 Wi-Fi

4.7.2. Arduino IDE software

According to (Kim et al., 2020) The Arduino IDE software is an open-source project that grants programmers to use the AT mega processors embedded in the software. The software enables programmers to create code and upload it to the AT mega processor, allowing it to run on the chip. The user may upload the code using Arduino, which is compatible with most 3D-electronic printers, including mechatronics, and RAMPS. Machine language is translated via "firmware" software, which interprets machine instructions and converts them into real movement. Marlin, Repeater, and Sprinter are among the most prominent alternatives described in the literature as Figure 6 Shows the Arduino IDE.

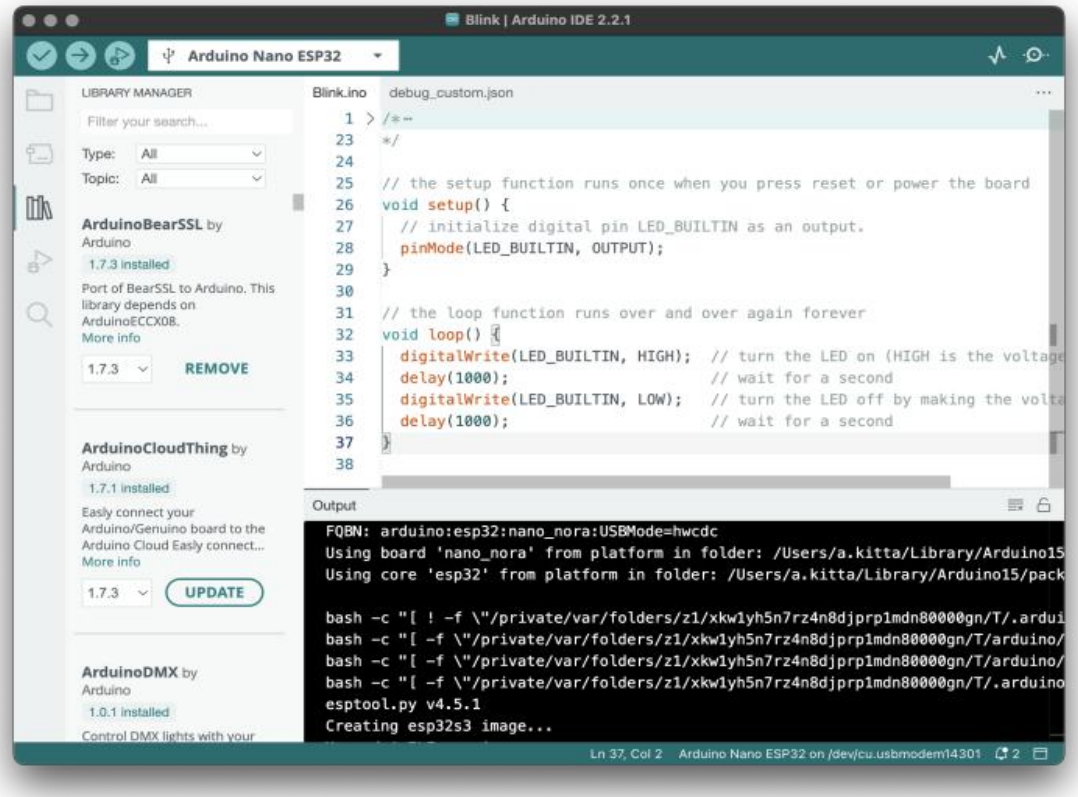

Figure 6

Arduino IDE

4.8. Sensors

Different categories of sensors have been used in this intelligent domicile and other domains to perceive and ascertain alterations in the surroundings through the Internet of Things. Below, we will concentrate on two specific sorts of sensors that are utilized for detecting temperature, humidity, and fire:

4.8.1. DHT 11 Temperature-Humidity Sensor

The DHT11 temperature-humidity sensor utilizes a calibrated digital signal output to accurately monitor temperature and humidity, ensuring both dependability and long-term stability (Meijer, 2014). The system includes integrated single-wire interfaces, which provide easy operation. Figure 13 illustrates the DHT11 temperature/humidity sensor.

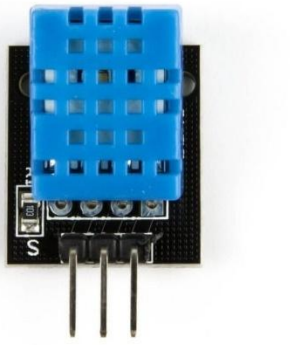

Figure 7

DHT 11 Sensor

4.8.2. Flame sensor

A flame detector detects and responds to flames or fires. Depending on the installation, detecting a flame may trigger an alert or activate a fire suppression system. A flame detector's technology allows for faster and more precise response compared to smoke or heat detectors. Infrared flame detectors detect heat from fires and open flames within 3 to 5 seconds. Flame detection devices in the infrared spectrum have a sensitivity range of 4.3 to 4.4 micrometers (Fig 4). This range includes the resonance frequency of Carbon Dioxide (CO2), which is produced by the combustion of hydrocarbon materials like wood and fossil fuels. Fires emit CO2 gasses, resulting in a peak in total radiation and a distinct spectral pattern in the infrared region that flame detectors may detect as Figure 8 shows Flame sensor (Ni Zaw, 2018).

Figure 8

Flame Sensor

4.9. Servo Motor

A servomotor is a compact and highly efficient device that precisely regulates the rotation or linear displacement between two positions. The system comprises a suitable motor that is linked to a sensor for the purpose of receiving or transmitting positional information. It has primarily been utilized

in robotics applications and 35 Internet of Things (IoT) devices. It can be utilized to control toys and robots from a distance via remote control or radio control as Figure 9 shows Servo motor (Hasan et al., 2020)

Figure 9

Servo Motor

4.10. Relays

(Anschau et al., 2020) defines Electronic devices are defined as devices that facilitate the opening and closing of electrical connections, as well as the activation and deactivation of other devices within the same electrical circuit. There are two primary categories of relay technology:

- ***Mechanical state:*** The movement of the switch is caused by electromagnetic forces generated by an inductor and a switch.
- ***Solid state***: These devices have the ability to perform the same functions as mechanical devices, but they use semi-conductors to alter impedance and control the opening and closing of circuits for activation or deactivation.

The relay parameters and their corresponding descriptions are presented in Table 2 below and Figure 10 shows the Relay module.

Table 2*Relay specifications (Peters, 2016)*

Specification	Description

MIL-R-5757	Electrical, Electronic, and Communication Type Equipment Relays
MIL-R-6106	Electromagnetic Relays
MIL-R-28776	Relays for Electrical for Electronic and Communication type Equipment, Hybrid
MIL-R-39016	Relay, Electromagnetic, Established Reliability
MIL-R-28750	Solid State Relay
MIL-R-83726	Time Delay, Hybrid, and Solid-State Relays

Figure 10

Relay Module

4.11. Radio Frequency Identification (RFID)

An identifying technique called radio frequency identification uses a transponder to record and retrieve long-distance data. A label or RFID card may be applied to a product, an animal, or a person to identify them by using radio frequency transmission at 125 kHz, 13.65 MHz, or 800-900 MHz. RFID uniquely identifies items or persons via radio wave transmission(Hasan et al., 2020). As seen in the Figure below, an RFID label, transponder, or tag has information that is electrically stored and read for a few meters Figure 11 Shows RFID.

Figure 11

Radio Frequency Identification (RFID)

4.12. Esp32 Camera

This module is a wireless module that incorporates a camera. This module has versatile applications, such as for CCTV and photography. Another notable feature is its capacity to detect and distinguish faces. The ESP32 cam is equipped with a remarkably small camera module that may operate autonomously with a minimal configuration. ESP32 cameras can be employed in various Internet of Things (IoT) applications. This technology is suitable for integration into smart home devices, industrial wireless control systems, wireless monitoring systems, QR wireless identification systems, wireless positioning system signals, and other Internet of Things (IoT) applications. (Rusimamto et al., 2021).

CHAPTER 5

SYSTEM IMPLEMENTATION

People interact with technology through their mobile devices. As such, applications can assist users in communicating with the environment to learn about the weather and the state of their smart homes. This program is a smart home system with automated protection controlled by a mobile app. This chapter describes all the system's functionality.

5.1. Hardware Part

The system includes an Arduino, a servo motor for controlling the door, four sensors (temperature, flame, humidity, and RFID), an Esp32 cam, and two relays to regulate the outputs (fan and light) figure 12 Shows the hardware part of the system.

Figure 12

The Hardware Part of the System

5.2. Software Part

The system is programmed with Arduino, which controls input and output devices using the C programming language. It also has Bynk connection programming, with the use of a single user who will operate and monitor the smart home system.

5.3. The Diagram of The Circuit

The figure below illustrates the electronic circuitry of a smart home system equipped with automated protection. The circuit is equipped with four sensors for detecting temperature, humidity, fire, and RFID figure 13 Shows the circuit Diagram.

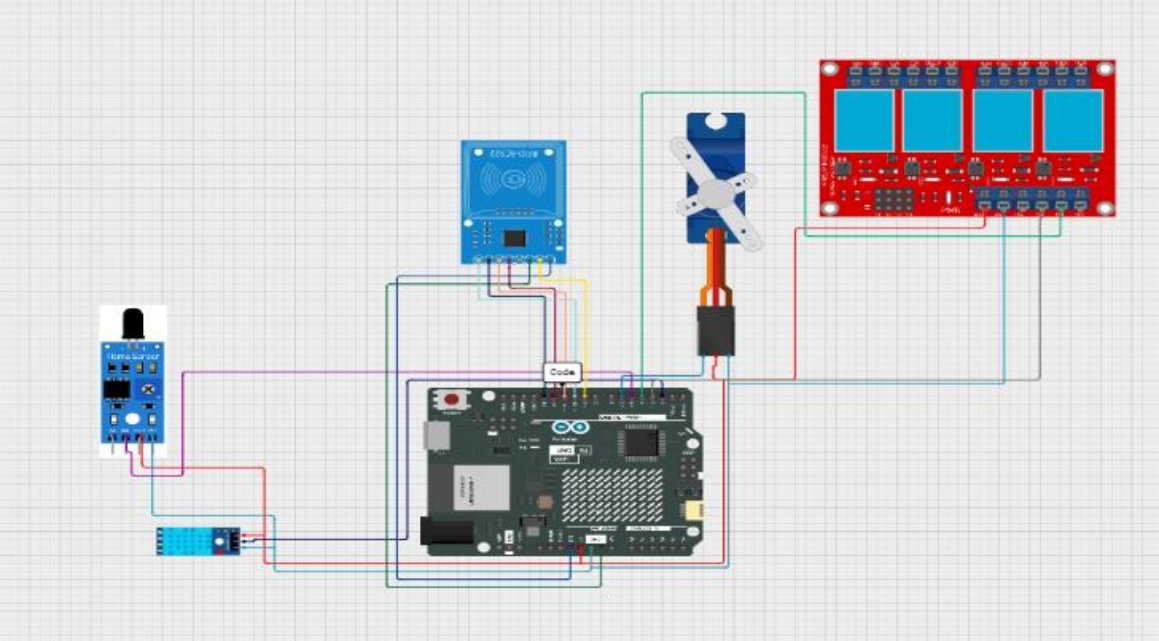

Figure 13

Circuit Diagram

The Flame Sensor

The Flame sensor senses Fire inside the house. If there is a fire inside the home, Arduino will send a notification and email it to the mobile.

The Temperature and Humidity Sensor

The DH11 sensor senses internal Temperature and humidity. The Arduino sends the temperature and humidity values to the Mobile Dashboard.

5.4. Blynk Setup

After installing the Blynk App, you will see the login screen. It has two fields: the first is for entering your email, and the second is for entering your Password as shown Figure 14 Snapshot of the login page

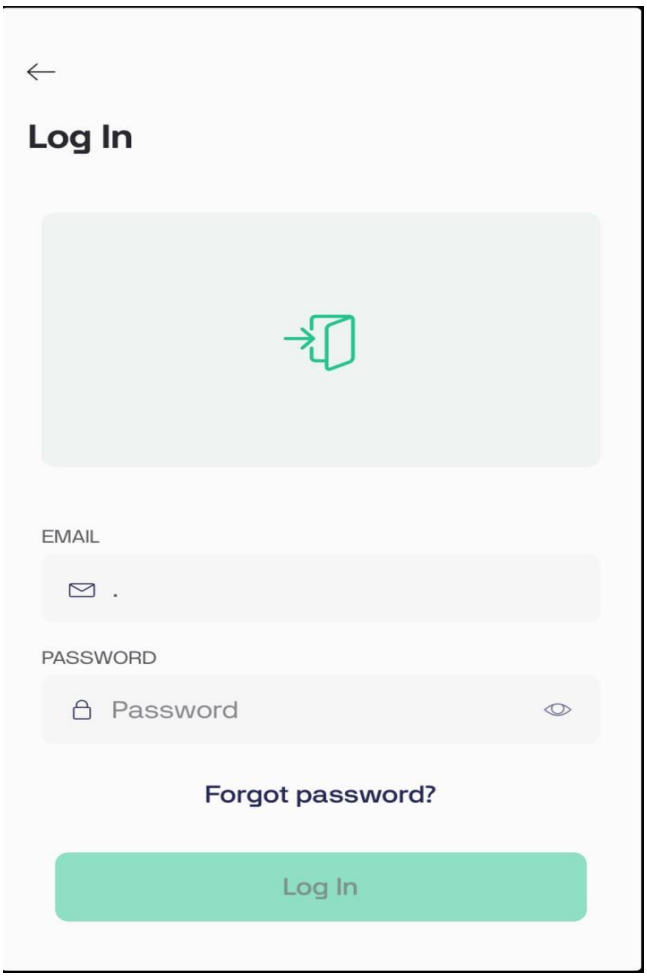

Figure 14

Snapshot of the login page

Then, the user will fill in these fields as shown in figure 15 Snapshot of the login page after filling in the fields.

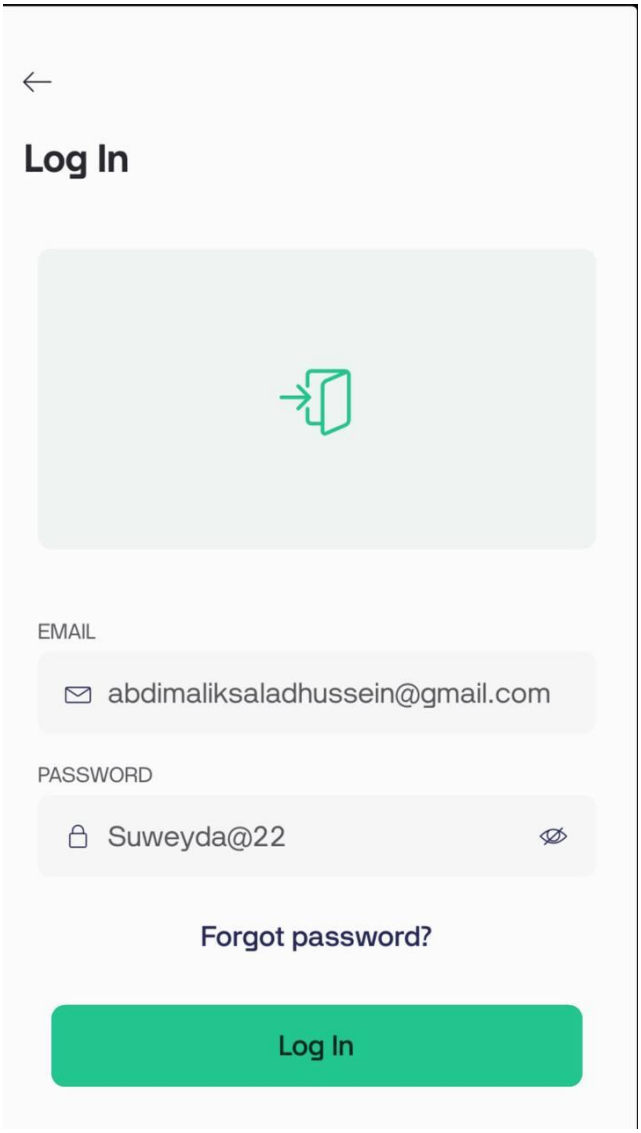

Figure 15

Snapshot of login page after filling in the fields.

Then, the user Can manage his home on the main screen as Figure 16 Shows the Application main screen.

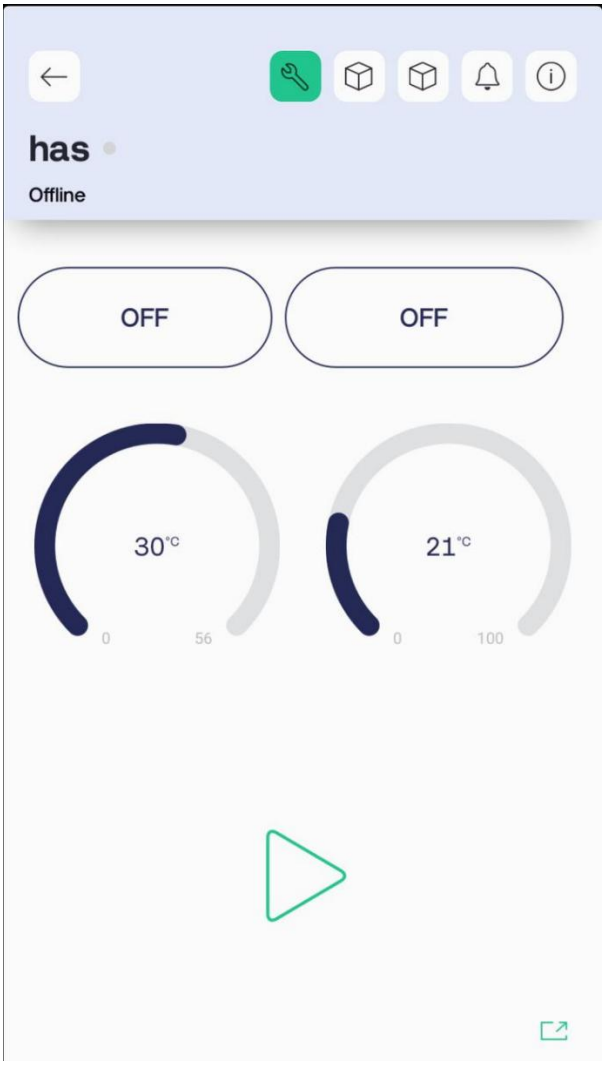

Figure 16

Application main screen.

Figure 17

System Fan

Figure 18

System RFID Door Control

Figure 19

Flame Sensor

Figure 20

DHT 11 Sensor

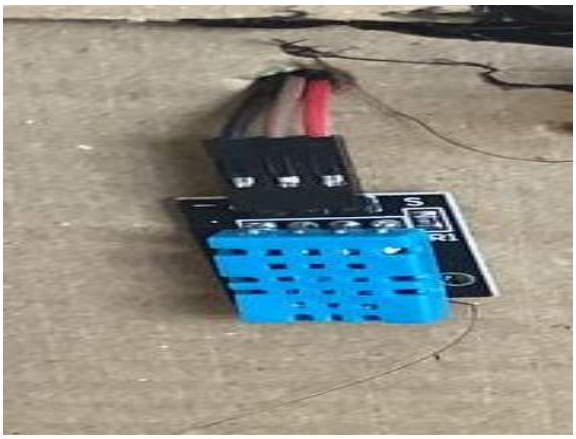

Figure 21 *ESP-32 CAM*

CHAPTER 6

DISCUSSION

The development and implementation of the smart home automation system presented in this study have demonstrated significant potential in enhancing the convenience and security of home management. The integration of IoT with home automation provides users with the ability to manage various home devices remotely, contributing to an improved quality of life. This section discusses the findings in relation to existing research, highlighting similarities, differences, and advancements made by this study.

Various studies have explored the use of different communication protocols, controllers, user interfaces, and applications in smart home automation systems.

6.1. Communication Protocols

Correspondingly, Wi-Fi is used as the primary mode of communication adopted by most smart home automation systems since it offers high data transfer rates and wide availability. For instance, in most systems implemented by Stolojescu-Crisan et al. (2021), Singh et al. (20220, Irugalbandara et al. (2023), Isyanto et al.(2020), and many others, device connectivity is primarily done using Wi-Fi. Some of them also use Bluetooth for short-range communication, as in the works by Singh et al.(2020), and R. Sivapriyan et al.(2020) Zigbee is also used in, among others, the system by Sun et al.(2020) for low-power, low-data rate applications. In contrast, our system deploys only Wi-Fi given its allowing home devices to be remotely controlled and monitored in real-time. This choice aligns with the majority of the existing research, ensuring compatibility and reliability in various home environments.

6.2. Controllers

Different controllers have been used in various studies to govern home automation tasks. Among them, due to the versatility and presence of Wi-Fi, Raspberry Pi and ESP8266 have mainly been used. Stolojescu-Crisan et al. (2021) and Irugalbandara et al. (2023) used both Raspberry Pi and ESP8266, while Singh et al. (2022) and Isyanto et al. (2020) focused on ESP8266. Sivagami et al. (2021), Hassan et al. (2022), and Vijayaraja et al. (2023) have employed Arduino due to the ease of use of the platform and community support. In this system, an Arduino Uno R4 Wi-Fi controller will be used, built with the Blynk application for home device management. This is because it is easy to work with Arduino, where support for IoT-oriented projects that will efficiently manage tasks regarding home automation is available.

6.3. User Interface

The user interface is a vital component of smart home systems. In most of the systems that consider mobile applications for user interaction, these provide a friendly interface in terms of remote control. According to Singh et al.(2020), Isyanto et al.(2020), and Ahmed et al.(2021), mobile applications can be utilized to provide control over home devices. Web-based applications are also widespread, as seen in Stolojescu-Crisan et al.(2021), and Tayef et al.(2021), and provide much-needed flexibility and accessibility. The system incorporates the Blynk application, offering a mobile interface with which users will find it very easy to control and monitor home devices. This approach will ensure ease of use or accessibility in the design of the user interface, conforming to the strategies applied in existing research.

6.4. Applications

Smart home systems are applied in different contexts, such as indoor and outdoor lighting control, security monitoring, energy management, appliance control, irrigation, and security and power management, as discussed by Stolojescu-Crisan et al. (2021), Singh et al.(2022), and of Umer et al.(2023), provide a system that focuses on indoor/outdoor control with capabilities for short-range applications. Isyanto et al. (2020) and Ahmed et al. (2021) focus on controlling specific appliances, such as TVs, lights,

and fans. It has the following features: light and fan on/off, checking room temperature and humidity, equally enhancing security through real-time CCTV surveillance and auto firefighting. All these applications have improved dramatically in-home convenience and safety, hence broadening the capabilities seen in related research.

6.5. Advancements and Novelty

What is new in the system is its firefighting operation on its own and real-time email and notifications in emergency conditions. Though remote control and monitoring were dealt with by existing literature, the implementation of those safety features into our system makes it unique. It gives a feel of security and satisfaction to the user. Critical safety concerns are addressed with this advancement, rendering essential utility to a smart home automation system.

CHAPTER 7

CONCLUSION AND RECOMMENDATION

This system is concerned with developing a mobile application that allows users to control smart home devices remotely using their mobile devices. A system to implement commands through a mobile application and execute them with Arduino, which controls the hardware. Accordingly, as proposed in this paper, suitable solutions should be provided for control and observation in smart home systems. These are the doors that can be opened and closed, turning on or off a fan whose light's brightness can be adjusted. It allows knowing the current room temperature and humidity. A user locks or unlocks the door using RFID technology. It can thereby trigger an alarm and send both a notification and an email in case of a breakout or fire. The system is manipulable through a web-based mobile application. A mobile application provides input into varied scenarios to the system.

7.1. Limitations

Though the system implementation has been successful, the following are some of its limitations:

- ***Network Dependency:*** System performance is dependent upon the stability of its Wi-Fi. Any disturbance in the internet service may hamper the system's performance and reliability.
- ***Scalability Issues:*** Setup works perfectly well with small-scale applications; however, scaling this system for more devices or embedding it into other smart home technologies could be problematic.
- ***Security Concerns:*** While RFID technology provides some level of security, the system could be vulnerable to hacking or unauthorized access if extra precautions to ensure security are not taken.
- ***Limited Range of Control:*** It primarily focuses on the automation of basic functionalities in a home. Much more complicated functionalities and

integrations are needed to have a commercial smart home system comparable to the market.

7.2. Practical Implications

The practical implications of this study are enormous for both consumers and developers in the smart home technology sector. This system will provide consumers of this technology with an affordable home automation solution that will improve comfort and security. This study will build the foundation that allows developers to investigate further IoT-based home automation with advanced features and limitation improvements.

7.3. Future Recommendations

1. **Improved Security Features:** Future work should target enhancing and improving the system's security features. Most future works should focus on encryption methods, followed by solid authentication techniques.
2. **Integration with Other IoT Devices:** Interconnecting the system with other IoT devices and platforms would make it more versatile and valuable to the user.
3. **Improved User Interface:** Enhancing the user interface in terms of intuitiveness and ease of use will significantly increase its value to the overall user experience.
4. **Integrate AI and Machine Learning:** It is also possible, through the integration of AI and machine learning, to get the system to learn from users and automate more tasks—making the home really 'smart.'
5. **Energy Management:** Future systems must be able to monitor and manage energy usage in a manner that saves energy and cuts costs for consumers.

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APPENDIX 1

Similarity report

Thesis

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APPENDIX 2

Ethics Declaration

NEAR EAST UNIVERSITY

SCIENTIFIC RESEARCH ETHICS COMMITTEE

25.03.2024

Abdimalik Salad Hussein

Your project **"DESIGN AND IMPLEMENTATION OF A SMART HOME AUTOMATION SYSTEM BASED ON THE INTERNET OF THINGS "** has been evaluated. Since only secondary data will be used the project does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Prof. Dr. Aşkın KİRAZ

The Coordinator of the Scientific Research Ethics Committee