# DEVELOPMENT OF IOT BASED SMART CLASSROOM WITH DOOR LOCK AUTOMATION USING NODEMCU ESP32 AND BLYNK APPLICATION

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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**This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours**

**Faculty of Electronics and Computer Technology and Engineering**

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Signature :

Supervisor Name : Raeihah Binti Mohd Zain

Date : 18 April 2024

Signature :

Co-Supervisor Name (if any) : NOT APPLICABLE

Date :

## DEDICATION

To my beloved family,

To my dear family, your love and support have been my guiding light through every moment of my life. From childhood to now, your wisdom, patience, and unwavering belief in me have shaped who I am. I am endlessly grateful for your presence and dedication. Today, I simply want to say thank you for everything.

# ABSTRACT

This project, "Development of IoT Based Smart Classroom with Door Lock Automation using NodeMCU ESP32 and Blynk Application," aims to enhance classroom security and efficiency. It creates a cost-effective door lock system using RFID and NodeMCU ESP32, integrated with the Blynk app for real-time control of door locks and classroom appliances. The system uses PIR sensors to manage lighting and fans, turning them off when no movement is detected to save energy. Key components include the ESP32 microcontroller, electronic door locks, and the Blynk platform for user-friendly control. This project provides a comprehensive smart classroom solution, improving security, convenience, and energy efficiency.

# *ABSTRAK*

Projek ini, "Pembangunan Bilik Darjah Pintar Berasaskan IoT dengan Automasi Kunci Pintu menggunakan NodeMCU ESP32 dan Aplikasi Blynk," bertujuan untuk meningkatkan keselamatan dan kecekapan bilik darjah. Ia mencipta sistem kunci pintu yang menjimatkan kos menggunakan RFID dan NodeMCU ESP32, disepadukan dengan aplikasi Blynk untuk kawalan masa nyata kunci pintu dan peralatan bilik darjah. Sistem ini menggunakan penderia PIR untuk mengurus pencahayaan dan kipas, mematikannya apabila tiada pergerakan dikesan untuk menjimatkan tenaga. Komponen utama termasuk mikropengawal ESP32, kunci pintu elektronik dan platform Blynk untuk kawalan mesra pengguna. Projek ini menyediakan penyelesaian bilik darjah pintar yang komprehensif, meningkatkan keselamatan, kemudahan dan kecekapan tenaga.

## ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor, Madam Raeihah Binti Mohd Zain, for her invaluable guidance, support, and encouragement throughout this project. Her expertise and insights have been instrumental in the successful completion of this work. I also extend my sincere thanks to Universiti Teknikal Malaysia Melaka (UTeM) for providing the resources and facilities necessary for this project. Additionally, I appreciate the support of my family and friends, whose encouragement has been a constant source of motivation. This project would not have been possible without the collective efforts and contributions of everyone involved.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background

In today's digital age, technology is increasingly becoming a crucial part of education, replacing traditional classrooms with smart classrooms equipped with IoT devices to enhance teaching, learning and administrative tasks. This project leverages IoT technology to create a smart classroom featuring automated door lock systems. Door lock automation component of the classroom setup: The electronic door lock system shall link with sensors through the Internet of Things. It does remote access control and monitoring. As a result of this kind of setup, only the authorized shall have access to the classroom, hence improved security.

Besides door lock automation, there can be much more to what a smart classroom can do. For example, with the help of motion sensors, it can detect a person's presence in a room. In that case, it can automatically turn the lights and fan on and off. The IoT-based smart classroom with door lock automation using NodeMCU ESP32 and the Blynk app is, therefore, a major step towards modernizing educational infrastructures in its entirety. Application of IoT technology in learning institutions improves general security, enhances effectiveness and creates a better learning experience for both students and teachers.

## 1.2 Problem Statement

There are many security problems in traditional educational environments, such as weak access control and backward teaching methods. Keys are risky since they can be easily copied without different authorization and there might be delays at times in triggering alarms thus compromising security. This put at risk to the smooth running of schools and the safety of the students, staff and property. Staff manually locking and unlocking the doors is much less secure compared to an electronic system. Furthermore, there are occasions when the lights and fans are not turned off at all which really wastes a lot of electricity.

It simply shows that class scheduling needs high attention, particularly to extra classes, so as not to confuse one with the other in choosing a classroom for learning. Overlapped class scheduling will disrupt the learning process due to interferences, which reduce the effectiveness of lessons delivered. The assurance that each class has its specific time and place keeps students and teachers from conflicts and engaging in educational activities without unnecessary disruptions. This monitors scheduling, thus keeping the environment organized for smooth and uninterrupted learning to be attained by all.

## 1.3 Project Objective

The main goal of this project is to build and load an IoT-oriented smart classroom system with automatic door-locking using the NodeMCU ESP32 microcontroller and the Blynk App. undefined

a) To develop a cost-effective and secure door lock automation system for classrooms by utilizing RFID technology and a NodeMCU microcontroller

b) To integrate the door lock automation system with a user friendly mobile application and control the electrical usage of the appliances.

c) To optimize an effective system for dock lock automation and managing electricity usage to reduce cost.

## 1.4 Scope of Project

The scope :

- Design and implement a secure door lock mechanism using RFID card technology.
- Develop a system for managing and controlling the use of electrical appliances in the classroom.
- Conduct comprehensive testing of the door lock and electricity usage control systems.
- Integrate the door lock automation system and electricity usage control system with a comprehensive mobile application using the Blynk platform.
- Enhance user convenience and operational effectiveness based on feedback and testing results.

## 1.5 Addressing Societal and Global Issues Through IoT-Based Smart Classroom with Door Lock Automation

Development of an IoT-based smart classroom with automated door locks addresses some of the most fundamental and global issues in society. Most traditional classrooms have various security-related problems, which include unauthorized access that can be hazardous to students, teachers, and school property. Smart classrooms give room for automated door locks controlled via RFID cards, improves security such that only authorized peoples are allowed to pass through the doors for protecting people and property towards a safer learning environment.

These smart classrooms would be fitted with ambient sensors that ensure indoor air quality, temperature, and humidity are maintained and regulated. A healthy indoor environment is important for the sake of students and staff, as it reduces respiratory risks and improves comfort and concentration levels.

Most importantly, secure access control systems help schools meet all existing legal requirements regarding safety and privacy. Protection of sensitive information and control over access to a school facility will help fulfill the legal obligations, avoiding thereby liabilities.

The infusion of advanced technologies into the learning environment can culturally guarantee digital literacy and prepare students to live in a technologized world. This approach shows a commitment to modernizing educational practices and embracing innovation, crucial for cultural progress and adapting to our rapidly changing global landscape.

An IoT-based smart classroom with door lock automation addresses essential societal, health, safety, legal and cultural issues. By boosting security, improving health conditions, ensuring legal compliance, and fostering cultural advancement this project takes a comprehensive approach to creating a safe, healthy and forward-thinking educational environment.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

In a literature review data on a certain study is systematized and clear picture about already existing research of the subject is developed. It aids a researcher in the identification of relevant theories, strategies and the outcomes obtained which, additionally, help in the improvement and orientation of the main research question and methodology. Literature review leads the project by critiquing the works done previously and confirms the researcher's aptitude to be critical and understand the scholarly work as well. Basically, it represents the basis of the research, providing for the fact, context as well as justification and to an extent, the groundwork for the own researcher's contribution to the discipline.

## 2.2 Past Related Project Research

### 2.2.1 IOT Based Smart Door Locked System Using Node MCU

The research paper presents an innovative IoT-based Smart Door Lock System that aims to enhance security, convenience, and the quality of life for users[1]. This system replaces traditional manual keys with digital codes and knock patterns, providing a more secure and modern method for accessing homes. By integrating a solenoid lock, a 12V relay, and a NodeMCU ESP8266, the system enables users to control the door locking mechanism remotely through a mobile application. This allows users to lock and unlock their doors from anywhere, adding a layer of convenience and security.

The basic idea of this project is to reduce the implementation costs as much as possible so that more people could afford such advanced technology in their search for effective protection of a house. The most accessible cost of such a system will make it available not only to those households that can afford to spend more on smart home technology.The system employs IoT technology in its implementation; hence, it can be internet-based and remote controlled in its operations. This is a perfect feature for individuals who intend to monitor and control the security of their homes even while they are not present. It is also compatible with a variety of microcontrollers and relay modules, thereby making an excellent choice in varying smart home environments[2].

Solenoid lock makes this system have a highly efficient locking system. This powerful lock, on the other hand, its power is drawn by the Relay 12V. Another device that is significantly important regarding this project is the NodeMCU ESP8266. It will provide the backbone for communication between the mobile application and the locking or the door lock system. The mobile application will allow the user to run the lock without many kinds of advanced technicalities and will provide an easy to use interface. This IoT-based Smart Door Lock System is an overall effective and practical implementation of digital smart locks.

It improves the security of the home through replacing old keys with some more secure digital option, convenience by way of remote control, and is cost-effective. All these above mentioned features make this locking system a vital addition in modern smart home environments: secure, convenient, and easy.

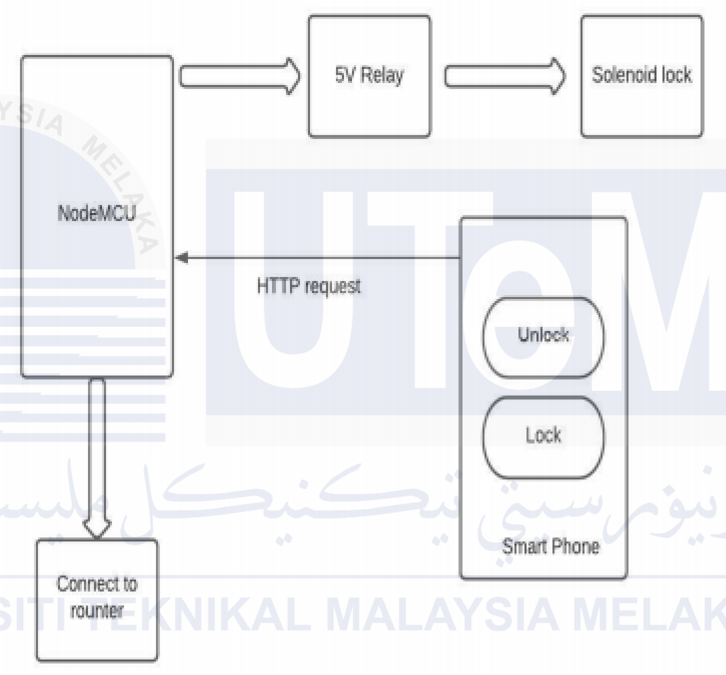


**Figure 2. 1 Block Diagram Of The Proposed System.**

### 2.2.2 IOT BASED SMART DOOR LOCK SYSTEM

The paper deals with the design and implementation of an IoT-based Smart Door Lock System, which helps either directly or indirectly in mitigating concerns of security posed by traditional mechanical locks[3]. It serves as a home security-enhancing device with multiple modern features, such as an embedded spy camera that captures the video to help a homeowner identify at real time whoever sounded his door bell. This constitutes an important feature in terms of unauthorized access detection and deterrence.

At the core of the system lies an ESP-32 that is interfaced to the Arduino Uno microcontroller ATMEGA328P. A combination of the two makes for effective control of the locking and unlocking of doors in enhancing security measures in general. The incorporation of facial recognition raises this one level higher, completely dispensing one from the use of keys to access any place. This not only enhances security but also offers greater convenience to the users, now able to unlock their doors simply by their facial features being recognized.[4].



This system allows the owner of the house to gain remote access to the door lock via a mobile app, hence giving him the independence to manage the lock at his own will wherever he is. The remote features are complemented by real-time notification alerts that are sent directly to the homeowner's mobile device in case of any attempt to access the door. Therefore, this feature provides flexibility and the ability to make fast decisions on allowance or rejection of access, independent of the relative location of the owner.

The IoT-based Smart Door Lock System incorporates several advanced security features and brings them to life with the help of modern technology. It provides great convenience and peace of mind for homeowners while increasing the safety features of the home with an integrated video surveillance system, facial recognition, and remote access features. Thanks to the IoT technology, smart door lock systems provide a strong solution for modern home security needs making them quite practical and effective for an upgrade over traditional mechanical locks.


**Figure 2. 2 ESP32 CAM MODULE**

### 2.2.3 The Concept and Implementation of Smart Room using Internet of things (IoT) for Cost Efficiency and Room Security

The research paper delves into the concept and implementation of a smart room using Internet of Things (IoT) technology to enhance cost efficiency and room security[5]. It begins by introducing the IoT concept, which involves the interconnection of devices to exchange information, thereby enabling automation and improving security within a smart room. The paper details the design of a smart room model that employs sensors and microcontrollers to automate electronic devices and bolster room security through the use of IoT technology.

A key objective of the smart room implementation is to improve operational cost efficiency, particularly in reducing electricity payments. This is achieved by automating the control of various electronic devices. For instance, the system uses sensors to monitor and control home and garden lights, blowers, and gas levels. The automation process is managed through commands embedded using Arduino IDE software and NodeMCU microcontrollers, which facilitate the efficient operation of these devices. Users can control and monitor these functions via smartphone applications, adding an element of convenience to the system.

The study also explores the broader concept of smart homes, highlighting the importance of energy efficiency, ventilation optimization, and the creation of comfortable living conditions through sensor-based networks. Specific hardware components used in the smart room include PIR sensors for motion detection, LDR sensors for light detection, MQ-2 sensors for gas monitoring, buzzers for alarms, blowers, and relay modules to control the power supply to various devices. The paper provides detailed information on the coding process using Arduino IDE, which is essential for program execution and the overall functionality of the smart room system[6].

Overall, the research paper presents a comprehensive overview of how IoT technology can be utilized to create a smart room that enhances both cost efficiency and security. By automating electronic devices and employing a range of sensors, the system not only reduces electricity costs but also ensures a secure and comfortable living environment. This integration of IoT into home automation reflects a significant advancement in the development of smart homes, showcasing the potential for improved energy management and enhanced security measures through modern technology.

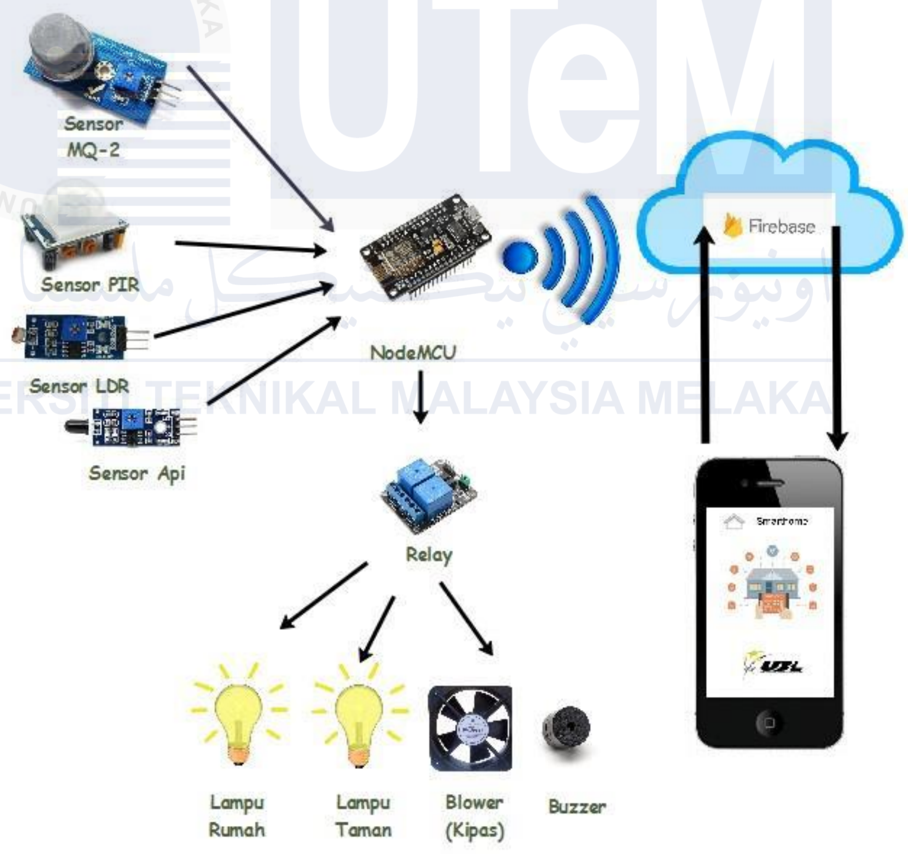


**Figure 2. 3 General system design**

### 2.2.4 Development of IoT Automated Door Lock System Using Blynk Application

The research paper explores the development of an IoT Automated Door Lock System that leverages the Blynk application for remote control of door locks via smartphone communication technology and IoT methods[7]. This system highlights the crucial role of IoT technology in improving home security and convenience, enabling users to monitor and control their door locks from any location at any time. The research emphasizes the importance of this capability, as it allows homeowners to ensure the security of their property even when they are not physically present.

A significant part of the study involved testing the system's durability, with a particular focus on the servo motor used to operate the door deadbolt lock. The tests were designed to ensure that the servo motor could handle the load effectively, confirming the system's reliability and robustness. This aspect is critical for the practical application of the automated door lock system, as it needs to function reliably under various conditions.

The paper also addresses the challenges associated with security in asymmetric networks. It highlights the necessity for lightweight encryption algorithms and security authentication methods to effectively manage these security concerns. This is important to protect the system from potential cyber threats and ensure that unauthorized users cannot gain access to the door lock[8].

Additionally, the research discusses the broader role of smartphones in monitoring different aspects of daily life. It illustrates how smartphones can be utilized for wireless access monitoring, significantly enhancing home security. This capability allows homeowners to receive real-time updates and notifications about the status of their door locks, adding an extra layer of security and convenience.

Overall, the paper presents a comprehensive overview of an IoT Automated Door Lock System that uses the Blynk application. By enabling remote control and monitoring of door locks, the system offers a significant enhancement in home security and convenience. The research underscores the importance of reliable hardware, robust security measures, and the integration of smartphones in modern home security systems, showcasing a practical and advanced application of IoT technology.


**Figure 2. 4 System Block Diagram**

### 2.2.5 Smart security door system using SMS based energy harvest

The Inventive smart security door system utilizes the highly developed security features along with the techniques of energy harvesting[9]. This paper manifests a unique solution in the field of security technology. On basis of the present study, researchers tried to enhance the performance of common security sliding doors, security panel doors, or security revolving doors by providing strong features of security along with electricity generation characteristics. This type of system has a lot to offer the customer; for instance, it contains a motion detector sensor for any intrusion and magnetic door lock opened only at a generated password, thus guaranteeing top level security measures. The wide range of potential features this smart door system could assure, an exciting one would be to make the most of the motion generated by the door to manufacture electricity. It is the most subsiding common problems of power shortage and improve this particular battery life of the system so that it works uninterruptedly and in a continuous mode. Due to this specific harvesting energy capacity, it is mainly effective in keeping up the functionality of the security system when such supply might be disruptive[10].



The system demonstrates its exceptional features with the motion of the door providing the generating power. This solves the common power shortage problem at one stroke and makes the battery of the system last longer to provide uninterrupted service for years. This feature is most useful in perpetuating the operation of the security system on a continuous basis instead of facing the vagaries of power supply.

The GSM module is also part of the system; it provides an important layer of security. Because of the module, the password generated can be quickly received by a user with authority. It takes around 3.6 seconds for the security code to be received by authentication. Such fast and reliable communication gives instant access to those who are authorized to have it but adds yet another layer of security.

The article gives experimental results regarding authentication in terms of power generation and speed. The same experimental results tell of the efficiency of this proposed system in real-world applications. The system provides the solution to one of the most common practical problems of power supply by borrowing from the concepts of energy harvesting and those of advanced security features for strong protection, and hence proves to be a worthwhile solution both in sustainability and reliability in compliance with contemporary security needs. In fact, this remains an improvement form within the security technological sector since such an advance allows for better safeguarding, functioning, and becomes even more effective.

### 2.2.6 Real Time Smart Door System for Home Security

This article presents the development of a real-time smart door system to bring cutting-edge security features home through video technology and Raspberry Pi [11]. With all the advancement, the proposed real-time smart door system can ensure early warning, high efficiency in communication, and comprehensive security features to guarantee a safe living environment for homeowners. Basically, it makes use of intuitive motion sensors and Bluetooth v4.0 low-energy devices for detection and prevention of unwarranted situations. The sensors can thus detect if someone is leaving the house and can alert the homeowner instantly in times of emergency as an added assurance of security and safety. This smart door system has a stand out point Offered, perhaps, by its ability to wirelessly communicate the images of a visitor to one's home. The person getting the real time images of the visitor at the door will have ample security advantage. It also supports sound communication whereby there is direct interaction between the Raspberry Pi and mobile devices. As such, one will communicate directly with the visitor without necessarily going to the door. This is ways quite useful to a few user authentication and more involved decision process with the help of intelligence tools. Another key cloud storage aspect of images clicked by the camera allows home users to store it and utilize it later, which may be required in security investigation matters or just for a general record of the visitor. Incorporation of like-minded advanced technologies makes this intelligent door system unique in contrast to other security solutions available in the marketplace[12].

All these smart door systems are the result of advanced security-related electronics, much to the growth in their popularity. With this kind of innovative technology, very common security and communication problems for most homeowners or office managers find an amicable solution. Brand In detail, these real-time video technologies, together with intelligent sensors and reliable methods of communication, help render this smart door system with excellent robustness for varied security purposes. -Based on the information provided, it is evident that the system allows for a more holistic solution that addresses both security and convenience thus enhancing safety while offering peace of mind in today's increasingly security-conscious world.

### 2.2.7 Development of a Microcontroller-Controlled Security Door System.

In this paper, a door security system will be designed that uses the smart card authentication. Access will be controlled by a microcontroller unit[13]. Every building must have security measures that prevent entry into the building without proper authority. There is a shift from the traditional lock to electronic systems like smart cards and biometrics that enhance security. The system has hardware as well as software components, and it allows authorized users into secured areas through smart card authentication - that provides a keyless entry.

It is also quite cost-effective and simple, hence a perfect solution to the needs in such high security 'sites' as banks or military research laboratories and private firms. On the same note, however, the paper further observes some other limitations that were linked with the use of traditional computer-based control systems, including the crosstalk issue and degradation over long distances, which impacted on their reliability. Also, high initial costs and maintenance requirements might prove a liability to some of the users post usage. Given the above, smart card authentication is an efficient and viable method for boosting security in sensitive areas[14].

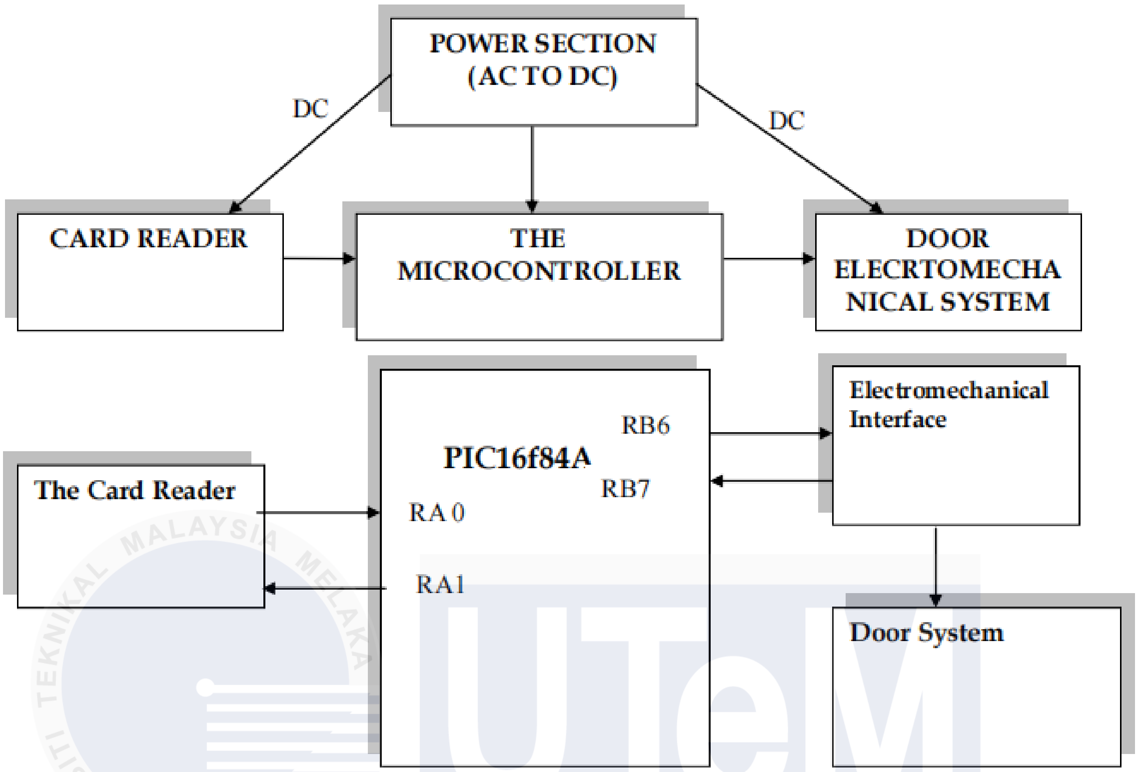


**Figure 2. 5 The Functional Block Diagram of the System.**

### 2.2.8 IoT Based Smart Classroom

The title of the research paper is "IoT Based Smart Classroom." The technology of IoT has been explored in this paper to make classrooms smart in terms of their management and efficiency[15]. The proposed project involves a number of improvements in the case of traditional education environments using IoT devices such as Raspberry Pi and NodeMCU. The improvements include online classroom booking, automatic real-time attendance, and dynamic automated control over lights and fans in order to efficiently use the energy resources and provide an ideal learning environment for students[16].

Dynamic classroom booking through the mobile application, notifications about lectures, statistics about attendance are available for students. Students and teachers attendance recording will be accurate with the help of portable biometric system. It saves paper and manual labor involved. Other features include control and monitoring of lights and fans to switch them off after classes to conserve energy.

Though the smart classroom system is efficient in saving energy and has many other benefits, it is notdıfferent to indicate its challenges: depend on technology and complexity in set up not forgetting privacy issues of volunteered biometric data. All the same, this project indicates IoT technology in modernizing classrooms and managing classes generally.

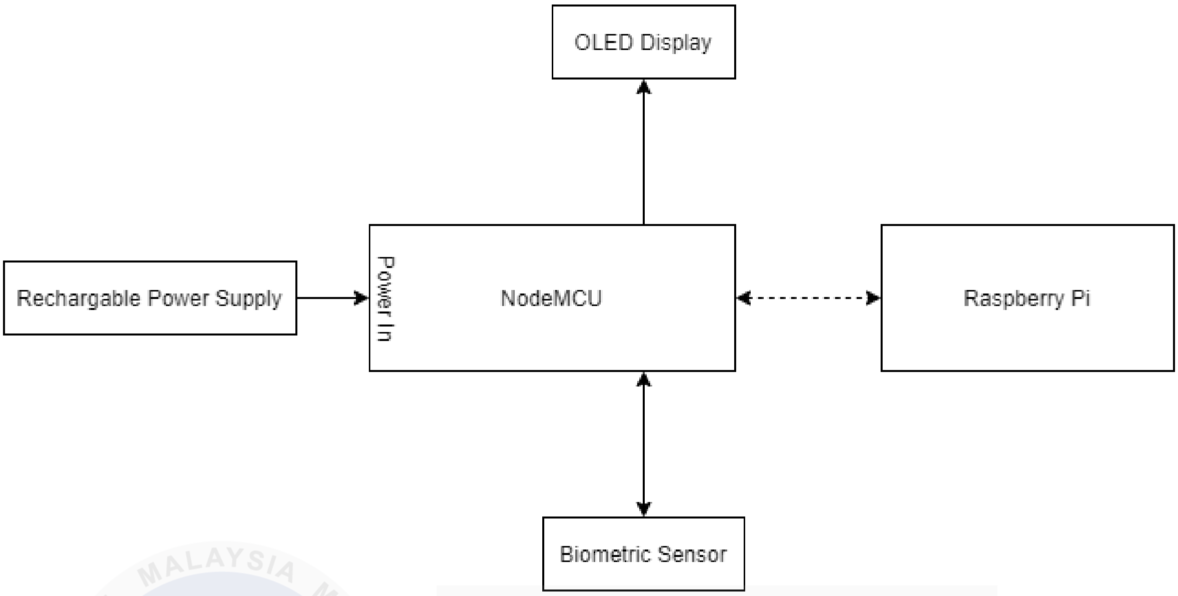


**Figure 2. 6 Block diagram of attendance processing subunit.**

### 2.2.9 DESIGN AND IMPLEMENTATION OF DOOR ACCESS CONTROL AND SECURITY SYSTEM BASED ON IOT

The paper focuses on the design and implementation of an IoT-based door access control and security system, as the security options available at the moment have become a necessity given that they are being breached by professionals with a much deeper understanding of technology, and as such, there is a great need for something more in terms of security[17]. To that effect, this intelligent system incorporates the use of biometric scanners, passwords, and security questions into the IoT system to provide more exceptional security in various uses. Another important feature of this system is IoT-based management of the access of doors from anywhere. This provides for a seamless and secure way to control entries. Not just this, but by incorporating sensors in this system, this system can depict all the entry and exit statuses in real-time, hence reducing the need for human surveillance at the spot all the time and hence providing high-end security. The proposed system, noticeably, provides a considering high level of security at a comparatively lower cost in comparison to traditional security methodologies[18].

The article basically presents a comprehensive security solution leveraging the full potential of IoT technology to make improvements in door access control with enhanced security standards. This new generation security solution provides unparalleled convenience and maximum cost savings with higher security standards. Security threats are constantly evolving and a solution like this is proactive in moving towards increasing safety and security measures in several sectors and their applications.

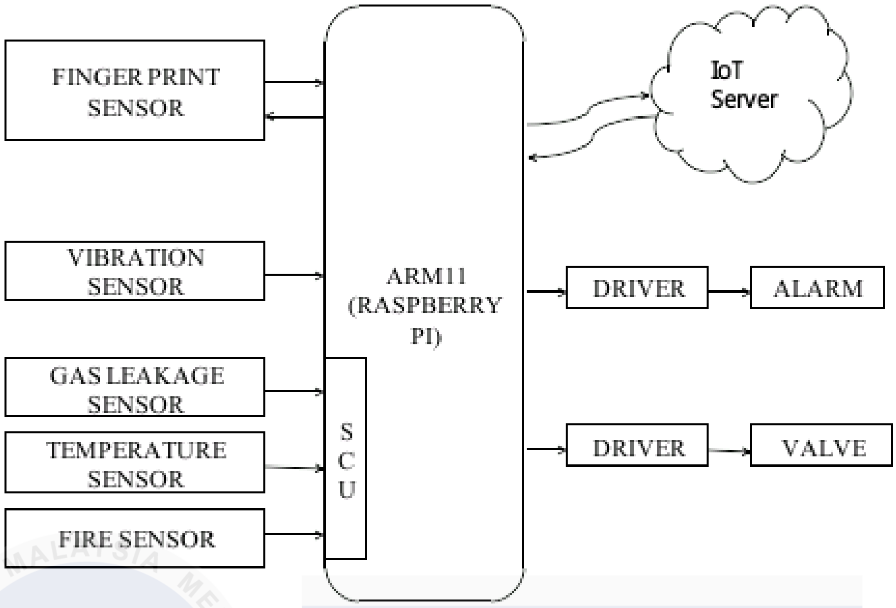


**Figure 2. 7 Block diagram of IoT based Door Lock System.**

### 2.2.10 IoT based Classroom Automation using Arduino

Based on IoT technology, the research paper explains the automation of classroom processes with the Arduino Mega 2560 as the basis for operations[19]. Given that the overall goal is to make the classroom more efficient in terms of energy and environmental monitoring processes, the project presents a detailed system that can be used to transform the management of the classroom. This makes the design with Blynk software of an Android app through which a teacher can control and manage all the functions of the classroom remotely via mobile phones a very impressive feature. Arduino Mega 2560 is used as the control center of this system to control appliances and monitor all the sensors placed on the board[20].

Another important aspect of this project is the use of Fingerprint ID technology to automate attendance tracking. It aims at providing efficient and effective recording and tracking of attendance. This attend acquisition will reduce the hectic work undertaken in technical institutions where students have to get out of class to attend their instances, which sometimes has made learning very inefficient. This is further indicated in the paper as it stresses on the long-term cost-effectiveness of the system where it can reduce electricity and paper costs of educational institutions.

In summary, the article presents a pragmatic application of IoT technology in optimizing classroom management and efficiency. By leveraging automation and remote monitoring capabilities, the system offers tangible benefits in terms of energy efficiency, attendance tracking, and overall cost savings. Through the integration of innovative technologies and a forward-thinking approach, the project exemplifies the transformative potential of IoT in revolutionizing educational environments.

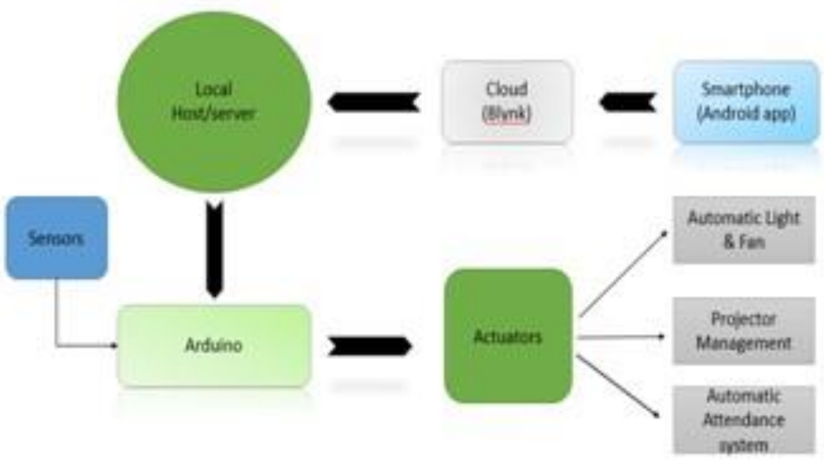


**Figure 2. 8 Block diagram of proposed system**

## 2.3 Understanding Societal and Global Issues in the Literature

The development of an IoT-based smart classroom with door lock automation using NodeMCU ESP32 and the Blynk application addresses several key societal and global issues. It enhances security by ensuring only authorized individuals can enter, thereby protecting students, staff, and property. Health benefits are achieved through environmental sensors that monitor and control indoor air quality, temperature, and humidity, creating a healthier learning environment. Legally, the system helps schools comply with safety and privacy regulations by securing access to facilities. Culturally, integrating advanced IoT technologies in education promotes digital literacy and prepares students for a technology-driven world. In summary, this project improves security, health, legal compliance, and cultural advancement in educational settings.

## 2.4 Summary for past related projects

**Table 2. 1 Summary for past related project**

| Title | Author | Approach | Advantage | Disadvantage |
|---|---|---|---|---|
| 1. IOT Based Smart Door Locked System Using Node MCU | Sujita B Dabekar, Sandhyarani A Lahade, Manasi S Lunge, Deepali Yewale; | The technology proposed in the paper aims to enhance human lives by improving security, ease, and lifestyle | The implementation costs of the system have been kept low, making it an affordable option for individuals seeking home security solutions | The reliance on technology for door locking may pose a risk of system malfunctions or hacking, potentially compromising the security of the home if not properly secured or maintained. |
| 2. IOT BASED SMART DOOR LOCK SYSTEM | Yashaswini Kondamu<br>Jyothsna Ardha<br>K Bhanu<br>Prakash Reddy<br>Rao | The system incorporates an embedded spy camera for video surveillance, allowing homeowners to monitor individuals attempting to access their home and ensuring the safety of guests during entry | The smart door lock system with an embedded spy camera provides increased security by allowing homeowners to view video footage of individuals attempting to access their home | As with any IoT device, there is a risk of potential hacking or unauthorized access to the smart door lock system, compromising security |

| | | | | |
|---|---|---|---|---|
| 3. The Concept and Implementation of Smart Room using Internet of things (IoT) for Cost Efficiency and Room Security | R Y Endra, A Cucus, F N Affandi | The Internet of Things (IoT) concept applied in designing a smart room for cost efficiency and room security, Potential impact on operational costs and home security through automation | Implementing a smart room using IoT can lead to significant cost savings, especially in operational expenses like electricity payments due to automation | Setting up a smart room with IoT technology may require an initial investment in sensors, microcontrollers, and other hardware components, which can be costly upfront |
| 4. Development of IoT Automated Door Lock System Using Blynk Application | Mohamed Affiq, Mohamed Bakhory, Suzanna Ridzuan Aw | Developing an IoT Automated Door Lock System using the Blynk application, allowing remote door control through smartphone communication technology and IoT methods | The system enables remote monitoring of the door lock through IoT technology, providing the flexibility to monitor the door status from anywhere at any time | Asymmetric networks pose challenges in security management due to varying data processing abilities between sensor nodes and gateway nodes, requiring efficient security measures to address potential vulnerabilities |
| 5. Smart security door system using SMS based energy harvest | Abdullah Hamas, Amgad Muneer, Suliman Mohamed Fati | The research paper presents a smart security door system that combines security measures with energy harvesting techniques, utilizing a motion detector sensor for security and door motion for electricity generation | The system uses a motion detector sensor and a magnetic door lock to detect intruders and securely lock the door with a generated password, improving overall security | The system heavily relies on the door's motion to generate electricity, which may pose challenges in scenarios where the door is not frequently used, potentially leading to power generation issues |

| | | | | |
|---|---|---|---|---|
| 6. Real Time Smart Door System for Home Security | Burak Sarp, Huseyin Kusetogullari | A real-time smart door system for home security, utilizing video technology and Raspberry Pi for enhanced safety and security | The system allows real-time visualization and identification of people visiting the home, even when it is empty, enhancing security | the reliance on technology, which may lead to vulnerabilities if there are malfunctions or technical issues with the system |
| 7. Development of a Microcontroller-Controlled Security Door System. | A Oke<br>O Olaniyi<br>O Arulogun<br>O Olaniyan | the development of a microcontroller-controlled security door system designed to allow privileged users to access a secure keyless door using smart card authentication. | The system provides a low-cost and low-complexity solution for door access control, making it accessible for various applications like banks, military research areas, and private companies requiring high security levels | Traditional computer-based control systems using parallel ports for access control face challenges such as crosstalk and reduced performance over long distances, impacting system reliability |
| 8. IoT Based Smart Classroom | Prajas Kadepurkar and Nivya Jomichan | Enhancing classroom efficiency through dynamic booking, attendance tracking, and automated control of lights and fans using IoT devices like Raspberry Pi and NodeMCU. | The system allows for dynamic classroom booking and automated control of lights and fans, optimizing energy usage and enhancing the learning environment | The smart classroom system relies heavily on IoT devices and software, which may lead to disruptions in case of technical failures or malfunctions |

| | | | | |
|---|---|---|---|---|
| 9. DESIGN AND IMPLEMENTATION OF DOOR ACCESS CONTROL AND SECURITY SYSTEM BASED ON IOT | G Sowjanya<br>S Nagaraju | Enhancing security systems through innovative technologies like IoT to address security breaches by intelligent thieves. The proposed system utilizes biometric scanners, passwords, and security questions integrated with IoT for door access control and security | The system provides high security at a low cost, making it a cost-effective solution for various applications | Traditional mechanical door locks face security vulnerabilities like lost, copied, or stolen keys, highlighting the need for more secure access control methods |
| 10. IoT based Classroom Automation using Arduino | Prince Roy | Utilizing IoT for energy-efficient Environmental Conditions monitoring and control in a classroom setting. The system design is based on Arduino Mega 2560, allowing control through an Android application developed using Blynk software. This project aims to enhance classroom automation using IoT technology, providing teachers with the ability to manage the classroom remotely via a smartphone application | The system allows real-time monitoring of sensors connected to the Arduino board, providing valuable insights into the classroom environment and conditions | Regular maintenance and updates may be necessary to ensure the system operates smoothly and securely over time |

## 2.5 Summary

The literature review for the development of an IoT-based smart classroom with door lock automation using NodeMCU ESP32 and Blynk application serves as a systematic examination of existing research on the subject. It aims to provide clarity and insight into relevant theories, strategies, and outcomes from previous studies. By critiquing prior works, it guides the researcher in refining the main research question and methodology for the project. Additionally, the literature review demonstrates the researcher's ability to critically engage with scholarly work while laying the groundwork for their own contribution to the field of IoT-based smart classrooms and door lock automation. In essence, it establishes the context, justification, and basis for the researcher's study within this discipline.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

In general, outlines the approach taken to achieve the project's goals. It describes the methods of research to be used, including surveys and interviews. Quantitative data will be analyzed using statistical tools and qualitative data will be subjected to thematic analysis. Pilot testing and peer review have therefore been included in the methodology to ensure accuracy and reliability in the findings. This orchestrates that the results of the project are clear, reliable and accurate.

## 3.2 Methodology



The methodology to be used in this project will be based on a few steps that allow the smooth progress of the project. It will start by choosing a good title, then research and reading journals that would suit the chosen topic. Afterwards, planning and design are done for the hardware and software configurations in the project. Implementation of the process is the next step, followed by testing on a smaller scale, whereby everything from the circuit to the program will be ensured to work correctly. The problems encountered in this stage must be effectively solved. The designing phase is further supported by the development of a flowchart and block diagram as it gives a visualization of the system. All these phases are important in understanding the requirements of the projects and the actions that must be taken through which a final complete report can be developed.

### 3.3 Block Diagram

The block diagram illustrates a smart classroom automation system centered around an ESP32 microcontroller, which manages and coordinates various system components. The ESP32 connects to multiple sensors and actuators, enabling interaction and communication. The Blynk platform is used for remote monitoring and control via a smartphone app, allowing users to receive sensor data and send commands to actuators.

The system includes an RFID module for access control, which sends data to the ESP32 when an RFID tag is scanned, allowing the microcontroller to decide whether to unlock the door. Additionally, a Passive Infrared (PIR) sensor detects motion by measuring changes in infrared radiation and sends a signal to the ESP32 when motion is detected. This can trigger actions like turning on lights or sending alerts to the Blynk app.

The system also incorporates several actuators: a door locking mechanism, a fan, and lights. The door lock is controlled by the ESP32 based on input from the RFID module or commands from the Blynk app, enabling remote locking and unlocking. The fan can be turned on or off by the ESP32 based on conditions like temperature, motion detection, or remote commands. Similarly, the lights can be triggered by the PIR sensor or controlled remotely through the Blynk app.

Overall, this setup offers a flexible and remotely manageable smart classroom system, allowing for automation and control through an easy-to-use mobile application.

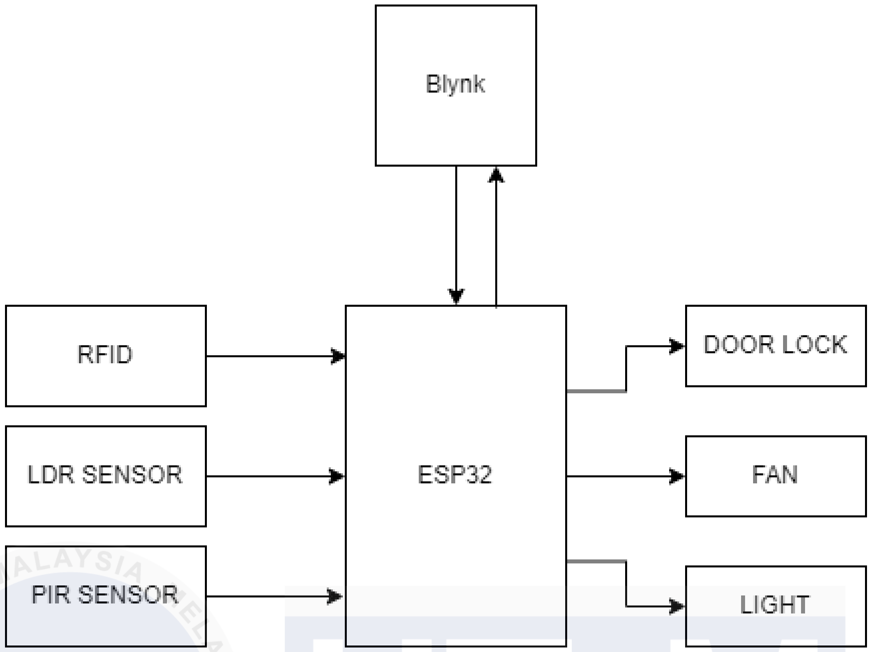


**Figure 3. 1 Smart Room Block Diagram**

### 3.4 Hardware

The hardware is the physical component and devices used to build up an IoT-based smart classroom system. There is a processing device at the core, represented by a microcontroller NodeMCU ESP32. There are further RFID modules for secure access control so that the door opens only in front of authorized people. PIR sensors in the system work for detecting motions so that lights and fans turn on and off automatically according to whether there is occupancy. It also applies different kinds of electronic components, lamps, fans, connectors, integrating them into the assembling and integration of the system. All these hardware components, in conjunction, are intended to build an effective, automated setting for improved security and functionality in a classroom.

**Table 3. 1 List of materials Required in Developing Prototype**

| NO | COMPONENT | Price | Quantity | Total |
|---|---|---|---|---|
| 1 | NodeMCU ESP32 | RM 25 | 1 | RM 25 |
| 2 | RFID | RM 10 | 1 | RM 10 |
| 3 | HC-SR501 PIR Sensor | RM 8 | 1 | RM 7 |
| 4 | Relay | RM 8 | 2 | RM 16 |
| 5 | DC Fan | RM 6 | 1 | RM 6 |
| 6 | Lamp 5V | RM 5 | 1 | RM 5 |
| 7 | Solonoid Lock | RM 22 | 1 | RM 22 |
| 8 | LDR sensor | RM 1 | 1 | RM 1 |
| 9 | Battery | RM 5 | 2 | RM 10 |
| Total | | | 7 | RM102 |

### 3.4.1 NodeMCU ESP32

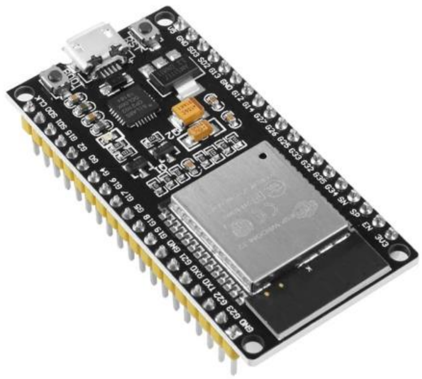

**Figure 3. 2 NodeMCU ESP32**

The NodeMCU ESP32 is a low-cost, dual-core processor, open-source development board used in IoT projects. This basically means that it processes most tasks at the same time. It has Wi-Fi and Bluetooth to join the internet and connect to other devices easily. It also contains a lot of useful features, such as analog-to-digital converters (ADC) for reading sensor data, digital-to-analog converters DACs for outputting a signal, touch sensors in case touch-sensitive controls are needed, and several kinds of interfaces like SPI, I2C, and UART for interfacing to other devices. It also has PWM for simply controlling things like motors and LEDs. One additional feature of the ESP32 is that it is quite energy-efficient, with the capability of going into deep-sleep mode in order to save that precious battery power. You can program it with either the Arduino IDE, Micropython, or Espressif's ESP-IDF, making beginners and advanced users equally at home. It also comes built-in with USB connectors and voltage regulators for easy connections and powering of your device.

### 3.4.2 RC522 Card Reader Module


**Figure 3. 3 Card Reader Module**

The RC522 card reader module is a reader device of Radio-Frequency Identification tags and cards. It is basically an RFID reader IC known as the MFRC522 with some supporting components like antennas and connectors. The module communicates through radio waves with RFID tags. The RF522 RFID Card Reader Module 13.56MHz is a very cheap reader based on the MFRC522 IC and is, therefore, very easy to use in several projects and applications. Hugely integrated reader/writer chip that operates with 13.56 MHz clock, and is used in applied communication contactless. RC522 developed by NXP is low-cost, low-power consume, thus highly compact solution, hence used mainly in smart meters and other portable handheld devices.

### 3.4.3 HC-SR501 PIR Sensor

**Figure 3. 4 PIR Sensor**

The HC-SR501 PIR sensor is a motion detector module used for detecting the movement of a human or any animal to its detection range. The module contains a pyroelectric sensor that gives changes in its output when there is a change in the infrared radiation emitted by the object within its field of view. Principle: The principle behind working is that every moving object emits heat in the form of infrared radiations which can be detected by the sensor. The HC-SR501 PIR is a small-sized electronic device that is used for detecting motion. PIR stands for Passive Infrared. That means, it senses the infrared light that objects emit in its field of view. It's used very commonly in security systems, automatic lighting, and other places where there might arise a need for the detection of motion. This sensor has some important features. First, it's passive, it actually does not emit any signals itself; it detects changes only in infrared radiation. The second feature is that it has a wide range of detections, usually up to about 7 meters with an adjustable sensitivity. Thirdly, it has a built-in delay circuit. This feature allows it to be set to trigger only after a certain period of motion is detected thus helping in preventing false alarms. Besides, it is low powered, hence suitable for battery powered devices. In short, the HC-SR501 PIR sensor is one such device that proves to be versatile and reliable when one considers a motion detecting device.

### 3.4.4 Relay

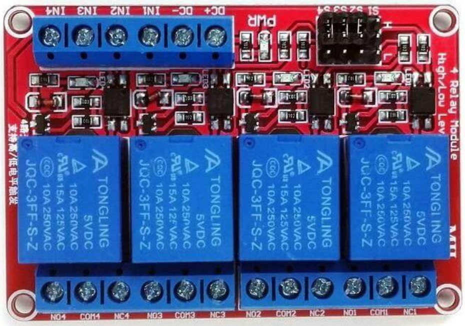

**Figure 3. 5 Relay**

Relays are essentially electrical switches that work on the basic of an electromagnet. The flow of electricity through the electromagnet generates a magnetic field. It then attracts a lever, which actually opens or closes a switch. This theory allows a large amount of electricity to be controlled through a small amount. This is known for the use of relays in the control of powerful devices from low power signals. Relays are applied in so many applications.; they, therefore, range from use in turning on and off lights, control motors, and even for protection against overloads. Some of the most general features of relays include inbuilt capacity to isolate parts of a circuit fast response time and reliability. There are also specific ones meant to perform particular functions, such as time delay relays. These are turned on or off after a certain period of time. They are used in everything: from the simplest form of electrical appliances to the most sophisticated computers and robots.

The 6-channel relay module will be apply in this project for linking up and controlling the devices and components involved in the intelligent classroom. The relay entails an electronic switch operation through electricity such that the low power signals can go ahead to operate higher powered devices. The devices that can be simultaneously operated by the 6-channel relay module are several; hence it perfectly ensures the consecutive needs of this project. Since it has independent channels on the module, each one can drive a separate electrical circuit of the system. Therefore, by using this system, door locking and unlocking, lights on and off, fan operation, functions that can be automated. The relay module serves as the interface between each equipment connected to it and the NodeMCU ESP32. For that, instructions given by the microcontroller are received by relays and switch ON/OFF devices connected to it. In this manner, all the automation features of the classroom are very much efficient and reliable.

### 3.4.5 DC Fan

**Figure 3. 6 Fan 5V**

A DC fan is a fan powered by direct current electricity. That is, it uses electricity provided by a battery or a DC power source, rather than an alternating current source like a wall outlet. DC fans tend to be more power efficient than AC fans, because they use less electricity and also can be better controlled. They can vary speed very problem-free are also generally quieter during operation. The highlights of the characteristics of DC fans are lowest power consumption, the speed can be varied, and the motor is very long-lasting because it does not undergo excessive wear and tear. These are used in computers, cars, and some household appliances because they are reliable and efficient. They are most welcome in applications wherein energy saving is a consideration.

### 3.4.6 Lamp

**Figure 3. 7 Lamp**

A DC lamp is one of the light sources which use direct or DC electricity. Compared to the majority of lamps that use the standard form of alternating or AC from wall outlets, a DC lamp uses batteries or another type of DC power source. This makes this type of lamp very useful in such places as automobiles, low-voltage solar systems, and for even emergency lighting. Since they produce less heat, DC lamps are often more energy efficient and durability guaranteed. They can easily be dimmed or rather controlled due to their simple electrical design. To mention some basic features of the DC lamp, low power consumption, durability, and the ability to run on renewable energy that is from sources such as solar panels. They find their applications in many places where efficient lighting and reliability are necessary.

### 3.4.7 Solenoid Door Lock

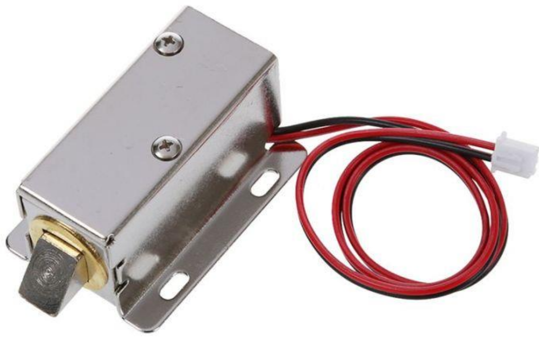

**Figure 3. 8 Solenoid Door Lock**

A solenoid door lock is an electronic lock. In this type, the mechanism of locking takes place by means of a device called a solenoid. This a coil of wire performing like a magnet when electricity passes through it. In a solenoid lock, when electric current is given, the solenoid pulls or pushes a metal rod for either locking it or unlocking the door. With this system, the lock can therefore be electronically controlled: by remote control, with a keypad where a code must be entered, or- extremely popular nowadays-with a smart system like an application from a mobile phone. Characteristics of solenoid door locks are as follows: they are very fast and reliable; they are so fast as to lock or unlock the door with a simple electrical signal in miliseconds. Security - They are secure in operation because they can be associated with other access control systems that allow an increase in safety. Long life- Because they have few moving parts, they wear less from mechanical wear and tear and thus last for a long time. They are very common in commercial building, homes, and any other place where access control that is secure and convenient is needed.

### 3.4.8 Light Dependent Resistor (LDR)

**Figure 3. 9 Light Dependent Sensor (LDR)**

A **Light Dependent Resistor (LDR)** is an electronic component that changes its resistance based on the amount of light shining on it. When it's dark, the LDR sensor has high resistance, making it harder for electricity to pass through. When light falls on it, the resistance decreases, allowing more electricity to flow. LDR sensor are usually made from materials like cadmium sulfide, which are sensitive to light.

These sensors are commonly used in everyday devices. For example, they help streetlights turn on automatically when it gets dark or adjust the brightness of screens on phones and TVs based on the surrounding light. They're inexpensive, simple to use, and work well for basic light-sensing tasks. However, they respond a bit slowly and aren't as precise as other light sensors.

### 3.4.9 Rechargeable Lithium-ion Battery


**Figure 3. 10 Rechargeable Lithium-ion Battery**

Rechargeable lithium-ion batteries can be used repeatedly by charging them after they run out of power. It is frequently found in electronic devices such as laptops and phones. Lithium is a strong and lightweight material used in this battery to store energy. Moving lithium ions between two components known as the positive and negative electrodes is how it operates. The ions travel in a single direction during charging and back when in use. Compared to older battery types, lithium-ion batteries are more popular because they are lighter, last longer, and charge more quickly. They must be handled carefully, though, to prevent damage or overheating. Rechargeable Lithium-ion Battery

## 3.5 Software

### 3.5.1 Blynk Application


**Figure 3. 11 Blynk Application**

Blynk is a greatly simplified Internet of Things  platform that provides for easy development and management of connected devices. Its services and tools facilitate building applications to remotely control and monitor hardware systems. Blynk enables the possible creation of user defined IoT project interfaces on a drag drop mobile app builder. It works with hardware via the Blynk cloud or a local server. Blynk supports a wide variety of microcontroller boards, single-board computers including Arduino, Raspberry Pi and microcontroller ESP8266 and ESP32. The platform is rich in built in widgets for the presentation of data coming from sensors, control of devices and notifications allowing for easy development and deployment of IoT solutions without any need for in-depth programming. Other Blynk features include multi device management, automation routine creation and integration with other cloud services. It is therefore a very versatile tool for Hobbyists and professionals into smart home projects, industrial automation, or any other IoT use.

### 3.5.2 Arduino IDE Application

**Figure 3. 12 Arduino IDE Application**

An Integrated Development Environment (IDE) is a software application that allows one to write, compile and upload code to Arduino boards. The user is facilitated with a very simple interface that actually allows a user with very little trouble to be able to come up with their program in a specially designed programming language by Arduino of C++ language. The module has inbuilt code along with a library that shows syntax highlighted and machine indented code, thereby making the writing and reading of codes easier. Besides it has a library manager built in that makes a huge number of pre written libraries available so that users can easily drop functionalities into projects. The Arduino IDE has a serial monitor for communicating with the Arduino board and debugging the code in real time. The Arduino IDE is a must have development tool for anyone working with Arduino hardware for the simple development and deployment of embedded systems projects.

### 3.6 Flowchart

This flowchart depicts the operation sequence of intelligent home automation on the basic of ESP32 microcontroller to control the access, lighting, and fan on/off functions. The entire process starts from the initialization of the microcontroller. Then check for any rfid detaction so that access can be allowed by unlocking the door. If no RFID is detected, it searches for any remote command from the Blynk app either to open or lock the door. After detecting an RFID tag or any command to open it, the system unlocks the door.

After this, with the help of a PIR sensor the system detects any movement. If there will be any movement then cooling fan and lights will turn on. The system will keep on monitoring for any movement while the fan and lights are on. In the absence of any movement, a 10sec timer starts. If during this cycle, again there is a reading of any movement then the timer gets automatically reset. If no movement is detected once the timer finishes, it turns off the fan and lights. The process then terminates and the system is ready again to go with the system running in a continuous cycle of checking for RFID detection and sensor inputs as well as executing commands set by the Blynk app. Through this, efficient and automated home access, lighting, and ventilation control is maintained based on real-time inputs and user commands.

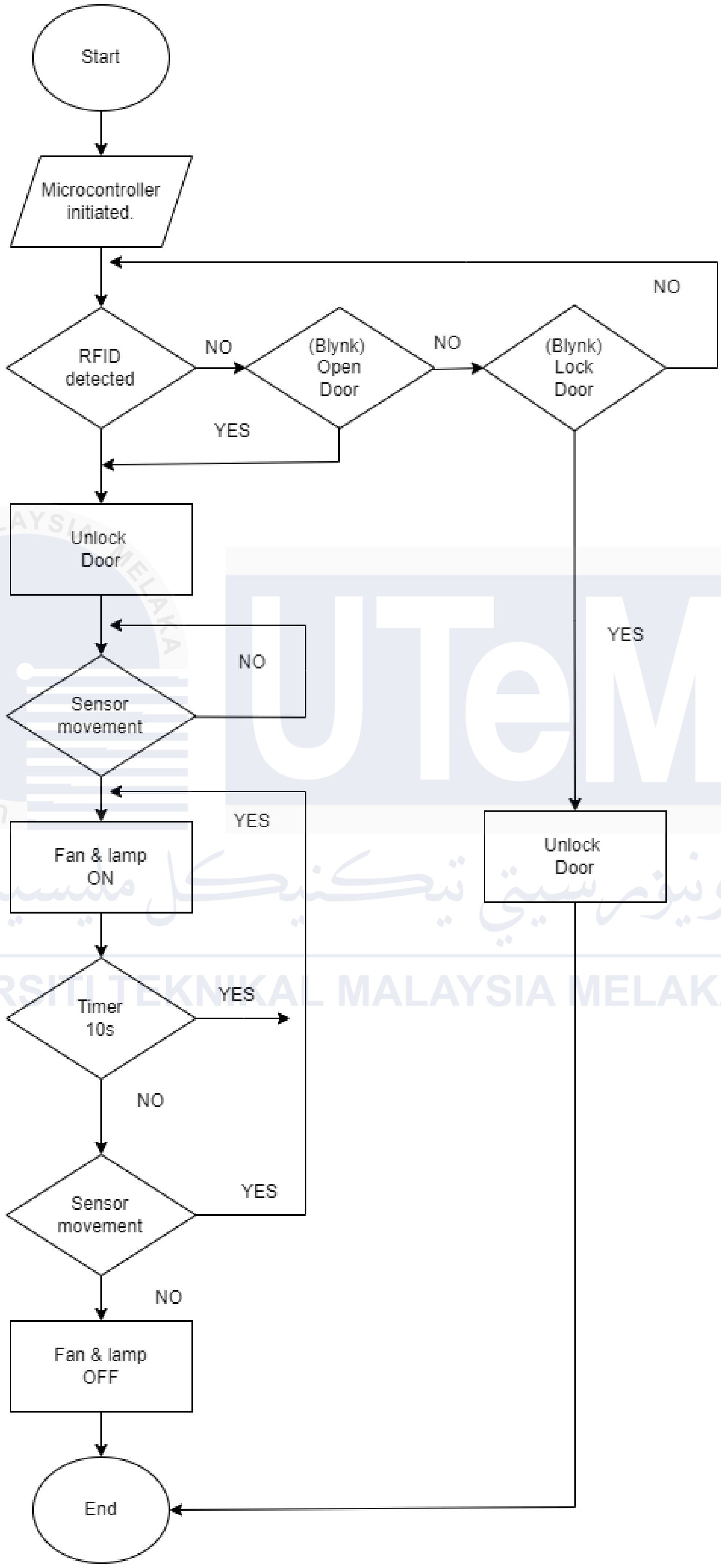


**Figure 3. 13 Flowchart**

### 3.7 Expected Result

This project concerns the design and implementation of IoT-based smart classroom system that considerably leads to improved security, efficiency in operations and energy management in educational institutions. By employing the NodeMCU ESP32 microcontroller and RFID technology it shall provide secure access by implementing robust and secure access control that will allow only authorized persons to the class. This will result in improved safety to students, staff and school properties since there will be minimal unauthorized access and security risks.

Also, the utilization of the Blynk application will allow for the real-time monitoring and control of the door lock system, as well as other classroom appliances, such as lights and fans. This feature will provide users with greater convenience and flexibility in managing the classroom environment and will be able to give quick responses to any emerging problems or track changes in conditions.

By using the PIR sensors to detect motion, it will automating lighting and fan control such that they will only be in operation when the class is in session. That way, energy is spent optimally with large energy savings and huge reduction in electricity bills. This also helps in environmental conservation whereby a minimal amount of energy is wasted unnecessarily.

The overall implication is that the project will change the concept of the traditional classroom to the modern, secure, and energy-sufficient process. This changeover will be beneficial to educational facilities in the aspects of making educational centers safe and healthy to the students using them and the staff operating them, proper functioning of the classrooms, and even facilitating energy sustainability.

## 3.8 Selecting and Evaluating Tools for Sustainable Development

In terms of the development progress of the IoT-based smart classroom with automation of the door lock based on NodeMCU ESP32 and the Blynk application. It also describes such methods of tool selection and evaluation for proper achievement of the sustainable development goals (SDG), particularly SDG 9 covering industry, innovation, and infrastructure; providing resilient infrastructure; increased innovation; and enhanced innovation in education about advanced technology.

I will be more concerned with the sensors and components to be used since in effect their accuracy and reliability hold the minds of sustainability of this project. Reliability proven NodeMCU ESP 32 microcontrollers are used with RFID readers considering low power consumption which reduces environmental impact. The application by Blynk has an interface that is easily understandable by the user for monitoring in real-time so that the sources can be utilized effectively.

Secondly, their compatibility should also be assessed. The selected hardware and software components function in unison and in harmony forming a "hold-together" kind of system that is optimized for all its components to bring about performance with minimal energy wastages. That in turn operates in support of sustaining the running of the system in the long term, thereby curtailing frequent replacements and upgrades.

It also considers the social-economic aspect. The system is cost-effective, hence accessible by more schools. Since operational costs are reduced by improving security and energy efficiency in the project, schools benefit economically. Open-sourced software like Blynk also makes it transparent to diverse stakeholders who need to understand and use the system.

It therefore follows that life cycle assessment is carried out on the components to establish their effect on the environment. Product analysis from production to final disposal is, in that case, considered to ensure that the chosen tool contributes as little as possible to environmental degradation.

It also ensures that through careful selection and evaluation of tools, this IoT-based smart classroom project further ensures sustainable design. It is cost-effective and impactful. It meanwhile supports SDG 9, the project integrates innovative technology in education, fosters resilient infrastructure, and pushes for sustainable practices.

## 3.9 Summary

Methodology of Designing the Smart Room Automation System. It starts with an introduction of the scope and objectives of the project. The methodology section explains step-by-step procedure to design, implement, and test the system.

The section on hardware describes the components that is physical which including ESP32 microcontroller, RFID module, PIR sensor, door lock, fan and lights and their functionality with respect to interconnection of individual parts. Whereas in the software section, programming tools with algorithms and integration of it with Blynk platform remotely for control and monitoring are explained.

The following block diagram illustrates the system architecture and the interaction of all other components with the ESP32 module and Blynk. The overall logic of the entire system has been step by step presented in the flowchart and explained their operation for RFID detection, PIR sensor input as well as Blynk commands received.

Overall, this chapter presents a brief yet detailed overview of the hardware and software components, structure of the architecture in the system and the operation logic, which would serve as a basis for the development and function of the room automation system.

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Introduction

The aim was to construct a safe, efficient and energy-saving classroom environment with advanced IoT technology. This chapter presents a detailed analysis of the system performance in enhancing security by executing RFID-based access control. Then, discussion on effectiveness of the Blynk application to provide real-time monitoring and remote control over classroom appliances like lights and fans has been made. Also, the chapter describes energy savings through PIR sensors' implementation for the automation of environmental management. Through discussion of these results, this chapter will show how the potential of IoT integration into traditional classrooms can change these to modern, safe and sustainable structures for learning and, thereby, benefit students, staff and educational institutions.

## 4.2 Hardware Analysis

**Figure 4. 1 Isometric view of the prototype project**

The prototype for the smart classroom project is displayed in **Figures 4.1** to **4.4**. The prototype is shown in an isometric view in **Figure 4.1**, which shows its compact shape and organized design. The ESP32 microcontroller, RFID module, PIR sensor, relay, and solenoid door lock are all neatly contained within a box. This setup maintains portability and ease of use. A top view of the case is shown in **Figure 4.2**, where the wiring and component placement is appropriate for operation and simple maintenance. The view underneath the box's lid is shown in **Figure 4.3**, displaying the inside connections between the sensors, actuators, and microcontroller that are required for the system to operate smoothly.

Finally, **Figure 4.4** shows a side view of the prototype, displaying the solenoid that has been positioning beside classroom door. This prototype is a reasonable and efficient solution for modern smart classrooms since it uses modern innovations like PIR sensors for automated energy-saving operations and RFID-based access control for improved security.

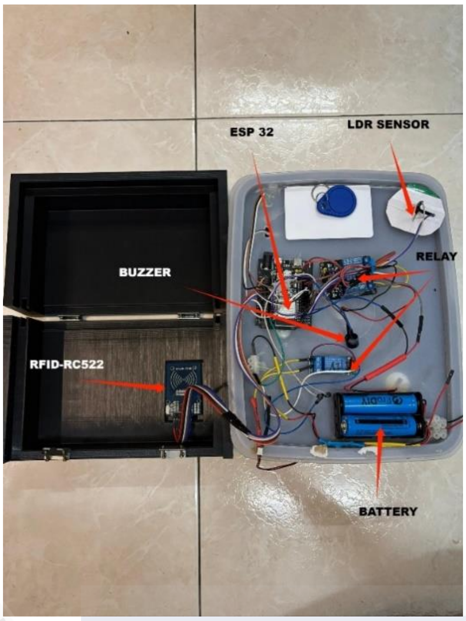


**Figure 4. 2 Top view inside case of the prototype project**

A top view of the case is shown in **Figure 4.2**, where the wiring and component placement is appropriate for operation and simple maintenance.



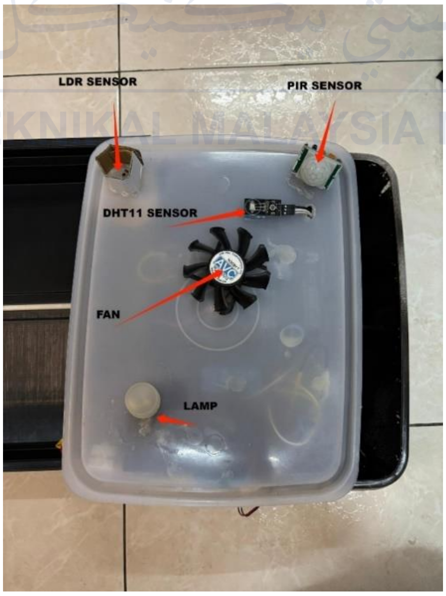


**Figure 4. 3 View under lid of the box of prototype project**

The view underneath the box's lid is shown in **Figure 4.3**, displaying the inside connections between the sensors, actuators, and microcontroller that are required for the system to operate smoothly.

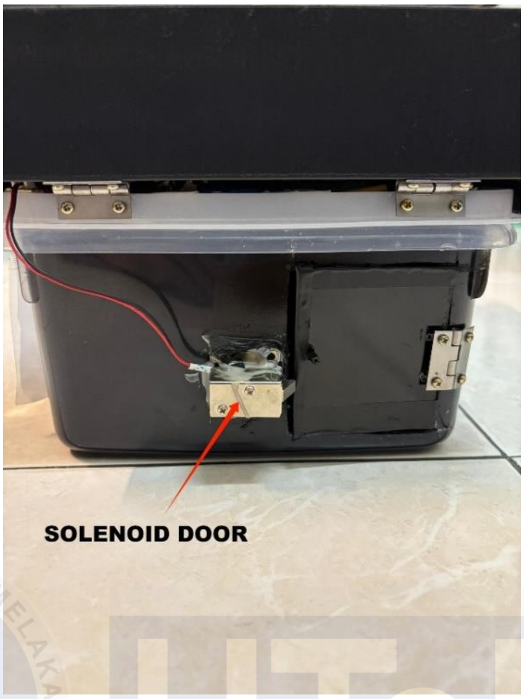


**Figure 4. 4 Side view of the prototype project**

The solenoid that has been positioned next to the classroom door is finally seen in a side view of the prototype in **Figure 4.4**. Because it makes use of modern technologies like RFID-based access control for improved safety and PIR sensors for automated energy-saving operations, this prototype is a sensible and effective solution for modern smart classrooms.

### 4.2.1 Circuit Design

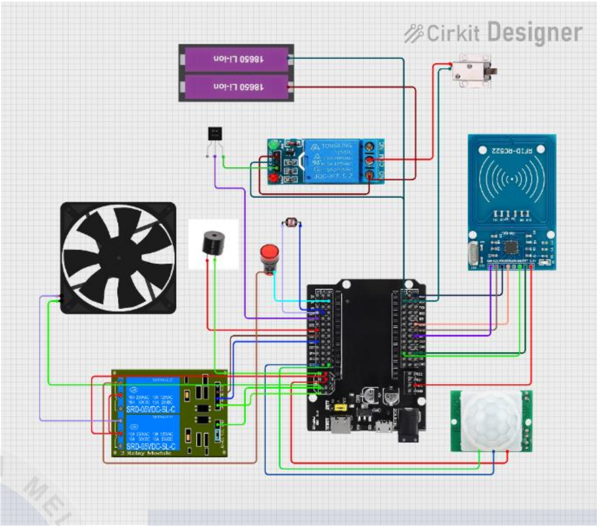


**Figure 4. 5 Circuit design using Cirkit Designer.**

This circuit uses a microcontroller as its main power source, and it is a system that includes two 18650 Li-ion batteries that provide power to the circuit's 12V solenoid. An RFID module enables the system to read RFID tags or cards, which can be used for access control or identification. When a PIR motion sensor senses movement, it transmits signals to the microcontroller, which can then activate various devices, such as a fan and light. Based on commands from the microcontroller, a relay module controls the fan and light, functioning as a switch to turn it on or off.

Buzzers are used to sound alerts, like confirmations or warnings. Additionally, there is an LDR (Light Dependent Resistor) that gauges the ambient brightness. By using this sensor, the system can adjust its behavior to the light levels, such as turning gadgets on or off based on whether it is day or night.

Relays are an important part of the circuit because they enable the microcontroller to securely regulate high-power components like the solenoid, fan, and light. Every part is switched on and linked to the microcontroller, which interprets inputs and transmits the appropriate commands to regulate the system.

## 4.3 Software Analysis


**Figure 4. 6 The main menu in Blynk Application**



A key feature of the system is the use of the **Blynk application** for real-time control and monitoring. **Figure 4.5** displays the main menu of the Blynk app, which serves as the user interface. The interface is simple and user-friendly, allowing users to manage the system effortlessly. The main menu provides access to various controls, such as unlocking and locking the door switch and switch of lights and fans.

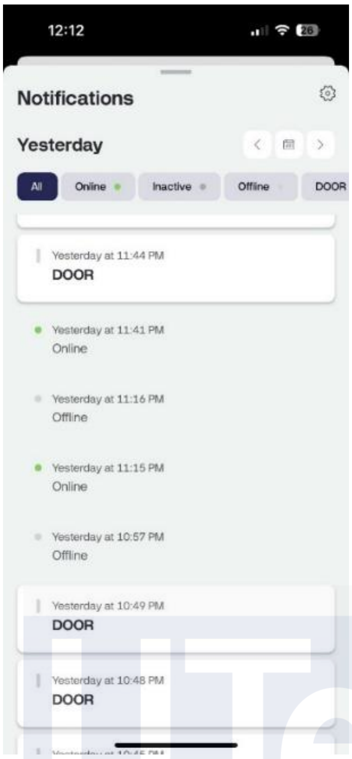


**Figure 4. 7 The timeline inside Blynk Application**

In **Figure 4.6** shows the timeline feature within the Blynk application. This timeline records and displays the activity of the smart classroom system, such as door lock events, online and offline status. The recorded data helps users track and analyze the usage patterns of the system, ensuring better control and maintenance.

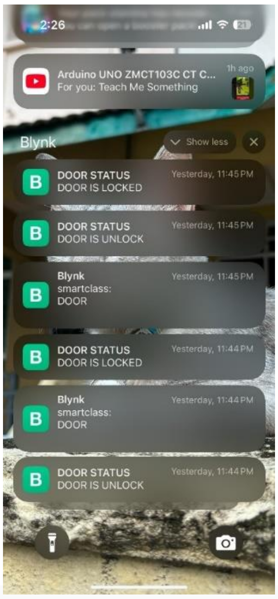


**Figure 4. 8 Notification outside of the Application**

In **Figure 4.7**, a notification feature outside the application is demonstrated. This notification alerts the user whenever the door is locked or unlocked. For example, **Figure 4.8** shows a push notification informing the user when the door is unlocked and locked. These notifications can improve security by keeping the user updated on system activity, even when they are not actively using the app.



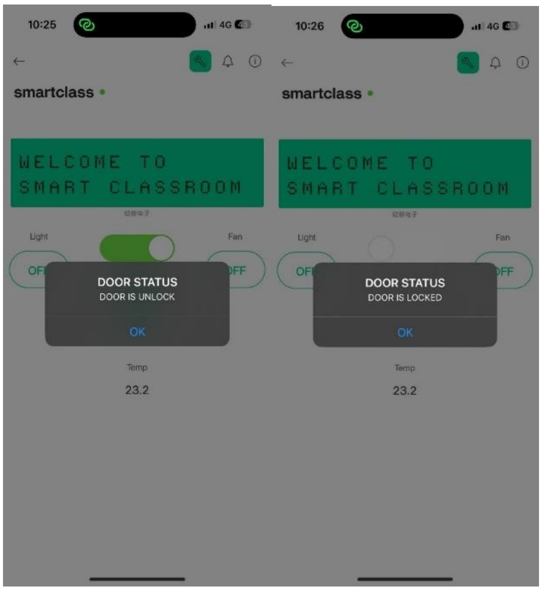


**Figure 4. 9 Push notifications when door is unlock and lock**

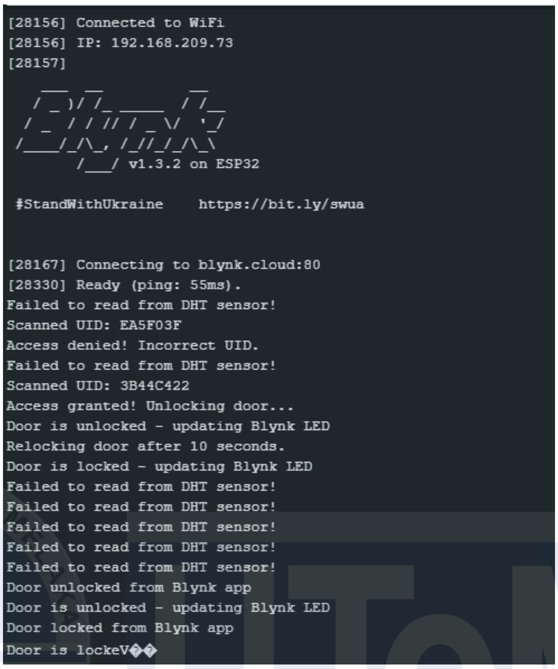


**Figure 4. 10 Serial Monitor from Arduino Ide**

Furthermore, as shown in **Figure 4.9**, this project also has a serial monitor to check output from ESP32. The Arduino IDE software includes a serial monitor that shows data and status updates from the hardware components in real time. It is useful for troubleshooting and making sure the system reacts properly to sensor inputs and user commands.

After everything is connected, the smart classroom system runs smoothly and is simple to monitor because of the combination of the Blynk app and Arduino serial monitor.

## 4.4 Data Analysis

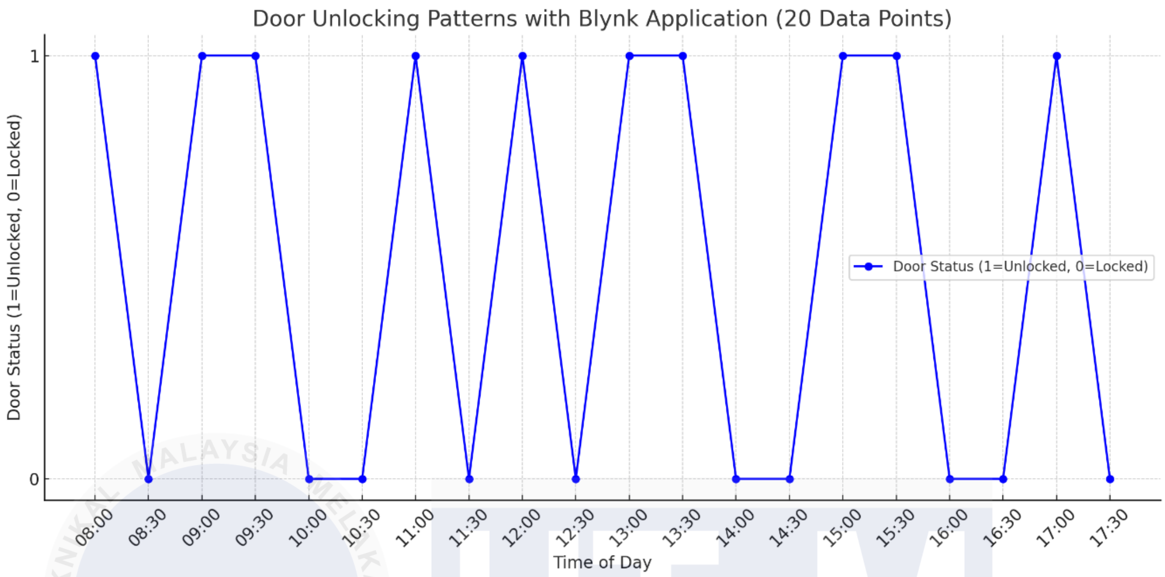


**Figure 4. 11 Blynk Application Graph Data**

The door status is shown over time in the graph in **Figure 4.10** using the Blynk application. The Y-axis shows whether the door is locked or unlocked. The door is said to be unlocked if the value is 1, and locked if the value is 0. The X-axis, which runs from 8:00 AM to 5:30 PM, shows the time of day.

The door status changes throughout the day, as indicated by the blue line connecting the points. Each point corresponds to a specific time when the door status was recorded. The door, for instance, was locked (0) at 9:30 AM and unlocked (1) at 8:00 AM. The door alternates between being locked and unlocked at different times, as this pattern repeatedly illustrates.

How frequently the door is locked or unlocked is easily visible thanks to the graph. The door was repeatedly unlocked throughout the day and then locked at designated times, as evidenced by this. This data will help to keep an eye on door access and maintain security.

**Table 4. 1 Table Data of Blynk Application**

| **Time** (HH:MM) | Door Status (0=Locked, 1=Unlocked) | RFID Scanned | Notification Sent |
|---|---|---|---|
| 08:00 | 1 | Yes | Yes |
| 08:30 | 0 | No | No |
| 09:00 | 1 | Yes | Yes |
| 09:30 | 1 | No | Yes |
| 10:00 | 0 | No | Yes |
| 10:30 | 0 | No | Yes |
| 11:00 | 1 | Yes | Yes |
| 11:30 | 0 | No | Yes |
| 12:00 | 1 | Yes | Yes |
| 12:30 | 0 | No | Yes |
| 13:00 | 1 | Yes | Yes |
| 13:30 | 1 | Yes | Yes |
| 14:00 | 0 | No | Yes |
| 14:30 | 0 | No | Yes |
| 15:00 | 1 | Yes | Yes |
| 15:30 | 1 | Yes | Yes |
| 16:00 | 0 | No | Yes |
| 16:30 | 0 | No | Yes |
| 17:00 | 1 | Yes | Yes |
| 17:30 | 0 | Yes | Yes |

The **Table 4.1** shows the 20 different times that the Blynk application interacts with the door lock system. The time for each event is stated in the Time (HH:MM) column. A value of 0 indicates that the door is locked, while a value of 1 indicates that the door is unlocked. This information will be shown in the Door Status column. If an RFID tag was used to unlock the door, it is indicated in the RFID Scanned column. A "No" means the RFID was not scanned, while a "Yes" means that it was. For every event, the Notification Sent column show if the user received a notification from the system. Notifications that are marked as "Yes" or "No" indicate that they were sent.

The table shows that the door is locked at some times and unlocked at others, including 8:00, 9:00, and 11:00. A notification will normally be sent and an RFID scan happens whenever the door is unlocked. Sometimes, like at 8:30, when the door is locked, no RFID scan is taken and no alert is given. Whether the door is locked or unlocked, notifications are primarily sent to ensure that every event is captured for the user to view. The activity of the door is tracked and monitored in real time with the help of this table.

| Light Dependent Resistor | PIR Sensor | Light | Fan |
|---|---|---|---|
| 0 | 0 | OFF | OFF |
| 0 | 1 | ON | ON |
| 1 | 0 | OFF | OFF |
| 1 | 1 | OFF | ON |

**Table 4. 2 Sensor Based Control Logic for Light and Fan Operations**

The table explains how the system uses two sensors which is Light Dependent Resistor (LDR) and a PIR sensor to control the light and fan in a smart classroom. The LDR detects the presence of ambient light, while the PIR sensor detects motion. The logic of the system makes sure that the fan and light only turn on when needed, which helps save energy.

The light and fan stay off if the LDR detects no light and the PIR sensor detects no motion because they are not required to be on. But, since the room is dark and someone is there, the system activates the fan and light if the PIR sensor detects motion but the LDR detects no light. However, if the LDR detects light but the PIR sensor detects no motion, the system turns off the light and fan because the room is already bright enough and no one is there to need the fan.

The system only activates the fan when the PIR sensor detects motion and the LDR detects light. The fan is turned on to ensure the person in the room is comfortable, but there is no need to turn on the light because the room is already bright. This logical approach ensures that energy is used efficiently by only activating devices when both the environmental conditions and user presence require it. 8 Hour component electric usage.

| Equipment | Power (W) | Hour | Power (kWh) | Cost first 200 kWh (RM) | Cost next kWh (RM) |
|---|---|---|---|---|---|
| Solenoid Door Lock | 7.2 | 1 | 0.0072 | 0.00 | 0.00 |
| Fan | 0.6 | 1 | 0.0006 | 0.00 | 0.00 |
| Lamp | 1.0 | 1 | 0.0010 | 0.00 | 0.00 |
| **Total** | 8.8 | 1 | 0.0088 | 0.00 | 0.00 |

**Table 4. 3 1Hour component electric usage**

This table shows the power consumption for three devices: the solenoid door lock, fan, and lamp, over one hour. Each device's power usage is measured in watts (W), and their energy consumption is recorded in kilowatt-hours (kWh). The solenoid door lock uses 7.2 W, the fan 0.6 W, and the lamp 1 W. Over one hour, the total energy consumed by these devices is 0.0088 kWh, costing almost nothing under both the first 200 kWh rate and the next rate. This data highlights the minimal energy cost of the system during a short operation

| Equipment | Power (W) | Hour | Power (kWh) | Cost first 200 kWh (RM) | Cost next kWh (RM) |
|---|---|---|---|---|---|
| Solenoid Door Lock | 7.2 | 8 | 0.0576 | 0.0244 | 0.0278 |
| Fan | 0.6 | 8 | 0.0048 | 0.0035 | 0.0035 |
| Lamp | 1.0 | 8 | | 0.0035 | 0.0035 |

| | | | | | |
|---|---|---|---|---|---|
| | | | 0.0080 | | |
| **Total** | 8.8 | 8 | 0.0704 | 0.0314 | 0.0348 |

**Table 4. 4 8Hour component electric usage**

This table expands the analysis to eight hours of usage. The solenoid door lock, consuming 7.2 W, uses 0.0576 kWh in eight hours. The fan and lamp, using 0.6 W and 1 W respectively, consume 0.0048 kWh and 0.0080 kWh over the same period. The total energy usage of all three devices is 0.0704 kWh, costing RM 0.0314 under the first 200 kWh rate and RM 0.0348 under the next rate. This demonstrates how energy-efficient the system remains even when used for an extended period

| Equipment | Power (W) | Hour | Power (kWh) | Cost first 200 kWh (RM) | Cost next kWh (RM) |
|---|---|---|---|---|---|
| Solenoid Door Lock | 7.2 | 23 | 0.1656 | 0.07 | 0.08 |
| Fan | 0.6 | 23 | 0.0138 | 0.01 | 0.01 |
| Lamp | 1.0 | 23 | 0.0230 | 0.01 | 0.01 |
| **Total** | 8.8 | 23 | 0.2024 | 0.09 | 0.10 |

**Table 4. 5 23Hour component electric usage**

This table calculates the energy usage of the devices over a full day (23 hours). The solenoid door lock consumes 0.1656 kWh, while the fan and lamp use 0.0138 kWh and 0.0230 kWh, respectively. Combined, the total energy consumption is 0.2024 kWh. This results in a cost of RM 0.09 under the first 200 kWh rate and RM 0.10 under the next rate. These figures underscore the system's capability to operate efficiently, even under continuous usage.

## 4.5 Summary

The results of creating an IoT-based smart classroom with door lock automation using NodeMCU ESP32 and the Blynk app. Our aim was to improve classroom security and convenience through automation.

The parts are matched well with a number of integrated hardware pieces that include an ESP32 microcontroller, an RFID module, PIR sensor, electronic door lock, a fan and lights. All these parts function well, with each one doing what it is supposed to do: the RFID module operating the access control, PIR sensor for motion detection and the ESP32 coordinating communication and control through the Blynk app.

The programming for the ESP32 was done and it was configured with the Blynk app for remotely monitoring and controlling it. The system in the course of performing the functions of door locking and unlocking as per the authentication done via RFID, also responded to motion and worked the operation of lights and fans.



The testing proved the reliability of the system in such a way that all responses to the inputs from the sensors were appropriate, and no command from the Blynk app delayed the execution of any of the respective commands. The whole project is successful if all the parameters needed for a secure and efficient smart classroom are fairly achieved. This project proves the potential of IoT and in turn automation in educational institutions.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

The project focuses on the smart classroom system's overall results and performance. The project's primary objective was to make use of IoT technology to build a safe, energy-efficient, and user-friendly classroom environment. By combining hardware elements such as the ESP32 microcontroller, RFID module, PIR sensor, solenoid door lock, fan, and lighting, this was effectively achieved. Each part cooperated to create a dependable and operational system.

The system's objective was achieved by improving security via RFID-based door access. The door could only be unlocked by authorized users, protecting the classroom from unwanted visitors. By enabling remote control of the door lock and real-time system monitoring, the Blynk application increased convenience. Users were given flexibility by this feature, which also simplified classroom management.

Energy efficiency was yet another great success. Fans and lights were only activated when movement was detected thanks to the use of PIR sensors, which also made sure that they automatically shut off when the room was empty. This automation made the system more environmentally friendly and affordable for long-term use by lowering energy expenses and saving electricity.

The project also demonstrated how IoT may be used to update conventional classrooms. The smart classroom system demonstrated that both staff and students can benefit from improved learning environments by combining the latest innovations with simple and accessible user interfaces. The project demonstrated how IoT solutions can successfully and basically address security, functionality, and energy-saving challenges.

## 5.2 Future Works

Future developments will concentrate on improving the system's software and hardware to make it more useful and efficient for everyday applications. Moving past the prototype stage and producing a physically functional model is the aim for hardware. Making the system more portable, robust, and simple to set up in classrooms is part of this. Upgrading the components in the future might entail adding features like temperature and humidity monitoring or utilizing more sophisticated sensors. The system would become even more effective and appropriate for a greater variety of applications with these improvements.

When it comes to software, the objective is to enhance the programming in order to add more features and make the system more intelligent. In addition, new controls for additional classroom appliances or more thorough notifications could be added to the Blynk application. Furthermore, complex code could be created to identify more accurate patterns of classroom activity or further optimize energy use. The system would become more dependable and user-friendly with these improvements.

Future research could also look into including improved IoT technologies, like machine learning to anticipate and automate tasks based on user behavior or cloud storage for data storage. The system would become more intelligent and flexible to meet the needs of various classrooms as a result. Future developments are intended to move the project from a simple prototype to a finished product that can be thoroughly applied in educational settings. While keeping the system's emphasis on convenience, security, and energy efficiency, these improvements would help it better serve the needs of schools.

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**APPENDICES**

**Appendices 1Gant Chart**

| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Briefing | ■ | | | | | | | | | | | | | |
| Registration | | ■ | | | | | | | | | | | | |
| Gant Chart | | | ■ | | | | | | | | | | | |
| Literature Review | | | | ■ | ■ | ■ | ■ | | | | | | | |
| Introduction | | | | | | ■ | ■ | | | | | | | |
| Objective | | | | | | ■ | ■ | | | | | | | |
| Scope | | | | | | ■ | ■ | | | | | | | |
| Project Background | | | | | | | | ■ | ■ | | | | | |
| Methodology | | | | | | | | ■ | ■ | ■ | ■ | | | |
| Prelimanary Result | | | | | | | | | ■ | ■ | ■ | | | |
| Ready for Slide | | | | | | | | | | | | ■ | ■ | |
| Presentation | | | | | | | | | | | | | | ■ |

**Appendices 2Coding**

```
#define BLYNK_TEMPLATE_ID "TMPL6Xpps06FF"

#define BLYNK_TEMPLATE_NAME "Quickstart Template"

#define BLYNK_AUTH_TOKEN "NquRjvD3nfwgTf2Ew3urbLFrlGlGg48j"


#define BLYNK_PRINT Serial


#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>

#include <MFRC522.h>

#include <SPI.h>

#include <DHT.h>


#define DHTPIN 14

#define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);


char ssid[] = "Penguin";

char pass[] = "bihannnn";


#define PIR_PIN 13

#define LDR_PIN 34

#define RELAY_LIGHT_PIN 25

#define RELAY_FAN_PIN 26
```

```
#define RFID_SS_PIN 5
#define RFID_RST_PIN 4
#define DOOR_LOCK_PIN 27
#define BUZZER_PIN 33  // Buzzer pin

int lightThreshold = 3000;
bool fanSwitch = false;
bool lightSwitch = false;
bool doorSwitch = false;

bool fanManualOverride = false;
bool lightManualOverride = false;

MFRC522 rfid(RFID_SS_PIN, RFID_RST_PIN);  // Create RFID object
BlynkTimer timer;

String authorizedUID = "3B44C422";  // Authorized UID

unsigned long lastMotionTime = 0;  // Track the time when motion was last detected
const unsigned long fanOffDelay = 5000;  // 5-second delay in milliseconds
double calibrationOffset = 22.0;

void setup() {
  Serial.begin(115200);
```

```
  // Connect to Wi-Fi and Blynk
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  // Initialize peripherals
  dht.begin();
  pinMode(PIR_PIN, INPUT);
  pinMode(RELAY_LIGHT_PIN, OUTPUT);
  pinMode(RELAY_FAN_PIN, OUTPUT);
  pinMode(DOOR_LOCK_PIN, OUTPUT);
  pinMode(BUZZER_PIN, OUTPUT);

  // Initialize SPI and RFID
  SPI.begin();  // Initialize SPI bus
  rfid.PCD_Init();  // Initialize RFID reader

  // Ensure relays are OFF initially
  digitalWrite(RELAY_LIGHT_PIN, HIGH);
  digitalWrite(RELAY_FAN_PIN, HIGH);  // Ensure fan is off on startup
  digitalWrite(DOOR_LOCK_PIN, HIGH);

  fanSwitch = false;  // Synchronize fan state
  lightSwitch = false;

  timer.setInterval(30000L, readTemperature);  // Update temperature every 30 seconds
}
```

```
void loop() {
  if (WiFi.status() == WL_CONNECTED) {
    Blynk.run();
    timer.run();
  }

  // Continuously scan for RFID cards
  checkRFIDAccess();

  // Other sensor and control logic
  handleLightAndFan();
  synchronizeBlynkSwitches();
}

// Add a timeout function to reset manual overrides
void resetLightOverride() {
  lightManualOverride = false;
  Serial.println("Light manual override reset. Control returned to sensors.");
}

void resetFanOverride() {
  fanManualOverride = false;
  Serial.println("Fan manual override reset. Control returned to sensors.");
}
```

```
// RFID-related functions remain unchanged
void checkRFIDAccess() {
  if (rfid.PICC_IsNewCardPresent()) {
    if (rfid.PICC_ReadCardSerial()) {
      String uid = "";
      for (byte i = 0; i < rfid.uid.size; i++) {
        uid += String(rfid.uid.uidByte[i], HEX);
      }
      uid.toUpperCase();

      Serial.print("Scanned UID: ");
      Serial.println(uid);

      if (uid == authorizedUID) {
        Serial.println("Access granted! Unlocking door...");
        digitalWrite(DOOR_LOCK_PIN, LOW);  // Unlock door
        digitalWrite(BUZZER_PIN, HIGH);  // Buzzer ON for access granted
        delay(200);  // Short delay to buzz
        digitalWrite(BUZZER_PIN, LOW);   // Buzzer OFF
        doorSwitch = true;
        updateDoorStatus();

        timer.setTimeout(10000L, []() {
          Serial.println("Relocking door after 10 seconds.");
```

```
        digitalWrite(DOOR_LOCK_PIN, HIGH);  // Lock door
        doorSwitch = false;
        updateDoorStatus();
        synchronizeBlynkSwitches();
      });
    } else {
      Serial.println("Access denied! Incorrect UID.");
      digitalWrite(BUZZER_PIN, HIGH);  // Buzzer ON for access denied
      delay(500);  // Short buzz for denial
      digitalWrite(BUZZER_PIN, LOW);   // Buzzer OFF
    }

    rfid.PICC_HaltA();  // Halt the current card
    rfid.PCD_StopCrypto1();  // Stop crypto
  }
}

if (!rfid.PICC_IsNewCardPresent()) {
  rfid.PCD_Init();  // Re-initialize the RFID reader if no card is present
}
}

void updateDoorStatus() {
  if (digitalRead(DOOR_LOCK_PIN) == LOW) {
    Serial.println("Door is unlocked - updating Blynk LED");
```

```
    Blynk.virtualWrite(V5, 255);  // Green LED on (unlocked)
    Blynk.virtualWrite(V3, 1);
  } else {
    Serial.println("Door is locked - updating Blynk LED");
    Blynk.virtualWrite(V5, 0);  // Green LED off (locked)
    Blynk.virtualWrite(V3, 0);
  }
}

BLYNK_WRITE(V3) {
  doorSwitch = param.asInt();
  if (doorSwitch == 1) {
    digitalWrite(DOOR_LOCK_PIN, LOW);  // Unlock door
    Serial.println("Door unlocked from Blynk app");
  } else {
    digitalWrite(DOOR_LOCK_PIN, HIGH);  // Lock door
    Serial.println("Door locked from Blynk app");
  }
  updateDoorStatus();
}

BLYNK_WRITE(V1) {  // Light control from Blynk
  lightSwitch = param.asInt();
  lightManualOverride = true;
  digitalWrite(RELAY_LIGHT_PIN, lightSwitch ? LOW : HIGH);
```

```
  Blynk.virtualWrite(V1, lightSwitch);
  timer.setTimeout(10000L, resetLightOverride);
}

BLYNK_WRITE(V2) {  // Fan control from Blynk
  fanSwitch = param.asInt();
  fanManualOverride = true;
  digitalWrite(RELAY_FAN_PIN, fanSwitch ? LOW : HIGH);
  Blynk.virtualWrite(V2, fanSwitch);
  timer.setTimeout(10000L, resetFanOverride);
}

void handleLightAndFan() {
  int motionDetected = digitalRead(PIR_PIN);
  int lightLevel = analogRead(LDR_PIN);

  if (motionDetected) {
    lastMotionTime = millis();  // Update last motion time when motion is detected
  }

  if (!lightManualOverride) {
    if (motionDetected && lightLevel < lightThreshold) {
      digitalWrite(RELAY_LIGHT_PIN, LOW);  // Turn light ON
      lightSwitch = 1;
    } else {
```

```
      digitalWrite(RELAY_LIGHT_PIN, HIGH);  // Turn light OFF
      lightSwitch = 0;
    }
  }

  if (!fanManualOverride) {
    if (motionDetected) {
      digitalWrite(RELAY_FAN_PIN, LOW);  // Turn fan ON
      fanSwitch = 1;
    } else if (millis() - lastMotionTime >= fanOffDelay) {
      digitalWrite(RELAY_FAN_PIN, HIGH);  // Turn fan OFF after 5 seconds without motion
      fanSwitch = 0;
    }
  }
}

void synchronizeBlynkSwitches() {
  int lightState = digitalRead(RELAY_LIGHT_PIN) == LOW ? 1 : 0;
  int fanState = digitalRead(RELAY_FAN_PIN) == LOW ? 1 : 0;
  int doorState = digitalRead(DOOR_LOCK_PIN) == LOW ? 1 : 0;

  if (lightSwitch != lightState) {
    Blynk.virtualWrite(V1, lightState);
    lightSwitch = lightState;
```

```
  }
  if (fanSwitch != fanState) {
    Blynk.virtualWrite(V2, fanState);
    fanSwitch = fanState;
  }
  if (doorSwitch != doorState) {
    Blynk.virtualWrite(V3, doorState);
    doorSwitch = doorState;
  }
}

void readTemperature() {
  double temp = dht.readTemperature();
  if (isnan(temp)) {
    Serial.println("Failed to read from DHT sensor!");
  } else {
    temp += calibrationOffset;
    temp = ((int)(temp * 10)) / 10.0;
    Serial.print("Temperature: ");
    Serial.print(temp, 1);
    Serial.println("°C");
    Blynk.virtualWrite(V6, temp);
  }
}
```