Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED HOME SYSTEM AUTOMATION USING ARDUINO

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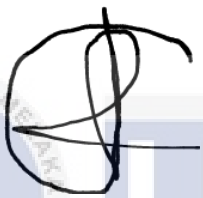
Bachelor of Electronics Engineering Technology with Honours

2022

DECLARATION

I declare that this project report entitled "DEVELOPMENT OF IOT BASED HOME SYSTEM AUTOMATION USING ARDUINO" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

I approve that this Bachelor Degree Project 1 (PSM1) report entitled "DEVELOPMENT OF IOT BASED HOME SYSTEM AUTOMATION USING ARDUINO" is sufficient for submission.

Signature : 

Supervisor Name : TS. MOHD RAZALI BIN MOHAMAD SAPIEE

Date : 26/1/2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature : 

Supervisor Name : TS. MOHD RAZALI BIN MOHAMAD SAPIEE

Date : 26/1/2023

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

This final year project is entirely dedicated to my dear parents, who have served as an inspiration and provided me with the moral, spiritual, emotional, and financial support necessary to continue forward with my studies

ABSTRACT

Home automation or domotics refers to home-based building automation, sometimes known as a smart home or smart house. A home automation system can monitor and/or control different aspects of a home, such as the temperature, the electricity, the entertainment systems, and the appliances in a remote way. Home security features like alarm systems and access control may also be included under home automation. The concept of home automation has been a main focus in several publications and home appliance companies. In this work, the most efficient and simple strategy for automating home appliances is discussed. Among the various techniques and things to be automated, this project focuses primarily on three aspects: controlling home appliances wirelessly using Arduino UNO and IoT, sensing intruders entering the home via the window or door, and monitoring the home using a smartphone in the case of a fire. Implementations of both hardware and software are addressed sequentially. The experimental and observational analysis for all three systems is also presented, along with simulation-based circuits and methods and tools connected to the algorithm that operates on a microcontroller.

ABSTRAK

Automasi rumah atau domotik merujuk kepada automasi bangunan berasaskan rumah, kadangkala dikenali sebagai rumah pintar. Sistem automasi rumah boleh memantau dan mengawal pelbagai aspek rumah, seperti suhu, elektrik, sistem hiburan dan peralatan dengan cara yang jauh. Ciri keselamatan rumah seperti sistem penggera dan kawalan akses juga boleh disertakan di bawah sistem rumah pintar. Konsep automasi rumah telah menjadi tumpuan utama dalam beberapa penerbitan dan syarikat perkakas rumah. Dalam kerja ini, strategi yang paling cekap dan mudah untuk mengautomasikan peralatan rumah akan dibincangkan. Di antara pelbagai teknik dan perkara yang akan diautomasikan, projek ini memberi tumpuan terutamanya kepada tiga aspek: mengawal perkakas rumah secara wayarles menggunakan Arduino UNO dan IoT, mengesan penceroboh memasuki rumah melalui tingkap atau pintu, dan memantau rumah menggunakan telefon pintar dalam kes api. Pelaksanaan kedua-dua perkakasan dan perisian ditangani secara berurutan. Analisis eksperimen dan pemerhatian untuk ketiga-tiga sistem juga dibentangkan, bersama-sama dengan litar berasaskan simulasi dan kaedah serta alatan yang disambungkan kepada algoritma yang beroperasi pada mikropengawal.

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CHAPTER 1

INTRODUCTION

1.1 Background

This project involves the automation of an IoT-based home system using Arduino. This project is based on controlling home appliances wirelessly with Arduino modules and Wi-Fi. The purpose of this project is to make it simpler for the user to switch or monitor household appliances, as well as to protect their home from intruders and fire. This project would utilize Arduino UNO module to wirelessly transmit and receive data using the Wi-Fi ESP32. The computer and sensor were linked to the ESP32 and Arduino module. The relay that is attached to the Arduino module would be used to connect household appliances such as lamps. The relay were served as the on/off switch for the household appliance, while the sensor would detect intruders, and fire. This initiative is focused on the residency application as well as on the elderly and disabled.

Furthermore, this project is also appropriate for monitoring whether or not a home appliance is in the on or off position. For instance, if a user on the first level wished to turn on or off an appliance on the second floor, the user does not need to walk to the second floor; instead, the appliance on the second floor may be monitored and turned on or off using a computer or a smartphone. Additionally, this project may be used to monitor our home's security against fire and invaders. As long as Wi-Fi is available, this project enabled the user to operate the appliance, monitor for fires, and get alerts for intruders while they are away from home.

1.2 Problem statement

Occasionally, when people left their houses unattended, fire or theft might occur which would lead to a major loss. When such an event happened, sometimes it's too late for one to take any rapid action due to late information received or lack of awareness of their surrounding.

Thus, with the development of alert notification of home automation systems that could detect an intruder and even fire, this method could help in coping with the issues mentioned above where one could take fast action on the problems that occur. Thanks to the development of the such system, the negative impact of theft and fire could be reduced.

Other than that, we sometimes tend to forget to close our lamp and fan when we are off for a holiday which caused electricity bills to skyrocket. with this home control appliance technology, it can help in solving the problem of expensive electricity bills. it also helps in making it easier for the elderly as well as the disabled to control their household appliances remotely.

1.3 Project Objectives

The main aim of this project is to propose systematic home automation regarding how to save energy, add more security, and have more safety in our homes. the objectives of this project are stated below:

a) To design and model smart homes using ESP32 and Arduino UNO.
b) To build a remote monitoring system that can access data from sensors that are saved in the cloud which is the Internet of Things platform known as Cayenne.
c) To analyze the performance of a home automation system that displays a wide spectrum of energy saving, the effectiveness of house security as well as efficiency of home safety.

1.4 Scope of Project

By narrowing the needs for this project, a few scopes were made to make sure that it would reach its goals. The scopes covered were:

a) Using Arduino UNO and ESP32 as a controller in monitoring home surroundings for home automation systems.

b) To implement an IOT using the cayenne platform to monitor and control home appliance

c) For energy saving, lamp can be monitor and control through cayenne. A relay is used as a switch to on or off the lamp.

d) For security purposes, a magnetic reed switch, vibration tilt sensor, and infrared sensor will be used to detect if any intruders are coming into the house and are placed in the window and door.

e) For the safety house, the flame sensor and MQ2 gas sensor are going to be used to detect the existence of fire and the level of gas respectively.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Various research papers and current literature have sought to enhance the environmental control, energy management, home security, and fire prevention of smart home automation systems. In the field of IoT, machine-learning techniques have been used for categorization, prediction, and analysis. This section contains IoT-related articles related to smart home automation systems.

2.2 Energy saving in home automation system

Siddharth Wadhwani et al in 2018 [1], presented a dynamic security system for the home using Arduino and IOT in addition to sensors that will be interfaced with Arduino. The situation of our home apparatuses will get transferred through a wireless module to a cloud system. Additionally, the framework and mobile should be associated with the same remote system. The sensors such as an accelerometer, flex sensor, magnetic sensor, flame sensor, and WI-FI module will be able to be enabled or disabled which will be under the control of the client. The flex sensor will rely on the motions of our fingers to control the apparatuses. Enhanced door-breaking security will be done by the magnetic sensor. Cloud platform like THINKSPEAK is used for data that can be seen by the user. The application of IoT can make our appointment easier and more comfortable effortlessly. This home automation system will be very advanced in our daily life to control things using smartphones and walking faster with changing of technology over the world.

In 2018, Singh et al [2] suggested an IoT-based smart home automation system that uses sensor nodes. The objective is to enhance home automation by utilizing a wireless sensor node. Multiple electrical gadgets were combined into the Home automation system and automated with little or no human interference. The smart home system monitors environmental factors and directs the operation of home appliances according to the user's preferences. The technology is used to automate household appliances, notify the homeowner of the cost of his electric bill at regular intervals, and book the gas cylinder automatically when the gas level falls below a certain threshold.

According to Muhammad Umer and Muhammad Miqdad Khan in 2020 [3], They have designed a wireless smart home automation system using the Arduino Uno microcontroller (ATMEGA328) as the primary controller. This system's architecture and implementation are low-cost, secure, universally accessible, and auto-configurable. This system's application software is based on Android, which currently has the largest smartphone user base. In addition, the construction of a Bluetooth wireless connection with the microcontroller simplifies the installation of the system. However, handicapped and elderly individuals are now able to manage their household equipment while remaining seated.

Rout et al. [4] introduced an Android-based smart home automation system with cloud computing services for the remote observation, monitoring, and control of home appliances, the physical environment, and intrusion detection using a smartphone. The system is controlled through a machine-to-machine (M2M) capability. Using a NodeMCU, ATMega 16, and ESP8266 IoT hardware, a prototype implementation was carried out.

2.3 Home security system

Soliman et al. [5] performed the Design and Implementation of a Real-Time Smart Home Automation System Based on an Arduino Microcontroller Kit and LabVIEW Platform. The suggested smart home system consists of two hardware components: using a laptop as a local server with LabVIEW platform administration and an Arduino microcontroller board. The Arduino microcontroller board is linked to sensors and home appliances. The homeowner's commands controlled, managed, and linked the home's equipment automatically. The architecture and flow diagrams of the proposed smart home system have advanced. The effectiveness and dependability of the suggested system have been examined, and a hardware implementation for three operational home devices has been developed: security camera, light, energy saving, temperature control, and ultrasonic distance detecting sensor. The system is designed to be user-friendly, versatile, and cost-effective, making it appropriate for the future of smart homes.

In 2018, Hossain et al. [6] proposed a security framework for IOT based Smart Home Automation System. Among other things, facilitates the separation of devices linked by motion sensors, fog computing, server, and switch connection. The home appliances in this system are controlled by a personal computer. activate home components based on the motion sensor's detection. When the motion sensor senses movement, the components are automatically turned ON/OFF. The developed intelligent home automation system is capable of observing things in the user's house and controlling the following actions: Webcam/CC-Camera ON/OFF, Fan ON/OFF, Light ON/OFF, Door ON/OFF Window ON/OFF, and Fire-Alarm/Sprinkler ON/OFF.

Hoque and Davidson developed an architecture for a smart door system in 2019 [7] the system is a versatile and cost-effective mobile Android application used to notify a house owner of door open events in an office or residential environment. The system's architecture comprises a Raspberry Pi 2 board for communication with a web server implementing a RESTful API and an Arduino microcontroller board compatible with Elegoo Mega 2560.

In 2018, Satapathy et al. accomplished Internet of Things (IoT) home automation using Arduino [8]. Using Arduino microcontroller boards, a cost-effective, dependable, and adaptable smart home automation system with added security is shown. Local Wi-Fi with IP connection for controlling, monitoring, and accessing home appliances through smartphone apps with user consent. The suggested solution relied on an independent server and the Internet of Things (IoT) to monitor household gadgets ranging from industrial machinery to consumer items. A smartphone application, web browser, or IR remote module may be used to access and monitor various household appliances.

2.4 Home safety system

Jabbar et al. [9] presented a hybrid approach to home automation. Through a mobile application or laptop application, the system controls electrical appliances and analyses ambient conditions, motion, and gas levels in the house, both locally and remotely. The authors created a prototype for the IoTHoMe system, which used a NodeMCU as a Wi-Fi-based gateway to link various home sensors. The sensor data is uploaded to a cloud server (Adafruit IO) and may be viewed through If This Then That (IFTTT) on the user's cell phones or PCs.

According H. Alqourabah [10] suggested the device would include integrated detectors for heat, smoke, and flame, among others. The signals from these detectors are processed by the system's algorithm to determine the likelihood of a fire, and then the

system's GSM modem broadcasts the expected outcome to different parties. A technology of the Internet of Things (IoT) has been adopted to give the fire brigade essential data without putting human lives at risk. The key characteristic of the suggested system is the reduction of false alerts, which increases the system's reliability.

In 2018, F.Saeed et al. [11] built and analyzed a wireless sensor network using numerous sensors for early detection of residential fires. In addition, the system avoided false alerts by using the Global System for Mobile Communications (GSM). Using the Fire Dynamics Simulator and a programming language, we simulated a fire in a smart house to evaluate the performance of our fire detection system. The simulation results show that our system can identify early fires, even when a sensor is not functioning while using an appropriate amount of energy from the sensors.

W. Hsu et al. [12] have created a smart created a smart kitchen fire prevention system with the following components and capabilities in 2019. Installing sensors above the cooktop. When they detect fires, high temperatures, or gas leaks, they promptly switch off the gas supply by activating the gas shutoff system. The alarm alerts occupants with a loud sound and flashing lights. The Line reporting system delivers Line messages to residents and the community management center, and the main entry door is immediately opened to enable appropriate employees to enter the home to address the incident. Installing an Internet protocol camera in the kitchen allows people to watch the gas burner from their mobile devices. If they discover the gas stove is still on, they may cut off the gas supply from their phones by activating the gas shutoff mechanism. The method is designed to limit the damage caused by cooking fires.

2.5 Comparison of previous related home automation system

Therefore, several academics have conducted studies on how the internet of things technology may be used. The internet has progressed, and an increasing number of people in both developed and developing nations have access to technology. Nevertheless, the concept of the Internet of Things symbolizes the next phase of human interactions. Unavoidable is the need for a system capable of coordinating the operation of all the electronic gadgets in the home. As a consequence of irresponsible human error, risks such as fire need a framework for their management. The IoT idea ensures that problems, such as fires, are quickly detected and extinguished. The IoT is a current trend, according to the literature study, which is another important point. Numerous research focused on how the IoT may be exploited to facilitate living and enhance security, such as by using CCTV and alarm systems. The global community is adopting the concept of sustainability, particularly concerning environmental damage. Consequently, the IoT trend because it solves various human concerns. Moreover, the IoT would reduce the cost of departing since it will enhance system management. Therefore, the argument that the IoT system would compromise the security of homes is unfounded. Utilizing technology effectively gives more advantages. Nonetheless, Table 2.1 summarises and tabulates the major aspects of earlier work that were discussed in the literature review section.

Table 2.1 Comparison between previous home automation's projects.

Author	Home devices control	Tool	Aims
Siddharth Wadhwani et all. [1]	a. Fans b. Light c. Door	a. ESP8266 b. Arduino UNO Board c. Flex sensor d. Reed relay sensor e. Flame sensor f. Accelerometer g. LDR	To ease the way we control our homes appliances
Singh et al. [2]	a. Energy consumption · level of the Gas cylinder b. door cartons c. Light d. Fan	a. Arduino UNO b. LDR module c. Node MCU d. ESP8266 e. LM35 f. IR sensors	Cost saving and energy conservation.
Muhammad Umer and Muhammad Miqdad Khan. [3]	a. Home Appliances	a. Arduino Software (IDE). b. BC547 transistor c. Light Emitting Diode d. Photo-Resistor	Design and build a low-cost, adaptable mobile phone-based home automation system.
Rout et al [4]	a. Fans b. Light	a. NodeMCU b. DHT11 c. ATmega16	Design low cost, flexible design and implementation ATmega16 as its master controller in the context of home automation application.

Soliman et al. [5]	a. Temperature management b. Light c. Security camera	a. Arduino b. Sensors c. Pc as server d. LabVIEW platform	Introduce a system that is easier to implement than the others.
Hossain et al. [6]	a. Light ON/OFF b. Fan ON/OFF c. Door ON/OFF d. Window ON/OFF e.Webcam/Camera ON/OFF f. Fire-alarm/Sprinkler ON/OFF.	a. Cisco Packet Tracer. b. Server-PT c. Switch-2960 d. Laptop-PT e. SBC-PT f. Motion Sensor	Built system is far more secure than the others since they all employ the same eye tracking technology. The system is much more secure than the others since it uses the same eye retina scan pattern for the response of the professional sensors, which will identify the person who owns that residence.
Hoque and Davidson [7]	a. doors	a. Raspberry Pi 2. b. Arduino or Elegoo Mega 2560 board. c. Magnetic reed switch. d. RF receiver–transmitter pair (433 Hz). e. Emulator or Android phone.	A system that uses RF-based communication in a household was created in order to offer a low-cost architecture for the creation of an Internet of Things-enabled home security system.
Satapathy et al.[8]	a. Light b. Fan c. TV	a. Arduino UNO b. 4-Channel Relay	Create an effective home automation system that is low cost, dependable, and versatile, and includes extra safety features.

		c. ESP8266-01 Wi-Fi module d. Gas Sensor e. Temperature Sensor	
Jabbar et al[9]	Electrical appliances	a. NodeMCU b. PIR motion sensor c. DHT11 d. MQ2 gas sensor e. Light-emitting diode (LED)	Develop an affordable and dependable automation system that not only lowers the amount of energy used but also significantly improves inhabitants' levels of convenience, safety, and security.
H. Alqourabah [10]	Fire-alarm/Sprinkler ON/OFF.	a. Flame sensor b. Temperature sensor c. Gas sensor d. Arduino Atmega328p e. NodeMCU	In order to acquire real-world data, provide the fire department with the required data, and reduce the number of false alarms, which will ultimately lead to an increase in the system's level of dependability.
F.Saeed et al [11]	Fire-alarm	a. ZigBee b. LM35 c. smoke sensors e. Gas sensor	Developed and implemented a wireless sensor network consisting of various sensors for the early detection of fires in residential buildings
W. Hsu et al [12]	a. Doors b. Camera c. Gas main switch	a. Arduino UNO b. Webduino c. DHT11 d. gas sensor e. IP camera	Designed and built a high-tech fire suppression system for kitchens, which includes the following components and capabilities:

2.6 Summary

In conclusion, chapter 2 discusses the overall past projects related to home automation. This chapter gives some ideas regarding the concept and method that were used in this project based on the information and the sources that are obtained from books, journals, and websites. Wi-Fi is one of the wireless technologies that are available on the market so the information on Wi-Fi technology will be further discussed. Besides that, previous related projects and hardware used will be discussed as well.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The performance system is split into a few stages to ensure that this project is completed successfully. The flowchart of this home automation system is given in Figure 3.1.

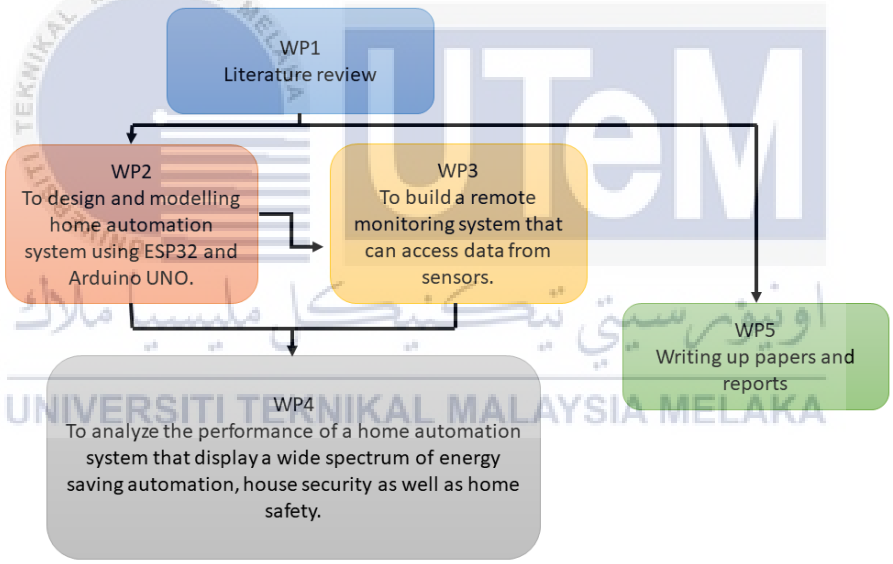


Figure 3.1 Flowchart of methodology

This research study will take one year to accomplish and is divided into five work packages: (1) literature review, (2) design and modeling home system automation using ESP32 and Arduino UNO (3) To build a remote monitoring system that can access data from sensors. (4) To analyze the performance of a home automation system that displays a wide

spectrum of energy-saving automation, house security as well as home safety and (5) compose papers and reports. The image below depicts the flow of the work packages.

3.2 Work package 1 : Literature review

3.2.1 Task 1: Literature review

ThThe goal of a literature review is to have a general understanding of past research conducted by scholars or institutions regarding home automation systems. Ideas and information regarding the component used, solutions to manage the problem, and the analytic approach was gathered from previous studies. The flow chart of the literature review is shown in Figure 3.2.

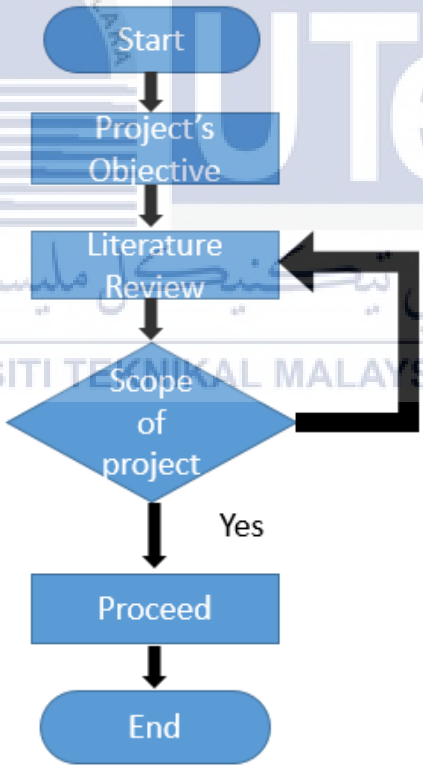


Figure 3.2 Flowchart of literature review

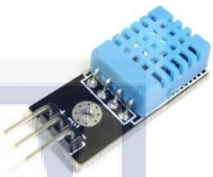
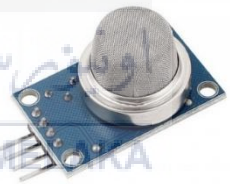
3.3 Work package 2: To design and modelling home automation system using ESP32 and Arduino UNO.

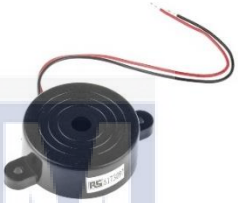
3.3.1 Selection of hardware component

The components that going to be shown in this part consist of hardware and software to be able to accomplish the home automation system. , the following is a table of equipment and components used to suffice the needs of the project.

Table 3.1 hardware component used for home automation system

ESP32	Run finalized code and used it as a wifi to connect with cayenne	
Arduino UNO	To control the lamp through a relay	
PIR sensor	Used to on/off Led when someone walking through the sensor	

Magnetic Reed Switch	To detect unauthorized entry at the front door.	
Flame sensor	The flame sensor were utilized as a safety detector in a master bedroom.	
DHT11	Sense humidity and temperature at home	
MQ2 gas sensor	Detect level of gas in the kitchen	
Vibration tilt sensor	Sense intruder coming from the piano room window	
Infrared sensor	Sense intruder coming from master bedroom window	

5 volt 4 channel relay	Used to switch on/off lamp	
LED Lamp	Used as output for energy saving	
Buzzer	Used as an alarm	
Arduino IDE	Programming language used	
Cayenne	Iot Platform used	

3.3.2 Block Diagram

The system proposed is meant to monitor and control home automation, which includes telegram notifications. The block diagram shown below is an IoT-based monitor system and manual actuation.

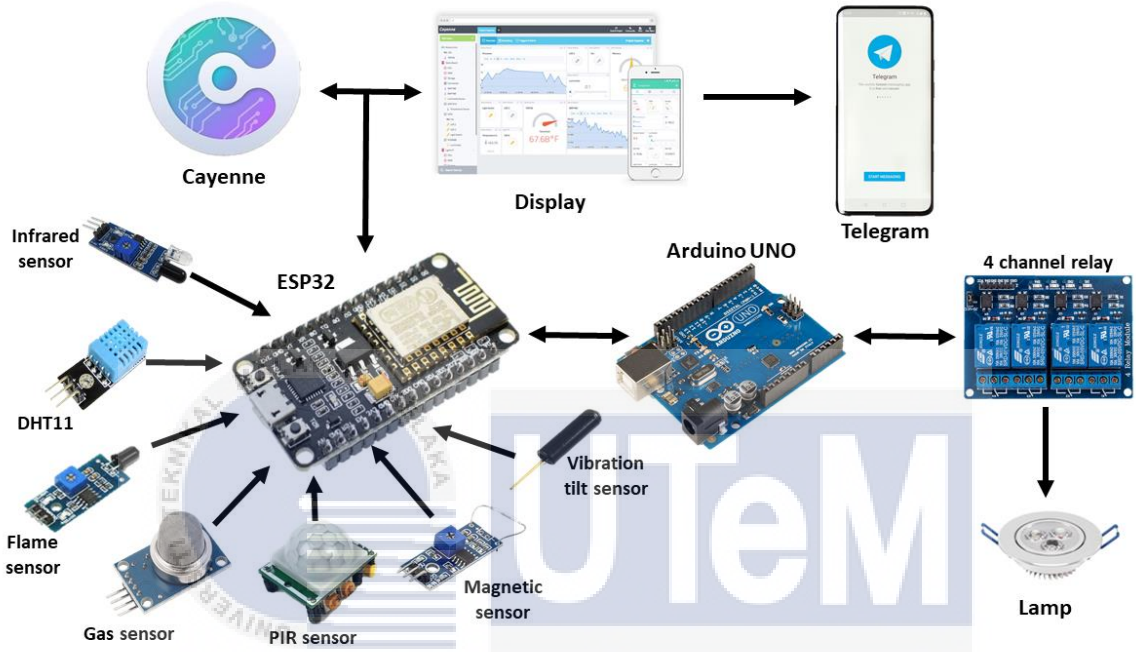


Figure 3.3 block diagram of IoT-based monitor and control system .

The figure shows the demonstration of the whole home automation system. this project is comprised of a microcontroller, which serves as the "brain" of the system and directs the behavior of the other components based on how the system is designed. The input part of this project consists of seven sensors. Each sensor would sense the input of the ESP32 and then ESP32 would send it to the cloud which is cayenne to display and monitor. For safety and security purposes, if the sensor hit the trigger, it would automatically send a message to the telegram group to notify the user. For the display, we can use it to monitor and control home appliances such as a lamp. To control the lamp, the user needs to hit the button at the display. The instruction would be sent to ESP32 and then to the Arduino UNO. Arduino UNO would sent the output to the relay to the lamp.

3.3.3 Wiring and connection

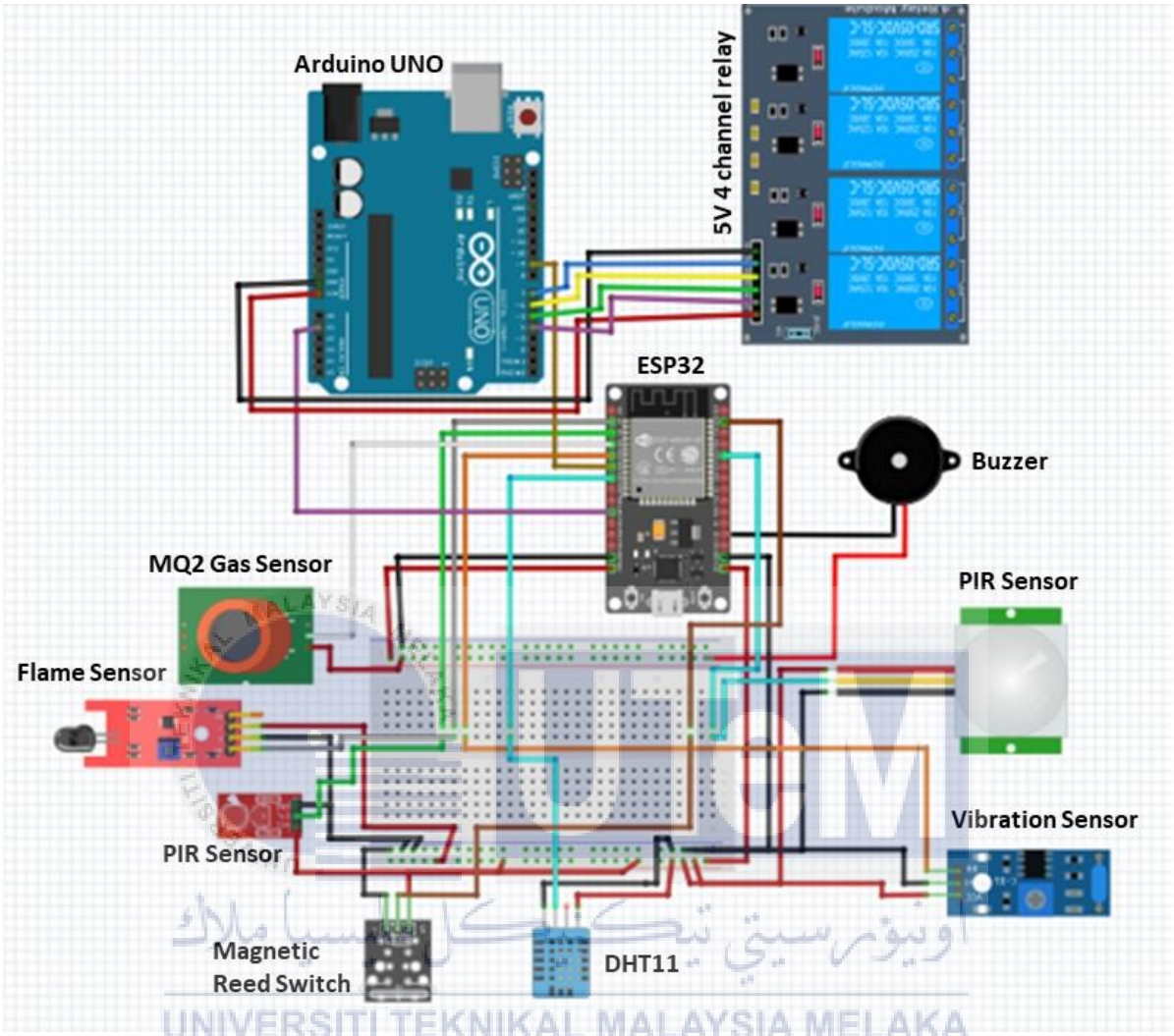


Figure 3.4 Circuit drawing for home automation system using fritzing.

The figure above demonstrates the whole connection of the home automation system. The brain of the system is ESP32 while Arduino is used to switching on or off the relay. The input part of this project consists of one buzzer, one relay, and seven sensors. One of the sensors which is the PIR sensor has three pins. The output pin is attached to the ESP32's D21 pin, the GND pin is connected to the Ground of the supply, and the VCC pin is connected to the supply voltage 3.3V of ESP32. The next component is the vibration sensor. The digital pin of the vibration sensor is connected to D35 of the ESP32, the GND pin is attached to the Ground of the supply, and the VCC pin is connected to the supply

voltage 3.3V of the ESP32. The DHT11 is the following sensor, and its input pin is attached to the D33 of the ESP32. The GND pin is connected to the Ground of the supply, and its VCC pin is connected to the 3.3V pin of the ESP32. For the flame sensor, the analog output is connected to D36 while the infrared sensor digital output is connected to D39 of the ESP32. Next, the magnetic reed switch output is connected to D22 while the vibration sensor output is connected to pin D35. All of the sensors except the MQ2 gas sensor supply are connected to the supply 3.3V of ESP32 while the MQ2 gas sensor is connected to Vin. The buzzer and the relay are both components that were designed as an output of this project. The Buzzer pin is connected to D2 of Esp32 while the relay pin is connected to pin 7 of Arduino UNO.

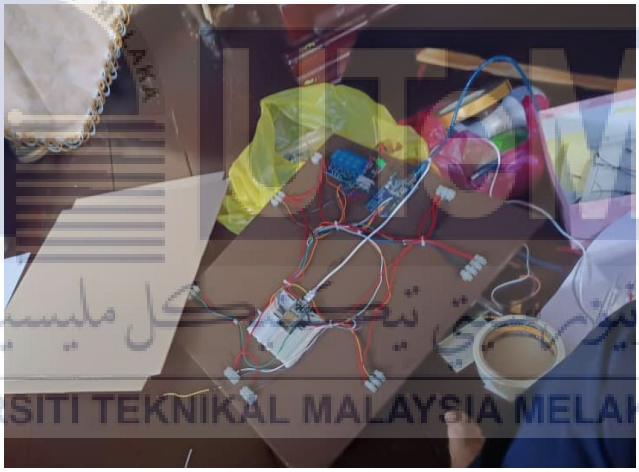


Figure 3.5 Install wiring for smart house

Figure 3.6 Test wiring continuity and voltage of each sensor

3.3.4 Drawing home automation and modelling

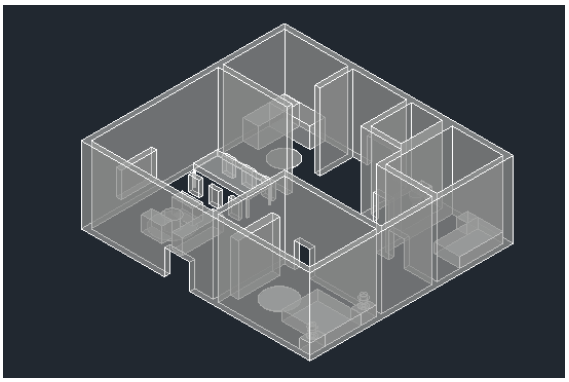


Figure 3.7 House model 3D view designed using AutoCAD

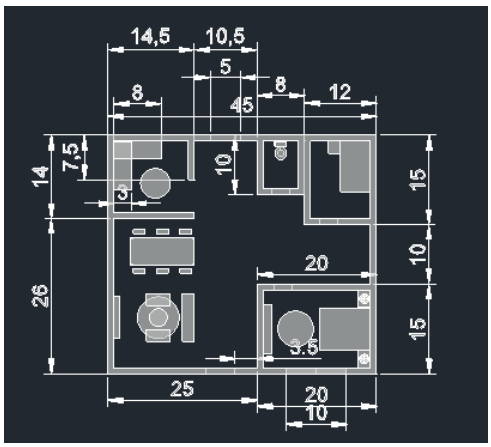


Figure 3.8 Dimension of house model

Figure 3.9 House model top view

Figure 3.10 House model 3D view

3.4 Work package 3: To build a remote monitoring system that can access data from sensors.

This part discusses the development of an IoT platform which is cayenne and telegram notification which is used to monitor and control home appliances..

3.4.1 Remote monitoring system flow.

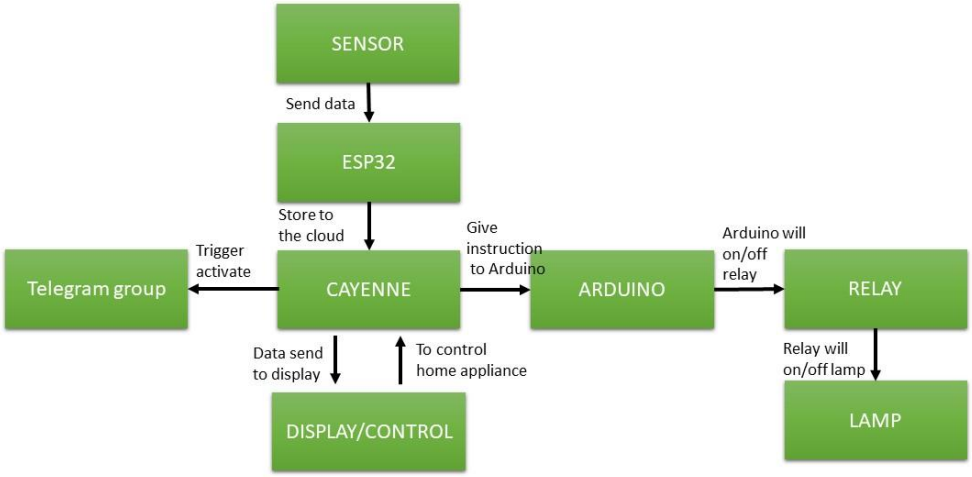


Figure 3.11 Figure show how remote monitoring system work

When the sensor senses something, it would send the signal to the ESP32 or Arduino UNO for the data. The data then transmitted to the IoT platform which is cayenne. The most important thing here is that it needs to have a strong and stable internet connection. After cayenne receives the data from ESP32 or Arduino, it would display the data in the dashboard. We can use smartphones or laptops to open and monitor the data as well as control it. To control the lamp, the user need to tap on the cayenne dashboard display on the smartphone, the instruction would be sent from the cayenne to Arduino. And then from Arduino to the relay and the relay will act as a switch to on the lamp. Lastly, for security systems, when each sensor detects an intruder coming through the house's door or window, the user would receive a notification from their smartphone's telegram group whereas the safety system would translate the signal in form of buzzer and telegram group notification.

3.4.2 Setup Cayenne

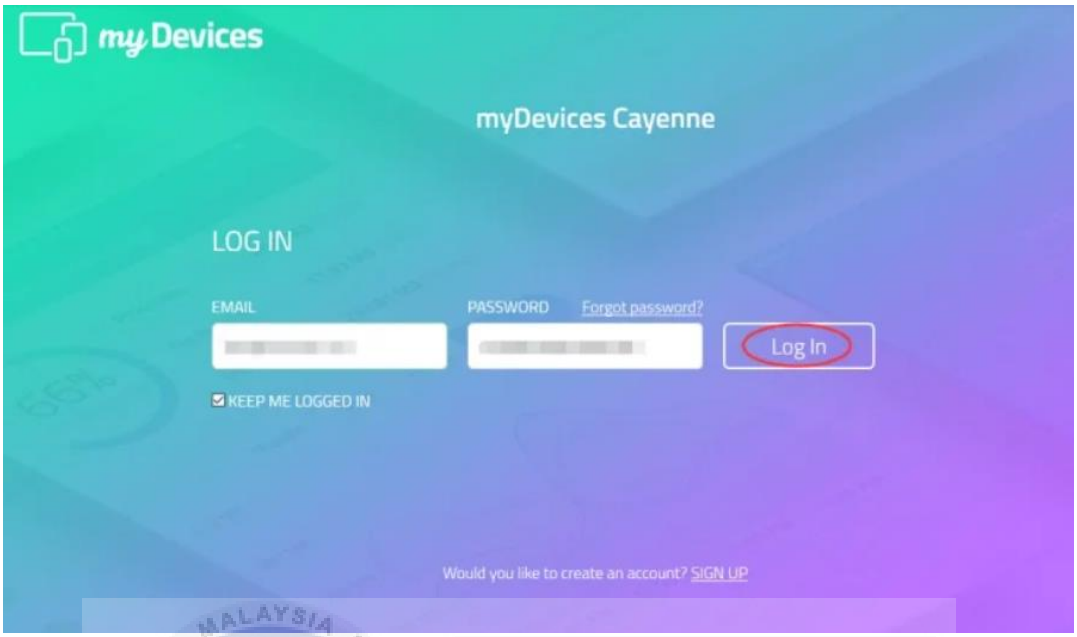


Figure 3.12: Step 1. Create Cayenne Account

Figure 3.13: Step 2. Hardware setup

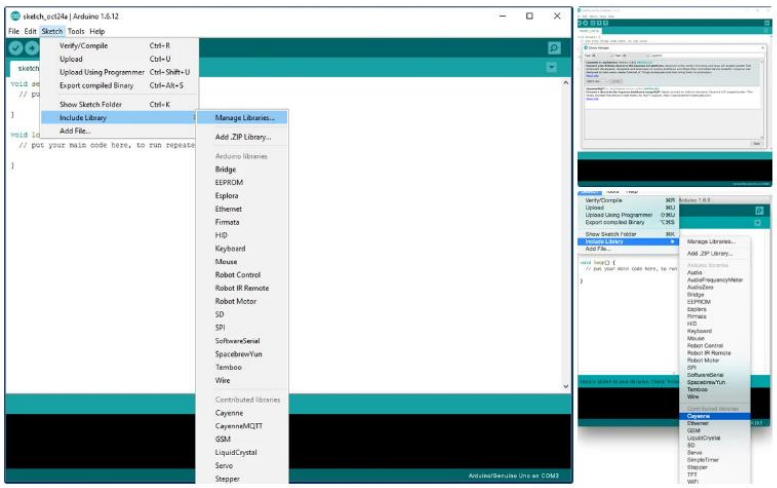


Figure 3.14: Step3. Add Cayenne Library to Arduino IDE

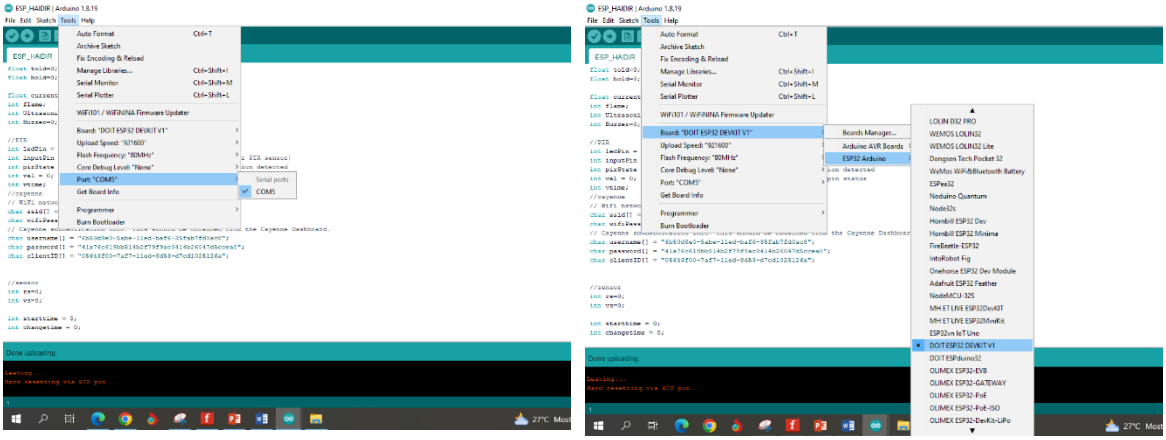


Figure 3.15: Step 4. Configure Arduino IDE

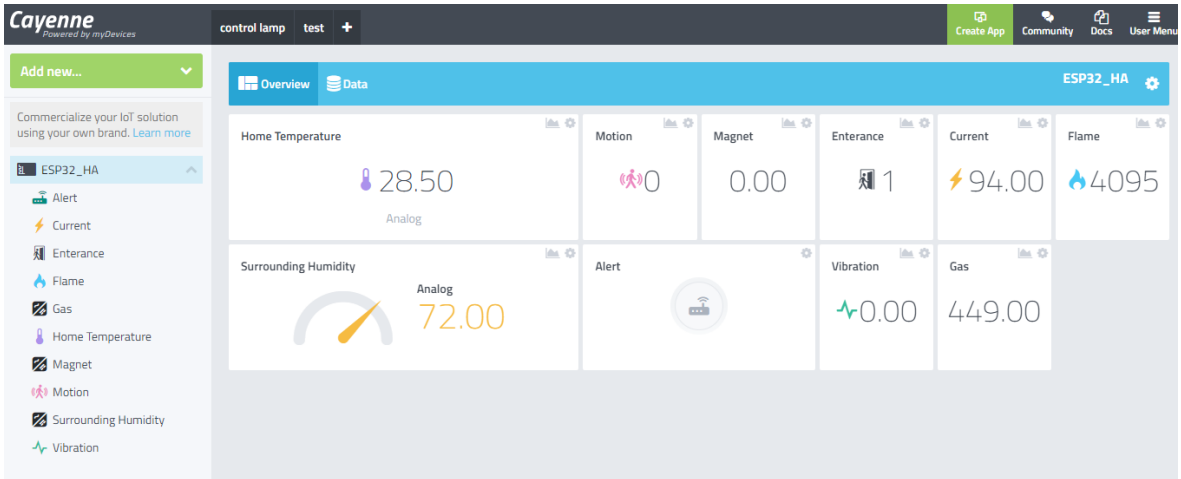


Figure 3.16: Step 5.Connect ESP32 to Cayenne IoT home automation

3.4.3 Add telegram group notification

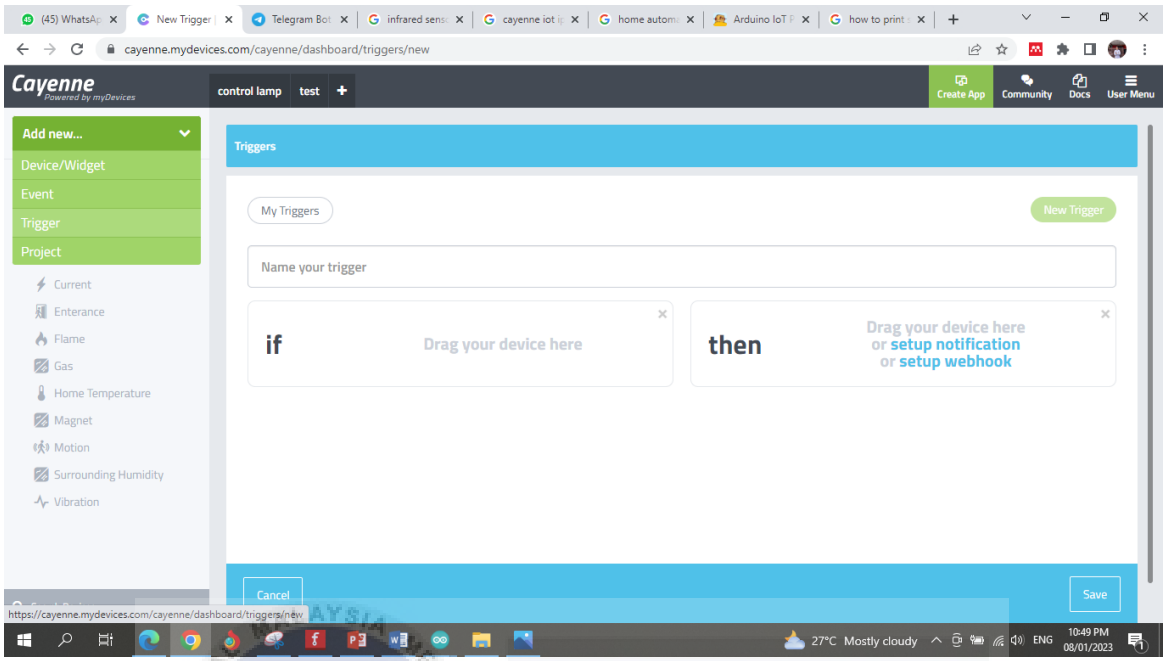


Figure 3.17: Step 1. Add new trigger

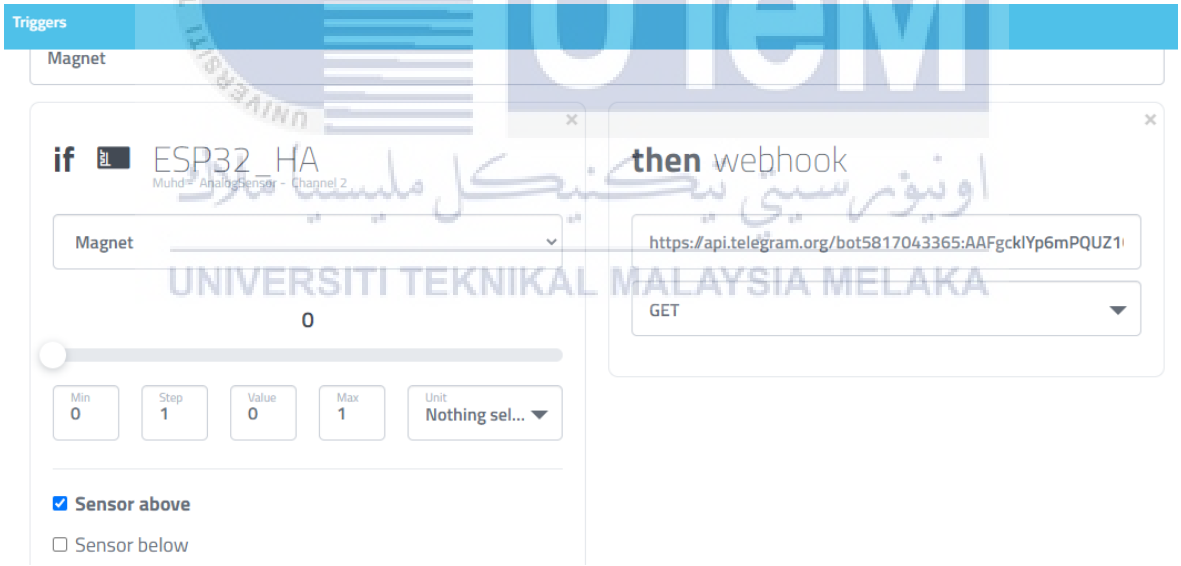


Figure 3.18: Step 2. Add if and then in the trigger

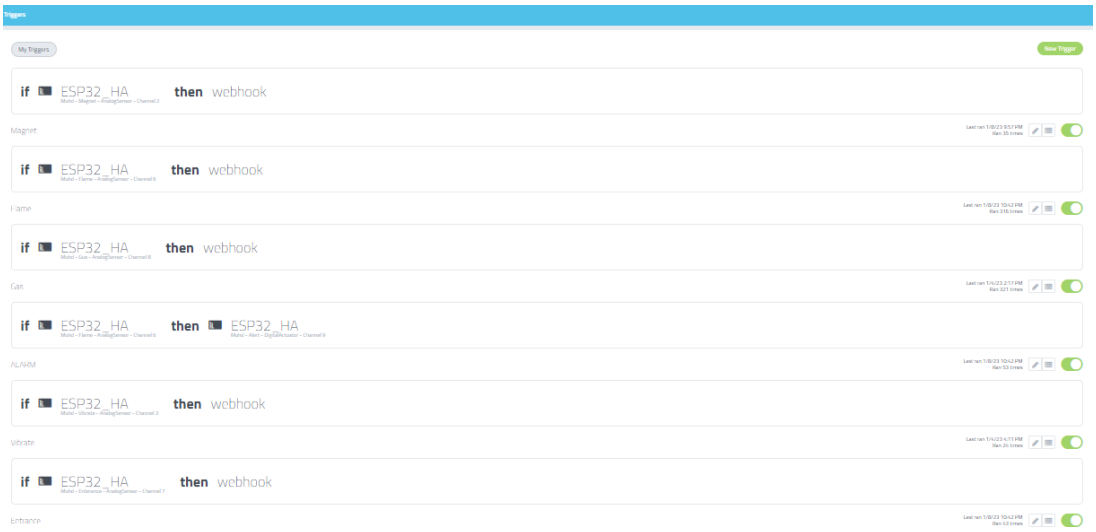


Figure 3.19: Step 3. Repeat steps 1 and 2 for another sensor

3.5 Work package 4: To analyse the performance of a home automation system that display a wide spectrum of energy saving automation, effectiveness of house security as well as efficiency of home safety.

In this section, the analysis and testing method is being explained. The process begins with the testing of the component functionality and analysis of the data.

The analysis and testing purpose is to test the system reliability performance of the IoT Home Automation System. The different types of sensors and different types of conditions which the home automation needs to perform will be tested. The process of testing is clearly shown in this subtopic. The performance of the Home automation system in terms of detecting the sensor and the control home appliance will be observed.

3.5.1 Energy saving

For energy saving, the method that were implemented was monitoring the hope appliance which is a lamp using cayenne as well as controlling it from far away. The sensor involved in this part is the PIR sensor which is connected to the relay and also the lamp. For the energy saving part, the relay would be used as a switch to on or off the lamp. So for this

section, the test is to on or off using the cayenne dashboard to control the lamp, and also PIR sensor would be a test whether it functions as desired or otherwise.

Table 3.2 Result for monitoring and control lamp

Sensor and actuator	Value at cayenne	Lamp status
Control using cayenne	Light will on/off	
PIR sensor	0 to 1	

3.5.2 Security system

For the security system, three sensors have been used in this home automation system. The sensor is a vibration sensor, magnetic reed switch, and infrared sensor. The infrared sensor was installed at the master bedroom window while the vibration sensor was installed at the piano room window. Lastly, the magnetic reed switch was installed at the door. Each sensor would be a tested whether it functions as desired or otherwise. For the security system, after each sensor turns from 0 to 1, it would notify the user via telegram group.

Table 3.3 Result of the security system

Sensor	Value at cayenne	Notification
Magnetic reed switch	0 to 1	
Vibration tilt sensor	0 to 1	
Infrared sensor	0 to 1	

3.5.3 Safety system

For the safety system, two types of sensors were implemented which are the MQ2 gas sensor and the flame sensor. MQ2 gas sensor was installed in the kitchen while a flame

sensor was in the master bedroom. Each sensor would be tested whether it functions as desired or otherwise. For the safety system, the value is an analog output that would display in the reading. If the condition requirement is met when the test is done, the buzzer would be activated and it will notify the user via telegram group.

Table 3.4 Result of the safety system

Sensor	Value	Notification	Alarm
Flame sensor	Range below 500		
MQ2 gas sensor	Range above 1500		

3.6 Work package 5: Writing up report.

In practice, the conference paper and article writing will occur concurrently with the completion of the other work packages. Additionally, after the conclusion of this study endeavor, a comprehensive report will be published.

3.7 Summary

This chapter covers the methods recommended to design a modern, effective, and comprehensive home automation system solution. The fundamental objective of the suggested technique is to achieve a simple, less rigorous, and effective estimate without significantly degrading the accuracy of the findings. The solutions are also meant to use the limited and publicly accessible network and load data from power utilities. The ultimate goal of the strategy is not to achieve the maximum level of precision, but rather an efficiency, usability, and flexibility on a wide distribution network.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the analysis and testing method is being explained. The process begins with the testing of the component functionality and analysis of the data.

The analysis and testing purpose is to test the system reliability performance of the IoT Home Automation System. The different types of sensors and different types of conditions which the home automation needs to perform will be tested. The process of testing is clearly shown in this subtopic. The performance of the Home automation system in terms of detecting the sensor and the control home appliance will be observed

4.2 Project prototype

Figure 4.1 below shows the prototype of the Home Automation. home automation system consists of one lamp, and seven sensors which are DH11, magnetic reed switch, vibration tilt sensor, flame sensor, MQ2 gas sensor, PIR sensor, and infrared sensor. Each sensor was installed at a different place. The microcontroller involved is ESP32 and Arduino Uno. lastly, a relay was used to control the lamp.

Figure 4.1 Smart house prototype

4.3 Project demonstration

Figure 4.2 shows the block diagram of the internet connection between Esp-32 with the access point of the internet which is the Wi-Fi router and mobile hotspot.

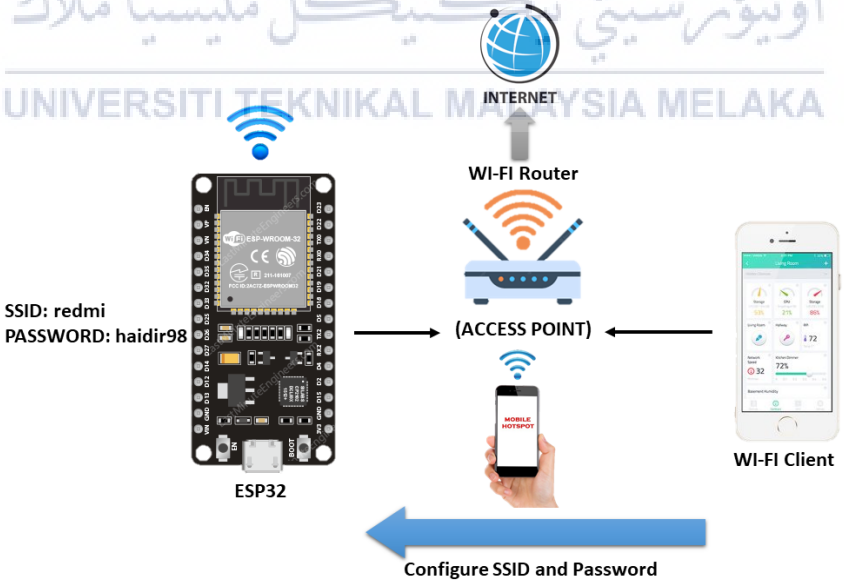


Figure 4.2 Block Diagram of internet connection to ESP32

4.4 Monitoring smart home using mobile or laptop

Just click the link and make sure have a stable internet connection on your mobile phone or laptop.

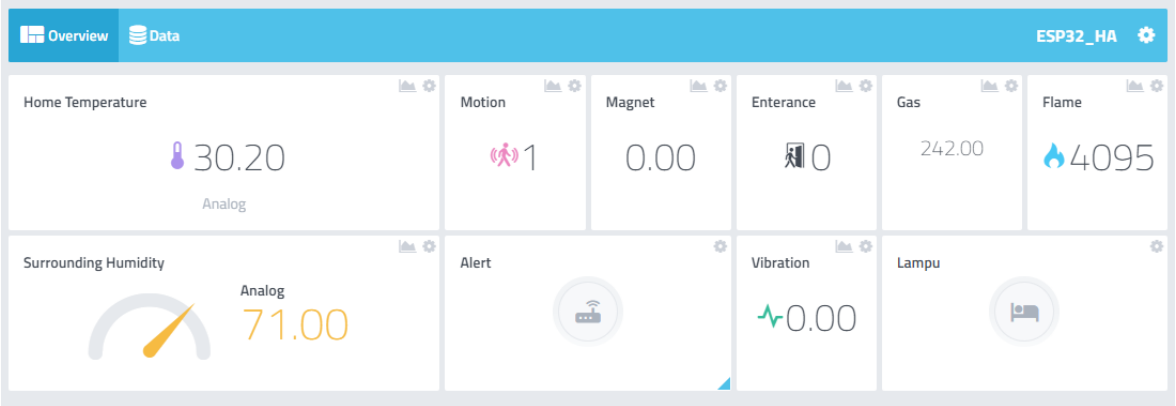


Figure 4.3 View using a laptop

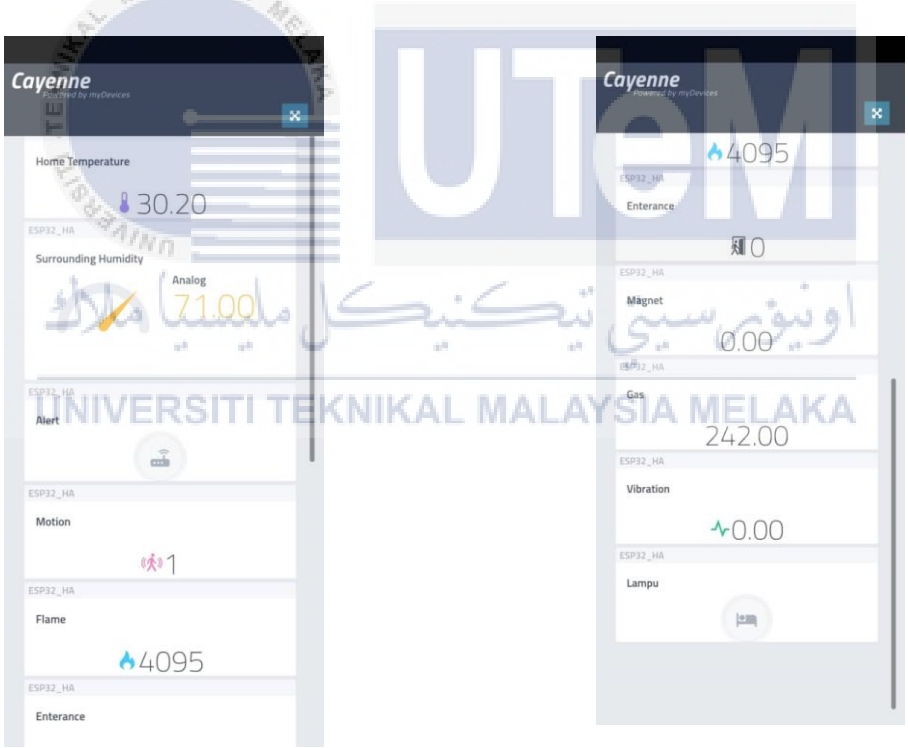


Figure 4.4 View using a phone

There are ten things that we can monitor for this home automation system. The user can check the humidity and temperature of their house. Other than that, the user can monitor the lamp status whether it is on or off condition as well as able to control it just by clicking

on the lamp widget button. For motion, it can detect if there is movement in the toilet. The user can also monitor the level of gas and the existence of flame as well as watch the door and window whether there is an intruder or not. Last but not least, the user can on or off the alarm as desired using cayenne.

4.5 Energy saving

For this part, there would be two part which is the monitor and control lamp. For the monitoring and control system, the status on/off would be displayed through a smartphone using IoT cayenne and the user would be able to on or off their lamp remotely. The only requirement that the user need is a stable internet connection to make sure that it would continuously connected with ESP32.

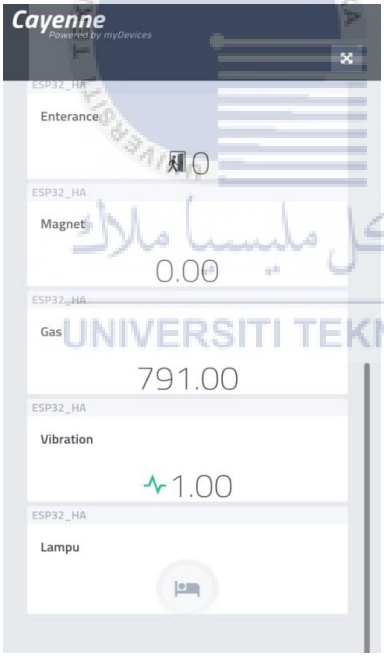


Figure 4.5 Display from smartphone status Light off

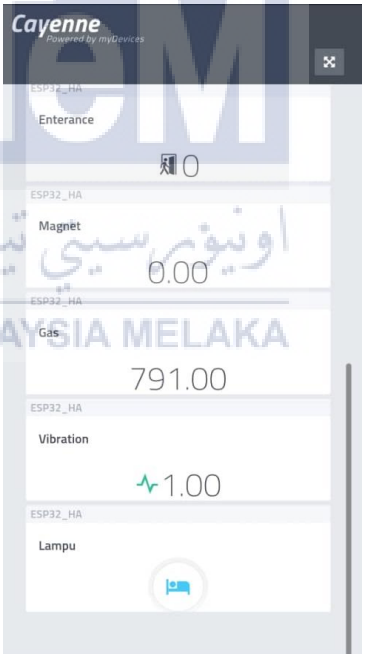


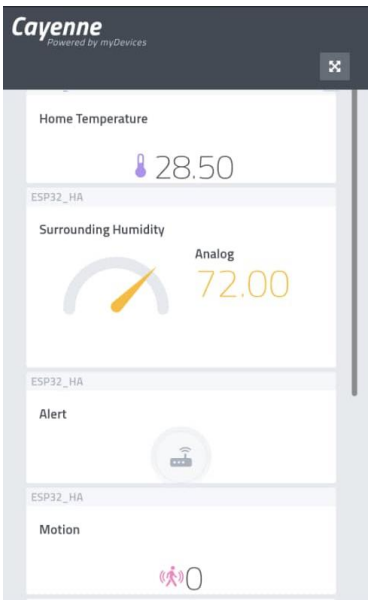
Figure 4.6 Display from smartphone status Light on

Figure 4.7 Light off

Figure 4.8 Light on

4.5.1 PIR sensor

Other than that, the sensor that was involved in this section was the PIR sensor. When the PIR sensor detects movement, the lamp would switch on for five seconds and then it would automatically switched off. The lamp would continuously switched on if it consistently detects movement.



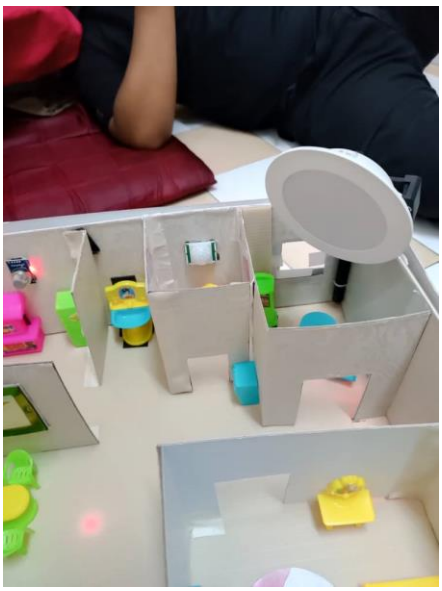


Figure 4.9 Before detect movement

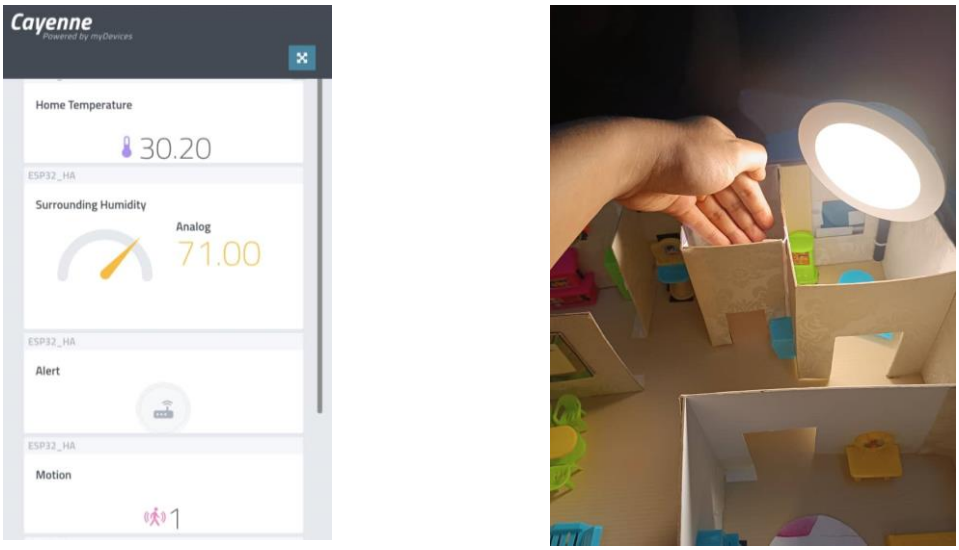


Figure 4.10 After detect movement

4.6 Safety system

For the safety system, there were two sensors that involved which were the gas sensor and the flame sensor.

4.6.1 Gas detector

The MQ2 gas sensor was utilized as the sensor type for the gas sensor. It was put in the kitchen for safety reasons. MQ2 Gas Sensor is a Metal Oxide Semiconductor (MOS) type Gas Sensor that detects gases such as methane, butane, lpg, smoke, and others. It is also called as Chemiresistors because gas detection is based on the change in resistance of the sensing material when in contact with the gas. Check out these Gas Sensors if you wish to monitor a different sort of gas.

The MQ2 Gas Sensor Module operates on 5V DC and consumes around800mW. It has a detection range of 200 to 10000 ppm for LPG, Smoke, Alcohol, Propane, Hydrogen, Methane, and Carbon Monoxide.

When the MQ2 gas sensor sense gas within range of 200 to 10000ppm, the reading would increase. After the reading value in the cayenne dashboard is more than 1500, the cayenne would activated the webhook where it would send a message to the telegram group user "Gas melebihi tahap bahaya! AWAS! Anda Waspada Anda Selamat!". The buzzer then would act as an alarm to alert people in the house.

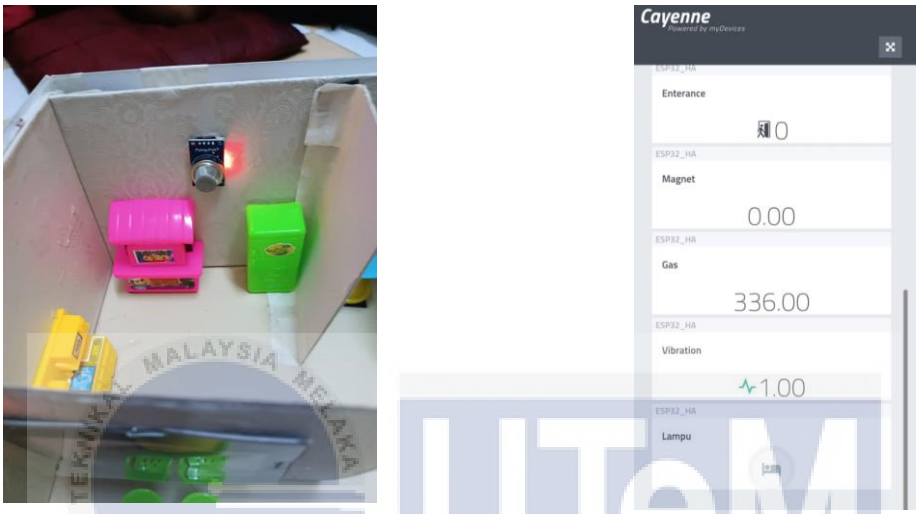


Figure 4.11 Before MQ2 gas sensor detects gas

Figure 4.12 After MQ2 gas sensor detects gas

Figure 4.13 Message sent to the telegram group after gas was detected at a dangerous level

Figure 4.14 Buzzer activated

4.6.2 Flame detector

The flame sensor was installed in the master bedroom. The flame sensor detects the presence of a flame by sensing infrared radiation emitted from the flame. When it does not detect any infrared radiation, it will shut off the furnace to prevent overheating and possible damage to other components. When the sensor sense flame radiation, the reading value in

the cayenne dashboard would be decrease. After the reading value is below 500, the buzzer which acts as an alarm would be on and at the same time, the telegram group would receive the message "Api Dikesan! Sila Ambil Langkah Segera Untuk Selamatkan Diri!.

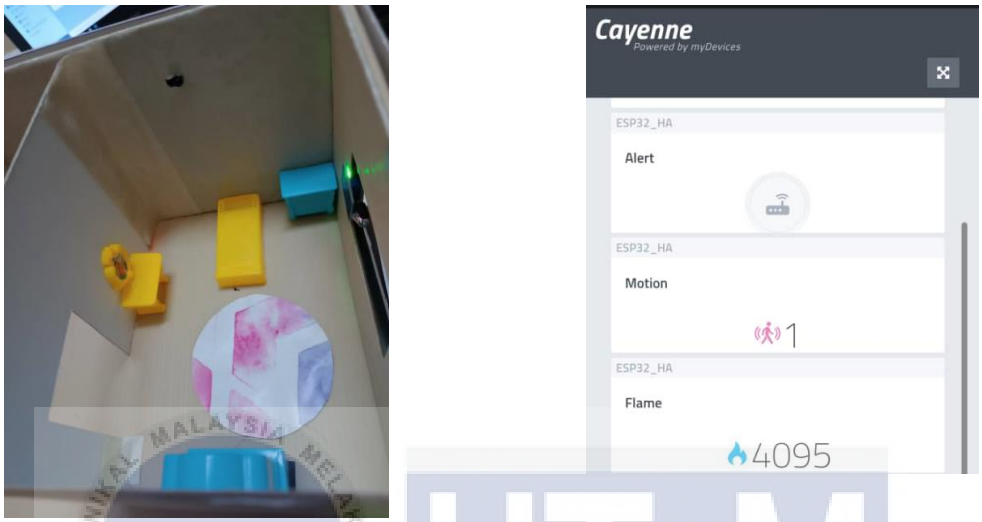


Figure 4.15 Before flame sensor detect flame radiation

Figure 4.16 After flame sensor detect flame radiaton

Figure 4.17 Message sent to telegram group after detecting the existence of flame

Figure 4.18 The buzzer will activated

4.7 Security system

4.7.1 Security for the door

The sensor used at the door was a magnetic reed switch. It was installed beside the door knob. The switching mechanism is made up of two ferromagnetic blades that are barely a few microns apart. When a magnet is brought close to these blades, they pull together. When the blades come into contact, the normally open (NO) contacts shut, allowing electricity to flow. When the door is open, the value in cayenne dashboard will change from 0 to 1. Then, the message "Pintu terbuka ada pencuri masuk! Will be sent to the user's smartphone telegram group to notify the user that there is an intruder opening the door.

Figure 4.19 Before the door was open

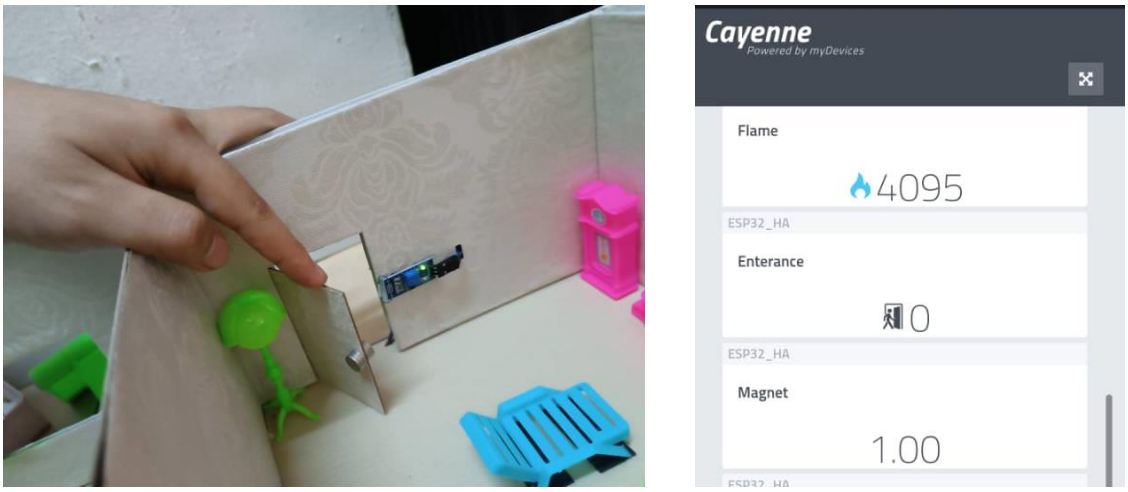


Figure 4.20 After the door was open

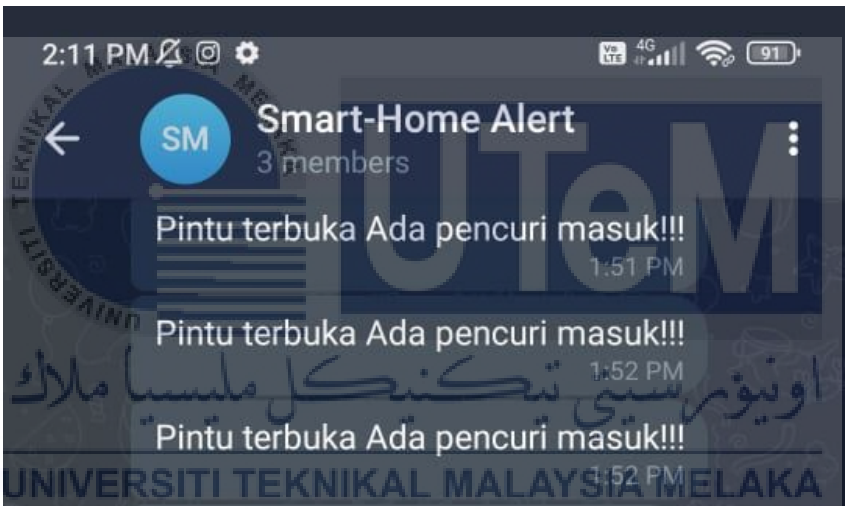


Figure 4.21 Message sent to telegram group after detecting the door open

4.7.2 Master bedroom window

The sensor used at the master bedroom window was the infrared sensor. It was installed beside a window. Infrared sensors use radar technology to transmit and receive infrared radiation. This radiation strikes nearby objects and bounces back to the device's receiver. When an intruder is coming through the window, the value at cayenne will change

from 0 to 1. Then, the message "ada orang masuk ikut tingkap depan! Will be sent to the user's smartphone telegram group to notify the user.

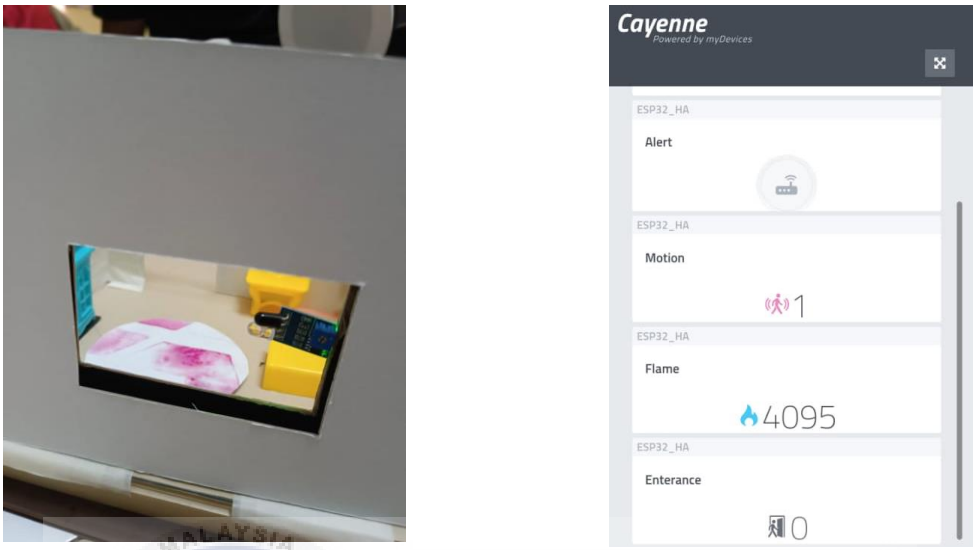


Figure 4.22 Before detecting the presence of someone coming through the master bedroom's window

Figure 4.23 After detecting the presence of someone coming through the master bedroom's window

Figure 4.24 Message sent to telegram group after detecting that someone coming through the window

4.7.3 Piano room window

The sensor used at the piano room window was a vibration tilt sensor. It was installed beside a window. Vibration tilt sensor can detect tilt and vibration for 360-degree multi-direction by some form of external stress that is greater than the tilt angle that was previously set, and automatically operate various devices ON/OFF. When an intruder is trying to break the window, the value at cayenne will change from 0 to 1. Then, the message "ada orang pecah tingkah belakang!" would be sent to the user's smartphone telegram group to notify the user.

Figure 4.25 Vibrate the vibration tilt sensor

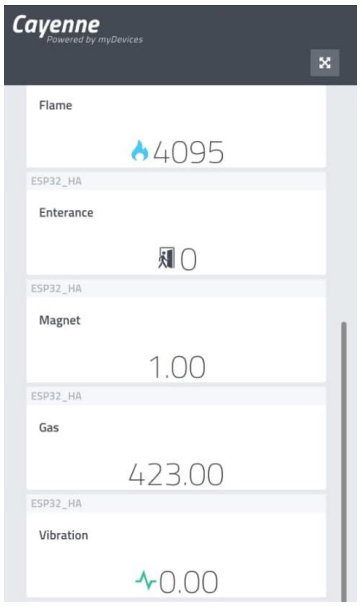


Figure 4.26 Before sense vibration

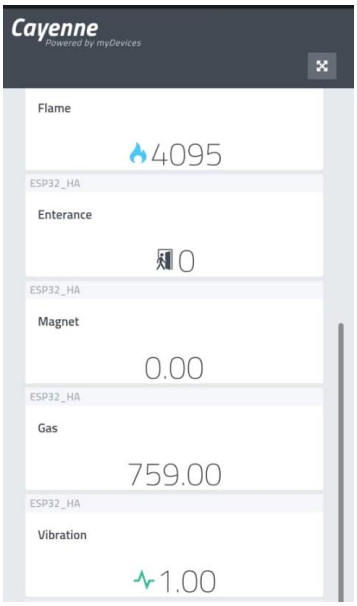


Figure 4.27 After sense vibration

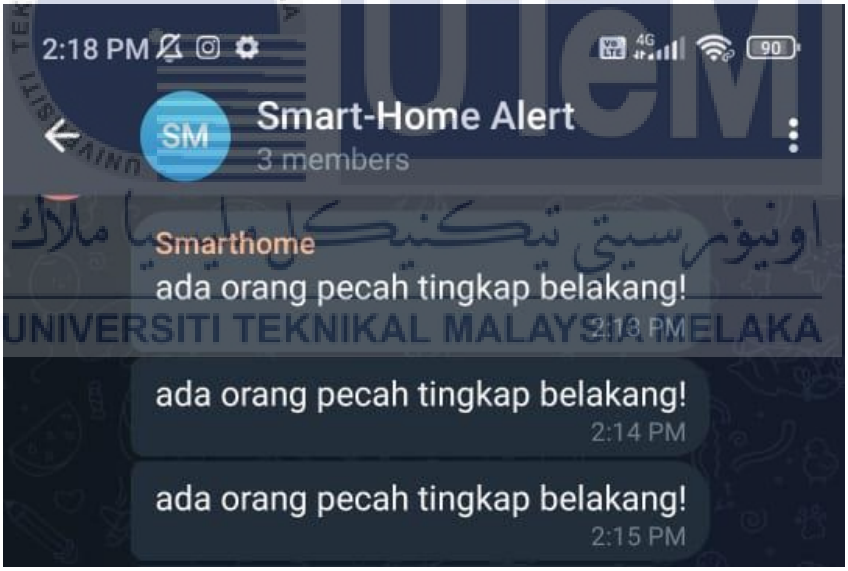


Figure 4.28 Message sent to telegram group after detected that someone break the window

4.8 Result and discussion

The comparison results for three different sections of the home automation system are shown in Table 4.1, Table 4.2, and Table 4.3. These sensors includes PIR sensor, vibration tilt sensor, infrared sensor, magnetic reed switch, MQ2 gas sensor, and flame sensor.

Table 4.1 Result for monitoring and control lamp

Sensor and actuator	Value at cayenne	Lamp status
Control using cayenne	Light will on/off	On/off
PIR sensor	0 to 1	On for five second if detect movement

When the user's smartphone connects with Cayenne, the user were able to monitors and controls the lamp installed in the house. Controlling the lamp remotely enables the user to save the electricity energy used when they are away from their home. Other than that, by having PIR sensor, the user doesn't have to worry about forgetting to switch off the lamp when they are away as it will automatically switched off when there is no movement detected in the installed area. However, the PIR sensor was too sensitive to movement and would switched on automatically without one's present which could come off as a slight advantage. Thus, this home automation system allows the user to disabled the lamp's movement detection completely by tapping the off button in their smartphone remotely. However, to enable the system would require a few minutes before it is fully functional

Table 4.2 Result of the security system

sensor	Value at cayenne	notification
Magnetic reed switch	0 to 1	Message sent to telegram group after detected the door open
Vibration tilt sensor	0 to 1	Message sent to telegram group after detected that someone break the window
Infrared sensor	0 to 1	Message sent to telegram group after detected that someone going through the window

According to the result of the security system, the value in cayenne dashboard will change from 0 to 1 and user will receive notification via telegram when magnetic reed switch, vibration tilt sensor and infrared sensor detects the door being opened and someone's coming through the window. However, the magnetic reed switch that was installed at the door would only work when the door is being opened. Thus, if the door were cut in the middle, the sensor would be pointless as it couldn't detects the door's movement to being open. While for both infrared and vibration sensor, these sensors were too sensitive to the surrounding and movement that it would easily activated, which could lead to false alarm. Thus, in order to solve this problem, installation of multi type of sensor in each door and window can help in avoiding false alarm and sensor not being able to detect intruder.

Table 4.3 Result of the safety system

Sensor	Value at cayenne	Notification	Alarm
Flame sensor	Range below 500	Message send to telegram group after detected existence of flame	Buzzer will activated
MQ2 gas sensor	Range above 1500	Message send to telegram group after detected gas at dangerous level	Buzzer will activated

Both the flame sensor and MQ2 gas sensor reading are in analog. Thus, when the flame sensor range is below 500, the alarm would be activated and notification would be send to the user smartphone's telegram while for MQ2 gas sensor, when the range is above 1500, the alarm would be activated and notification will be send to the user's Telegram. The flame sensor used is an Infrared flame sensor. This sensor is available in small size and is used to detect a source of fire or any other clear light source. Basically, this kind of sensor detects infrared light with 760 nm to 1100 nm range wavelength that is generated from the light source or fire. However, when the flame sensor detects any sort of light near it, it will trigger and activated the buzzer. To solve this issue, additional of sensors which is DHT11 is required. DHT11 helps in detecting the temperature and humidity whereas the flame sensor is used to detect the source of fire or any other clear light source. The reading of temperature and humidity level must be above certain level due to existence of flame and the flame sensor must be able to detect the source of flame to be able for the buzzer to send the alert notification to the user's Telegram

4.9 Summary

In conclusion, this chapter discuss about the sensor used to fulfilled this project main objectives which was to analyze the performance of a home automation system that displays a wide spectrum of energy saving, the effectiveness of house security as well as efficiency of home safety.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Conclusion

In conclusion, this IOT-based project has been successful in meeting the objectives to design a smart home, to build a remote monitoring system, to analyses the performance of home automation systems in security, energy saving, and home safety as well as improving the deficiencies of previous studies on related topics using ESP32 and Arduino.

Next, throughout the making, of this project, I have managed to identify the components involved which are the flame Sensor, MQ2 gas sensor, Vibration tilt sensor, Magnetic reed switch, Infrared sensor, PIR sensor, buzzer as well as a relay to control the light. The components involved are also affordable, easy to use, and portable in line with the main objectives of the project which is to analyze the performance of a home automation system that displays a wide spectrum of energy-saving automation, house security as well as home safety

Finally, the results of my project using Cayenne software is successful in monitoring and controlling the safety, security, and energy saving of the house even at long distance. Should there be any threats or emergencies that had to happen to the house, a signal would be sent to the phone using the platform Telegram to update on the current state of the house. Early precautions could be taken to avoid any unwanted matter from happening.

5.2 Future Works

The following enhancements might be made to the findings of this project to make this project better::

a) To apply this project to the real live house

b) Control lamp's brightness as well as other home appliances such as fans and air conditioners using a smartphone

c) Add voice google assistant to control home appliance

d) Add camera for security system

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APPENDICES

Appendix A Coding for home automation system

```
#define CAYENNE_PRINT Serial
#include <CayenneMQTTESP32.h>

#include "DHT.h"
#define DHTPIN 33
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);


#define distin 39
const int relay = 27;

//define sound speed in cm/uS
#define SOUND_SPEED 0.034
#define CM_TO_INCH 0.393701

long duration;
int distanceCm;


float h=0;
float t=0;
float told=0;
float hold=0;

float currents;
int flame;
int Ultrasonic;
int Buzzer=0;

//PIR
int ledPin = 5;             // choose the pin for the LED
int inputPin = 21;              // choose the input pin (for PIR sensor)
int pirState = LOW;             // we start, assuming no motion detected
int val = 0;                // variable for reading the pin status
int vtime;
//cayenne
// WiFi network info.
char ssid[] = "redmi";
char wifiPassword[] = "haidir98";
// Cayenne authentication info. This should be obtained from the Cayenne Dashboard.
char username[] = "6b50d8e0-5abe-11ed-baf6-35fab7fd0ac8";
char password[] = "41a76c619bb514b2f79f9ac0414b26047d5ccea0";
```

```
char clientID[] = "05643f00-7af7-11ed-8d53-d7cd1025126a";


//sensor
int rs=0;
int vs=0;

int starttime = 0;
int changetime = 0;

int gass=0;


    float h2 =0;
    float t2 =0;
    int rs2 =0;
    int vs2 =0;
    int pirState2=0;
    float currents2 =0;
    int flame2=0;
    float distanceCm2=0;
    int Buzzer2=0;
    int gass2=0;


void setup() {
  // put your setup code here, to run once:
  dht.begin();
  //pinMode(26,OUTPUT);
  pinMode(35,OUTPUT);
  pinMode(25,OUTPUT);
  pinMode(relay, OUTPUT);      // declare LED as output
  pinMode(ledPin, OUTPUT);      // declare LED as output
  pinMode(inputPin, INPUT);     // declare sensor as input
  pinMode(2, OUTPUT);
  Serial.begin(9600);
  Cayenne.begin(username, password, clientID, ssid, wifiPassword);
  starttime = millis();
  digitalWrite(35,LOW);
  digitalWrite(25,LOW);
  Cayenne.virtualWrite(V0,h);
  Cayenne.virtualWrite(V1,t);
  Cayenne.virtualWrite(V2,rs);
  Cayenne.virtualWrite(V3,vs);
  Cayenne.virtualWrite(V4,pirState);
//  Cayenne.virtualWrite(V5,currents);
  Cayenne.virtualWrite(V6,flame);
  Cayenne.virtualWrite(V7,distanceCm);
  Cayenne.virtualWrite(V8,gass);
```

```
}

void loop() {
  dhts();//1
  pir();//2~
  current();//
  reed();//
  vib();//5
  usdistance();//6
  fuego();
  gas();
  //siren();
  //changetime = millis() - starttime;
 //if (changetime > 1000){
  Cayenne.loop();
  publishdata();
  starttime = millis();
 //}
 delay(500);
}

CAYENNE_IN(V9)
{ Serial.println(getValue.asInt());
if(getValue.asInt()==1)
{ digitalWrite(2,HIGH); }
else
{ digitalWrite(2,LOW);}
}

CAYENNE_IN(V10)
{ Serial.println(getValue.asInt());
if(getValue.asInt()==1)
{ digitalWrite(relay,HIGH); }
else
{ digitalWrite(relay,LOW);}
}

void publishdata()
{
  bool test;
  test = ( h != h2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V0,h);}
  test =false;

  test = ( t != t2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V1,t);}
  test =false;

  test = ( rs != rs2 ) ? true : false;
```

```
  if (test) {Cayenne.virtualWrite(V2,rs);}
  test =false;

  test = ( vs != vs2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V3,vs);}
  test =false;

  test = ( pirState != pirState2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V4,pirState);}
  test =false;

//  test = ( currents != currents2 ) ? true : false;
//  if (test) {Cayenne.virtualWrite(V5,currents);}
//  test =false;

  test = ( flame != flame2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V6,flame);}
  test =false;

  test = ( distanceCm != distanceCm2 ) ? true : false;
  if (test) {Cayenne.virtualWrite(V7,distanceCm);}
  test =false;


  test = ( gass != gass2 ) ? true : false;
  if (test){Cayenne.virtualWrite(V8,gass);}
  test =false;

   h2 = h;
   t2 = t;
   rs2 = rs;
   vs2 = vs;
   pirState2 = pirState;
//   currents2 = currents;
   flame2= flame;
   distanceCm2 = distanceCm;
   Buzzer2= Buzzer;
   gass2 = gass;
   Serial.println("Dist: "+String(distanceCm));
}
void dhts()
{
  h = dht.readHumidity();
  // Read temperature as Celsius (the default)
  t = dht.readTemperature();

  if (isnan(h) || isnan(t)) {
    Serial.println(F("Failed to read from DHT sensor!"));
    return;
  }
```

```
  if ( h != hold|| t != told){
  Serial.print(F("Humidity: "));
  Serial.print(h);
  Serial.print(F("% Temperature: "));
  Serial.print(t);
  Serial.println(F(""));
  hold=h;
  told=t;
  }

}

void pir(){
  val = digitalRead(inputPin);   // read input value

  if (val == HIGH)  // check if the input is HIGH
  {
    digitalWrite(ledPin, HIGH);  // turn LED ON

    if (pirState == LOW)
  {
      Serial.println("Motion detected!"); // print on output change
      pirState = HIGH;
      digitalWrite(relay,HIGH);
    }
  }
  else
  {
    digitalWrite(ledPin, LOW); // turn LED OFF

    if (pirState == HIGH)
  {
      Serial.println("Motion ended!");  // print on output change
      pirState = LOW;
      digitalWrite(relay,LOW);

    }
  }

}

void current(){
 currents= analogRead(32);
 Serial.println("Current: "+String(currents));
}

void fuego(){
 flame =analogRead(36);
 Serial.println("Flame: "+String(flame));
```

```
}

void gas(){
 gass = analogRead (34);
 Serial.println("Gas:"+String(gass));
}

void reed(){
  if (digitalRead(22)!=  0){
  rs=1;
  Serial.println("Magnet  Detected");}
  else{
    rs=0;
  }
}

void vib(){
  Serial.println("Vib:  "+String(analogRead(35)));
  if (analogRead(35)==  4095){
    vs=1;
    vtime=millis();
  Serial.println("Vibration  Detected");}
  else{
    if (millis()-vtime  >= 3000){
    if (vs == 1){
    vs=0;
    Serial.println("Vibration  Ended");}
    }
  }
}

void usdistance(){
  int x = analogRead(39);
  if (x > 3000){
  distanceCm=0;}
  else{distanceCm=1;}


}
```