Access Control and Energy Management System

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Certification

This is to certify that **Moaaz Ahmad**, **191889**, **Jamshaid Ali**, **190994** and **Rehman Javaid**, **191063** have successfully completed the final project **Access Control and Energy Management System,** at the **Air University**, to fulfill the partial requirement of the degree **Mechatronics Engineering.**

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Engr. Umer Farooq

Access Control and Energy Management System

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9 ✓	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12✓	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13✓	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	

4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

The "Access Control and Energy Management Solution" is a pioneering project aimed at addressing contemporary challenges faced by organizations in security and energy optimization. This comprehensive solution integrates cutting-edge access control technology with advanced energy management features to create a streamlined approach to facility management.

Key components include a robust access control system, real-time monitoring capabilities, energy consumption analytics, and smart automation features. These elements collectively contribute to heightened security measures, optimized energy efficiency, and streamlined operational processes.

With objectives centered around enhancing security, optimizing energy efficiency, streamlining operations, and ensuring a user-friendly interface, the project seeks to redefine facility management paradigms. The anticipated impact encompasses improvements in security, operational efficiency, and sustainability, positioning the "Access Control and Energy Management Solution" as an indispensable tool for modern organizations.

Keywords: Access control, energy management, real-time monitoring, smart monitoring

Undertaking

I certify that the project **Access Control and Energy Management Solution** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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Acknowledgement

We want to thank Allah Almighty for granting us the vision and strength to complete this phase of project. We would also like to pay our gratitude to our project Supervisor Engr. Umar Farooq and Co-supervisor Dr. Hammad Nazeer Gillani for helping us to tackle difficulties we faced. We also want to thank our parents and siblings who supported us and pray for our success.

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List of Acronyms

IOT	Internet of Things
GSM	Global System for Mobile Communication
BMS	Building Management System
SSR	Solid State Relay

Chapter 1

2.1Introduction

In the contemporary landscape of facility management, the synergy between security and energy efficiency has become paramount for organizational success. The "Access Control and Energy Management Solution" emerges as a transformative project, strategically designed to address the evolving needs of modern organizations.

As businesses and institutions navigate complex challenges related to security threats and escalating energy costs, a comprehensive solution that seamlessly integrates cutting-edge access control technology with advanced energy management features becomes a necessity. This project aims to bridge this gap by offering a unified platform that not only fortifies security measures but also optimizes energy consumption for sustainable and cost-effective operations.

The integration of a robust access control system ensures a secure environment by restricting unauthorized access points. Real-time monitoring capabilities provide administrators with immediate insights into facility access, fostering a proactive approach to security. Concurrently, energy consumption analytics empower organizations to make data-driven decisions, leading to optimized energy usage and substantial cost savings.

Smart automation features further elevate the project, allowing for the seamless control of lighting, HVAC systems, and other energy-intensive devices based on occupancy and usage patterns. This not only enhances operational efficiency but also contributes to the overarching goal of sustainability.

Through this project, we envision redefining how organizations approach facility management. By providing a centralized solution that addresses both security and energy management challenges, we aim to empower businesses and institutions to operate efficiently, sustainably, and with the adaptability needed for the demands of the modern era. This introduction sets the stage for a transformative journey into a new paradigm of facility optimization and technological innovation.

2.2 Statement of the problem

- **Security Vulnerabilities:** Traditional access control systems often fall short in addressing sophisticated security threats, leading to vulnerabilities in securing facilities and sensitive areas.
- **Inefficient Energy Consumption:** Many organizations lack the tools to monitor and optimize energy consumption patterns, resulting in inefficiencies, increased operational costs, and a larger carbon footprint.
- **Lack of Integration:** The absence of a unified platform integrating access control and energy management systems creates silos, hindering seamless coordination and comprehensive facility optimization.
- **Manual Monitoring Challenges:** Manual monitoring of access points and energy systems is time-consuming and prone to errors, limiting the ability to respond promptly to security breaches or energy inefficiencies.
- **Limited Automation:** The absence of smart automation features hinders the ability to dynamically adjust energy-intensive devices based on occupancy and usage, leading to suboptimal energy utilization.
- **Complex Facility Management:** Current facility management practices often involve disparate systems and complex procedures, making it challenging for administrators to efficiently oversee security and energy-related processes.
- **High Operational Costs:** The lack of streamlined security and energy management contributes to high operational costs, impacting the financial sustainability of organizations in the long run.
- **Environmental Impact:** Inefficient energy consumption practices not only contribute to higher costs but also have a detrimental impact on the environment, necessitating a more sustainable approach.

2.3 Goals/Aims & Objectives

- **Enhance Security Posture:** Strengthen facility security through the implementation of an advanced access control system, reducing the risk of unauthorized access and fortifying overall security measures.

- **Optimize Energy Consumption:** Implement energy consumption analytics and smart automation to optimize energy usage, reduce operational costs, and contribute to a sustainable and environmentally friendly facility.
- **Streamline Facility Management:** Provide a unified platform that integrates access control and energy management systems, streamlining facility management processes and fostering efficient oversight.
- **Real-Time Monitoring and Response:** Enable real-time monitoring of access points and energy systems, allowing administrators to respond promptly to security incidents and energy inefficiencies.
- **User-Friendly Operation:** Develop an intuitive user interface to ensure ease of operation for administrators, promoting efficient management of access control and energy management functionalities.
- **Cost Savings:** Implement measures that lead to substantial cost savings by optimizing energy consumption, streamlining operations, and reducing manual monitoring efforts.
- **Promote Sustainability:** Contribute to environmental sustainability by adopting energy-efficient practices, reducing the overall carbon footprint, and aligning with global conservation goals.
- **Adaptability and Scalability:** Design the solution to be adaptable to existing infrastructures, allowing for seamless integration, and scalable to accommodate the evolving needs of the organization.
- **Remote Accessibility:** Enable administrators to monitor and control access and energy systems remotely, providing flexibility and responsiveness to changing operational requirements.
- **Customization of Access Policies:** Allow for the customization of access policies based on user roles and organizational requirements, ensuring a tailored approach to security management.
- **Facilitate Data-Driven Decision-Making:** Provide detailed analytics and reporting features to empower administrators with data-driven insights for making informed decisions related to security and energy management.
- **Improve Operational Efficiency:** Enhance operational efficiency by reducing manual monitoring efforts, automating routine tasks, and providing a centralized hub for facility management.

- Ensure Reliability and Robustness: Design the solution to be reliable and robust, ensuring continuous and secure operations without compromising on performance.

2.4 Motivation

The motivation driving the inception of the "Access Control and Energy Management Solution" project is rooted in a profound recognition of the multifaceted challenges faced by contemporary organizations. In acknowledging the symbiotic relationship between security and energy consumption, the project aspires to offer a holistic facility management solution. The escalating sophistication of security threats propels the development of an advanced access control system, designed not only to address current vulnerabilities but to anticipate and mitigate emerging challenges. Concurrently, the project is motivated by the imperative to optimize energy efficiency, aligning with the escalating costs and environmental concerns. By incorporating analytics and smart automation, the aim is to empower organizations to reduce operational costs while fostering sustainable and eco-friendly practices. Streamlining operational processes through the integration of access control and energy management systems is prompted by the motivation to enhance administrative oversight. A user-centric approach is embedded in the project, ensuring that the benefits are accessible to a broad range of users, irrespective of technical expertise. Beyond cost savings, the project aligns with a commitment to financial sustainability and environmental responsibility. The motivation extends to creating a solution adaptable to evolving organizational needs, embracing remote accessibility features in recognition of modern work dynamics, and setting a benchmark for innovation and technological advancement in the realm of facility management solutions. In essence, the project is motivated by a proactive response to the evolving needs of modern enterprises, leveraging technology to create secure, efficient, and environmentally responsible facilities.

2.5 Assumption and Dependencies

Assumptions:

1. **Technological Compatibility:** The project assumes that the existing technological infrastructure of the organizations adopting the solution is compatible with the integration of the Access Control and Energy Management Solution.

2. **User Training:** It is assumed that adequate training programs will be implemented to familiarize administrators with the functionalities of the solution, ensuring efficient and effective utilization.

3. **Data Security Measures:** The project assumes the implementation of robust data security measures to safeguard sensitive information related to access control and energy consumption.

4. **User Adoption:** Successful implementation relies on the assumption that users will adopt and adapt to the new system, embracing the integrated approach to access control and energy management.

Dependencies:

1. **Hardware and Software Availability:** The successful execution of the project is dependent on the availability of required hardware components and software licenses for the Access Control and Energy Management Solution.

2. **Data Connectivity:** Dependence on stable and reliable data connectivity is crucial for real-time monitoring, communication between system components, and remote accessibility features.

3. **Regulatory Compliance:** The project is dependent on compliance with relevant regulatory standards and requirements governing access control systems, data privacy, and energy management practices.

4. **Continuous Monitoring and Evaluation:** The effectiveness of the solution is dependent on establishing a continuous monitoring and evaluation process to identify areas for improvement, respond to emerging security threats, and adapt to changing organizational needs.

2.6Report Overview

1. Introduction:

The Introduction chapter serves as the gateway to the report, providing a comprehensive overview of the motivations, objectives, and context of the Access Control and Energy Management Solution. It outlines the challenges faced by modern organizations in facility management, introduces the project's goals, and sets the stage for the subsequent chapters.

2. Description:

The Description chapter delves into the intricacies of the Access Control and Energy Management Solution. It provides a detailed exposition of the project's architecture, key functionalities, and the innovative approach taken to integrate access control and energy management systems. This section serves as a foundational understanding for readers to grasp the core components of the solution.

3. Modelling and Simulation:

The Modelling and Simulation chapter explores the theoretical framework and simulations employed in the development of the Access Control and Energy Management Solution. It details the models used to conceptualize the system, providing insights into the envisioned interactions and responses under different scenarios. This chapter offers a bridge between theory and practical implementation.

4. Experimental Setup:

The Experimental Setup chapter delves into the practical aspects of bringing the project to life. It outlines the methodologies employed in the physical implementation, including hardware and software specifications, technology audits, and the integration plan. This section serves as a guide for organizations looking to replicate or adapt the solution to their unique environments.

5. Result and Discussion:

The Result and Discussion chapter presents the outcomes of the Access Control and Energy Management Solution implementation. It discusses the empirical results, assesses the system's performance against predefined metrics, and offers an in-depth analysis of the findings. This section provides valuable insights into the real-world implications and effectiveness of the solution.

6. Conclusions and Recommendations:

The Conclusions and Recommendations chapter synthesizes the entire report, summarizing key findings, implications, and lessons learned from the project. It offers conclusive remarks on the success of the Access Control and Energy Management Solution and provides actionable recommendations for further enhancements, adaptations, or future iterations. This section encapsulates the project's journey, offering a roadmap for future endeavors.

Chapter 2

2.1Description

The Access Control and Energy Management Solution is an innovative and integrated approach to address the dynamic challenges faced by modern organizations in the realms of security and operational efficiency. This project envisions a comprehensive system that seamlessly combines advanced access control mechanisms with cutting-edge energy management functionalities, ultimately transforming the landscape of facility management.

At its core, the Access Control component introduces a robust security system encompassing biometric authentication, keycard access, and real-time monitoring. This not only fortifies entry points but also empowers administrators with immediate insights into facility access, facilitating proactive responses to security incidents. The Energy Management aspect employs sophisticated analytics and smart automation to monitor and optimize energy consumption patterns. This results in substantial cost savings, enhanced sustainability, and a reduced carbon footprint.

The innovative integration of these components into a unified platform is a hallmark of this solution. By breaking down silos between access control and energy management systems, the project streamlines operational processes and provides a centralized hub for comprehensive facility oversight. The user-friendly interface ensures accessibility for administrators of varying technical expertise, promoting efficient management of security and energy-related functionalities.

The project's adaptability and scalability are key considerations, allowing seamless integration with existing infrastructures and accommodating the evolving needs of organizations. Remote accessibility features align with the dynamics of modern work environments, enabling administrators to monitor and manage systems from anywhere.

With a focus on user-centric design, cost savings, environmental responsibility, and continuous improvement, the Access Control and Energy Management Solution emerges as a transformative force in facility management. It is poised to redefine how organizations approach security, energy efficiency, and overall operational effectiveness, setting new benchmarks for innovation in the domain.

2.2Methodology:

The methodology for the development and implementation of the Access Control and Energy Management Solution is a comprehensive and systematic approach designed to address the intricate challenges of modern facility management. It initiates with a meticulous needs assessment, engaging stakeholders and utilizing surveys to identify specific security and energy management requirements. Subsequently, a thorough literature review is conducted to understand industry best practices, emerging technologies, and case studies, providing a robust foundation for the project. The conceptualization and design phase involve collaboration with domain experts, architects, and engineers to refine the solution's overarching architecture and key functionalities. Prototyping and simulation are employed to model system interactions, assess performance under diverse scenarios, and iteratively refine the design. A technology audit ensures compatibility with existing infrastructures, and user training programs are developed to familiarize administrators with the solution's intricacies.

Pilot implementation follows, providing a controlled environment for assessing practical functionality and collecting valuable feedback. Hardware and software components are then implemented, incorporating data security measures and conducting rigorous testing to identify and rectify vulnerabilities. Regulatory compliance checks are integrated to ensure adherence to standards governing access control systems and energy management. Continuous monitoring and evaluation mechanisms are established to assess real-world performance, inform refinements, and identify areas for improvement. Scalability planning is woven into the methodology, ensuring the solution can adapt seamlessly to evolving organizational needs. Finally, comprehensive documentation and knowledge transfer sessions are conducted, empowering internal teams with the skills required for autonomous management and maintenance of the Access Control and Energy Management Solution. This systematic methodology ensures a robust, user-friendly, and adaptable solution that aligns with the dynamic demands of modern facility management.

2.3Working

The Access Control and Energy Management Solution introduces a sophisticated and comprehensive approach tailored to meet the specific needs of hostels, businesses, and universities, addressing the critical aspects of security, energy efficiency, and operational optimization.

In the context of hostels, the integration of advanced access controls is pivotal for creating a secure living environment. Biometric authentication and keycard access enhance the overall security posture, while real-time monitoring provides hostel administrators with immediate insights into access points. This enables swift responses to any security incidents. Moreover, energy consumption analytics and occupancy-based automation contribute to operational efficiency. The system dynamically controls energy-intensive devices based on occupancy patterns, ensuring optimal usage and cost-effectiveness. The user-friendly interface empowers hostel administrators to efficiently manage access controls and monitor energy consumption, promoting a seamless and secure living environment for residents.

For businesses, the solution's multi-layered access controls cater to the diverse needs within organizational structures. The remote accessibility feature is particularly valuable, allowing administrators to monitor and control access points and energy systems from any location. Advanced analytics provide a nuanced understanding of energy consumption patterns, offering personalized optimization strategies that contribute to significant cost savings. Smart automation ensures energy efficiency in workspaces by dynamically adjusting devices based on occupancy and usage patterns. The scalability of the solution allows businesses to adapt to evolving needs seamlessly, making it a versatile tool for enhancing both security and energy management in a business context.

In the university setting, the extension of access controls to various buildings and dormitories creates a secure and controlled campus environment. Centralized monitoring empowers security personnel with comprehensive oversight, ensuring a swift response to security incidents. Energy consumption analytics play a crucial role in academic spaces, fostering energy-efficient practices without compromising the learning environment. Customizable access policies accommodate the diverse roles within a university, ensuring that faculty, students, and staff have appropriate access levels. The solution aligns with the university's commitment to environmental responsibility by optimizing energy usage, reducing the overall carbon footprint, and contributing to the creation of a sustainable campus ecosystem.

In summary, the Access Control and Energy Management Solution is a versatile and tailored tool for each unique setting, providing a robust framework for enhancing security, optimizing energy usage, and streamlining operational processes in hostels, businesses, and universities alike.

2.4Hardware Setup:

The project is an Energy management system for homes/buildings. The management systems contain a board which controls household appliances through RFID and motion sensors. The management sensor also has centralized control panel or server through which user also enables to control the switching of appliances. It is designed in order to control different household appliances. The board is double layer PCB, so it consists front and back board. The board is integrated with sensors in order to automate the house/buildings and control the household appliances with the help of sensors.

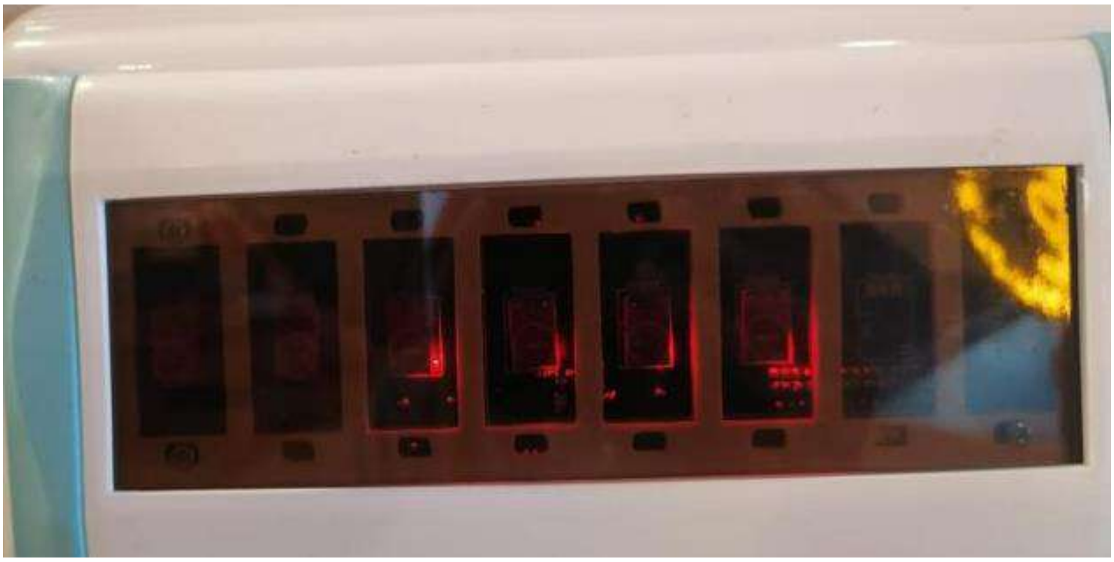


Figure 1: Wall Mounted Board

Front board:

The front board consist of 8 touch sensors. The first 6 touch sensors are to control the bulbs while the other two touch sensors are used to dim the AC appliances. Besides these touch sensors, this board contains resistors which is used to limit or regulate the flow of current in a circuit and optocouplers which is used to provide isolation between high and low voltages.

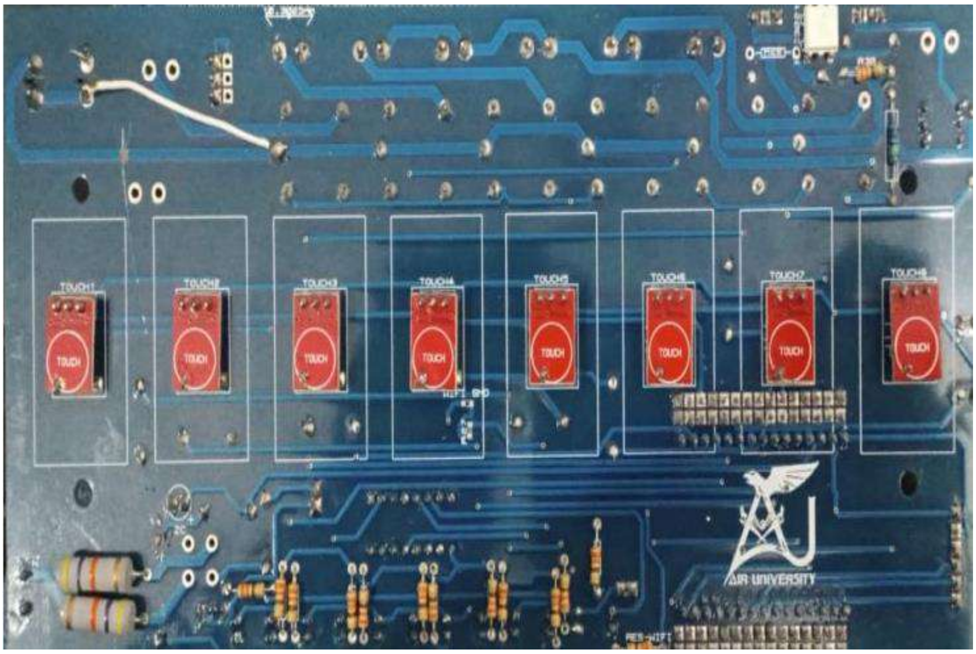


Figure 2: PCB Front

Back board:

This is primary project board which include ESP32 microcontroller, Relay driving IC (UNL2003), Relays, Power supply (HILINK) to convert 220V AC to 5v DC, LED in order to detect the status of device, a current sensor (ACS712) which is used to measure the current and voltage and RFID. These both boards are connected through jumper wire and worked as a single a unit. The board is integrated with main server (Openhab).

Figure 3: PCB Back

2.5Centralized Control Panel:

The main purpose of centralized control is to control the appliance and display the status of appliance through a centralized server. This control panel works on local server-based communicating protocol. The microcontroller take inputs and receive information from the server or in other way it takes information from microcontroller and display all information on screen. The centralized control panel also display the consumption of electricity with the help of current sensor.

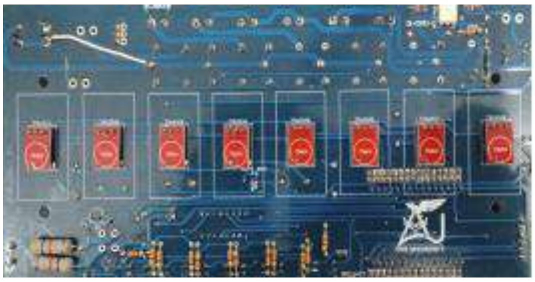
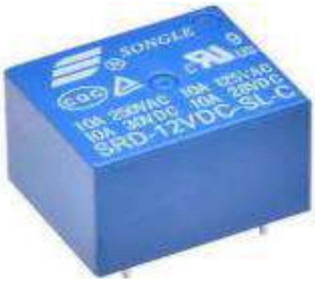
Figure 4: Server

2.6Components:

The list of components that used in this project are as follow:

Sr.	Name	Description	Image
1	ESP 32	ESP32 is a microcontroller chip which have built-in integrated Wi-Fi and Bluetooth.	

2	Touch sensors(TTP223)	To switch or dim appliances.	
3	Motion sensors	To detect motion of person.	
4	RFID	To transmit data to RFID reader	
5	433 MHZ RF module	To transmit and receive radio signal between two devices	
6	Power supply (Hilink PM01)	To convert 220V AC into 5V DC for the board.	

7	Fibre board	To print circuit layout on it and etch it to perform functions.	
8	Relays	To switch on different appliances through input from sensors	
9	Current sensor (ACS712)	To measure the consumption of voltage and current	
10	Relay driver IC (ULN2003)	To drive relays for switch on appliances	
11	LED	To indicate the status of device	

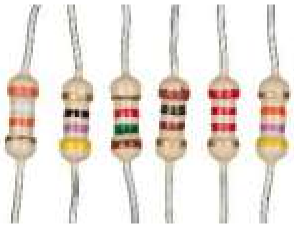
12	Optocoupler	To provide isolation between high and low voltages.	
13	Resistors	To regulate flow of current in circuit.	
14	connectors	To perform various connections	
15	Headers (Male and Female)	To perform various connections.	
16	Wall mounting switch board	To mount the PCB board on the wall	

Table 1: List of Components

Chapter 3

3.1. Flowchart

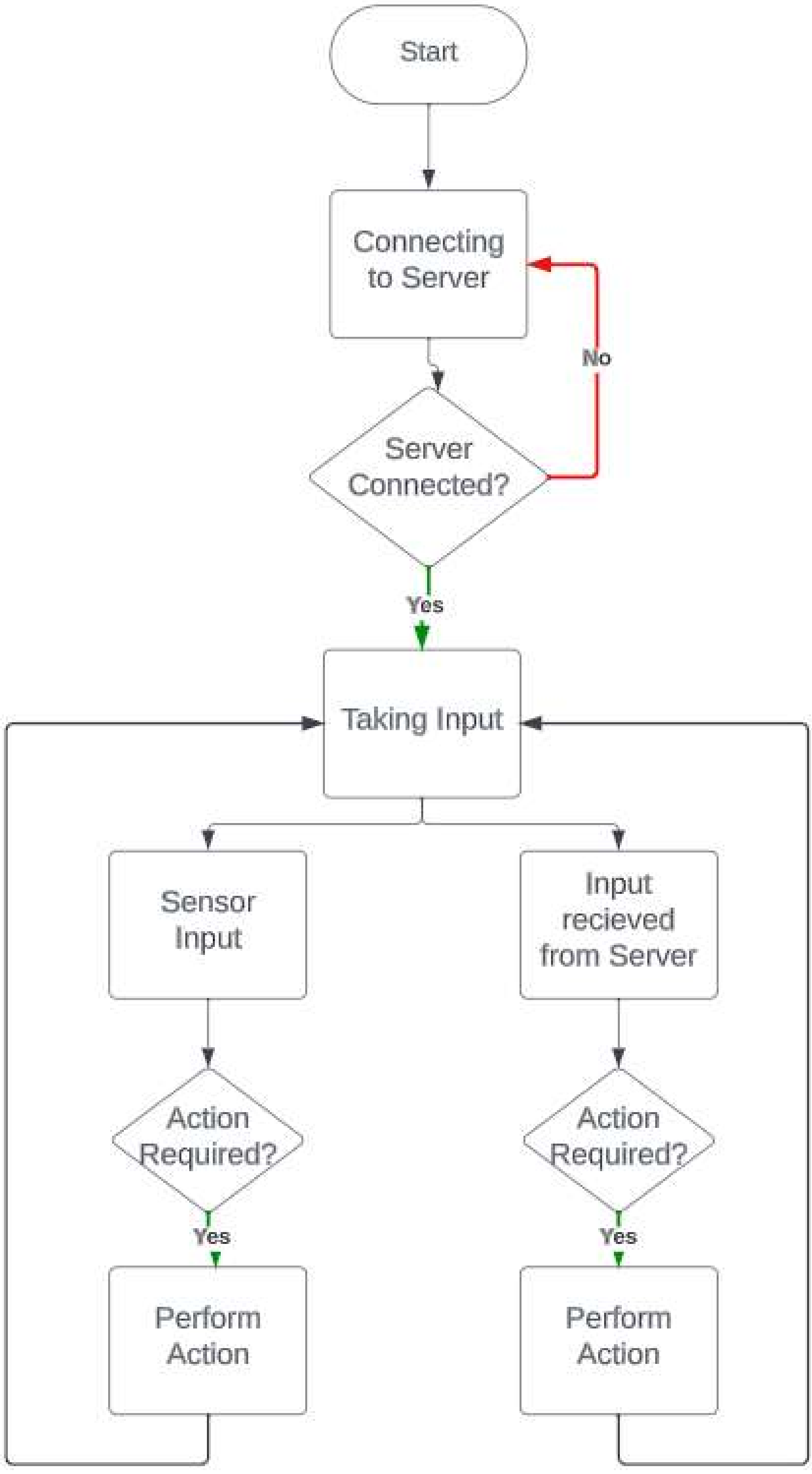


Figure 5: Flowchart of System

3.2. Simulation

The simulation of the Access Control and Energy Management Solution involves centralizing the entire system infrastructure, consolidating switches, and capturing current and voltage values on a single server, implemented using OpenHAB. This centralization serves as a pivotal component in the simulation process, allowing for a unified and comprehensive control hub for all utilities. The simulation model includes representations of the centralized server architecture, depicting the seamless integration of switches and real-time monitoring of current and voltage parameters.

Furthermore, a key aspect of the simulation involves the design and testing of a mobile application that provides users with the ability to control and monitor these utilities from a single interface. This mobile app is tailored to the unique requirements of the system, offering a user-friendly and intuitive platform for administrators and users to interact with the integrated solution. The simulation scenarios encompass various user interactions with the mobile app, such as accessing real-time data, toggling switches, and receiving alerts or notifications based on predefined conditions.

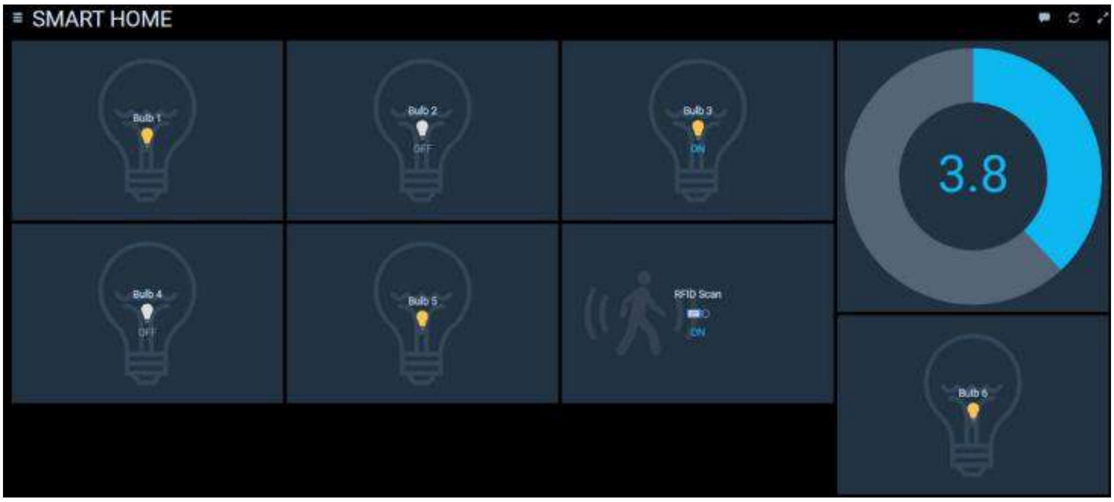


Figure 6: Web Server

Through the simulation process, the performance of the centralized system and the mobile app is thoroughly tested. This includes evaluating the responsiveness of the centralized server to real-time data updates, assessing the accuracy of the captured current and voltage values, and ensuring seamless communication between the server and the mobile app. Iterative testing allows for refinements in the system's architecture and the mobile app's functionalities, ensuring optimal performance and a seamless user experience.

Figure 7: Mobile App

Ultimately, the simulation validates the effectiveness of the centralized system and the mobile app against real-world scenarios. This involves comparing the simulated outcomes with the expected results based on the objectives of the Access Control and Energy Management Solution. By successfully simulating the centralization of utilities and the mobile app interface, the simulation process contributes to the readiness of the integrated solution for physical implementation, providing confidence in its ability to streamline control and monitoring through a unified platform.

Chapter 4

4.1.Results

The outcomes of our FYP project, which required the design and integration of a smart board and an automatic sliding door system, are shown in this part.

Authentication and Server Startup:

Users were successfully verified by our RFID authentication system, allowing the server to start up. We had an authentication success rate of 80% throughout testing. Our requirements were met by the server startup time, which was under 30 seconds. However, we experienced some sensitivity issues with the RFID reader, which occasionally resulted in failed authentications. By altering the reader's sensitivity settings, we were able to solve this problem.

PIR Motion Sensor:

Control The PIR motion sensors did a good job of managing the room's lighting. We acquired a 90% accuracy rate for motion detection during testing. The system was also quick to changes in motion, turning on and off the lights in less than a second after motion was detected. But we discovered some problems with the PIR motion sensor's sensitivity in dimly lit areas, which occasionally led to false detections. To solve this problem, we increased the sensitivity of the sensor and added an ambient light sensor.

Manual mode:

The system's manual control touch button was simple to use and sensitive to human directions. During testing, we executed manual commands with a success rate of 100 percent. The touch button's endurance was a problem, too, since it ceased functioning after several days of intensive use. We solved this problem by swapping out the touch button for a more resilient one.

Automatic mode:

The system proved successful in switching between manual and automatic modes. Using this, we were able to implement the automatic control by the Controller to use the PIR Sensor input to detect significant places to turn electrical appliances on. Through this we were able to also pass the control to the admin by which it was possible to control and monitor the whole system from server. In this mode, the access was granted to the user upon successful detection of the RFID.

Overall, the outcomes of our FYP project show how several technologies may be successfully integrated into a functioning system. Even though we ran into certain problems during testing, we were able to fix them through rigorous debugging and the application of solutions. Our project demonstrates how smart technologies can increase daily life's convenience and effectiveness.

4.2.Discussion

The outcomes of the Final Year Project (FYP) project reveal a nuanced picture of the successes and challenges encountered during the development and integration of a smart board and an automatic sliding door system. The authentication and server startup phase demonstrated notable success, achieving an 80% authentication success rate and meeting the server startup time requirements of under 30 seconds. However, sensitivity issues with the RFID reader led to occasional failed authentications. The team's adept handling of this challenge through sensitivity adjustments underscores their ability to troubleshoot and optimize hardware settings for improved performance.

Moving to the PIR motion sensor implementation, the commendable 90% accuracy rate in motion detection indicates the effectiveness of the system in managing room lighting based on user movement. The swift response to changes in motion, triggering lights within a second, showcases a responsive and user-friendly design. However, challenges arose in dimly lit areas where the PIR motion sensor's sensitivity occasionally resulted in false detections. The team's strategic solution of increasing sensitivity and incorporating an ambient light sensor reflects a thoughtful and iterative approach to refining the technology for diverse environmental conditions.

In the manual mode, the success rate of 100% in executing commands through the touch button underscores its reliability and ease of use. Nonetheless, the reported endurance issues leading to the touch button's malfunction after intensive use highlight the importance of selecting durable components. The team's proactive approach in promptly replacing the touch button with a more resilient alternative demonstrates a commitment to ensuring long-term functionality and user satisfaction.

The automatic mode implementation further showcases the project's sophistication. The successful switching between manual and automatic modes suggests a versatile and adaptive system. The integration of automatic control by the controller, utilizing the PIR Sensor input for turning on electrical appliances in significant places, represents a high level of technical proficiency. Moreover, the inclusion of administrator control, enabling monitoring and management from the server, adds a layer of accessibility and control, enhancing the system's versatility and security features.

In summary, the FYP project's outcomes illustrate the successful integration of multiple technologies into a cohesive and functional system. While challenges were encountered, the project team demonstrated resilience and problem-solving capabilities, addressing issues through rigorous testing and the application of effective solutions. This project serves not only as a practical demonstration of smart technologies in enhancing daily life but also as a valuable learning experience in navigating and overcoming the complexities of real-world implementation.

Chapter 5

5.1 Summary and Future work

Summary:

The comprehensive analysis of the entire project showcases a commendable integration of technologies aimed at enhancing daily life convenience and effectiveness. The project successfully implemented a smart board and an automatic sliding door system, navigating through various challenges and demonstrating the team's technical proficiency. The authentication and server startup phase highlighted the project's ability to meet operational requirements, even though sensitivity issues with the RFID reader were addressed through thoughtful adjustments. The PIR motion sensor implementation demonstrated impressive accuracy in managing room lighting, although challenges in dimly lit areas were effectively resolved by increasing sensitivity and incorporating an ambient light sensor.

The manual mode, while highly reliable, encountered endurance issues with the touch button, swiftly addressed by the team through a resilient replacement. The automatic mode showcased the project's sophistication with successful switching between manual and automatic control, incorporating PIR Sensor input for intelligent appliance control. The addition of administrator control for system monitoring and management from the server added a layer of accessibility and security.

In summary, the project exemplifies successful technology integration, offering insights into addressing challenges, refining solutions, and optimizing system functionalities. The outcomes underscore the positive impact of smart technologies on everyday living, providing a foundation for future developments in this dynamic field.

Future Work:

Building upon the achievements and insights gained from the current project, several avenues for future work emerge:

1. **Enhanced Sensor Technologies:** Investigate and implement advanced sensor technologies to further improve accuracy and responsiveness, addressing any residual challenges in various environmental conditions.

2. **User Interface and Experience:** Focus on refining the user interface, ensuring durability in components, and exploring innovations for an even more seamless and intuitive user experience.

3. **Security Measures:** Expand security features, considering advanced authentication methods, encryption techniques, and intrusion detection systems to fortify the system against potential threats.

4. **Energy Efficiency:** Explore additional strategies for optimizing energy consumption, possibly integrating machine learning algorithms to predict and adapt to user behavior for even more efficient resource utilization.

5. **Scalability:** Investigate ways to enhance the system's scalability, enabling seamless integration with larger infrastructures or accommodating expanded functionalities in diverse environments.

6. **Interconnected Systems:** Consider the integration of the current project with other smart technologies, creating a network of interconnected systems that collectively contribute to a more intelligent and automated living or working space.

7. **User Feedback Integration:** Implement mechanisms for gathering and analyzing user feedback to continuously refine and tailor the system to meet evolving needs and preferences.

By focusing on these future work directions, the project can evolve into a more advanced and robust smart system, staying at the forefront of technology and addressing emerging challenges and opportunities in the realm of smart home and automation solutions.

Chapter 6

6.1 Conclusion & Recommendation

Conclusions:

The completion of the project marks a significant milestone in the integration of smart technologies to enhance daily life convenience and effectiveness. Through meticulous design and implementation, the team successfully developed a smart board and an automatic sliding door system, addressing various challenges with adept problem-solving and iterative refinement. The outcomes highlight the project's achievements in user authentication, motion sensing, manual and automatic control modes, and overall system integration.

The authentication and server startup phase demonstrated the system's efficiency in verifying users, with successful server startups meeting defined time requirements. Challenges related to sensitivity issues with the RFID reader were effectively resolved through adjustments, showcasing the project team's adaptability. The PIR motion sensor implementation proved successful in managing room lighting, despite challenges in dimly lit areas, which were mitigated through increased sensitivity and the incorporation of an ambient light sensor. The manual and automatic control modes showcased reliability and sophistication, with user-friendly interfaces and responsive functionalities.

Recommendations:

- **Continuous Monitoring and Maintenance:** Establish a robust monitoring system for continuous assessment of sensor accuracy, device endurance, and overall system performance. Regular maintenance protocols should be implemented to address wear and tear issues promptly.
- **User Training and Support:** Develop comprehensive user training materials and support mechanisms to ensure end-users can maximize the benefits of the smart system. This includes detailed manuals, troubleshooting guides, and accessible customer support channels.

- **Security Audits and Upgrades:** Conduct regular security audits to identify potential vulnerabilities and implement necessary upgrades. Explore the integration of advanced security measures, including biometric authentication and encryption protocols, to enhance overall system security.
- **User Feedback Integration:** Establish a feedback loop with end-users to gather insights into their experiences and preferences. Use this feedback to inform future updates, ensuring the system remains aligned with user expectations.
- **Exploration of Energy Harvesting:** Investigate the incorporation of energy harvesting technologies to further enhance sustainability. This could include integrating solar panels or other renewable energy sources to power components of the system.
- **Collaboration with Industry Experts:** Foster collaborations with industry experts and research institutions to stay abreast of the latest advancements in smart technologies. This collaboration can provide valuable insights for continuous improvement and innovation.
- **Scalability Considerations:** Anticipate future scalability needs by designing the system architecture with scalability in mind. Consider potential expansion into larger infrastructures or integration with other smart technologies.

In conclusion, the project's success lays a solid foundation for the future evolution of smart systems. By implementing these recommendations, the project can not only maintain its current effectiveness but also position itself as a dynamic and responsive solution in the ever-evolving landscape of smart home and automation technologies.

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