Faculty of Electrical Technology and Engineering

DEVELOPMENT HOME AUTOMATION AND SAFETY CIRCUIT BREAKER WITH ESP8266 MICROCONTROLLER FOR DETECTING GAS LEAKAGE AND TRACKING POWER USAGE

BRANDON JAMES

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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DEVELOPMENT HOME AUTOMATION AND SAFETY CIRCUIT BREAKER WITH ESP8266 MICROCONTROLLER FOR DETECTING GAS LEAKAGE AND TRACKING POWER USAGE

BRANDON JAMES

A project report submitted
in partial fulfillment of the requirements for the degree of
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DEDICATION

I would like to express my sincere gratitude and dedication to my beloved parents, Mr. James Ningkan and Mrs. Amlis Anak Siduh, whose constant support and heartfelt prayers have been the pillars of strength throughout my academic journey. Their unwavering encouragement has been a driving force behind my accomplishments. Additionally, I extend profound appreciation to my dedicated supervisor, Dr. Nur Azura Binti Noor Azhuan, for her exemplary guidance and relentless support in advising and assisting me through the intricacies of this project. Their collective influence has played an instrumental role in shaping the successful completion of this endeavour.

ABSTRACT

This study addresses common challenges in conventional home electricity usage, focusing on safety concerns related to gas leakage. The current technology lacks immediate power usage tracking, and manual control of circuit breakers, sockets, and lamps proves challenging, particularly when users are away. To overcome these issues, this project employs an Esp8266 Wi-Fi Shield Arduino as a microcontroller connected to sensors and a servo motor. The system detects gas leakage, controls lamp and socket activation, and manages the RCCB with the servo motor by utilizing Blynk apps for monitoring. The study's objective is to design a centralized system enabling the control and management of home electrical appliances via smartphone. This methodology involves developing a microcontroller program for the Cytron ESP8266 WiFi Shield, creating an auto-reclosure circuit breaker notification, and building a practical gas leakage detection prototype for household application. Additionally, the system addresses lightning-induced overvoltage issues, analyzing nuisance tripping and providing control over home appliance usage while effectively detecting hazardous gas leaks. The approach is based on Blynk and the Esp8266 Wi-Fi Shield Arduino by incorporating data from limit switch conditions, relay status, voltage sensors, current sensors, and power consumption. The results justify the servo's efficient performance, reliable relay operations, and precise gas sensor triggering. Despite slight variations in current and voltage values compared to the actual meter, the system offers a successful and systematic approach to enhance home electricity management and safety.

ABSTRAK

Kajian ini mengatasi cabaran-cabaran biasa dalam penggunaan tenaga elektrik di rumah konvensional, dengan memberi tumpuan kepada kebimbangan keselamatan yang berkaitan dengan kebocoran gas. Teknologi semasa kurang dalam pemantauan segera penggunaan tenaga elektrik, dan kawalan manual terhadap pemutus litar, soket, dan lampu terbukti mencabar, terutamanya ketika pengguna jarak jauh. Untuk mengatasi masalah ini, projek ini menggunakan Esp8266 Wi-Fi Shield Arduino sebagai mikropengawal yang disambungkan kepada sensor dan motor servo. Sistem ini mengesan kebocoran gas, mengawal pengaktifan lampu dan soket, dan menguruskan RCCB dengan motor servo dengan menggunakan aplikasi Blynk untuk pemantauan. Objektif kajian adalah untuk mereka bentuk sistem terpusat yang membolehkan kawalan dan pengurusan alat elektrik di rumah melalui telefon pintar. Metodologi ini melibatkan pengekodan program mikropengawal untuk Cytron ESP8266 WiFi Shield, mencipta notifikasi pemutus litar auto-reclosure, dan membina prototaip pengesanan kebocoran gas yang praktikal untuk kegunaan rumah tangga. Selain itu, sistem ini menangani isu kelebihan voltan yang disebabkan oleh kilat, menganalisis gangguan pemutusan dan menyediakan kawalan ke atas penggunaan alat elektrik di rumah sambil secara berkesan mengesan kebocoran gas berbahaya. Pendekatan ini berdasarkan pada Blynk dan Esp8266 Wi-Fi Shield Arduino dengan merangkumi data dari keadaan suis penghad, status relay, sensor voltan, sensor arus, dan penggunaan tenaga. Keputusan menunjukkan prestasi efisyen motor servo, operasi relay yang boleh dipercayai, dan pencetus sensor gas yang tepat. Walaupun terdapat variasi kecil dalam nilai arus dan voltan berbanding dengan meter sebenar, sistem ini menawarkan pendekatan yang berjaya dan sistematik untuk meningkatkan pengurusan tenaga elektrik dan keselamatan di rumah.

ACKNOWLEDGEMENTS

Foremost, I extend my heartfelt appreciation to my supervisor, Dr. Nur Azura Binti Noor Azhuan, for their invaluable guidance, words of wisdom, and unwavering patience throughout the entirety of this project.

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V	-	Voltage
A	-	Ampere
W	-	Watts
Kwh	-	Killowatts per hour
ppm	-	Part per million

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CHAPTER 1

INTRODUCTION

1.1 Background

Every piece of electrical equipment is crucial in today's world. Imagine how useful it would be to be able to use your phone to switch the electrical systems in your house both inside and outside of the house [1]. What about a security system that can detect gas, excessive electricity usage, turn on RCCB automatically if a trip occurs within the house, and send you a notification via phone? Home automation is all about this, and there are countless uses for it.

Due to the inherent capabilities of its WiFi source, this extraordinary project is built to operate effortlessly inside domestic settings while providing the convenience of remote monitoring from anywhere, whether inside or outside the house. Users may easily control and keep an eye on numerous components using a smartphone [2]. The Blynk platform seamlessly connects to a variety of crucial components, such as limit switches, servos, relays, gas sensors, voltage sensors, and current sensors. Additionally, the Arduino guarantees a steady power supply to the Esp8266 WiFi Shield, allowing for continuous operation.

In the modern era, a home without a high-tech automation system is rare. This technology has transformed how we interact with our living spaces, allowing remote control of appliances, detecting gas leaks, monitoring electricity usage, and sending instant alerts via smartphones.

1.1.1 Introduction

Building automation systems for homes or offices are becoming more and more popular because of their many advantages [1]. Nowadays, most home automation systems are used to reduce human labor in the production of services and goods [2]. Automation uses electricity and water efficiently and economically, mostly minimizing waste [3]. It involves the use of various sorts of sensors and actuators to manage the lighting, temperature, and humidity while also keeping an eye on how much energy is being used in buildings, workplaces, schools, and museums [4].

As age of people increase, they tend to forget basic things like switching off lights/fans. To reduce the burden of attending tasks such as the deactivation of household appliances and saving energy, home automation technology can overcome the conventional distribution board [5]. In addition, they may forget to switch off cylinder gas causing liquefied petroleum gas (LPG) gas leakage, leading to fire in home. LPG (Liquid Petroleum Gas), an exceedingly combustible gas, is composed of a meticulously blended amalgamation of propane and butane. This volatile fuel source finds extensive employment in domestic culinary endeavors, gastronomic establishments, as well as certain sectors of industrial operations. Gas leakage incidents commonly manifest due to human negligence or malfunctioning equipment. Recently, some researchers suggested using MQ-5 sensor to detect the gas leakage where it is capable of sensing H2(molecule hydrogen), LPG, CH4 (methane), CO (carbon monoxide) and Alcohol ([6], [7]).

Other than that, in the absence of cutting-edge technological advancements, the ordinary distribution board lacks the capability to promptly notify consumers of any potential disruptions or malfunctions. Consequently, users are compelled to independently diagnose and troubleshoot issues in the event of a power outage. Standard distribution boards lack the sophisticated technology required to effectively mitigate the occurrence of vexatious tripping incidents. In instances where lightning strikes near the distribution board, it generates an electromagnetic wave with a propensity to induce excessive voltage, there by posing a significant threat to the integrity of electronic devices within the household, such as televisions and refrigerators ([8], [9]). Furthermore, when the premises are unoccupied and an unwarranted tripping event ensues, users face an exacerbated predicament as they are unable to promptly activate the Residual Current Circuit Breaker (RCCB) due to their physical absence from the residence.

In a shared enclosure, an electrical power input is divided into subsidiary circuits and each circuit is equipped with a protection fuse or circuit breaker. More modern boards typically include residual-current devices (RCDs) [10] or residual current breakers with overcurrent protection (RCBOs) [11], along with a main switch. These distribution boards are commonly used in various settings such as homes, factories, and stores where electricity is required. Occasionally, during periods of high electrical demand, tripping may occur, leading to reduced productivity in a factory or disruption in online work for individuals working from home [12]. However, with the availability of new technologies in today's era, one can address such situations.

By using Internet of Thing (IoT) connected smartphones, one can be remotely controlled and monitored, offering a solution to overcome these challenges. Due to the inherent capabilities of its Wi-Fi source, the Wi-Fi Shield ESP8266 is one of the examples, that provides wireless connectivity to Arduino and other microcontroller platforms. It is based on the ESP8266 microcontroller chip, which has built-in Wi-Fi capabilities. The shield allows devices to connect to Wi-Fi networks, communicate over the internet, and interact with web services ([13], [14]). It simplifies the process of adding Wi-Fi functionality to projects, making it easier to create IoT applications and remote-control systems. Meanwhile, Blynk, which is a mobile app, allows users to create a custom interface and remotely control the system. Blynk provides a range of widgets and features that enable real-time data visualization, equipment control, and power consumption monitoring. Recently, Durani *et. al* uses Wi-Fi Shield ESP8266 together with Blynk apps to monitor circuit devices [15]. Similarly, Karuppusamy proposed a sensor-based monitoring station to monitor the efficiency of energy utilization by the control devices [16].

In this study aims to build an operation inside domestic settings while providing the convenience of remote monitoring from anywhere, whether inside or outside the house. Users may easily control and keep an eye on numerous components using a smartphone. The Blynk platform seamlessly connects to a variety of crucial components, such as limit switches, servos, relays, gas sensors, voltage sensors, and current sensors. Additionally, the Arduino guarantees a steady power supply to the Esp8266 Wi-Fi Shield, allowing for continuous operation.

The study relies Esp8266 Wi-Fi Shield on the as the brain, detecting codes and starting the process. If the RCCB switch is nuisance tripped, the limit switch and servo motor will push it back ON. If the RCCB trips three times, the system will send a malfunction notification. Additionally, the system can display power consumption data, providing a clear picture of energy usage to optimize consumption. The system can also control home appliances via a mobile app, minimizing energy waste. It monitors gas leakage and abnormal sounds and sends notifications to the user. Lastly, the system can measures power consumption using voltage and current sensors, displaying the data on an LCD and Blynk.

1.1.2 Project Idea

The project relies on the Cytron ESP8266 WiFi Shield as the brain, detecting codes and starting the process. If the RCCB switch is nuisance tripped, the limit switch and servo motor will push it back ON. If the RCCB trips three times, the system will send a malfunction notification. Additionally, the project can display power consumption data, providing a clear picture of energy usage to optimize consumption. The system can also control home appliances via a mobile app, minimizing energy waste. It monitors gas leakage and abnormal sounds and sends notifications to the user. The project measures power consumption using voltage and current sensors, displaying the data on an LCD and Blynk.

1.2 Addressing Global Pollution Through Gas Sensor Leakage Project

A crucial first step in reducing environmental and health risks is addressing global pollution through a programmed to find and fix gas leaks. This initiative focuses on finding and fixing gas leaks to lessen the emission of dangerous gases into the atmosphere. The initiative provides monitoring systems to quickly discover leaks through joint efforts with stakeholders, including governmental entities, energy businesses, and environmental organizations. The project works to reduce gas leakage and its harmful effects on the environment by implementing maintenance and repair protocols, increasing public awareness, fighting for legislative reforms, and promoting renewable energy options. This all-encompassing strategy helps ensure that communities around the world have a cleaner and healthier future.

1.3 Problem Statement

Our nation currently faces a profound and pressing energy crisis, which is exacerbated by the reckless and thoughtless way individuals are utilizing the available energy resources. When departing from the confines of their residences, a multitude of individuals tend to neglect the imperative act of switching off the lights and various electrical appliances. However, even midst these challenging circumstances, the utilization of sophisticated home automation technology empowers individuals to exert remote control over these technological marvels through the convenience of smartphones. In addition to yielding substantial time savings, the adoption of such practices enhances everyday productivity by liberating us from the burden some concerns of diligently attending to tasks such as the deactivation of house hold appliances.

A conventional distribution board, typically positioned at an elevated location, can prove an arduous inconvenience for those seeking access, particularly maintenance personnel seeking to carry out their assigned tasks. In the absence of cutting-edge technological advancements, the ordinary distribution board lacks the capability to promptly notify consumers of any potential disruptions or malfunctions. Consequently, users are compelled to independently diagnose and troubleshoot issues in the event of a power outage. Standard distribution boards lack the sophisticated technology required to effectively mitigate the occurrence of vexatious tripping incidents. In instances where lightning strikes near the distribution board, it generates an electromagnetic wave with a propensity to induce excessive voltage, there by posing a significant threat to the integrity of electronic devices within the household, such as televisions and refrigerators. Furthermore, when the premises are unoccupied and an unwarranted tripping event ensues, users face an exacerbated predicament as they are unable to promptly activate the Residual Current Circuit Breaker (RCCB) due to their physical absence from the residence.

Liquefied Petroleum Gas (LPG), an exceptionally combustible and volatile gas, is intricately composed of a meticulously blended amalgamation of propane and butane. This highly flammable fuel source finds extensive employment in various domestic culinary endeavors, gastronomic establishments, as well as specific sectors of industrial operations. Incidents of gas leakage commonly manifest due to human negligence or malfunctioning equipment. Consequently, industries and innovators have remarkably secured patents for a diverse array of gas detection apparatuses, aiming to effectively address this pervasive issue and avert potential calamities. However, the prevailing predicament associated with current gas detection equipment lies in its lack of user-friendliness, as they tend to be unwieldy in nature and often necessitate a rudimentary grasp of technical knowledge for seamless operation. Thus, the fruition of this pioneering and groundbreaking system shall revolutionize the realm of gas leak detection, amalgamating advanced internet connectivity capabilities with effortless installation procedures, thereby rendering it an indispensable, quintessential, and pragmatic solution meticulously tailored to meet the discerning needs of residential end-users.

1.4 Project Objective

The objective of the project is to design prototype and rectify problems due to lightning nuisance tripping, control some home appliance usage by turning on and off home appliances and alert of the presence of abnormal sound dan dangerous gas leaks. Specifically, the objectives are as follows:

a) To design a centralized system that can control and manage the electrical load appliances at home by using smartphone.

b) To develop microcontroller Cytron ESP8266 WiFi Shield program on auto reclosure circuit breaker notification to user and built the prototype hardware of the auto reclosure circuit breaker and develop a system that can detect the leakage of gas in a household setting that is easy to install and practical for home users

a) To analysis of lightning nuisance tripping, control some home appliance usage by turning on and off home appliances and dangerous gas leaks.

1.5 Scope of Project

The goal of this project is to create and investigate a smart home monitoring and automation system. This system will include a power, voltage, and current monitoring device, which will send notifications to the user and can be accessed through a smartphone interface. The home automation features will include automatic RCCB activation using a servo motor, centralized control for all connected appliances, and notifications for gas leaks. The aim is to create an intelligent home automation and safety circuit breaker system utilizing the Esp8266 microcontroller. Notably, the gas detector incorporated in the system is designed with a limitation threshold of 700 ppm for effective detection of gas leakage. The project will gather power, voltage, current, and energy consumption data from distribution boards in the home. By using Proteus software and arduino IDE software to create a userfriendly graphical interface and an organized data centre. Wireless communication will also be necessary, as data collected from the project devices will sent wireless to the user's smartphone for monitoring and management. The project will involve planning, design, and problem solving to achieve its objectives. This project aims to contribute to the evolution of home automation, safety, and energy management

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review on home automation would typically include an examination of the various technologies, products, and services that are available for creating a smart home. This would typically include a discussion of the different types of sensors, controllers, and other devices that are used in these systems, as well as the software platforms and applications that are used to manage them. Additionally, a literature review might explore the various benefits and drawbacks of home automation, including its impact on energy efficiency, convenience, security, and privacy. One important area of research in home automation is the development of intelligent algorithms and machine learning models that can help to optimize the performance of these systems. This might involve the use of predictive analytics to anticipate user behavior and adjust the system accordingly, or the use of reinforcement learning to enable the system to learn from user feedback and adapt over time. Another important area of research is the design of user interfaces and user experience for home automation systems. This might involve the use of natural language processing and other advanced techniques to enable users to interact with the system using voice commands or other intuitive interfaces.

2.2 Understanding Global Pollution Through Gas Sensor Leakage Project

Understanding global pollution through a gas leakage project literature review provides valuable insights into the various aspects and impacts of gas leaks on the environment. The literature review explores existing studies, research articles, and reports related to gas leakage, focusing on the causes, consequences, and mitigation strategies. It sheds light on the sources of gas leakage, such as industrial facilities, pipelines, and storage infrastructure, and highlights the environmental and health risks associated with these leaks. Additionally, the literature review examines the effectiveness of monitoring systems, maintenance protocols, and policy interventions in reducing gas leakage and its subsequent pollution [17]. By synthesizing and analyzing the available literature, this review contributes to a deeper understanding of global pollution caused by gas leakage and informs the development of effective strategies to address this critical issue.

2.3 Residual Current Circuit Breaker

In a shared enclosure, an electrical power input is divided into subsidiary circuits and each circuit is equipped with a protection fuse or circuit breaker. More modern boards typically include residual-current devices (RCDs) or residual current breakers with overcurrent protection (RCBOs), along with a main switch. These distribution boards are commonly used in various settings such as homes, factories, and stores where electricity is required. Occasionally, during periods of high electrical demand, tripping may occur, leading to reduced productivity in a factory or disruption in online work for individuals working from home [19]. However, with the availability of new technologies in today's era, we can address such situations. Using IoT connected smartphones, this project can be remotely controlled and monitored, offering a solution to overcome these challenges.

Through the utilization of this system, we have the capability to detect a broken MCB by receiving notifications that specify which MCB has malfunctioned. In the event of a nuisance trip, the servo motor can be employed to reset the MCB to the ON state, allowing uninterrupted workflow without the need to manually locate the tripped MCB [19]. Additionally, by incorporating current and voltage sensors, we can effectively monitor the power usage of the MCB, and this information is conveniently displayed on the LCD panel situated near the distribution box.

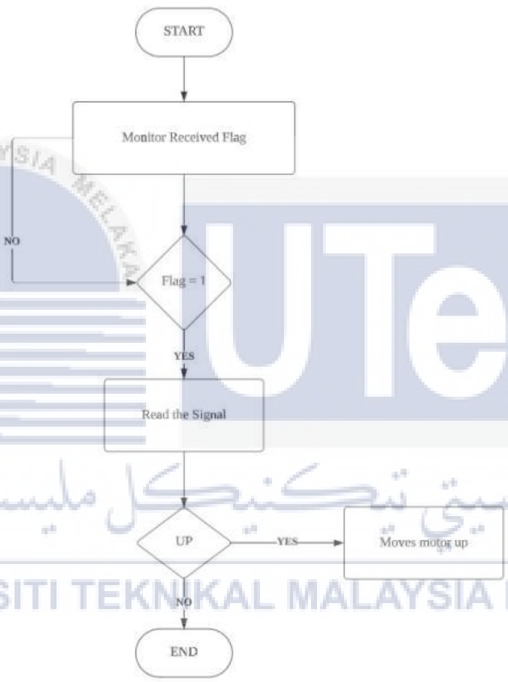

Figure 2.1 Flowchart monitoring Distribution box

2.3.1 RCCB Working Principle

An RCD operates by comparing the current flowing through its conductors or winding. The RCCB device consists of a current transformer with primary, secondary, and sensing windings.

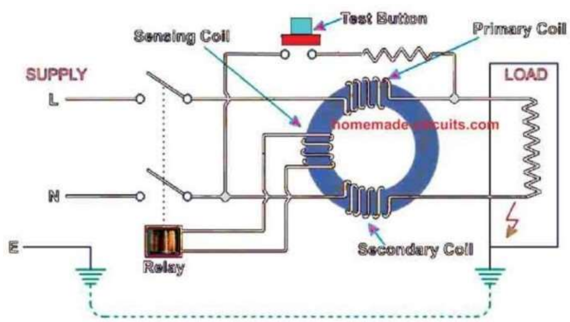

Figure 2.2 RCCB circuit

The main phase line or LIVE line is connected to the primary winding of the current transformer, while the neutral line is connected to the secondary winding. A third winding, called the sensing coil, is positioned between these two windings and is connected to the relay coil. The relay used in this system is a type of permanent magnet relay with normally closed contacts, meaning the contacts are typically closed when no fault or leakage is present [19]. Under normal conditions, when there is no phase-to-ground fault, the current flowing through the sensing winding of the current transformer is nearly zero. However, in the event of an earth leakage or human contact with the LIVE wire, a portion of the current deviates from the live line of the winding, causing an imbalance in the sensing current transformer. This imbalance generates a magnetic flux within the core of the current transformer, resulting in an equivalent current being produced in the sensing coil. Ultimately, this current in the sensing coil triggers the trip relay or permanent magnet relay (PMR), generating the necessary impulse to trip the contacts of the RCD or RCCB. As a result, the contacts are promptly released, and the mains supply is disconnected.

2.3.2 VRCCB

The VRCCB, or voltage operated circuit breaker, is a device that operates base don the current flowing through the RCCB. It incorporates a relay loop, which connects one end to the metallic load body and the other end to the ground wire. If the voltage of the load body increases, creating a potential difference between the load body and the earth, there is a risk of electric shock . This voltage difference results in an electric current flowing from the load metallic body through the relay loop and into the ground. When the voltage on the load metallic body reaches a hazardous level exceeding 50 volts, the current flowing through the relay loop activates the relay contact, disconnecting the power supply to prevent any potential electric shock hazards [18].

2.3.3 IRCCB

The IRCCB is a circuit breaker that operates based on the current passing through the RCCB. This current is directed towards a current transformer device and the load. The current from the load is also directed back to the transformer device. Under normal conditions, the total current supplied to the load is equal to the total current coming out of the load. This balance ensures that the current transformer device is not affected. However, if there is any earth current leakage due to earth damage, the balance between incoming and outgoing current is disrupted. This imbalance in current generates a signal, and if the current exceeds the specified threshold, the RCCB will activated and cut off the power supply. The device is also known as RCD (residual current device) in IEC or RCCB (residual current circuit breaker) [18].

2.3.4 Problems of RCCB

A Residual Current Circuit Breaker (RCCB) is an electrical device employed for protective purposes. Its primary function is to disconnect the power supply in the event of a fault. However, a concern arises regarding whether the RCCB can automatically reset and resume its normal functioning if an error occurs without human intervention, due to various reasons. The RCCB relies on a mechanical switch that necessitates manual switching. Once the RCCB is tripped, it remains in the off position until someone physically pushes it back to the on position, regardless of whether the fault is a temporary one lasting just a millisecond [18]. Moreover, the RCCB does not have the capability to distinguish between temporary and permanent faults, nor does it react differently to these two types of faults.

2.3.5 Electrical faults

A fault refers to any abnormal situation in an electrical system, where the intended flow of electrical current through specific components may or may not occur as expected. Equipment failure can also be attributed to various circuit defects, such as loose connections, insulation failure, or short circuits. The following are types of faults commonly encountered in a distribution network circuit:

I. Overload faults, which occur when unexpected increases in loads take place [19].

II. Faults on electrical equipment, resulting from factors like lightning strikes, insulator breakage, non-compliant product design, or improper equipment installations [19].

Direct lightning phenomena often lead to temporary faults, while faults on electrical equipment are examples of permanent faults.

2.3.6 RCCB Features

Figure 2.3 displays a Home RCCB with its protective housing, which serves the purpose of safeguarding the circuit. In this image, we can observe the presence of a mechanical switch and a black box.

Figure 2.3 Home RCCB with Housing

Figure 2.4 showcases the complete set of RCCB components housed within. One crucial aspect of the system is the utilization of high-quality insulators for the live and neutral cables. This measure is essential to prevent any self-faults within the RCCB.

Figure 2.4 The System Inside RCCB

2.4 Internet Of Thing (IOT)

Internet of Things (IoT) technology is a contemporary method of connecting and facilitating communication between diverse devices via the internet. This technological advancement greatly aids in simplifying human life by enabling remote control of interconnected systems, including energy management and home appliances. Previous studies have extensively explored home automation systems, with one such example being a paper by Shahzeb Hussain that presents the design and implementation of a prototype centralized control system utilizing Wi-Fi technology as the network infrastructure.

Numerous projects have utilized the concept of IoT, including an IoT based home automation system over the cloud as described by Feng Xia, Laurence T. Yang, Lizhe Wang and Alexey Vinel [20]. This project focuses on controlling various home appliances through a smartphone interface. Noteworthy features of the system include the ability to notify and alert users if they inadvertently leave a switch turned on while away from home. In areas with weak internet connectivity, the system automatically seeks out and connects to a stronger internet connection. It should be noted that the entire system heavily relies on a stable internet connection for seamless communication with users, as depicted in figure 2.5.

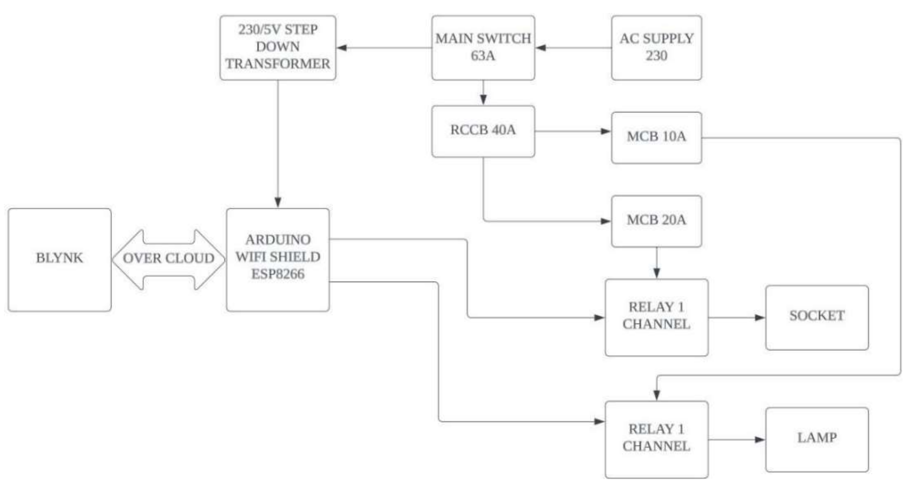

Figure 2.5 Block Diagram Home Automation Over The Cloud

The following research is titled "Smart Electricity Monitoring and Control System Using Data Usage based on Internet of Things (IoT)" conducted by Mohammad Kamrul Hasan, Musse Mohamud Ahmed, Bishwajeet Pandey, Hardik Gohel, Shayla Islam, and Izzul Fitrie Khalid [21]. This study aims to assist consumers in reducing electricity consumption by implementing the IoT concept. The proposed system establishes a centralized framework that connects to a smartphone via an internet connection, as depicted in Figure 2.6. Through this system, users gain the ability to remotely manage and control all electrical appliances within their homes using a smartphone. Furthermore, the system enables users to monitor and track the rate of electricity consumption in their households.

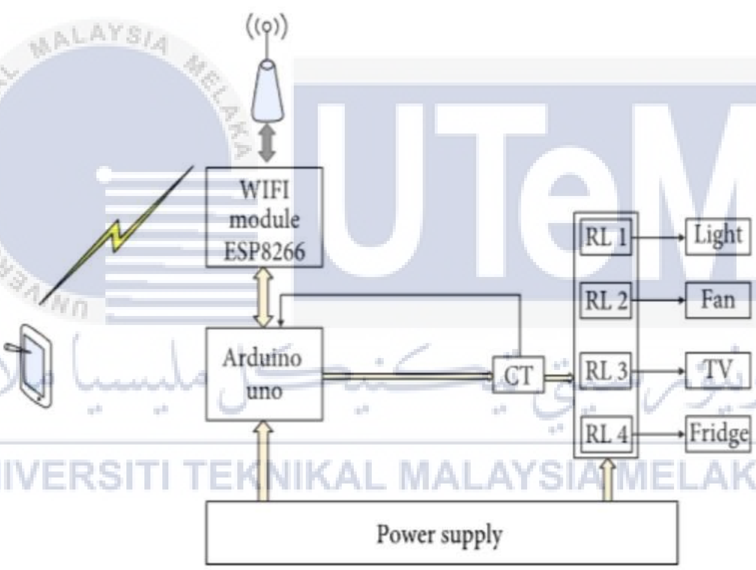

Figure 2.6 System Block Diagram of IoT-Based Control

2.4.1 Energy Monitoring

In general, despite electricity suppliers installing meters in our homes, only a minority of individuals possess the knowledge to effectively monitor and control their electricity consumption using these meters. This is because the process involves manual calculations based on meter data to determine the current rate of electricity usage. Consequently, the presence of suitable technology is considered a solution to aid consumers in managing, monitoring, and recording their household electricity consumption, thereby enabling them to adopt energy-saving practices.

A research study conducted by Wesley Tyler Hartman, Alexander Hansen, Erik Vasquez, Samy El-Tawab, Karim Altaii focused on the development of energy monitoring systems utilizing Wi-Fi technology and the Internet of Things (IoT) [22]. The study specifically explored the use of communication devices in Home Energy Monitoring System (HEMS) applications for tracking energy consumption during deep sleep mode. The study findings, as depicted in figures 2.7 and 2.8, revealed an increase of 0.3W per cycle and an average power dissipation of less than 0.1W/s.

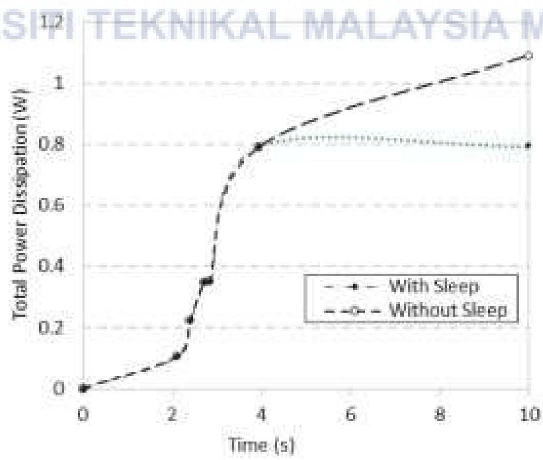

Figure 2.7 Comparison of power consumption with and without sleep

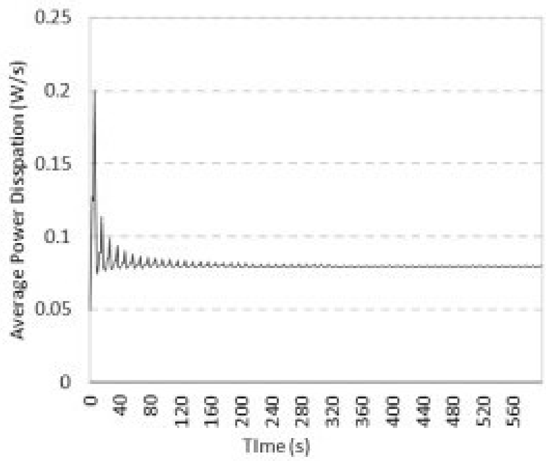

Figure 2.8 Average power dissipation over a period of one hour

Following that, a team consisting of Fuminori Sano, Osamu Saeki, Kiichiro Tsuji conducted a system development to monitor energy consumption of various household appliances and promote energy-saving practices. Their device for energy monitoring utilized Arduino and ESP8266 technology [23]. The measurements of energy were conducted based on the assumption that the voltage for each device is 230Vrms. However, it is worth noting that relying solely on assumptions to determine voltage values is a limitation of their study.

In another study conducted by S. Chaudhari, P. Rathod, A. Shaikh, D. Vora and J. Ahir they explored the development of intelligent energy measurement applications by integrating Arduino and GSM SMS (Short Message Service) communication [24]. The findings demonstrated the effectiveness of reporting and reducing energy costs. However, the study did not examine the associated communication costs. It is important to consider that advancements in control and automation technology, along with the progress of wireless technology, have greatly facilitated electricity management in residential settings.

2.5 Gas Detection Technology

The presence of various gases in the environment is detected and monitored using gas detection technologies. Combustible gases such as methane and propane, poisonous gases such as carbon monoxide and hydrogen sulfide, and oxygen deficit or enrichment are examples of these gases. Gas detectors are available in a variety of configurations, including portable handheld devices, fixed-mount systems, and wireless and networked systems.

Gas detectors can use a variety of detecting technologies, including electrochemical, catalytic bead, infrared, and photoionization (PID). Each method has its own set of advantages and disadvantages and is better suited to specific types of gases and situations. Industrial facilities, oil and gas, mining, HVAC, laboratories, and emergency response are just a few of the industries and applications that use gas detection systems. The usage of gas detection equipment is critical for the safety of workers and the public, as well as for environmental protection.

It is critical to remember that gas detection systems must be properly calibrated, maintained, and used to ensure proper operation. It is also critical that users are taught in the proper use and interpretation of gas detection equipment readings.

2.5.1 History of the Development of Gas Detector Alarm

Gas detectors have a rich history that traces back to the early nineteenth century, when scientists first delved into the study of gases and their potential hazards. In 1815, Sir Humphry Davy introduced the "safety lamp," which emerged as one of the pioneering gas detectors of its time [25]. This innovative device employed a flame to identify the presence of methane and other perilous gases within mines. Over time, various other gas detection systems were devised, including the "poison gas detector" utilized during World War I to identify hazardous gases on the battlefield.

In the 1920s and 1930s, the advent of electronic gas detectors brought about significant advancements. These detectors employed technologies like the electrochemical cell and the catalytic bead, finding predominant use in industrial environments to detect gases such as carbon monoxide and hydrogen sulfide. As technology progressed, the later part of the twentieth century witnessed the emergence of more sophisticated gas detectors, including infrared, ultraviolet, and laser-based detectors. These newer models offered enhanced precision, reliability, and the ability to detect a wider range of gases.

Today, gas detectors continue to evolve and improve, thanks to the utilization of cutting-edge technologies such as electromagnetically systems (MEMS) sensors and wireless communication. These advancements contribute to the development of highly efficient and effective gas detection systems, enabling enhanced safety measures in various industries and applications.

2.5.2 Importance of Gas Detector

Gas detectors play a pivotal role in ensuring the safety of workers, the public, and the environment by effectively detecting and monitoring the presence of various gases in the surroundings. These detectors can identify flammable gases like methane and propane, poisonous gases such as carbon monoxide and hydrogen sulfide, as well as oxygen deficiency or enrichment.

One of the key advantages of utilizing gas detectors is their ability to provide early warnings to employees and emergency services regarding the presence of harmful gases, enabling prompt and appropriate actions to be taken before they reach hazardous levels. This proactive approach safeguards the well-being of workers, the public, and prevents potential environmental damage.

Gas detectors find applications in a multitude of industries and professions, including industrial facilities, oil and gas operations, mining, HVAC systems, laboratories, and emergency response teams. Each industry has unique requirements and challenges, and gas detectors are specifically designed to meet these specific needs.

In the oil and gas industry, for instance, gas detectors play a critical role due to the ubiquitous presence of toxic gases like hydrogen sulfide (H2S) and methane (CH4). These gases pose significant risks as they are highly combustible and toxic. Gas detectors facilitate the detection and continuous monitoring of these gases, empowering employees to take necessary precautions to ensure their safety and protect the environment.

Moreover, regulatory bodies such as OSHA (Occupational Safety and Health Administration) mandate the implementation of gas detection systems in certain industries, along with appropriate training for personnel to operate and maintain these detectors.

2.5.3 Household Gas Detector

A domestic gas detector serves the purpose of detecting the presence of specific gases within a residence. These gases encompass combustible gases like methane and propane, commonly used for heating and cooking, as well as hazardous gases such as carbon monoxide (CO) and natural gas (methane). Residential gas detectors are available in various configurations, ranging from portable handheld devices to fixed-mounted systems, as well as wireless and networked setups. They employ different methodologies including electrochemical, catalytic bead, infrared, and photoionization (PID) to detect gases.

Among the different types, carbon monoxide detectors are widely used in households. Carbon monoxide is a toxic gas that is colorless, odorless, and produced when fuels like gas, oil, wood, and coal burn inefficiently. It poses significant health risks and can even be fatal if left undetected and uncontrolled. Another prevalent type is the natural gas (methane) detector, which detects leaks in natural gas pipes. Natural gas, also colorless and odorless, is a combustible gas used for heating and cooking. Identifying leaks is crucial to prevent the risk of fire or explosions.

Gas detectors play a vital role in residential settings by detecting the presence of harmful gases and alerting occupants in case of emergencies. Regular inspection and maintenance of these detectors is essential to ensure their proper functioning and reliability.

2.5.4 LPG in a Household Setting

LPG is extensively used in the home for cooking and heating. It is normally stored in a tank located outside the residence and is connected to the stove or furnace through a gas pipe. A delivery vehicle comes by on a regular basis to refill the tank.

LPG can also be used to power equipment such as water heaters, dryers, and fireplaces. It is widely regarded as a safe and dependable fuel source for residential usage.

However, proper LPG equipment installation and maintenance are critical to assure safety. This includes inspecting the equipment and tanks on a regular basis and ensuring that all connections and seals are secure.

2.5.5 LPG Gas Detector

An LPG (Liquefied Petroleum Gas) gas detector is designed to identify the presence of LPG, a combination of propane and butane gases, within the environment. LPG is widely used as a fuel for heating and cooking purposes in both residential and commercial settings. As a cooking fuel, LPG offers numerous advantages [26]. It is cost-effective and its efficient heating capabilities allow for faster food preparation, resulting in fuel savings. LPG burns cleanly without leaving behind residue or particulate matter, leading to reduced maintenance costs and a lower carbon footprint.

LPG gas detectors are available in various forms, including handheld devices, fixed mounted systems, as well as wireless and networked setups. These detectors employ different technologies, such as catalytic beads and infrared sensors, to function effectively. The catalytic bead sensor is the most common type of LPG gas detector. It operates by detecting flammable gases like propane and butane. The sensor contains a catalytic bead coated with a combination of platinum and palladium, which heats up when exposed to LPG, triggering an alert.

2.6 The comparison for literature review

Table 2.1 Comparison Literature Review

Title Of Journal	Automatic Residual Current Device	Home Automation Project	LPG gas sensor detection using Iot
Author	AHMAD KHAIRUDDIN BONARI	Rajan Jiten Patel	Dr. Chetana Tukkoji
Techniques / Component	Using GSM Method Using PIC controller	Using ESP8266	Using MQ6 Gas sensor Arduino Pro Mini
Advantages	- Can control automatic residual current devices.	- Can control lamp and socket. - cheap.	- Can sense gas leakages. - Can monitoring gas value from phone.
Disadvantages	- Not cheap because need to top up the credit for sim card. - Different method use	- Cannot monitor power usage at home. - Cannot sense gas leakages	- Cannot monitoring power usage and automatic RCCB reclosure

2.7 Summary

As a conclusion for this chapter, based on the previous studies of this project and the articles and journals that are related to this project, there are a variety of techniques that can be implemented in the development of this prototype of an auto reclosure RCCB, controlling socket and lamp, monitor energy power usage and gas detector that has the capability to connect to the internet. These techniques can be found in various articles and journals. This is because the method or technique itself has improved over time, which has led to an increase in the number of features that contribute to the overall improvement of this project. This is in addition to the progress that has been made in technology. In this chapter, under the heading of "Development home automation and safety circuit breaker with Esp8266 microcontroller for detecting gas leakage and tracking power usage," the findings of this research have been dissected and analyzed. In addition to this, the findings of the research that was carried out for the purpose of this chapter indicate that certain research is superior to other research, while another research needs to be improved so that it can be applied more effectively.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter holds significant importance as it thoroughly outlines the meticulous execution process of the project. The methodology will serve as an elaborate roadmap, meticulously delineating each intricate stage and seamless flow in perfect alignment with the meticulously designed flow chart. This comprehensive approach encompasses meticulous data collection, aimed at achieving the multifaceted objectives of the project, while ensuring the seamless attainment of the anticipated outcomes and meticulous verification of the project's efficient completion. Remarkably, this endeavor comprises a grand total of four painstakingly crafted stages, each contributing indispensably to the project's success. The journey commences with the meticulous execution of preparatory work, diligently delving into the technical examination process, drawing upon an extensive array of diverse sources, including erudite journals, esteemed project papers, and invaluable past research. Stage two gracefully unfolds as the harmonious implementation of stage one, deftly encompassing the profound realms of data analysis and the imaginative design of novel ideas. The saga continues with the impressive third stage, wherein hardware undergoes meticulous development and assembly within this specialized domain. Ultimately, the illustrious fourth stage emerges triumphantly, centering its unwavering focus upon the seamless integration of each constituent element of the project, adroitly addressing their interfaces and diligently eliminating any lingering tribulations that may impede progress.

3.2 Selecting and Evaluating Tools for a Sustainable Development

When undertaking a project focused on the sustainable development of global pollution through gas sensor leakage, it is crucial to carefully select and evaluate the tools to be used. The choice of appropriate tools can significantly impact the project's effectiveness and outcomes. To begin, thorough research should be conducted to identify reliable and accurate gas sensor technologies capable of detecting and measuring various gases associated with pollution. Factors such as sensitivity, specificity, response time, and compatibility with the project's objectives should be considered during the evaluation process. Additionally, the selected tools should possess features that support sustainability, such as energy efficiency, reliability, and durability, aligning with the project's overarching goal of promoting environmentally friendly practices. Furthermore, it is essential to assess the usability and compatibility of the tools with existing monitoring systems and data collection methods, ensuring seamless integration and efficient data management. By carefully selecting and evaluating the tools for this project, it becomes possible to establish a solid foundation for sustainable development initiatives targeting global pollution through gas sensor leakage, ultimately contributing to a cleaner and healthier environment for all.

3.3 BDP Process Flowchart

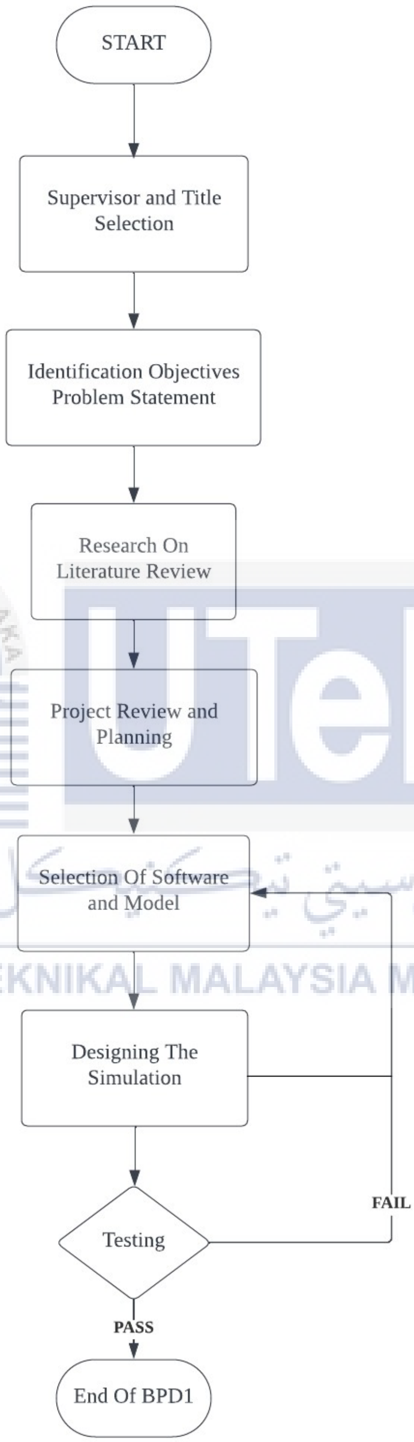

Figure 3.1 BDP1 Flowchart

3.4 Development of process project development

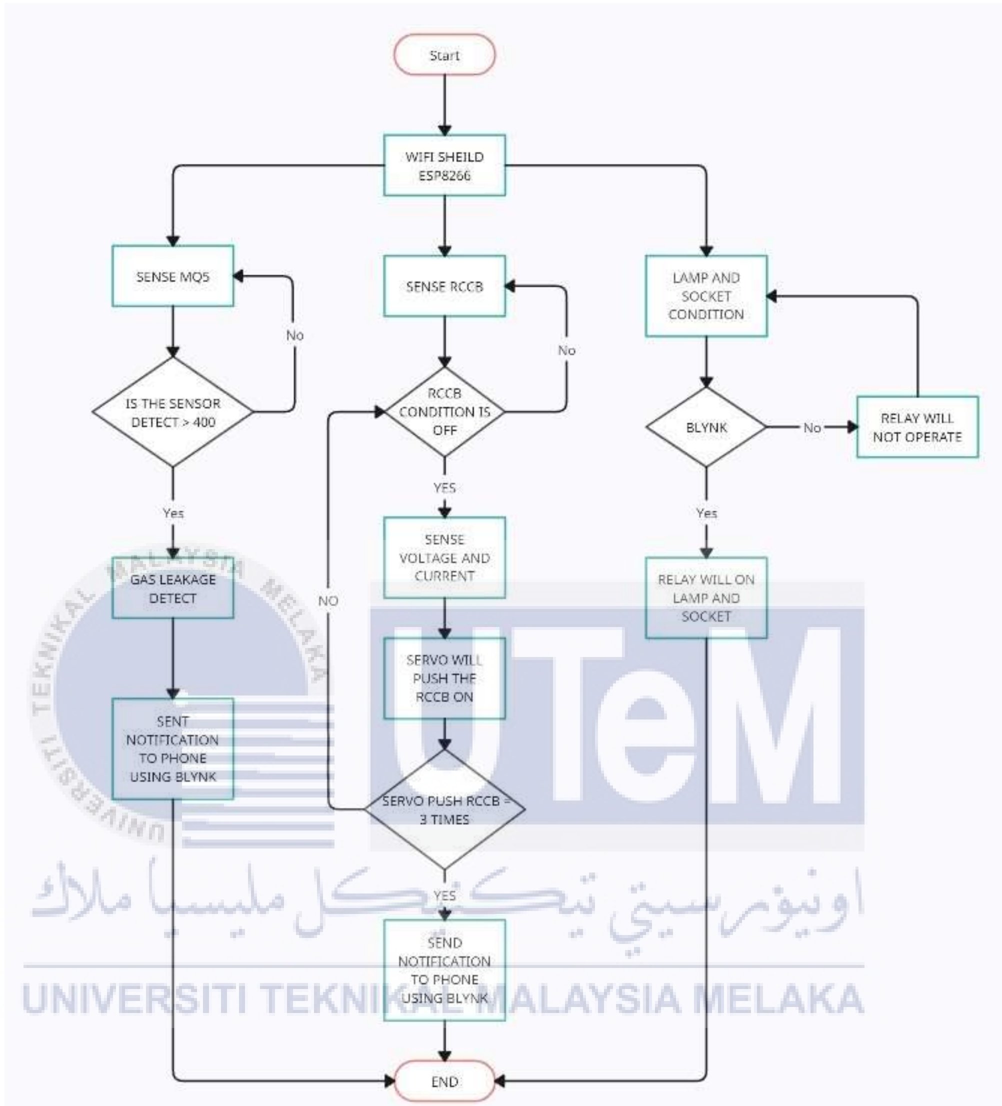

Figure 3.2 Flowchart of the project

3.5 Block Diagram of project development

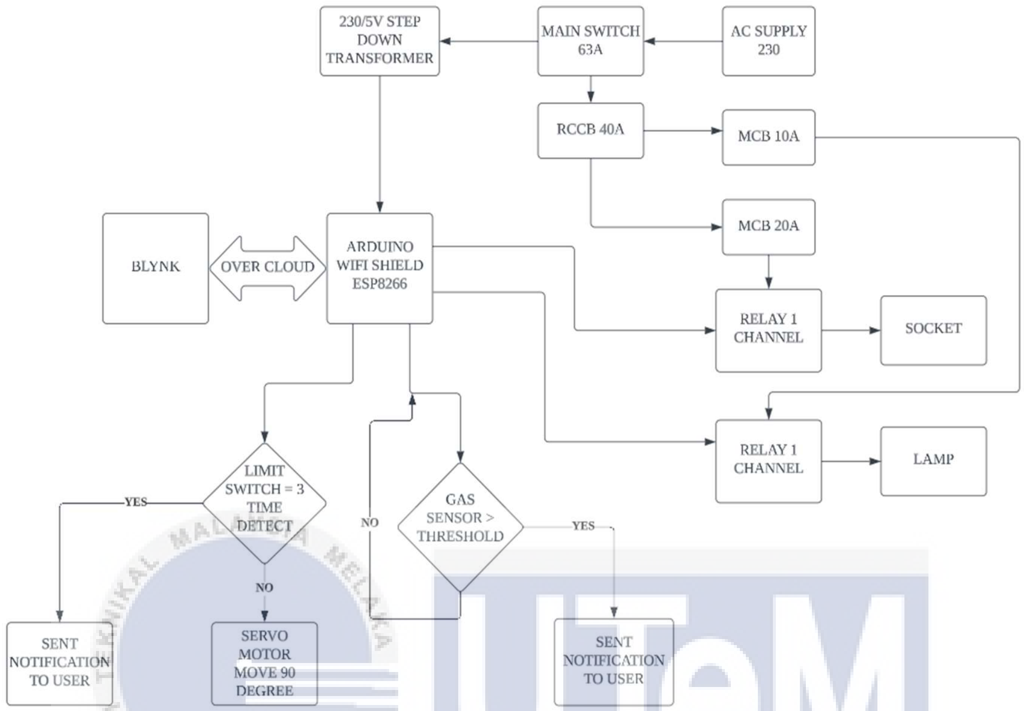

Figure 3.3 Block Diagram Of Project

3.6 System structure

The idea of this project is to enhance the technology of a distribution box which is to add it with a touch of IoT so that the distribution box is always connected to the user. Basically, the project starts with Wi-Fi shield Esp8266 which is like the brain of the whole project. When we apply the coding into the Wi-Fi shield Esp8266 then it will detect the codes and began the process. If the RCCB switch is tripped, the limit switch will push it back ON and if the event happens three times, but the RCCB still tripped, it will stop pushing the RCCB ON and send out notification to the consumer saying that the RCCB is broken. Then, the user also can control lamp and socket using microcontroller Wi-Fi shield esp8266 to turn on and turn off the socket. The user can monitor the power usage from the phone and Wi-Fi shield esp8266 also can detect gas leakage at home. When happen gas leakage at home the Wi-Fi shield esp8266 will send notification through phone to alert the user when happen gas leakages at home.

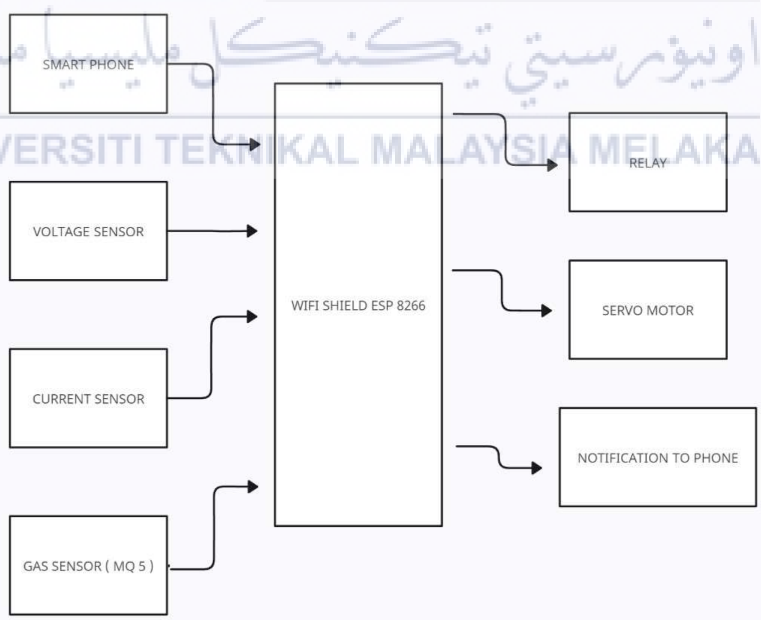

Figure 3.4 System structure of project

The comprehensive block diagram provided above meticulously illustrates the intricate process by which this exceptional undertaking shall be executed. At the heart of this remarkable venture lies the microcontroller Wi-Fi shield esp8266, assuming a pivotal role as the central component. Additionally, an extensive array of inputs, including the voltage sensor, current sensor, limit switch, MQ5 sensor, and relay channel, shall converge harmoniously to breathe life into this project. Effortlessly, the user shall transmit signals to the Wi-Fi shield Esp8266, eliciting a chain reaction whereby the Wi-Fi shield Esp8266 communicates these signals to the servo motor, diligently orchestrating the precise movements necessary for pushing back the RCCB. Concurrently, an automated notification shall be seamlessly dispatched to the user's smartphone, succinctly apprising them of the progress. In addition, the Wi-Fi shield Esp8266 shall adeptly monitor the power consumption of the RCCB, assuring meticulous oversight. Moreover, the user shall retain the freedom to dispatch signals to the Wi-Fi shield Esp8266, enabling the convenient activation and deactivation of both the lamp and socket. Furthermore, this formidable Wi-Fi shield Esp8266 shall vigilantly alert the user in the event of a potentially hazardous gas leakage transpiring within the confines of their home, dutifully safeguarding their well-being.

3.7 Simulation design

The project simulation circuit and the components that utilized in the project are developed using simulation design. To create and simulate the project circuit for simulation and programming, Proteus software is utilized.

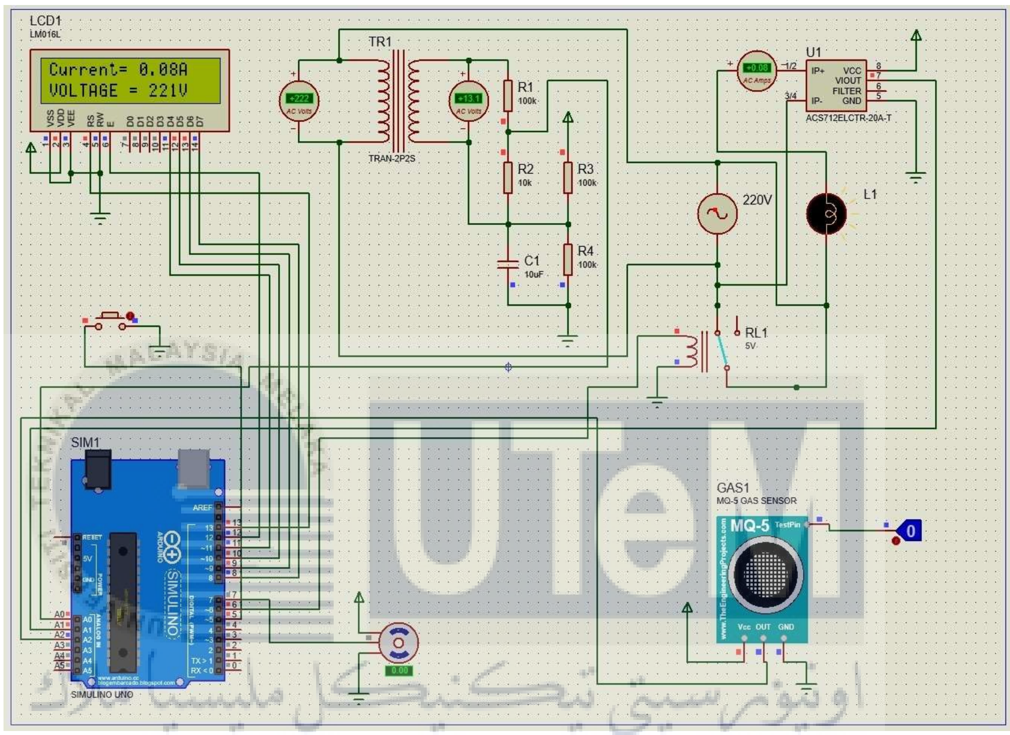

Figure 3.5 Simulation design

3.8 Equipment and material

In this project, a diverse array of equipment and materials were employed to facilitate the successful execution of the desired objectives. The central component of the project is the Arduino Uno, a versatile microcontroller board that serves as the brain of the system. It complemented by the microcontroller Wi-Fi Shield ESP8266, which adds Wi-Fi connectivity, enabling wireless communication and integration with online resources. A servo motor is utilized to achieve precise control over the rotational position of mechanical parts, while limit switches will provide essential input signals based on specific positions or limits in the project. The inclusion of an LCD display will enhance the user interface by providing visual feedback and information display. Additionally, voltage and current sensors will enable accurate monitoring and control of electrical parameters. To ensure safety, the project will incorporate MCBs (Miniature Circuit Breakers) and RCCBs (Residual Current Circuit Breakers) to protect against overloads, short circuits, and ground faults. A distribution box will serve as a centralized hub for organizing electrical components and power distribution. Lastly, a switching power supply will efficiently convert electrical power between voltage levels to meet the specific requirements of the project components. Through the utilization of these diverse equipment and materials, the project aims to create a comprehensive system that combines wireless communication, precise motor control, position sensing, data visualization, electrical parameter monitoring, safety mechanisms, and efficient power distribution.

3.8.1 Arduino

The Arduino Uno is a popular microcontroller board used for electronics projects. It has a microcontroller chip, input/output pins for connecting sensors and actuators, analog inputs for reading analog signals, a USB interface for programming and communication, and can be powered in multiple ways. It follows a simplified programming language and promotes modularity with its compatibility with expansion boards called shields. Overall, it provides an accessible and versatile platform for creating interactive projects.

Figure 3.6 Arduino Uno

3.8.2 Wi-Fi Shield ESP8266

The Wi-Fi Shield ESP8266 is an expansion board that provides wireless connectivity to Arduino and other microcontroller platforms. It is based on the ESP8266 microcontroller chip, which has built-in Wi-Fi capabilities. The shield allows devices to connect to Wi-Fi networks, communicate over the internet, and interact with web services. It simplifies the process of adding Wi-Fi functionality to projects, making it easier to create Internet of Things (IoT) applications and remote-control systems.

Figure 3.7 ESP8266 Wifi Shield

3.8.3 Switching Power Supply

A switching power supply is an electronic device that efficiently converts electrical power from one voltage level to another using high frequency switching circuits. It uses a power transistor to rapidly switch the flow of energy through an inductor or transformer. This allows for higher efficiency, smaller size, and lighter weight compared to traditional linear power supplies. A feedback control mechanism ensures a stable output voltage by continuously monitoring and adjusting the switching frequency and duty cycle.

Figure 3.8 Power Supply

3.8.4 Voltage Sensor

A voltage sensor is a device used to measure and monitor voltage levels in an electrical circuit. It provides an electrical output that corresponds to the voltage being measured. Voltage sensors can be analog or digital, and they are used in a variety of applications such as power monitoring, battery management, and control systems. They are commonly used in conjunction with microcontrollers like Arduino to interface with and measure voltage from different sources.

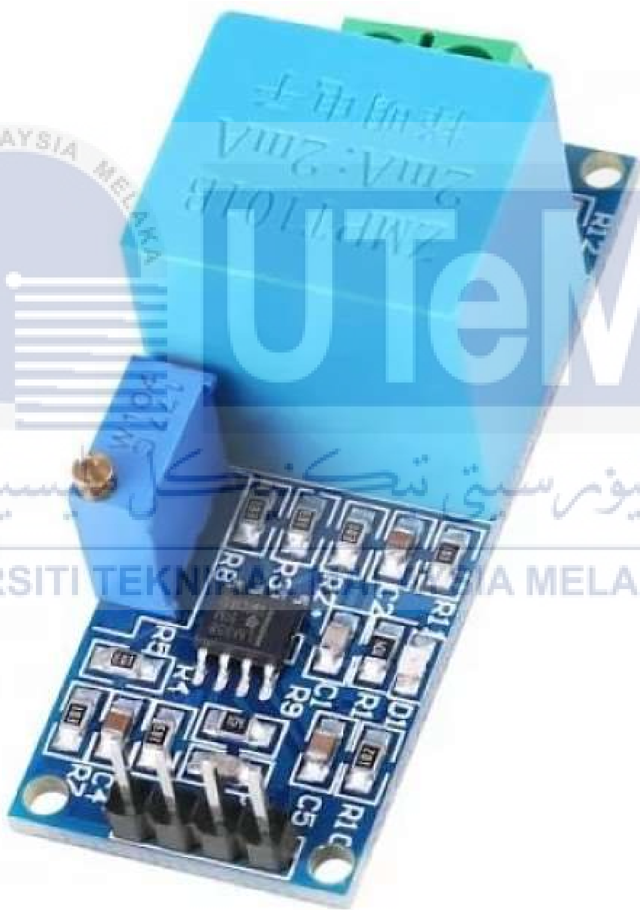

Figure 3.9 Voltage Sensor

3.8.5 Current Sensor

A current sensor is a device that measures and monitors the flow of electric current in a circuit. It provides an electrical output signal that represents the magnitude of the current being measured. Current sensors can be based on different principles such as magnetic, resistive, or hall-effect sensing. They are used in a variety of applications, including power monitoring, motor control, energy management, and safety systems. Current sensors are commonly used in conjunction with microcontrollers or other measurement devices to monitor and control current levels in electrical systems.

Figure 3.10 Current Sensor

3.8.6 Relay

A one-channel relay module is a device that allows to control the switching of a single electrical circuit using a low-voltage control signal. It consists of a relay and associated circuitry. When the control signal is received, the relay switches the circuit on or off, depending on its configuration. This makes it useful for applications such as home automation, robotics, and industrial control systems where you need to control the power supply to a specific device or equipment.

Figure 3.11 One channel relay

3.8.7 MQ5 Gas Sensor

The MQ5 gas sensor is a commonly used gas sensing module that is designed to detect various types of flammable gases in the air. It is particularly sensitive to gases such as natural gas (methane), liquefied petroleum gas (LPG), and propane. The MQ5 gas sensor operates based on the principle of gas conductivity. It consists of a sensing element made of a tin dioxide (SnO_2) semiconductor. When the target gas is present in the air, the gas molecules interact with the sensing element, changing its conductivity. The MQ5 sensor module includes an integrated heating element that heats the sensing element to an optimal temperature for gas detection. The module also includes a built-in variable resistor to calibrate and adjust the sensitivity of the sensor.

Figure 3.12 MQ5 Gas Sensor

3.8.8 Residual current circuit breaker

A residual current circuit breaker (RCCB) is an electrical safety device that detects and interrupts abnormal current flow to protect against electric shock and prevent electrical fires. It continuously monitors the current balance between live and neutral conductors. If an imbalance exceeding a certain threshold is detected, the RCCB quickly trips and cuts off the current to the circuit, ensuring safety.

Figure 3.13 Residual Current Circuit Breaker

3.8.9 Limit Switch

A limit switch is an electromechanical device used for detecting the presence or absence of an object or determining the position of a moving part. It consists of a sturdy housing with an actuator or lever mechanism. When the actuator is triggered by an object or motion, the switch's electrical contacts change their state, allowing control over other devices or circuits. Limit switches are commonly used in industrial machinery, robotics, and various applications where precise object detection or position sensing is required.

Figure 3.14 Limit Switch

3.9 Software

For the construction of the project, the software chosen is Proteus. Proteus provides a user-friendly and interactive platform for designing and simulating circuits. It allows users to drag and drop components, connect them together, and visualize the circuit's functionality before implementing it physically. Regarding the coding aspect, the Arduino Software (IDE) will be utilized. The Arduino IDE is a popular development environment that simplifies the programming process for Arduino boards. It provides a comprehensive set of libraries and functions that make it easier to write, compile, and upload code to the Arduino Uno or other compatible boards. To enhance the project's capabilities, the Blynk application will combine with the Arduino IDE. Blynk is a mobile app that allows users to create a custom interface and control their projects remotely. By integrating Blynk with the Arduino code, users can monitor and control their project using their smartphones or tablets. Blynk provides a range of widgets and features that enable real-time data visualization, equipment control, and power consumption monitoring.

To establish a connection between the Arduino and the Blynk app, a Wi-Fi Shield ESP8266 was employed. The Wi-Fi Shield ESP8266 is an expansion board that adds Wi-Fi connectivity capabilities to the Arduino. It enables Arduino to connect to the internet and communicate with the Blynk app. The Arduino code will upload to the ESP8266 via a USB cable, allowing for seamless communication between the Arduino, Wi-Fi Shield, and the Blynk app. Once the project is set up and running, the Blynk application will serve as a user-friendly interface, displaying all the connected equipment and providing real-time monitoring of power consumption. This combination of Proteus, Arduino IDE, Blynk, and the Wi-Fi Shield ESP8266 creates a comprehensive solution for designing, coding, and remotely controlling and monitoring the project.

3.9.1 Proteus

Proteus is a software suite developed by Lab Centre Electronics that is widely used for electronic circuit design, simulation, and PCB layout. It provides engineers, students, and hobbyists with a powerful set of tools for designing and testing electronic circuits before they are physically built.

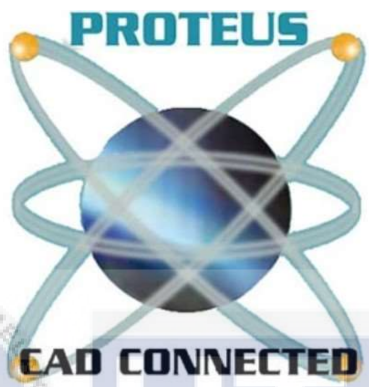

Figure 3.15 Proteus Software

3.9.2 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a software application used for programming Arduino microcontroller boards. It provides a user-friendly interface and a set of tools that enable users to write, compile, and upload code to Arduino boards.

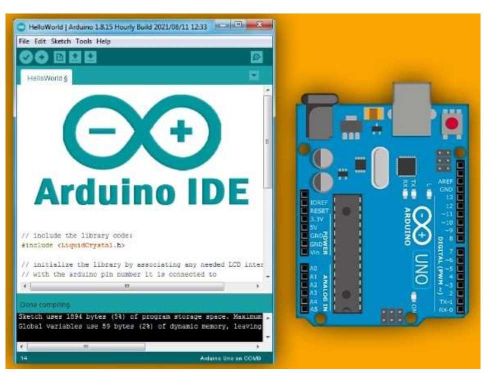

Figure 3.16 Arduino IDE

3.9.3 Blynk Application

The Blynk application provides a convenient way to develop smartphone applications that interact with microcontrollers and even your computer. The primary objective of the Blynk platform is to streamline the process of creating mobile apps. As demonstrated in this session, it is remarkably easy to create a mobile app that establishes a connection with your ESP8266 Wifi Shield by simply dragging a widget and specifying a pin. With Blynk, you can effortlessly control devices like LEDs or motors from your phone without requiring any programming skills. You can easily obtain the Blynk application from either the Play Store or the App Store.

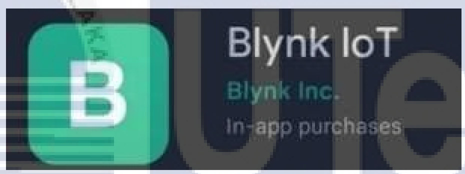

Figure 3.17 Blynk Iot Application

3.10 Summary

In summary, although it is understandable that Distribution Boards are often positioned at elevated locations for security purposes, this also presents a greater challenge for consumers to access them. The notable advantage of the Auto Reclosure Circuit Breaker is its impressive ability to protect sensitive electronic devices like TVs and refrigerators from the destructive effects of lightning strikes. Furthermore, users can be reassured that their distribution board will quickly restore power in the event of an unexpected occurrence, eliminating any concerns about functionality. Additionally, users have the remarkable benefit of monitoring their power consumption through their smartphone, enabling them to efficiently manage energy usage and achieve significant cost savings. Moreover, the system offers exceptional home security by effectively detecting potential gas leaks, ensuring the utmost safety for the household. Users will also receive immediate real-time notifications in case of any gas leakage events, allowing them to promptly respond and mitigate potential risks.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter provides a comprehensive overview of the research, focusing on two distinct projects. Firstly, it delves into the examination of electricity consumption in a home, emphasizing the acquisition of current and voltage values. The collected data is processed using Arduino, enabling the calculation of electricity consumption in kilowatt hours. Rigorous testing procedures ensure the accuracy of equipment configurations within the specified parameters. The subsequent sections detail the conclusions and analyses derived from the research, emphasizing the evaluation of hardware performance and circuitry. The assembled project undergoes thorough testing, including the assessment of the ESP32 microcontroller and Blynk application connection, as well as the functionality of individual components such as Voltage sensor, Current sensor, Limit Switch, and Servo Motor. Additionally, the chapter transitions seamlessly to the outcomes and analysis of a parallel project involving the development of a Household Gas Detector Alarm with Internet Connection Capability. Data collected aligns with project aims and scope, with subsequent analysis and observations presented as preliminary results.

4.2 Software Design

The software designed was made by an online website called Proteus Simulation. The hardware can be built and run or tested directly via online if it has an Internet connection. The main components that must be available are the Microcontroller, Arduino uno, voltage sensor, current sensor, relay, gas leakage, LCD, Bulb and Servo Motor. Figure 4.1 shows the simulation diagram.

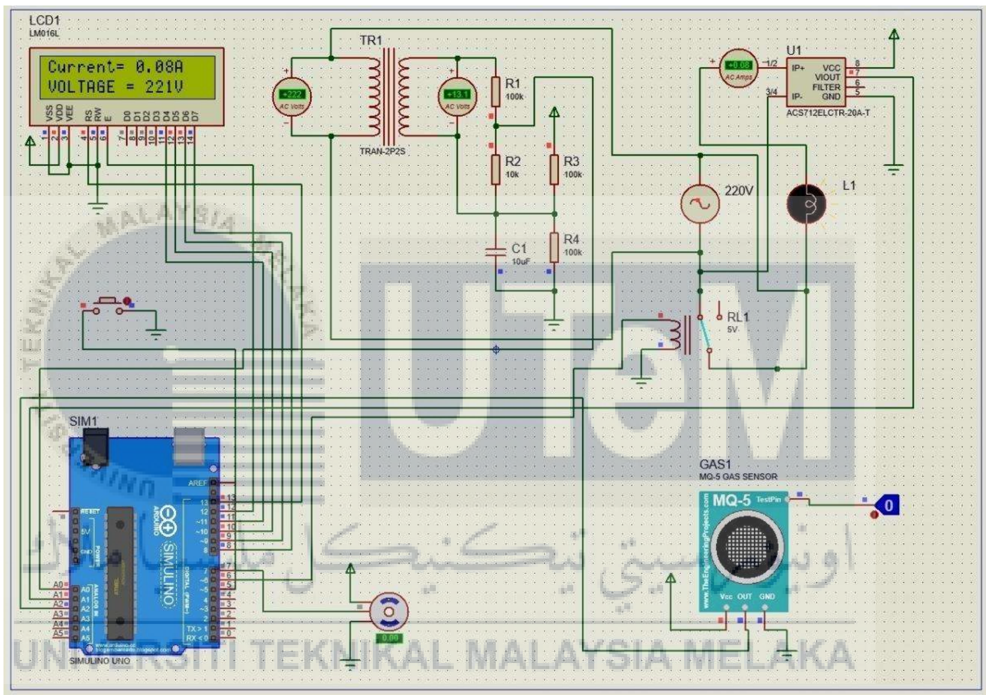

Figure 4.1 Proteus Simulation

The voltage sensor handles single-phase voltage at 240V, while the current sensor supports up to 50 amps. They detect and monitor load current.Upon microcontroller activation, the relay controls the lamp's on/off state, accessible via mobile phone. The gas sensor measures gas leakage nearby, and the LCD displays voltage,current, and gas status. The servo motor resets the RCCB switch to ON, rated at 20kg/cm. Relevant data, including current, voltage, power, gas sensor and tripping events, can be monitored via the Blynk app on a mobile phone.

4.3 Hardware Design

This system aims to improve a distribution box's technology by adding a touch of IoT, ensuring it stays connected to the user. If the RCCB switch trips, a limit switch will push it back ON. If this happens three times and the RCCB remains tripped, the system stops trying to reset and sends a notification to the user, indicating a problem with the RCCB. Figure 4.2 illustrates the hardware components of the system.

Figure 4.2 The hardware of the system

The user gains control over lighting and electrical sockets using a microcontroller with Wi-Fi shield Esp8266, allowing easy activation and deactivation. Additionally, users can monitor power consumption from their smartphones. The Wi-Fi shield Esp8266 is equipped to detect gas leaks, triggering prompt notifications via the Blynk mobile app in case of an incident. Figure 4.3 visually depicts the Blynk application's graphical user interface.

Figure 4.3 The interface of Blynk apps

4.4 Arduino Instruction

The coding for this project utilizes the Arduino Integrated Development Environment (IDE) software. Most modern operating systems provide support for this open-source programming language, which is based on C and C++. A comprehensive understanding of the C++ programming language is essential for effectively modifying programming instructions. The microcontroller employed in this project is the ESP8266 Wi Fi shield. It was specifically chosen due to its enhanced capabilities compared to the Arduino UNO. Notably, it possesses a comparable number of analog and digital input pins. The following Arduino code is utilized to simulate the Proteus software. This Arduino code is responsible for providing instructions to various components, including the voltage sensor, current sensor, gas sensor, relay, servo, and limit switch, enabling them to operate according to the predetermined plan.

```
#include <LiquidCrystal.h>
#include "EmonLib.h"
#define MQPin A2

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

EnergyMonitor emon1;

const int Sensor_Pin = A1;
int sensitivity = 185;
int offsetvoltage = 2532;
int relaypin = 6;
int power;
int BUTTON_PIN = 5;
double kilowh = 0;
double pf=0;

void setup()
{
  emon1.voltage(A0,187, 1.7);
  pinMode(BUTTON_PIN,INPUT_PULLUP);
  pinMode(relaypin,OUTPUT);
  pinMode(MQPin, INPUT_PULLUP);
  lcd.begin(16,2);
  lcd.setCursor(0,0);
  lcd.print("MEASUREMENT");
  lcd.setCursor(0,1);
  lcd.print("AC CURRENT");
  delay(100);
  lcd.clear();
}

void loop()
{
 emon1.calcVI(20,2000);
 int Voltage1 = emon1.Vrms;
 int gas_value = digitalRead(MQPin);

 if(gas_value==HIGH)
 {
  lcd.clear();
  lcd.setCursor(6, 0);
  lcd.print("GAS");
  lcd.setCursor(3, 1);
  lcd.print("DETECTED");
  delay(1000);
 }

byte buttonState = digitalRead(BUTTON_PIN);

if (buttonState == LOW)
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("P =");
  lcd.print(power);
  lcd.print("W");
  lcd.setCursor(0,1);
  lcd.print("WH =");
  lcd.print(kilowh);
  lcd.print("kWH");
  lcd.setCursor(8,0);
  lcd.print("PF");
  lcd.print(pf);
  delay(1000);

double AC_Current = 0;
unsigned int temp=0;
float maxpoint = 0;
for(int i=0;i<500;i++)
{
 if(temp = analogRead(Sensor_Pin), temp>maxpoint)
 {
  maxpoint = temp;
 }
}
float ADCvalue = maxpoint;
double Voltage = (ADCvalue / 1024.0) * 5000;
double Current = ((Voltage - offsetvoltage) / sensitivity);
AC_Current = - (( Current ) / ( sqrt(2) ));
digitalWrite(relaypin,HIGH);
delay(100);
lcd.setCursor(0,0);
lcd.print("Current= ");
lcd.print(AC_Current);
lcd.print("A");
delay(100);

lcd.setCursor(0,1);
lcd.print("VOLTAGE = ");
lcd.print(Voltage1);
lcd.print("V");
delay(100);

power = Voltage1*AC_Current;
delay(100);
kilowh = power*60;
delay(100);
pf = power / (Voltage1*AC_Current);
delay(100);
}
```

Figure 4.4 Arduino Code

4.5 Result and analysis

4.5.1 Relay Result

The relay was thoroughly tested using a mobile device to control the turning on and off both a lamp and a socket. Relay 1 is specifically designed to manage the lamp, allowing it to be turned on and off as needed. On the other hand, Relay 2 is focused on handling the socket, taking charge of both the starting and stopping of the electrical connection for the lamp. Tables 4.1 provide a detailed breakdown of how long it takes for each relay to perform its designated tasks.

Table 4.1 The time taken for the relay

Relay	Time taken for turn on	Time taken for turn off
1	0.4 s	0.3 s
2	0.4 s	0.3 s

The information extracted from the table related to the duration required for both Relay 1 and Relay 2 to execute their operations, specifically in the context of activating the lamp and the socket outlet. A discernible distinction is noted in the operational time between Relay 1 and Relay 2, elucidating the variance in the temporal sequences for the initiation and cessation of these relays, as they contribute to the activation and deactivation processes of the lamp and socket outlet.

4.5.2 Auto Reclosure Result

The tripping event was tested for multiple sets. 1 set consists of more than 3 times of tripping to see that the prototype is fully working. In this case, The Distribution Board was included with load which 1 LED Bulb and a Water Heater. Table 4.2 and Table 4.3 shows the tripping event and how many times does it counter the tripping event.

In Set 1, the result stems from the servo condition aimed at applying a counteractive force against the residual-current circuit breaker (RCCB) during the fourth instance of nuisance tripping, thereby lessening and dealing with the repetitive interruption.

Table 4.2 Event of Nuisance Tripping SET 1

Event of Nuisance Tripping	Does the servo motor push back the RCCB	Comment
First nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Second nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Third nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Fourth nuisance tripping	Yes	The RCCB is still OFF and the user will receive notification

For set 2, the state arises following the resetting of set 1, and this signifies the end result for set 2 subsequent to the entire reset process being finalized.

Table 4.3 Event Of Nuisance Tripping SET 2

Event of Nuisance Tripping	Does the servo motor push back the RCCB	Comment
First nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Second nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Third nuisance tripping	Yes	The RCCB is back ON and the circuit is fully running.
Fourth nuisance tripping	Yes	The RCCB is still OFF and the user will receive notification

4.5.3 Fault tripping event

During a fault-induced tripping event, the Residual Current Circuit Breaker (RCCB) consistently switches to the OFF state, even after multiple attempts to reset it manually. The table below outlines the sequence of events and expected outcomes during such occurrences. If the tripping happens three times in less than 10 seconds, it indicates a fault-induced tripping rather than a mere nuisance tripping.

4.5.4 Time taken for the Prototype to counter the event

This prototype performance is depending on the speed and strength of the internet connection. If the internet connection is slow, it may affect the speed to counter the tripping event. Table 4.4 shows the time taken for the servo motor to push back the RCCB back to ON state.

Table 4.4 Time Taken for Servo Motor

Tripping event	Time Taken	Comments
1	2.1s	RCCB ON
2	2.4s	RCCB ON
3	2.5s	RCCB ON
4	-	RCCB OFF

4.5.4.1 Fault tripping notification

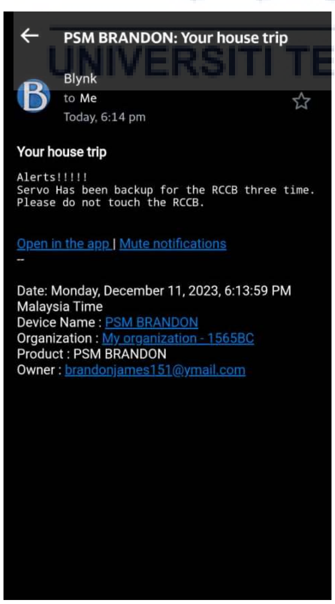

Figure 4.6 Notification Email

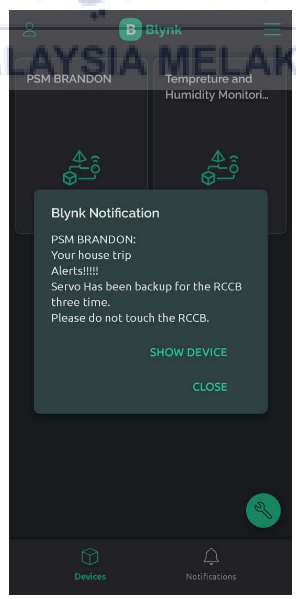

Figure 4.5 Notification on Blynk Apps

4.5.5 Gas Sensor Result

The outcome or data obtained from conducting an experiment is referred to as an experimental result. It can be a measurement, an observation, or any other sort of data obtained during an experiment. The results of experiments are used to evaluate hypotheses and theories to get a better knowledge of the phenomena under investigation.

Table 4.5 Gas Sensor Result

Distance	GAS DETECTED		BUZZER CONDITION
	VALUE (ppm)	TIME TAKEN	ON / OFF
0	700	1	ON
30	348	1	ON
60	274	1	ON
90	318	2	ON
120	273	3	ON
150	330	4	ON
180	335	5	ON

The tabular representation explain information acquired from a gas detection sensor, encompassing details such as distance, gas concentration measured in parts per million (ppm), the duration of the data collection process, and the operational state of the buzzer. Upon examination the table 4.5, it becomes apparent that the activation time of the buzzer is contingent upon the gas concentration exceeding 300 ppm.

This graphical representation illustrates the outcomes obtained by measuring the concentration of gas (in parts per million, ppm) at varying distances. The findings indicate a discernible trend, elucidating that as the distance decreases, there is a corresponding increase in the measured value of gas concentration (ppm).

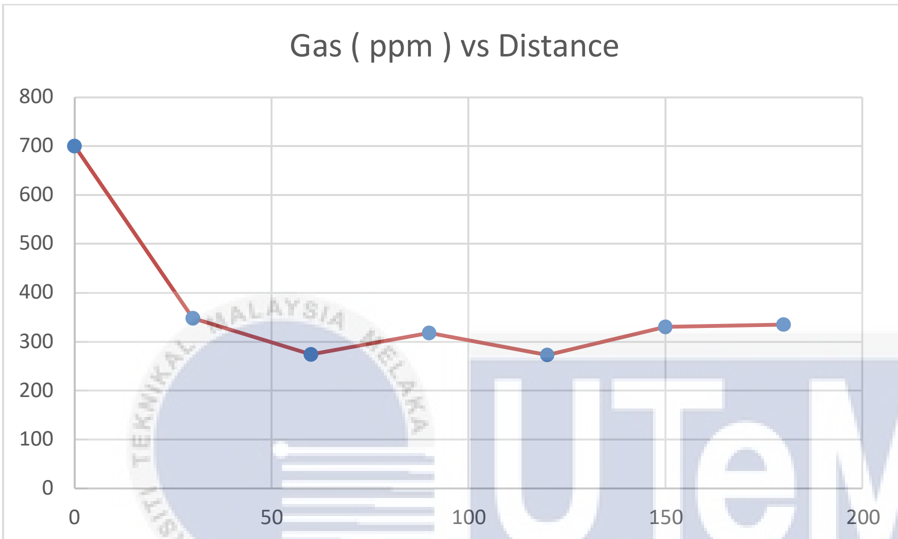

Figure 4.7 Gas (ppm) vs Distance

4.5.5.1 Gas Notification

If the concentration of gas (measured in parts per million, ppm) surpasses the threshold of 300 ppm, it will trigger the activation of the buzzer, simultaneously initiating the dispatch of notifications to the user. The illustrative depiction below provides a visual representation of the Blynk platform engaging in the process of dispatching notifications to the user through the medium of electronic mail (email).

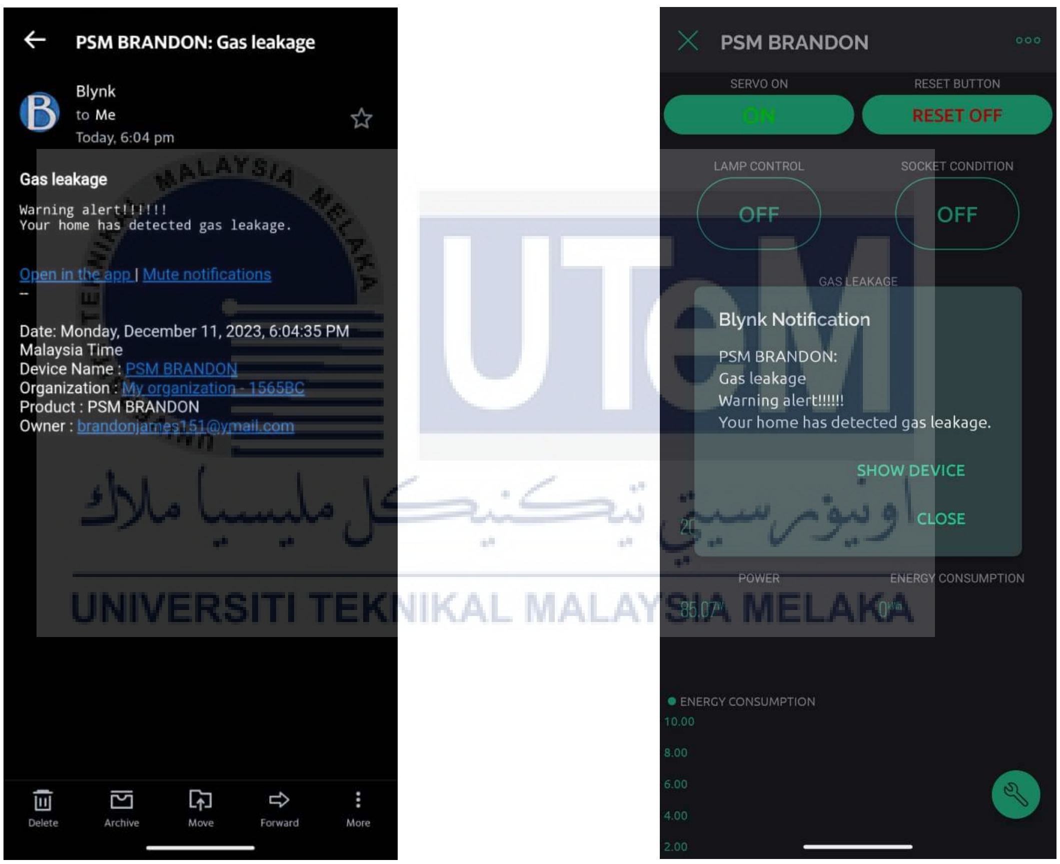

Figure 4.8 Gas Notification alert from email and blynk application

4.5.6 Energy Consumption Result

To ensure the successful realization of this project, the Blynk application serves as a pivotal tool, responsible for generating comprehensive calculation results, particularly in the domain of energy consumption. Beyond its calculative functions, the Blynk application assumes a dual role as a communication medium, facilitating user interaction for monitoring the energy consumption of all household appliances integrated into the system. Moreover, this undertaking places significant emphasis on the intricate calculations executed by the system, culminating in the development of a simplified circuit diagram that accurately reflects the load and power supply dynamics in accordance with real-time requirements. The comparative analysis depicted in Figure 4.4, 4.5, and 4.6 delineates the discernible distinctions between the values of current flow as indicated by the Blynk application and the actual current observed over corresponding time intervals within the system.

4.5.6.1 Comparison between socket outlet current over time.

Table 4.6 show the information about the electrical current in a socket outlet, measured using both a clamp meter and an Arduino-based current sensor for one hour. The table compares the actual current with the measured current values obtained from these two methods. The measurements were taken directly from the electrical system's socket outlet.

Table 4.6 Comparison Socket outlet current over time

TIME	Actual Current	Measure Current	Absolute Error	Error
5	5.9	5.72	0.18	3.15 %
10	0.6	0.56	0.04	7.14 %
15	0.6	0.54	0.06	11.11 %
20	0.6	0.55	0.05	9.09 %
25	0.6	0.54	0.06	11.11 %
30	0.6	0.57	0.03	5.26 %
35	5.9	5.72	0.18	3.15 %
40	5.9	5.72	0.18	3.15 %
45	0.6	0.56	0.04	7.14 %
50	0.6	0.54	0.06	11.11 %
55	0.6	0.55	0.05	9.09 %
60	0.6	0.54	0.06	11.11 %

Based on the observations of the current flow in real-time and the subsequent measurements, the collected data clearly show some error. Specifically, there are small errors of 0.18, 0.04, 0.06, 0.05, 0.06, 0.03, 0.18, 0.18, 0.04, 0.06, 0.05, and 0.06. When we closely examine the data, we notice a slight difference between the actual current and the measured current, which is around 3.15%, 7.14%, 11.11%, 9.09%, 11.11%, 5.26%, 3.15%, 3.15%, 7.14%, 11.11%, 9.09%, and 11.11%, respectively.

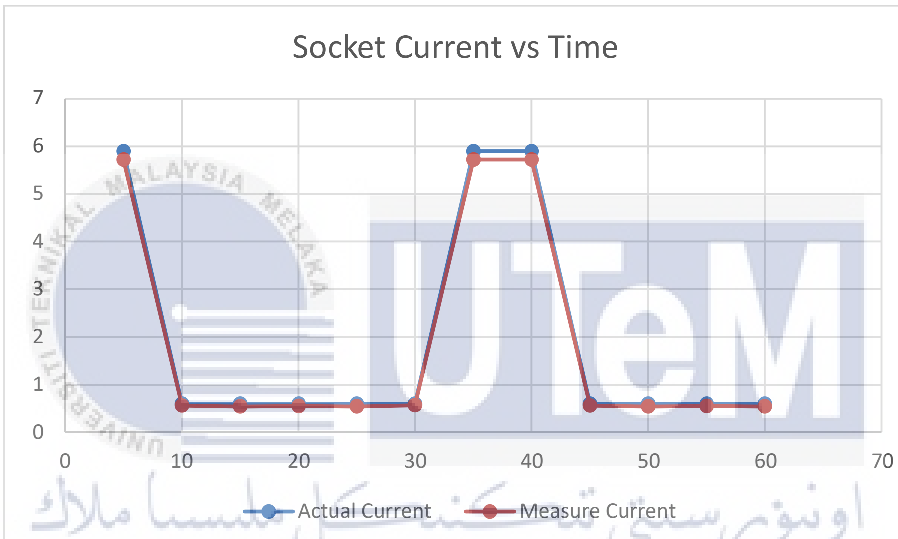

Figure 4.9 Socket Current over Time

From this figure 4.9, we can see the difference between the actual current and the measured current. The measured current depends on the electrical connection from the socket outlet to devices like the heater, phone charger, and laptop charger. The results are based on the amount of current used per hour. We can see that the heater uses 5.5 amperes, the phone charger uses only 0.13 amperes, and the laptop charger uses 0.27 amperes. It's important to know that the actual current readings come from a clamp meter, while the measured current comes from a sensor in the Arduino system.

4.5.6.2 Comparison between lamp current over time

Table 4.7 show the information about the electrical current in a lamp, measured using both a clamp meter and an Arduino-based current sensor for one hour. The table compares the actual current with the measured current values obtained from these two methods. The measurements were taken directly from the electrical system's lamp.

Table 4.7 Comparison lamp current over time

TIME	Actual Current	Measure Current	Absolute Error	Error
5	0.080	0.072	0.008	0.111 %
10	0.075	0.064	0.011	0.172 %
15	0.080	0.082	-0.002	0.024 %
20	0.075	0.065	0.010	0.154 %
25	0.080	0.063	0.017	0.269 %
30	0.075	0.063	0.012	0.190 %
35	0.080	0.078	0.002	0.025 %
40	0.075	0.063	0.012	0.190 %
45	0.080	0.056	0.024	0.428 %
50	0.075	0.082	-0.007	0.085 %
55	0.080	0.065	0.015	0.230 %
60	0.075	0.063	0.012	0.190 %

Based on the observations of the current flow in real-time and the subsequent measurements, the collected data clearly show some error. Specifically, there are small errors of 0.008, 0.011, 0.002, 0.010, 0.017, 0.012, 0.002, 0.012, 0.024, 0.007, 0.015, and 0.012. When we closely examine the data, we notice a slight difference between the actual current and the measured current, which is around 0.111%, 0.172%, 0.024%, 0.154%, 0.269%, 0.190%, 0.025%, 0.190%, 0.428%, 0.085%, 0.230%, and 0.190%, respectively.

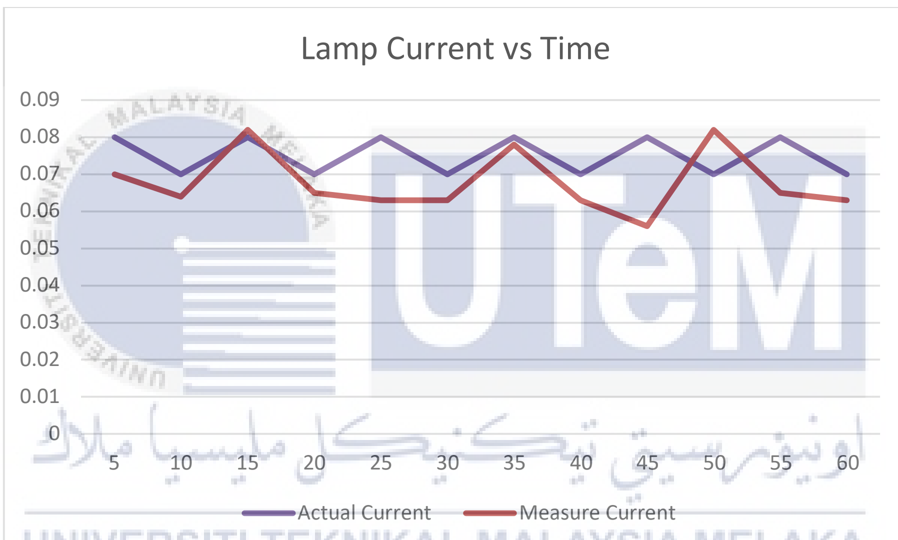

Figure 4.10 Lamp current between Time

Examining the provided visual representation, the assessment of lamp current involves the utilization of both a clamp meter and a current sensor integrated into the Arduino system, with a focus on the current consumption over a span of one hour. It is observable that the stability of current measurement obtained from the clamp meter surpasses that of the current sensor interfaced with the Arduino. Specifically, the readings acquired from the clamp meter yield values of 0.08 and 0.075, exhibiting a marginal variance when compared to the values derived from the Arduino current sensor.

4.5.6.3 Energy Consumption result

These results are about looking at how much electricity the phone charger, laptop charger, and lamp use in one hour. The information will tell us the specific amounts of electricity, and we get this data from the Arduino current sensor. The focus is on how much electrical power each device uses in a continuous one-hour time frame. It's important to note that the total energy usage includes situations where both the phone and laptop are still in use while being charged.

Table 4.8 The data of Energy Consumption

TIME	Energy comsumption (Kwh)
5	0.011
10	0.021
15	0.031
20	0.041
25	0.051
30	0.061
35	0.072
40	0.082
45	0.092
50	0.103
55	0.113
60	0.123

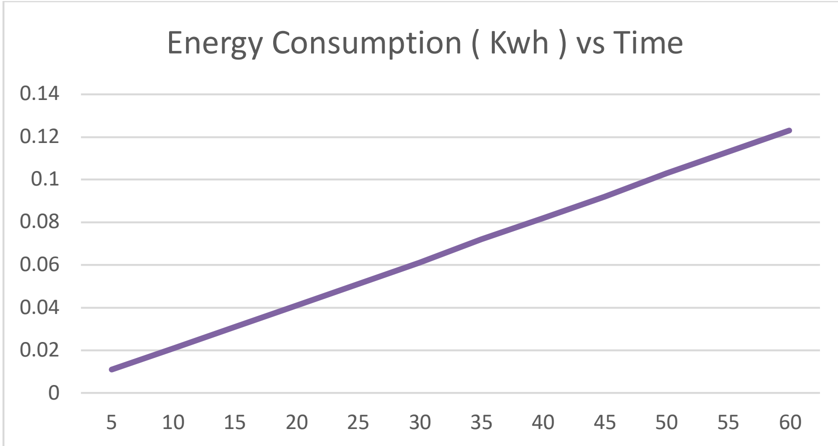

Figure 4.11 Energy consumption over Time

In Figure 4.11, we can see that the energy use of the phone charger, laptop charger, and lamp is directly linked to time, focusing on a 1-hour period. The data clearly show a slow but noticeable increase in energy use per hour for both the socket outlet and lamp, starting at 5 minutes and continuing up to the full 60 minutes.

4.6 Result theoretical and simulation.

The information in this table comes from a mix of simulated values and readings from a real meter for Table 4.9. For Table 4.12, we thoroughly tested the relay using simulations in the Proteus software. Additionally, the data in Tables 4.10 and 4.11 only comes from simulations using the Proteus platform. It's important to note that all this data is from simulation procedures.

Measure the current and voltage for one bulb.

Table 4.9 Measurement Current, Voltage And Power

	Clamp meter	Simulation
Voltage	230 V	230 V
Current	0.08 A	0.08 A
Power	25.3 W	18.4 W

Gas Sensor Measurement

Table 4.10 Gas Sensor Measurement

Event	Simulation On Gas Sensor
Gas Leakage Happen	LCD show gas detected
No Gas Leakage Happen	LCD does not display

Servo Motor and Limit Switch condition

Table 4.11 Servo Motor and Limit Switch Condition

Event	Limit Switch	Servo Motor
No trip	No Trigger	0 degree
Trip	Trigger	90 degrees

Relay 1 and Relay 2 condition

Table 4.12 Relay 1 and Relay 2 Condition

Event	Condition
Relay 1	Turn on lamp or turn off the lamp
Relay 2	Turn on socket or Turn of the socket

The findings include a comprehensive analysis derived from simulation and manual data collection methods. Table 4.9 shows disparities in voltage, current, and power between Proteus simulation and clamp meter measurements. Table 4.10 provides gas sensor measurements obtained exclusively through the Proteus simulation, highlighting accuracy and reliability. Table 4.11 reveals insights into servo control motion and its response to the limit switch, demonstrating the efficacy and performance of the system. Table 4.12 show the condition of relay operates. These tables offer a comprehensive set of data for evaluating and analyzing the simulation and measurement results obtained from Proteus, providing valuable insights into the systems and components.

4.7 Discussion Analysis result

This chapter explores the integral process of result analysis, crucial for comprehending and deriving meaning from data or findings obtained through experiments or studies. The analysis involves comparing results to existing theories or hypotheses, recognizing patterns or trends, and drawing conclusions or forming inferences. Both quantitative and qualitative analyses are discussed, where statistical tools examine numerical data, and non-numerical materials, such as text or images, are evaluated. This systematic approach aids in the validation or rejection of hypotheses and ideas within the scientific method. The chapter then seamlessly transitions to specific outcomes from two projects: the correlation between gas sensor distance and detection time, and the functionality of an Auto Reclosure Circuit Breaker. The latter involves a straightforward procedure where voltage and current sensors detect values displayed on an LCD. Tripping the RCCB prompts a series of actions, from the switch's descent to the microcontroller signaling the servo motor for resetting. The concluding remarks highlight the study's hardware-based results, acknowledging potential errors like discrepancies in voltage and current values affecting calculations. Notably, the consistency of measurement results, based on the proposed approach, is emphasized in producing accurate and reasonable outcomes, despite nuanced differences between computer and manual calculations.

4.8 Summary

Essentially, The Auto Reclosure Circuit Breaker procedure involves voltage and current sensors detecting values displayed on an LCD. If the RCCB trips, the microcontroller signals the servo motor to push it back to the ON state. Result analysis is the process of interpreting data from experiments or studies, comparing them to existing theories, and drawing conclusions. It can be quantitative (statistical analysis) or qualitative (evaluating non-numerical data). In this study, simulation and manually obtained results are presented, highlighting the system's process and potential errors. Manual and computer calculations may differ due to decimal points and component values. The proposed approach yields consistent and accurate results correlating current values to power.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, this thesis outlines the development process of a household gas detector alarm with internet connectivity, presenting an effective and robust methodology designed for simplicity and successful everyday use. The study has significantly contributed to our understanding of the Household Gas Detector Alarm's effectiveness and reliability. The methodology utilizes a fair amount of input data, employing an easy-to-understand approach that generates speedy, believable, representative, and reasonably accurate results. The research has also introduced methodologies for quantifying and evaluating gas leakage detection and anomalous loud noise in a residential context. This groundwork lays the foundation for future research. The final year project spanned two semesters, involving extensive research on nuisance tripping and sensor selection for the prototype. Implementation of the prototype in real-life scenarios is crucial, as it offers benefits such as monitoring power consumption to help users save on bills and protect electronic devices. The culmination of this work provides valuable insights for future endeavors in the field.

5.2 Recommendation

5.2.1 Future Improvements for Household Gas Detector Alarm with Internet:

I. Gas Sensor – Type of gas sensor used may be of a better quality with more accurate reading and faster response time, with even more robust hardware settings.

II. Internet Connection Capability – The response rate from the actual device to the users' notification device heavily depends on the strength of the internet connection, so other approach to transmit and receive the feedback might improve the response rate.

III. User Interface – The user interface should be able to not only receive live feedback (data acquisition) from the device, but it should also have some supervisory control over the device.

5.2.2 Future Improvements for Auto reclosure and data monitoring

i) Android Application Development - Introduce an Android application for improved accessibility and convenience in accessing power consumption data.

ii) Developers' Own Application - Enhance adaptability and user-friendliness of the monitoring and control system.

iii) Analysis and Simulation - Conduct thorough analysis and simulation considering real-world conditions, accuracy, and potential losses.

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APPENDICES

Appendix A Project Coding

```
#define BLYNK_TEMPLATE_ID "TMPL63P94c4tU"
#define BLYNK_TEMPLATE_NAME "PSM BRANDON"
#define BLYNK_AUTH_TOKEN "Oh3vPrpsRxCrtCjfUtHhtl5yXvwBf7sh"

#define BLYNK_PRINT Serial

#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>
#include "EmonLib.h"
#include "ACS712.h"
#include <Servo.h>
#include <ezButton.h>

char auth[] = BLYNK_AUTH_TOKEN;

char ssid[] = "Ataraxia";
char pass[] = "Brandona";

#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3);

#define ESP8266_BAUD 9600

ESP8266 wifi(&EspSerial);

EnergyMonitor emon1;

Servo myservo;

ezButton limitSwitch(8);

#define relay1 6
#define relay2 7

ACS712 sensor(ACS712_30A, A1);
ACS712 sensor1(ACS712_30A, A2);
int MQ5 = A0;
int data = 0;

float kWh = 0;
unsigned long lastmillis = millis();

int flag1=0;
int flag2=0;
int count=0;
```

```
void gas()
{
  data = analogRead(MQ5);

  if ( data > 400)
  {
    Blynk.logEvent("gas_leakage");
    tone(buzzer, 1000);
    delay(1000);
  }
  else
  {
    noTone(buzzer);
    delay(1000);
  }
  Blynk.virtualWrite(V0, data);
}

BLYNK_WRITE(V5)
{
  bool value1 = param.asInt();
  if (value1 == 1) {
    digitalWrite(relay1, HIGH);
  }
  else
  {
    digitalWrite(relay1, LOW);
  }
}

BLYNK_WRITE(V6)
{
  bool value2 = param.asInt();
  if (value2 == 1)
  {
    digitalWrite(relay2, HIGH);
  }
  else
  {
    digitalWrite(relay2, LOW);
  }
}
```

```
  else if(i==0)
  {
    myservo.write(55);
    delay(300);
  }
}

BLYNK_WRITE(V8)
{
  int u = param.asInt();
  if(u==1)
  {
    count=0;
  }
}

void power()
{
  limitSwitch.loop();
  emon1.calcVI(20, 2000);
  float voltage = emon1.Vrms;

  float I1 = sensor.getCurrentAC() - 0.03;
  float I2 = sensor1.getCurrentAC() - 0.23;
  float I = (I1 + (I2 / 2.0)) ;

  if(I < 0.03)
  {
    I = 0;
  }
  if (I2 < 0.09 )
  {
    I2 = I2 + 0.08;
  }

  float power = voltage*I;

  Blynk.virtualWrite(V1, voltage);
  Blynk.virtualWrite(V2, I);
  Blynk.virtualWrite(V3, power);
  kWh = kWh + power*(millis()-lastmillis)/3600000000.0;
  lastmillis = millis();
  Blynk.virtualWrite(V4, kWh);
```

```
    myservo.write(55);
    Blynk.logEvent("your_house_trip");
    count++;
    flag1=0;
  }
}

void setup()
{
  Serial.begin(9600);
  delay(10);
  pinMode(relay1, OUTPUT);
  pinMode(relay2, OUTPUT);
  emon1.voltage(A3, 200.5, 1.7);
  myservo.attach(9);
  pinMode(buzzer, OUTPUT);
  sensor.calibrate();
  sensor1.calibrate();
  EspSerial.begin(ESP8266_BAUD);
  delay(10);
  Blynk.begin(auth, wifi, ssid, pass);
}

void loop()
{
  power();
  gas();
  Blynk.run();
}
```

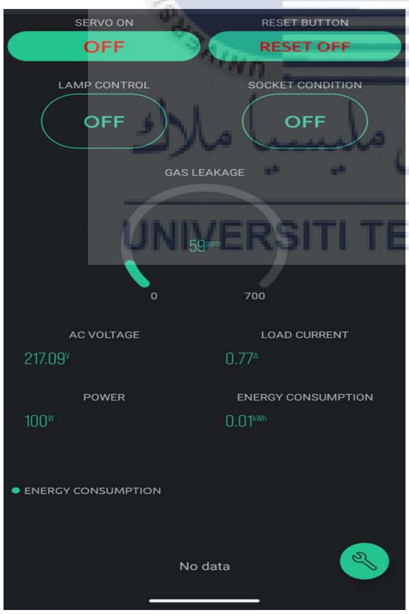
Appendix B Coding for gas sensor

```
void gas()
{
  data = analogRead(MQ5);

  if ( data > 400)
  {
    Blynk.logEvent("gas_leakage");
    tone(buzzer, 1000);
    delay(1000);
  }
  else
  {
    noTone(buzzer);
    delay(1000);
  }
  Blynk.virtualWrite(V0, data);
}
```

Appendix C Coding for power consumption

```
void power()
{
  limitSwitch.loop();
  emon1.calcVI(20, 2000);
  float voltage = emon1.Vrms;

  float I1 = sensor.getCurrentAC() - 0.03;
  float I2 = sensor1.getCurrentAC() - 0.23;
  float I = (I1 + (I2 / 2.0)) ;

  if(I < 0.03)
  {
    I = 0;
  }
  if (I2 < 0.09 )
  {
    I2 = I2 + 0.08;
  }

  float power = voltage*I;

  Blynk.virtualWrite(V1, voltage);
  Blynk.virtualWrite(V2, I);
  Blynk.virtualWrite(V3, power);
  kWh = kWh + power*(millis()-lastmillis)/3600000000.0;
  lastmillis = millis();
  Blynk.virtualWrite(V4, kWh);
```

Appendix D Hardware, app interface and video demonstration



Video Demonstration link : https://youtu.be/hvFvdVGJChM