UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

DEVELOPMENT OF SMART HOME: FIRE SAFETY SYSTEM USING IOT

MUHAMMAD FIRDAUS BIN JAMALUDDIN

Bachelor of Computer Engineering Technology (Computer System) with Honours

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DEVELOPMENT OF SMART HOME: FIRE SAFETY SYSTEM USING IOT

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A project report submitted
in partial fulfilment of the requirements for the degree of
Bachelor of Computer Engineering Technology in
Computer System with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DECLARATION

I declare that this project report entitled “Development of Smart Home: Fire Safety System Using IoT” 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 : 

Student Name : MUHAMMAD FIRDAUS BIN JAMALUDDIN

Date : 24/1/2023

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 Computer Engineering Technology(Computer System) with Honours.

Signature : 

Supervisor Name : EN NOOR MOHD ARIFF BIN BRAHIN

Date : 24/1/2023

Signature :

Co-Supervisor :

Name (if any)

Date :

ABSTRACT

Every house now requires a fire safety detection system, as it has become increasingly common over the past year. This is due to the extensive damage caused by the fire, which resulted in the loss of human life. When a fire spreads to the surrounding area, those accidents can be far more catastrophic than we realize at the time. Fire safety systems are meant to detect fires early in their emergence, allowing for the emergency evacuation of occupants while the fire is still in its early stages of growth. As a result of this type of situation, the development of a Smart Home Fire safety system using IoT has been decided, which will involve the usage of the Internet of Things, which will be a critical component of the project's development. The objective of this project is to design a monitoring system using a smoke sensor, flame sensors, and a microcontroller, to develop a telegram bot to monitor & control home appliances, and to validate the developed project prototype for the smart home system. This project will be using ESP32 as a microcontroller that acts as the brain of the project. Then, the flame and smoke sensor will be deployed in the project as the main sensor for the detection of smoke, gas, and fire in the household. This project features that allow users can control any safety equipment with their smartphones if a fire happens unexpectedly. This project is user-friendly as it introduced a better improvement for life.

ABSTRAK

Setiap rumah kini memerlukan sistem pengesanan keselamatan kebakaran, kerana ia telah menjadi semakin biasa sejak setahun lalu. Ini berikutan kerosakan besar akibat kebakaran yang mengakibatkan kehilangan nyawa manusia. Apabila kebakaran merebak ke kawasan sekitar, kemalangan tersebut boleh menjadi jauh lebih malapetaka daripada yang kita sedari pada masa itu. Sistem keselamatan kebakaran bertujuan untuk mengesan kebakaran pada awal kemunculannya, membolehkan pemindahan kecemasan penghuni semasa kebakaran masih dalam peringkat awal pertumbuhannya. Hasil daripada situasi jenis ini, pembangunan sistem keselamatan kebakaran rumah pintar menggunakan IoT telah diputuskan, yang akan melibatkan penggunaan Internet , yang akan menjadi komponen penting dalam pembangunan projek. Objektif projek ini adalah untuk mereka bentuk sistem pemantauan menggunakan penderia asap, penderia nyalaan dan mikropengawal, untuk membangunkan bot telegram untuk memantau & mengawal perkakas rumah, dan untuk mengesahkan prototaip projek yang dibangunkan untuk sistem rumah pintar. Projek ini akan menggunakan ESP32 sebagai mikropengawal yang bertindak sebagai otak projek. Kemudian, penderia api dan asap akan digunakan dalam projek itu sebagai penderia utama untuk pengesanan asap, gas dan api dalam isi rumah. Ciri projek ini yang membolehkan pengguna mengawal sebarang peralatan keselamatan dengan telefon pintar mereka jika kebakaran berlaku tanpa diduga. Projek ini mesra pengguna kerana ia memperkenalkan peningkatan yang lebih baik untuk kehidupan.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Every house now requires a fire safety detection system, as it has become increasingly common over the past year. This is due to the extensive damage caused by the fire, which resulted in the loss of human life. When a fire spreads to the surrounding area, those accidents can be far more catastrophic than we realize at the time. Fire safety systems are meant to detect fires early in their emergence, allowing for the emergency evacuation of occupants while the fire is still in its early stages of growth (Ahrens, 2020). Early detection is also critical in ensuring the protection of emergency responders on the scene. Due to early detection, it is possible to decrease property damage and minimize downtime for the operation. This is possible since control efforts are initiated when the fire is still in its early stages. In most cases, emergency personnel is provided with specific details relating to a fire, which speeds up the process of putting out the flames (Maciej Serda, 2013).

There are a variety of factors that contribute to the occurrence of fires in residential buildings. In addition to causing property damage and life-threatening incidents. One of the most common causes and contributing factors to such accidents is the use of kitchen utensils in the household. Because of their mentality, most people do not pay attention while using cooking tools such as toasters or ovens, and the majority of them are preoccupied while cooking in their unconscious minds (Ahrens, 2020). Lightning strikes can also cause fires in homes, which is something to be aware of because of the influence of changing weather patterns disasters like this cannot be predicted. Other problems also can happen when electrical appliances and components are used in the home. This problem will be caused by a short circuit that occurs unexpectedly and will invariably result in a fire happened.

As a result of this type of situation, the development of a Smart Home: Fire Safety System Using IoT has been decided, which will involve the usage of the Internet of Things, which will be a critical component of the project's development. Since the Internet of Things can be accessed from any location and may also inform users via their smartphones when a terrible situation occurs. The system also can give freedom for the user to control any home appliances in their home using the telegram bot. The usage of the Internet of Things in the project will help it adapt to the new standard of the system that is currently in use this day.

1.2 Problem Statement

To understand the project's relevance, it needed basic study that may lead to its development. This project's research employed a dataset from an English and Welsh study on statistics that includes the percentage of households with fire alarms and the overall number of fire deaths. According to the report, 93% of households have fire alarms, but many people still die in fires (Saeed et al., 2018). More than ten deaths per million inhabitants still occur annually, as well as severe property damage, which can be attributed to an alarm malfunction, no reaction, and other inexplicable circumstances. This event gives the inspiration to design the notion of a smart home, which incorporates an Internet of Things-based fire safety system that is low-cost production, provide control in house and easy to be deployed throughout the house to increase awareness.

1.3 Project Objective

It is necessary to meet several goals to complete this project, and the achievement of these goals will define the project's overall success. In this project, the primary goal is to design a Development of Smart Home: Fire Safety System Using IoT. The following are the objectives that have been established:

I. To design a monitoring system by using flame sensor, MQ2 gas sensor and microcontroller.
II. To develop a telegram bot to monitor & control home appliances.
III. To validate the developed project prototype for the smart home system.

1.4 Scope of Research

This project is concerned with the development of new product technology that is in line with existing requirements. Additionally, this project will be followed by the development of product designs and the completion of some research into how the fire occurred and how to avoid a recurrence of the occurrence utilizing the specified system. Furthermore, the analysis of it is the primary emphasis of this study. As a result, this project adheres to the scope of the study outlined below:

I. Design the prototype of Smart Home: Fire Safety System Using IoT.

II. The system will trigger the sensor included in it (IR infrared Flame detection Sensor, MQ2 Smoke LPG CO Sensor)

III. This system will notify users via telegram bot when a fire and smoke is detected in the house.

IV. Users can control home appliances in their houses.

1.5 Project Outline

This report is broken down into four different chapters, each of which discusses a different aspect of the project's execution. Following the purpose that has been discussed before, this project is broken up into four (4) chapters, the contents of which are summarised as follows:

I. In Chapter 1, the background of the Smart Home: Fire Safety System Using IoT is introduced. There is a problem statement and a list of objectives to be attained to solve the problems.

II. Chapter 2 reviews the literature. In this part, describe researcher project implementation and functionality-related research. A comparison of the projects reveals the main idea, theory, and substance of implementation for this project.

III. The methods utilized to carry out this project are described in Chapter 3. Taking specific measures to build this project while adhering to the given objectives constitutes the technique. In addition, a flowchart is intended to depict the entire operation of this project's system.

IV. Included in Chapter 4 are the specifics of the preliminary outcomes gained from the execution of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss some data and research gathered from prior projects. Thus, this study is founded on the significance of numerous aspects, including the requirement for IoT in a project, the significance of past projects, and the benefits of the established project. This is critical to ensuring that the project that will be developed meets the stated objectives. In summary, the end of this chapter will compare the project that was previously developed and implemented, as well as the project's shortcomings and advantages.

2.2 Concept of Smart Home in Safety System

In the simplest concept and general, any house configuration that allows appliances and equipment to be automatically controlled from anywhere with an internet connection using a smart telephone or other networked device is referred to as a "smart home." In a smart home, devices communicate with one another through the internet, allowing the user to control features such as home security access, door, exhaust fan, and the function of the other. On the other concept according to (Ricquebourg et al., 2006), Smart Homes, alternatively referred to as automated homes, intelligent buildings, integrated home systems, or domotics, are a relatively new concept in architecture nowadays. With the emergence of this smart home, it will essentially make it easier for us to operate the equipment or certain components in the house according to our preferences.

Figure 2. 1: Example of smart home concept

The concept of the smart home enables consumers to experiment with new features, such as (Chan et al., 2009) :

1. The smart home may improve the comfort, safety, convenience, and interactivity of home life, as well as maximize people's way of life by utilizing technology.
2. Smart homes can track and communicate with their surroundings through the use of telephones, smartphones, and remote networks, allowing them to detect and respond to anomalies in real-time.
3. Enable the "three networks" business model and provide the best intelligent service possible.

Thus, it can be concluded that there are numerous benefits associated with the existence of the smart home concept, which has become a phenomenon in the twenty-first century. This is because the smart home's role might be a convenience to the entire house in terms of ensuring the family's safety and property.

2.3 Concept of the fire detection system

Essentially, a fire safety detector or system is a type of safety system that assists in the prevention of fires. The system incorporates many sensors that act as inputs for determining the source of the incident, such as the presence of fire and unexpected smoke detection, as well as alarm features that detect when anything is wrong, deter possible threats, and alert the appropriate authorities. rapidly and efficaciously. This is a summary of the notion of a fire safety system that the public constantly hears about but possibly few people understand how the concept of this system works and functions properly. As previously said in the earlier chapter, having this type of fire prevention system will enable the entire house to be protected if something horrible happens, such as a fire. According to the National Fire Protection Association (NFPA), two-thirds of all household fires in the United States occur on-premises without functioning smoke alarms, alarms that are not maintained properly, or alarms that are lost (Ahrens, 2011). Therefore, having good maintenance of the alarm and the system is a good idea to practice in every household to keep the system up to date and properly functioning.

2.4 Concept of Internet Of Things

As a general concept, the term "IoT" (i-o-t) refers to the Internet of Things. This term is gaining popularity in today's fast-paced technological world. Now and then, the Internet of Things is discussed everywhere. It is a network-based concept in which equipment, machines, sensors, and devices are connected to the internet, and data collection, as well as transfer, occur through a network. According to (Adhao & Mapari, 2017), The Internet of Things (IoT) concept was coined in 1999 by a member of the Radio Frequency Identification (RFID) development community, and it has only recently gained practical relevance, owing largely to the growth of mobile devices, embedded and ubiquitous communication, cloud computing, and data analytics. Consider the following examples of how the Internet of Things concept is applied:

1. Without IoT, the user's home door is simply another door. When installed, a gadget detects when the door is opened or closed and sends a notification to the user's smartphone.
2. Motion detection (motion detection) is used by home CCTV cameras to capture images and deliver them to the host.

3. Cat is equipped with a chain-mounted GPS tracker, and the user can view the cat's whereabouts via a phone app. A more complex system will send an alert if a cat leaves a specified geographical radius.

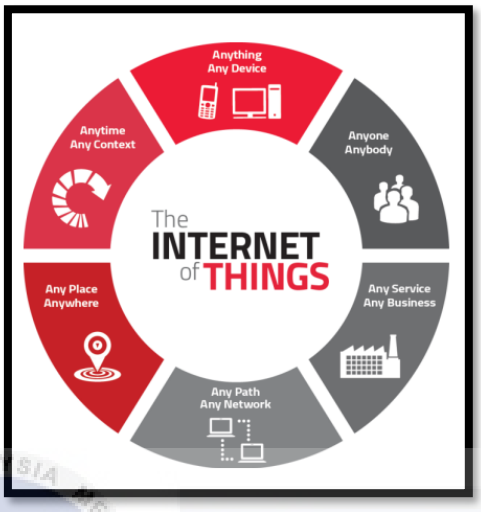

Figure 2. 2 : Example of IoT concept

The Internet of Things (IoT) is a concept and a paradigm that refers to the pervasive presence in the environment of a variety of things/objects that can interact with one another and cooperate with other things/objects via wireless and wired connections and unique addressing schemes to create new applications/services and accomplish common goals. The research and development problems associated with creating a smart world are tremendous in this context. A world in which the physical, digital, and virtual converge to produce intelligent settings that improve the efficiency of energy, transportation, and cities, among other areas (Patel et al., 2016).

2.5 Previously Related Projects

The analysis of prior relevant projects focuses mostly on the IoT-based smart home and fire detection features contained in the system. The previous related project's research will serve as a benchmark for the development project stated in the final chapter of the introduction. As such, this section will include projects that employ comparable tactics and ideas in order to accomplish the project's aim.

2.5.1 IoT Based Intelligent Smart home Environment for Fire Prevention and Safety.

Faisal Saeed, Anand Paul, Abdul Rehman, Won Hwa Hong, and Hyun Cheol Seo are the authors of the project, and they stated that the suggested smart home fire detection system is composed of four essential components which are a sensor, a processing unit that serves as the primary house sink, a GSM communication system, and an alarm system (Saeed et al., 2018). They also stated that they were deployed multi-sensor examples like smoke/gas sensors and heat sensors for each portion of the smart homes. All these sensors have their own unique event detection mechanism when the system is fully operating. The figure below will show the complete model for the proposed project of it. The processing unit includes a home sink that communicates with the sensors through ZigBee. The sink decides whether to detect a fire based on sensor data and user input. If a single sensor node detects a fire, the sink instantly enables GSM communication and alerts the user. The sink decides based on the user's response or alerts from other sensors. The sink triggers an alarm after two or more detectors, or the user confirms a fire incident. At the same time, the system sends event data to the cloud and local server, helping to reach emergency service units.

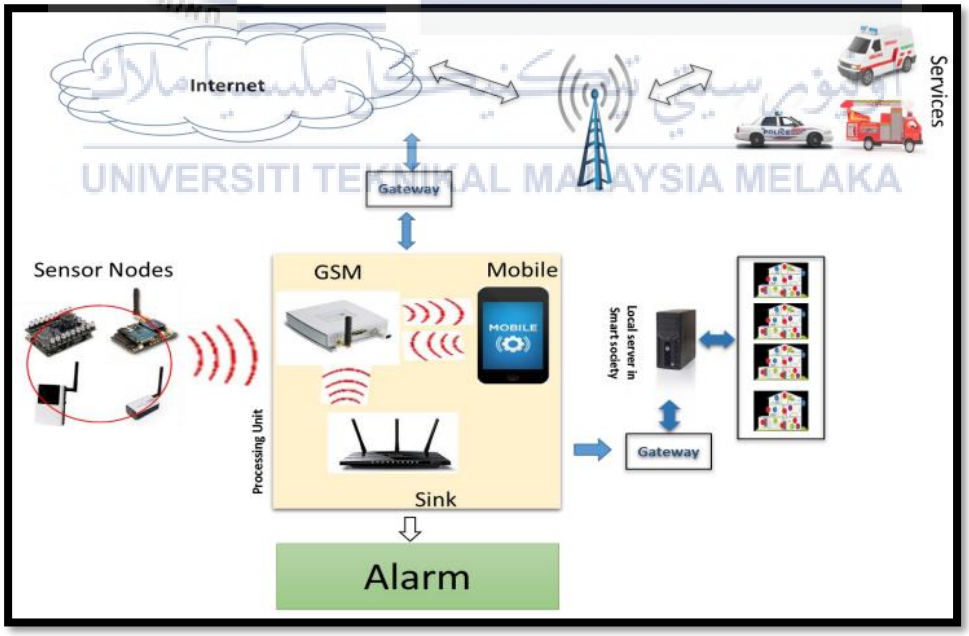

Figure 2. 3: The proposed concept of IoT Based Intelligent Smart home Environment for Fire Prevention and Safety

2.5.2 IoT based Fire Detection System

The project's authors, Devanshi Pandey, Rutuja Pawar, Jyoti Sharma, Santosh Rathod, and Chetan Mahajan, claim that the Smoke Sensor (MQ2 gas sensor) was used to detect the concentration of gases such as liquefied petroleum gas (LPG), propane, methane, hydrogen, alcohol, flue gas, and carbon monoxide in the air by using an electronic sensor (Patil et al., 2021). When operating at a constant voltage of 5 V, the sensor in the proposed invention can detect gases with concentration ranges up to 10,000 parts per million. The ESP8266 is used as a Wi-Fi module, which allows any microcontroller to connect to a wireless network using the designed solution. The ESP8266 can be used to host an application, or it can be used to load all Wi-Fi network functions from a separate application processor. The ESP8266 is employed as a Wi-Fi module in this project because the Arduino Uno is the microcontroller that is being deployed. Whenever a smoke or heat detector is activated, a signal is sent to the alarm system, which then triggers a pre-programmed response to take place. Most users have their systems configured to send emergency calls to the central monitoring station as soon as the gadget is activated by the user to ensure that the fire department arrives on the scene as soon as possible.

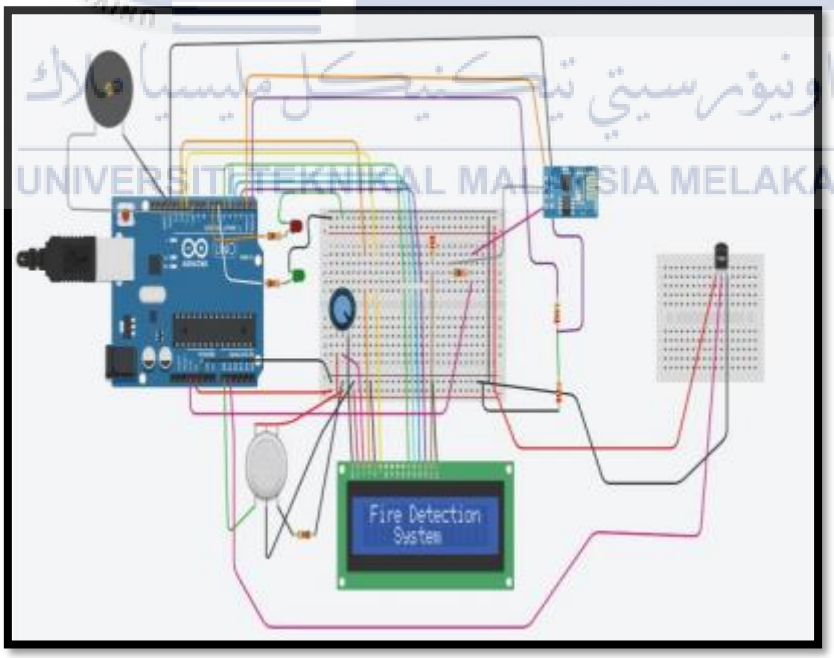

Figure 2. 4: Circuit diagram of the project (IoT based Fire Detection System)

2.5.3 Smart Home System using Internet Of Thing

The authors of the project, Leo Willyanto Santoso, Resmana Lim, and Kevin Trisnajaya, indicated that they used a WeMos ESP8266 as the microcontroller. As mentioned, ESP8266 is a low-power Wi-Fi chip that includes a complete TCP/IP stack and an MCU (Santoso et al., 2018). When the WeMos ESP8266 is connected to RFID in order to read data from existing ID tags, switches are important for organizing the connected solenoid with the 12-V adapter and WeMos ESP8266. PIR sensors are used to detect the movement of people, animals, and other things in the proposed project. They are frequently employed in alarm systems and lighting systems that operate on their own. The sensor transforms the ensuing change in the infrared radiation received into a change in the output voltage, which initiates the detection. Additionally, the database is used to store data that is received from a server and user input. The database stores information about user accounts, such as tokens and RFID tags.

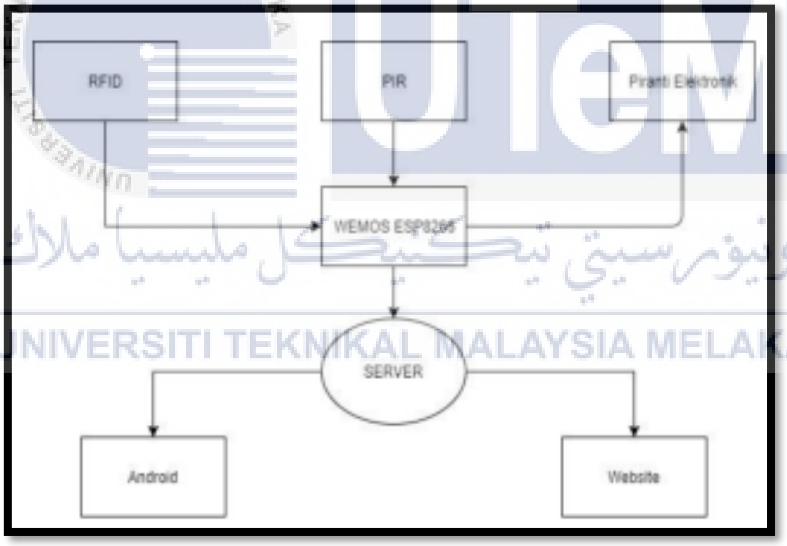

Figure 2. 5: Block diagram of the proposed project

2.5.4 IoT Based Automatic Fire Alarm System

The author of the project, A.T. Jeevanandham a, P. Sivamurgan stated that the IoT Based Fire alert framework utilizes two sensors which are a temperature sensor (DHT 11) and a smoke sensor (MQ-2). Once the temperature and the smoke reach a certain level, the small-scale controller is changed to make the bell sound (A.T & P, 2020). As the smoke is already identified, the fumes fan is turned on and releases the smoke out from the shop or premises. The author also stated that Arduino will send the information to the Wi-Fi module ESP8266 to accompanying information to the IoT site. The following data of temperature, smoke value, and Timestamp will be displayed on the LCD monitor for detail. After the sensor in Arduino senses smoke or fire, it sends AT commands to the GSM module to communicate to it. A text message was sent to the registered cell phone number that was set up in the system for emergencies.

2.5.5 Smart Home System Using Arduino

Smart Home System Using Arduino, according to the project authors U. Parmar, F. Rajkotwala, and S. Pandya, is comprised of five major components: the Arduino Uno microcontroller, the Bluetooth Module (HC-05), the Power Supply, the Relay module, and the Android application running on a smartphone (Parmar et al., 2020). According to the developers, the Arduino serves as the system's brain, while the Bluetooth module will serve as a link between the user's smartphone and the system, allowing the user to control home appliances through an Android application. The primary goal of the project is to be able to control the desired home appliances, including the ability to turn them on and off. The remote control operation is accomplished through the use of a smart Android operating system phone.

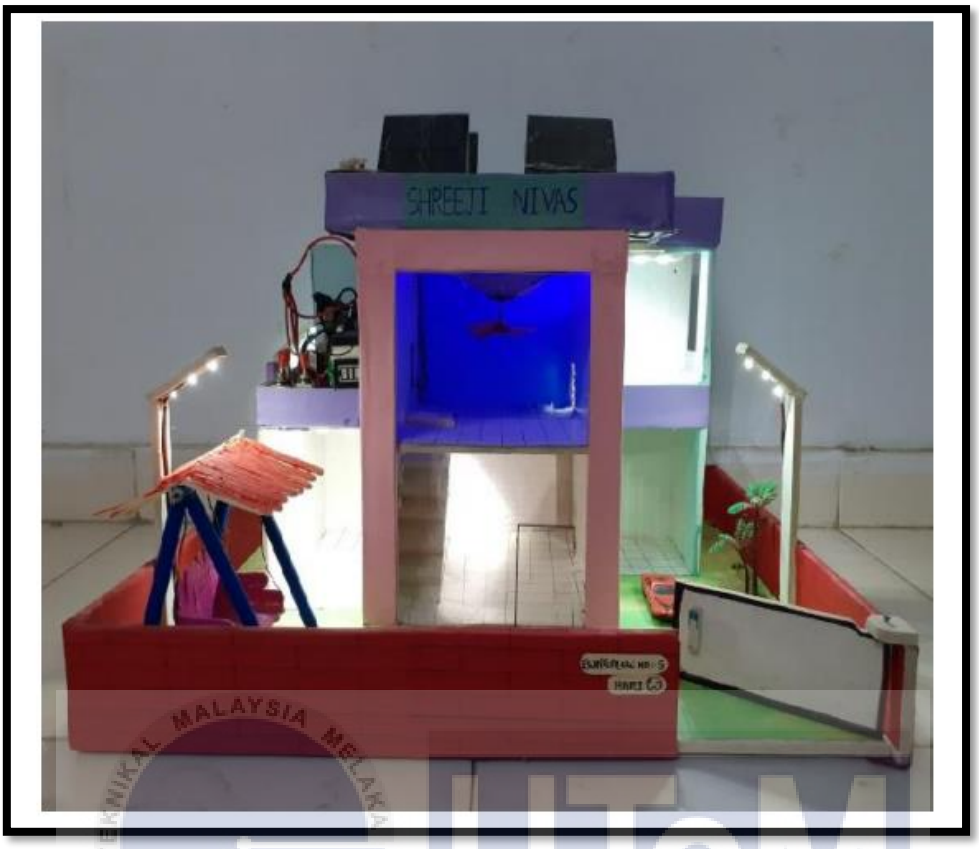

Figure 2. 6: Prototype of the smart home system using Arduino

2.6 Comparison of previous related projects

Based on the previous related project that has been discussed, there is some difference between those of the projects in terms of the implementation and the functionality. Therefore, the table below shows the comparison between the research article in terms of the method uses as well as the advantages and disadvantages of the project.

Table 2. 1: Project comparison

No	Reference	Method	Advantages	Disadvantages
1	(Saeed et al., 2018)	The project uses Raspberry Pi as a microcontroller and includes a GSM module that acts as a medium for communication. The sensor has a unique detection mechanism that will be triggered if unexpected heat or smoke appears. If the sensor detects a fire, it will be instantly for GSM to alert the user and the event data will be sent to a local server for reaching public service units.	- have more features as a microcontroller - Users can be alerted in anytime	-Only for fire detection - Do not have a Smart Home features for safety measure - High cost for the Raspberry Pi
2	(Patil et al., 2021)	The project uses Arduino Uno as a microcontroller and ESP8266 is deployed as Wi-Fi module for the medium of connection to the user. When the sensor is triggered by the unexpected smoke or heat, a signal is sent to the alarm system and the user can send an emergency call as soon the user activated it.	- Low cost - easy to use	- Only for smoke and heat detection - Do not have smart home features for safety measure
3	(Santoso et al., 2018)	The project uses WeMos ESP8266 as the microcontroller that will act as a processing unit. This smart	- Consist of RFID for door access	-Limited function

		home system consists of RFID function that will be functional as a door access and also PIR sensor that will act as a motion sensor to detect any movement of people or animals. The system also stores user accounts into the database including the RFID tags.	-system able to store	- Do not have a fire detection system
4	(A.T & P, 2020)	The project consists of two sensors which are a Temperature sensor(DHT11) and a smoke sensor (MQ—2). The microcontroller that is used in the project is Arduino as well as ESP8266 for the Wi-Fi module to connect users for the information. When the sensor in Arduino senses smoke or fire, the GSM module will be able to communicate with the registered phone number that is already set up in the system emergency.	-Low cost for production -Users can be alerted anytime	- Only for fire detection - Do not have a Smart Home features for safety measure
5	(Parmar et al., 2020)	The project consist of Arduino Uno as a microcontroller, Bluetooth module as a medium for connecting between device and controller, and an Android application for the user to control the desired smart home appliances including light, fans, and the others.	-Low cost for production -Having android application to control desired smart home function	- Only limited for smart home function - Do not have a fire detection system

2.7 Summary

Simply said, after doing extensive research and observation based on the previous relevant project, it is clear that there are numerous methods that may be used to integrate IoT into the project. There is much detail that needs to analyze to make sure the project achieved the main objective and can be used properly. There is also the other thing that needs to consider especially the cost of the project, the available electronic component that is available in the market, and the capability of the project. Therefore, the research on the previous related project is important to get the detail and information to create own prototype.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter of the study will present the method that will be used and how it was implemented in the development of the project to accomplish the project's objective and goal. There are three primary components to project development: study design, project process flow, and hardware specification. To ensure the project's development works properly, each part of the research must be properly conducted by the prioritized priorities. As mentioned in the first component, the study design plays a significant influence in the creation of the idea. This can be observed in the project's primary aims, how it operates, and to whom this initiative is devoted. Proceed to the next key component, process flow elaboration this section discusses the project's flow and will be elaborated in detail, followed by the project's detailed hardware specification.

3.2 Study Design

The project aims to design a Smart Home: Fire Safety System Using IoT that can be employed in any household as a preventative measure against an unforeseen incident such as a fire that occurs frequently in households. This project will be using ESP32 as a microcontroller that acts as the brain of the project. Then, the flame and MQ2 gas sensor will be deployed in the project as the main sensor for the detection of smoke, gas and fire in the household. This project also allow users to control the home equipment with their smartphones in their house. Finally, the software being used in this project is Arduino IDE which is known to program the hardware of the microcontroller, thinkercad is used to simulate ESP32 with sensor and proteus software to construct and design the circuit of the project. Therefore, a flowchart diagram of the project is created to show how each of the tasks is taken and implemented in detail.

3.3 Project process flowchart

3.3.1 Project Implementation flowchart

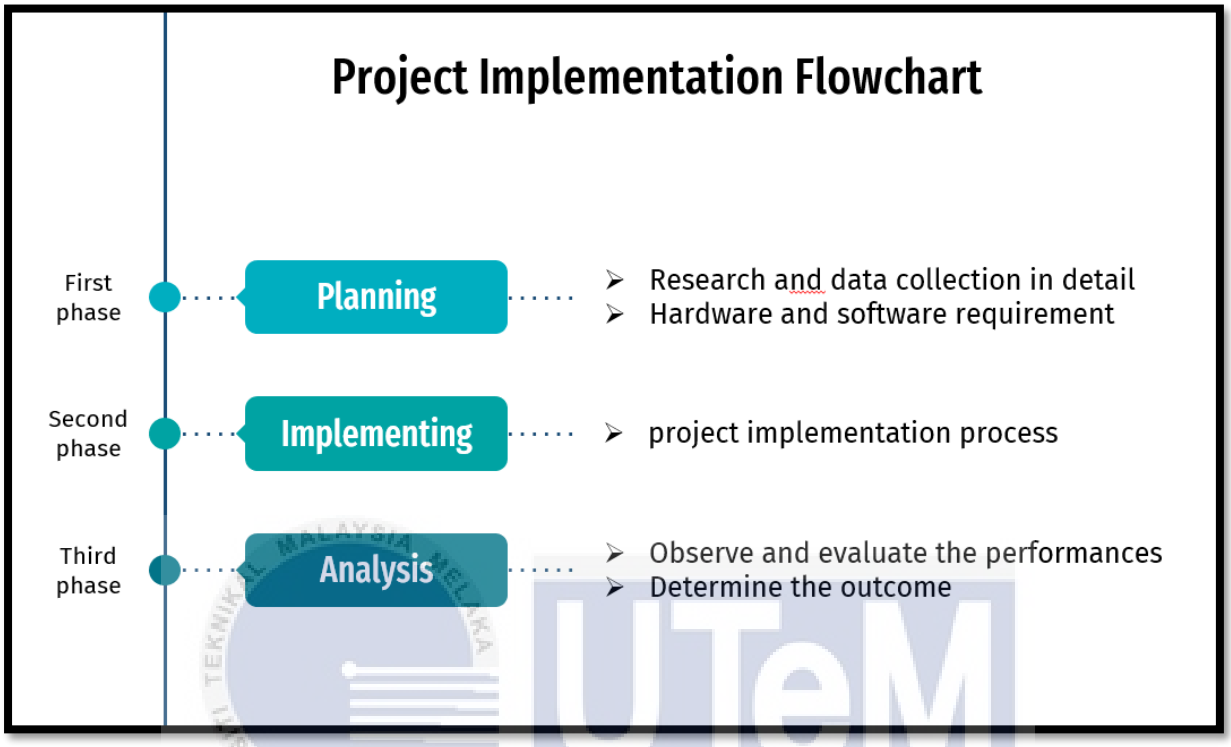

Figure 3. 1: Project implementation flowchart

The figure 3.1 shows the flowchart of the project implementation that will be implemented during the project's development process. This section will explain in detail how the project is completed by referring to the figure 3.1. In a general, the flowchart above consists of 3 main components which are known as planning, implementation, and analysis. Each of the phases is an important key to the process of the project development due to make sure the planning of the development will be done according to the project goal based on the stated idea. At first in the planning phase, all the research about the related project that has been done in the previous chapter will be the important key to generating the creative idea that can be used in the project plan. This can be shown with the idea of the previous project can be used as a reference to adding a new feature of the project that can give the benefits to the user for having an innovative project that can contribute to the society. At this phase as well, it needed to determine the hardware that will utilize in the project as well as the software required to make sure the planning will run smoothly based on the planned.

Moving on to the next phase, this section is needed to implement the collection of the data from the research and how the project will operate. In this process, a circuit design and programming of the project take place to generate the exact output based on the aim and expectation. A design of the circuit is conducted on the Proteus 8 software where the program of the ESP32 that has been coding on the Arduino IDE can be compiled and uploaded on the Proteus software for the circuit simulation. Thus, this implementation process with the simulation can give the first outcome if there is no issue with the project before proceeding to the actual hand-on project.

The final phase of the flowchart is about the analysis. In this phase, the analysis data is collected based on the outcome of the implementation process that has been done before. The project needs to be observed and evaluated in detail regarding the performance to make sure there is no problem related to the hardware and software or any issue during the implementation phase. Therefore, any development project needs to be determined the possible outcome to make sure it achieves the desired result that has been expected during the development of the project.

3.3.2 Project Block Diagram

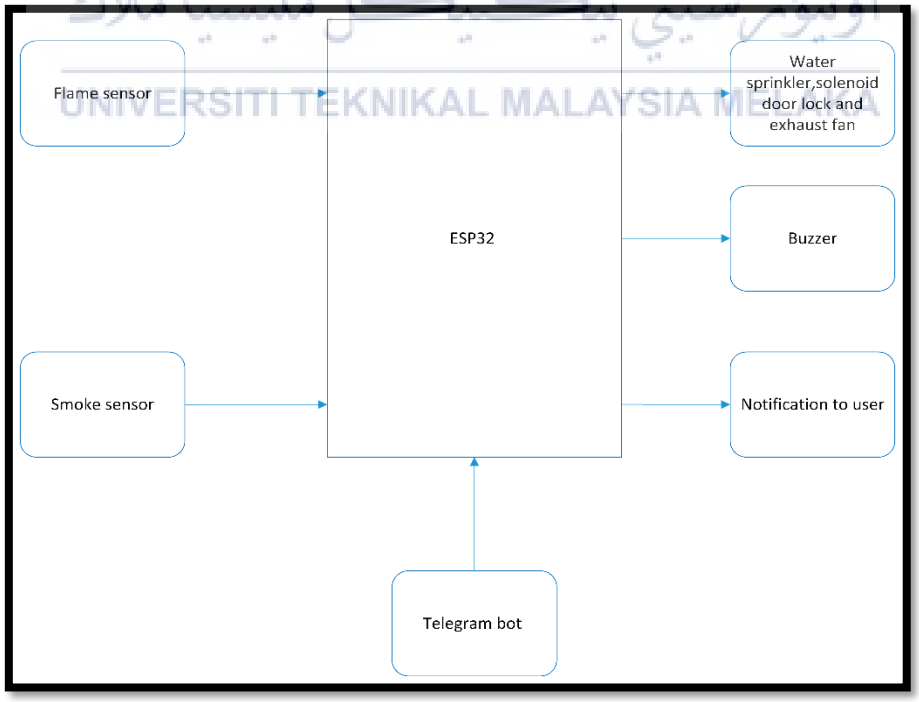

Figure 3. 2: Project block diagram

3.3.3 Project Development Flowchart

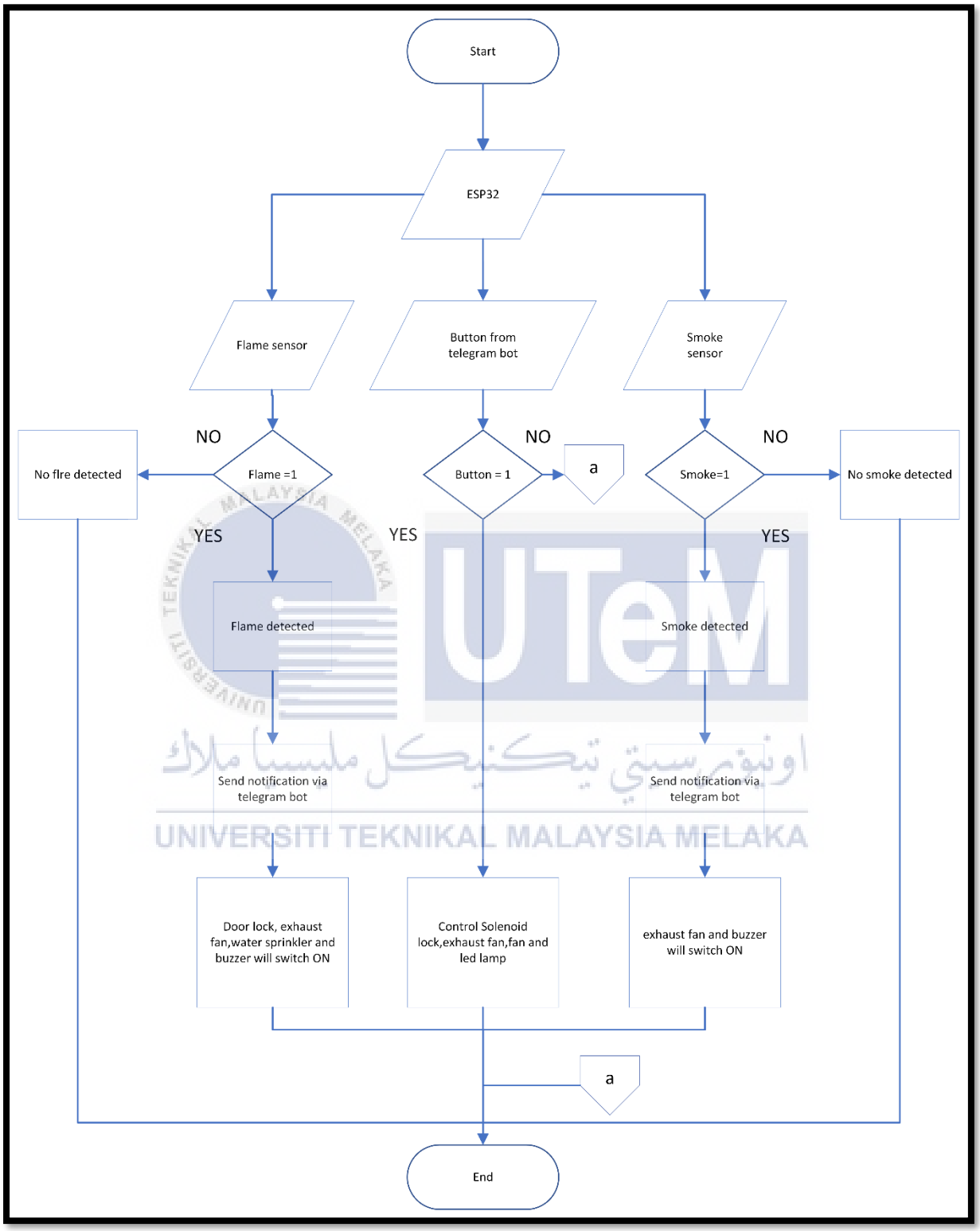

Figure 3. 3: Project development flowchart

By referring to the figure 3.3, it shows the project development flowchart based on the study and research for the project development mentioned earlier. In this section, it will be focused on a suitable hardware component to produce the actual project. For the software required in the project, Arduino IDE is used as a part to compile the written code into the ESP32 board to trigger the input and output in the development project. The project begins with the 2 main sensors in the circuit which are a flame sensor, and a smoke sensor is chosen as an input for the fire safety system. At first, if the smoke sensor is triggered by the upcoming smoke, the microcontroller will receive the data that stated there is a cloud of smoke detected on the premise and it will activate the exhaust fan and the alarm from the buzzer to ring as a sign of warning to the people in the household. Then, if the flame sensor is activated by the appearance of fire, the ESP32 will receive the sensor's data and transmit it to the output to activate the buzzer's alarm. In response to the detection of a flame in the home, smart home appliances such as an exhaust fan, water sprinkler and solenoid lock will activate as safety precautions. Therefore, there was no fatality in the house as a result of the unexpected occurrence. Then, the notification via telegram will be delivered to the user if an unanticipated incident, such as a fire and smoke that occurs in the home, and the user will be notified via their smartphone as a safety signal. The user also can control their home appliances using telegram bot on their smartphone.

3.4 Hardware Specifications

3.4.1 ESP32

Figure 3. 4: ESP32 board

Figure 3.4 depicts the ESP32 board, a low-cost System on Chip (SoC) microcontroller manufactured by Espressif Systems, the makers of the renowned ESP8266 SoC. It is available in single-core and dual-core configurations of Tensilica's 32-bit Xtensa LX6 Microprocessor and is the successor to the ESP8266. The features include a generic Wi-Fi, Bluetooth, and Bluetooth Low Energy (LE) MCU modules that designed for a wide range of applications, from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming, and MP3 decoding. This is the primary component that will be implemented in the project and will serve as the project's brain to complete the system objective.

3.4.2 Flame sensor

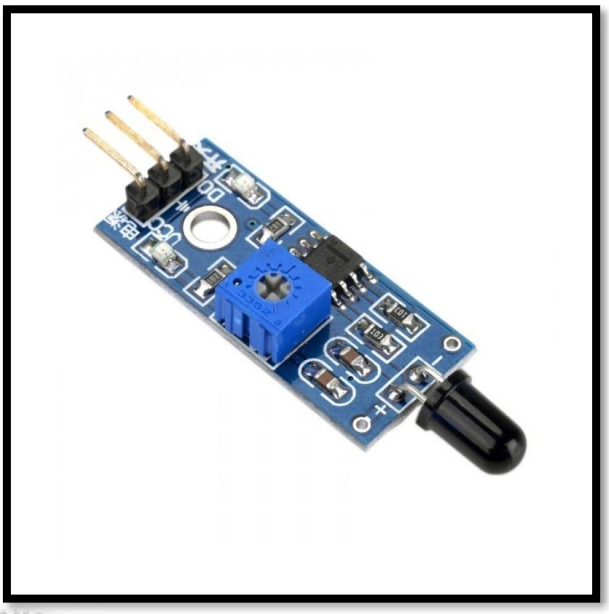

Figure 3. 5: IR Infrared flame detection sensor

The figure 3.5 represents a flame sensor, one of the existing sensors incorporated in the creation of the fire safety system. The flame sensor is a type of detector that functions to detect and react to fire and flame. The detection of the sensor is contingent on the installation of the fire safety system, which may include the sounding of an alarm bell or any fire suppression system. The mentioned sensor has three pins, including a VCC pin that supplies 3.3V to 5.3V, a ground pin, and a digital output pin. Hence, the primary goal of the sensor in this project is to limit the danger connected with the ignition in a house.

3.4.3 Smoke Sensor (MQ 2 gas sensor)

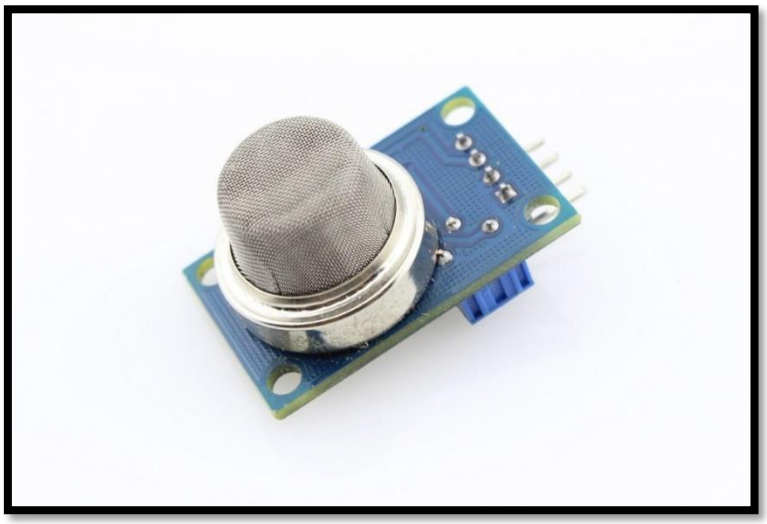

Figure 3. 6: MQ2 gas sensor

MQ2 Gas sensor in the figure 3.6 is an electronic sensor that will be used as a part of a developing project that acts for sensing the concentration of gases in the air such as carbon dioxide or smoke that leaks or appears. This sensor has a sensing device made primarily of ceramic coated with Tin dioxide and encased in a mesh of stainless steel. There are six connecting legs attached to the sensing device. The two of the leads are responsible for heating the sensor element, while the remaining four are for signal output. The sensor operates on a 5V direct current voltage and it is capable of detecting gases with concentrations ranging from 200 to 10000 parts per million (ppm). Hence, the use of this sensor in the project will detect the presence of smoke and gas that occurs in the house.

3.5 Software Specification

The purpose of using the Arduino IDE in the project is to implement the written program code into the ESP32 microcontroller that acts as the brain of the project. Thus, the Arduino IDE is software that is really important in the early phase of testing or in the final phase of testing to make sure the project is running based on the desires depending on the code compile on it.

3.5.1 Arduino IDE

Figure 3. 7 Arduino IDE

The Arduino IDE is open-source software that is used to write and upload written code to the ESP32 board. The board is attached to a computer through USB, where it communicates with the Arduino IDE. The user develops ESP32 code in the IDE, then uploads it to the microcontroller, which runs the code that interacts with I/O such as sensors and the others.

3.5.2 Telegram bot

Figure 3. 8: Telegram bot

Telegram is a chat messenger service comparable to WhatsApp, with the added benefits of data encryption, security, and privacy. A telegram bot is a unique type of user that is not a person but a computer program that can provide organizations or brands with a variety of services, including the transmission of information, reminders, playing of music, and more. With the use of a telegram bot in this project, users can get a notification through their smartphone if unexpected events occur in their house and be able to control their home appliances on their residence.

3.6 Summary

In summary, this chapter describes and explains in detail the methodology of the development project which is “Smart Home: Fire Safety System Using IoT”. The methodology of the project is important for achieving the objective of the project in the development phase and it is needed to standardize, structure, and organize the project for the successful result and aims. Therefore, to have a successful result for the project, all of the important stages from the flow of the implementation to the flowchart of the development project must be completed with detail and followed with determination. Based on the previous research, there is an important element that needs to study in detail regarding the hardware that will be used starting from the basic electronic component like the sensor for input and output in the circuit until the software that is related to the development of the project to make sure there is no issue at all to complete the stated project.

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This chapter it will elaborate on the final result and discuss the project as a whole. Included are all testing results prior to data finalization, operating circumstances, and data analysis. These assessments and evaluations serve as a reference for deciding whether the project meets its primary objective.

4.2 Project Circuit Design

To begin the overview of the project, the first experiment will be undertaken utilizing design provided by Proteus version 8. The ESP32 microcontroller will serve as the brain of the project. Sensors such as a smoke sensor (MQ2 gas sensor) and a flame sensor (IR Infrared flame sensor) will be added into the circuit that serves as the project's input in order to verify that the project's initial objective is being fulfilled. In the meanwhile, a particular DC fan and DC motor in the circuit will serve as models for smart home appliances such as solenoid door locks, water sprinklers, and exhaust fans that will operate automatically when the circuits with two sensor inputs are active. The other DC motor and lamp will function as household appliances that can be controlled by the user via a Telegram bot.

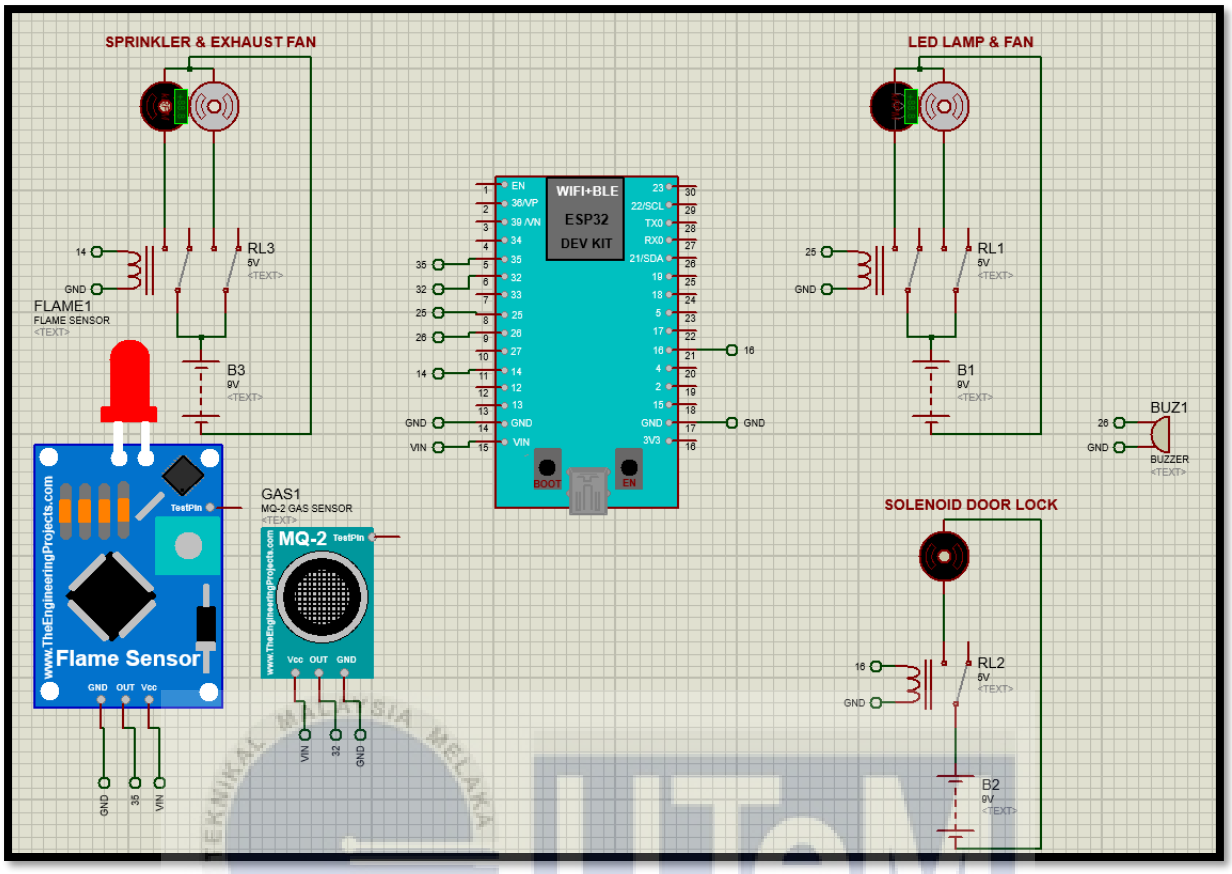

Figure 4. 1: Circuit design using Proteus 8

4.3 Software Development

To begin with the software development of this project, a telegram bot will be used to push a notification message to their smartphone that indicates a warning about the situation in the residence for the user if the both sensor is triggered by the emergences of flame, gas or smoke. The employment of a telegram bot as an emergency notification tool in the event of an unpleasant circumstance will be advantageous because it can be accessible everywhere, not just on the android operating system, but also on iOS devices and Windows computers. This procedure entails including choosing the relevant Telegram bot library in the Arduino IDE to generate the proper bot based on the specified parameters. After selecting the bot library, such as the Universal telegram bot library, the API key for the already-created telegram bot is necessary that allow user to interact with the bots and control the bots using HTTPS request to Telegram Bot API. The figure 4.2 show the procedure when creating a telegram bot for the first time using the botfather on telegram.

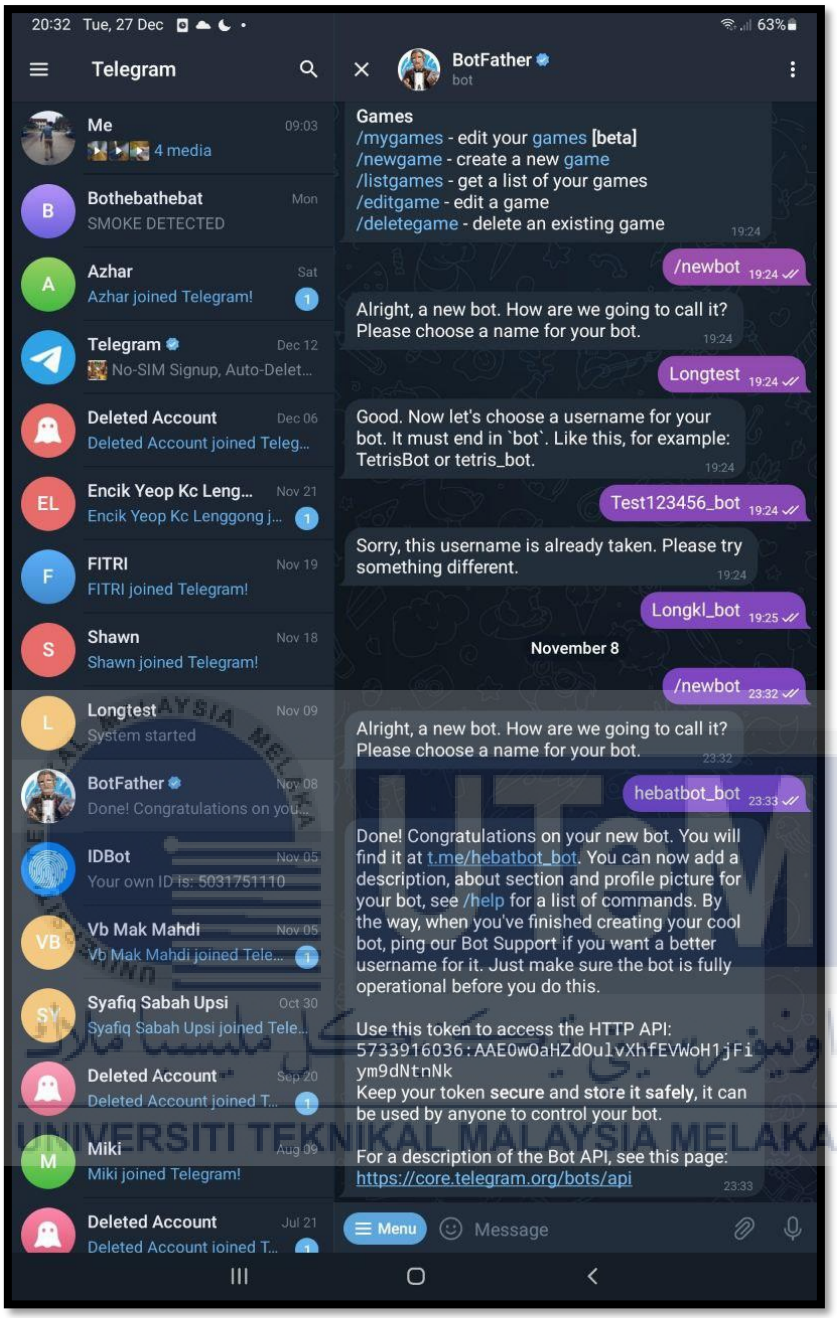

Figure 4. 2 Telegram bot layout (1)

Apart from notifications for user, Telegrams bot can be used to provide the ability to manage home appliances. A system such as this makes Telegram Bot not only focused on notifications, but also a new innovation in the usage of IoT that is capable of functioning as a remote that controls home appliances such as fans and lamp. This circumstance can be seen when the layout and design in the bot is based on the program that has been created in the IDE. Moving into the next phase, the user will be able to see the function that can be found on the Telegram Bot to control home appliances. Within this function, there is an chat action that allows the bot to receive messages from the user and send back the next message to the user so that the user can view their options for controlling home appliances. The figure 4.3 show the layout of Telegram Bot.

Figure 4. 3 Telegram bot layout (2)

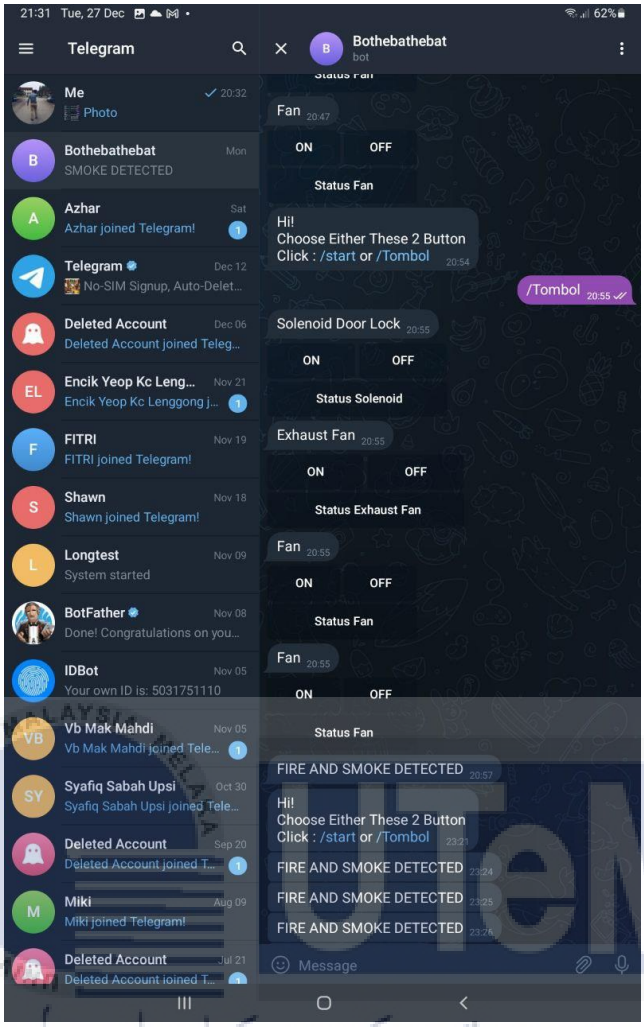

Figure 4. 4 Telegram bot layout (3)

4.4 Hardware Development

The following pieces of hardware were used in the creation of this project: an ESP32 board, a flame sensor (IR infrared flame detection sensor), a smoke sensor (an MQ2 Smoke LPG CO Sensor), a 5V Relay module, a DC water pump 5V, an LED Lamp 5V, a DC fan 5V, a 9V adapter, buzzer and a 9V battery. Figure 4.5 showing the initial hardware that was used in the development of the Internet of Things-based Smart home : Fire Safety System.

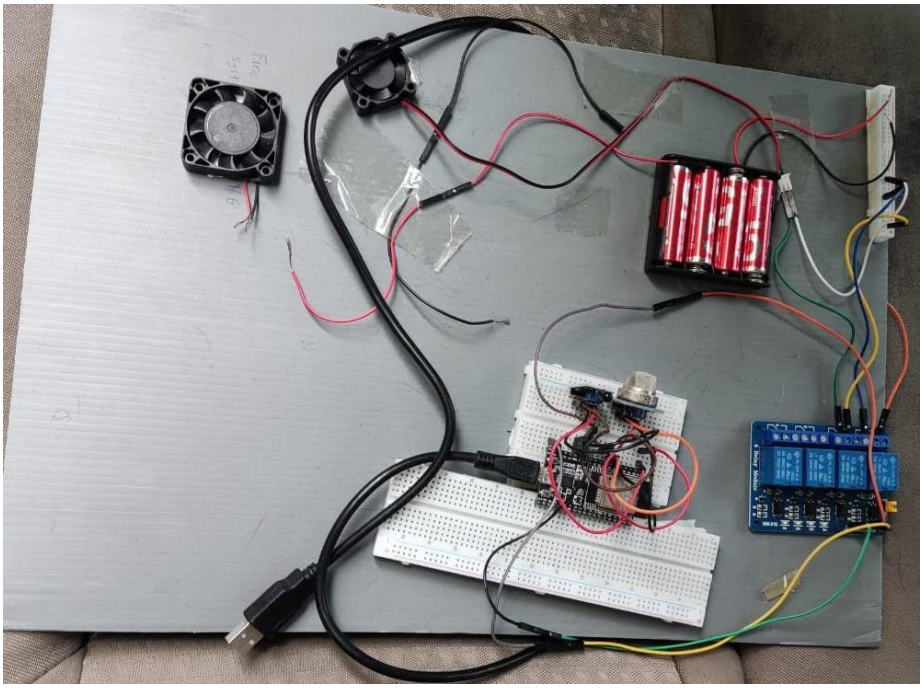

Figure 4. 5 Initial hardware used

In this particular developed project, an ESP32 microcontroller board will serve as the project's brain by executing the commands that have been programmed in the integrated development environment (IDE). The Wi-Fi capability of the ESP32 was a major factor in deciding to use it in the development of Internet of Things (IoT) related projects. Programming will be done on the ESP32 board so that it can access and communicate with the telegram bots that will be used in the project to gain the access for the push message notification, including the control of home appliances on the user's behalf. In the meantime, there are two primary sensors, a flame sensor, and a smoke sensor, which will serve as the primary input for the project that is being produced.

The following sensors, which serve as an indicator that a fire or gas leak is occurring in the home and it will be activated when smoke, fire, or gas is detected. The aforementioned notification function will be used to notify the user if there is a burning situation which include a certain home appliances like exhaust fan, solenoid and water sprinkler will be activated. This will serve as a warning message of the incident. Not to mention the fact that the hardware that was mentioned, such as a DC fan, LED lamp, and solenoid door lock it illustrate as a actual home appliances, and it will be able to control either to switch on or off using the same telegram bot.

4.5 Prototype Development

Figure 4. 6 Project Prototype

Figure 4.6 shows the prototype model for the Smart home : Fire safety System using IoT that replicates the version of the actual house. The base of the model for the prototype is constructed out of corrugated plastic cardboard, which will also be used in the prototype for the construction of walls. When utilizing DC output devices that illustrated a home appliances, this prototype's situation is one that is realistic and reasonable to use. A DC fan that will function as an exhaust fan will be placed on the main wall of the prototype, including the two input sensors and a model of a water sprinkler will be installed on the left side of the prototype. Next, there will be a DC Solenoid door lock placed on the prototype floor, as well as another DC fan installed on the right side of the prototype, which will be illustrate as an actual fan. Lastly, a 5V LED strip lamp will be attached to the model and used as a light source inside the house.

4.6 Project Workflow

The development of Smart Home : Fire Safety System Using IoT is designed for homeowners as a protective measure for them and their families, including the capability to control attributes of the houses when connected to the internet, such as lamps, fans, and door locks. The workflow of this project will be stated in this section. At first, the ESP32 microcontroller needs to be supplied with power from a source that is reliable and adequate from the very beginning. Next, the user needs to turn on either the mobile hotspot or the Wi-Fi in their home in order to provide an internet connection to the microcontroller.

This is dependent on the program that has been done in the Arduino IDE, in which the Wi-Fi ssid name and password have been set to ESP32 in order to connect it to the internet network. Within the context of this project, the microcontroller had already been set up with the mobile hotspot configuration. The ssid name for the configuration is "Hensem," and the password for it is "lrt12345." Once it is connected, the Telegram bot will send out a notification message indicating that it is already connected to the internet and this will indicate the system is now ready to be used.

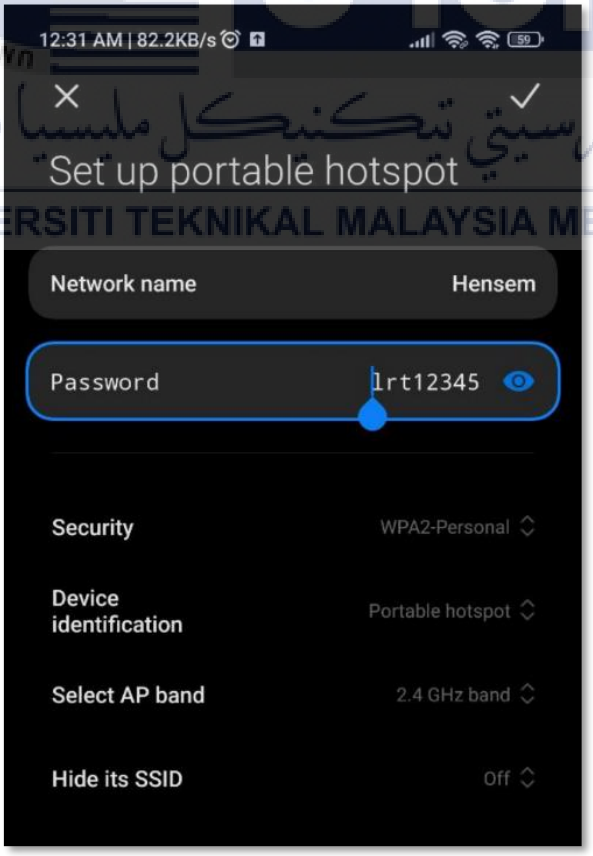

Figure 4. 7 Internet configuration

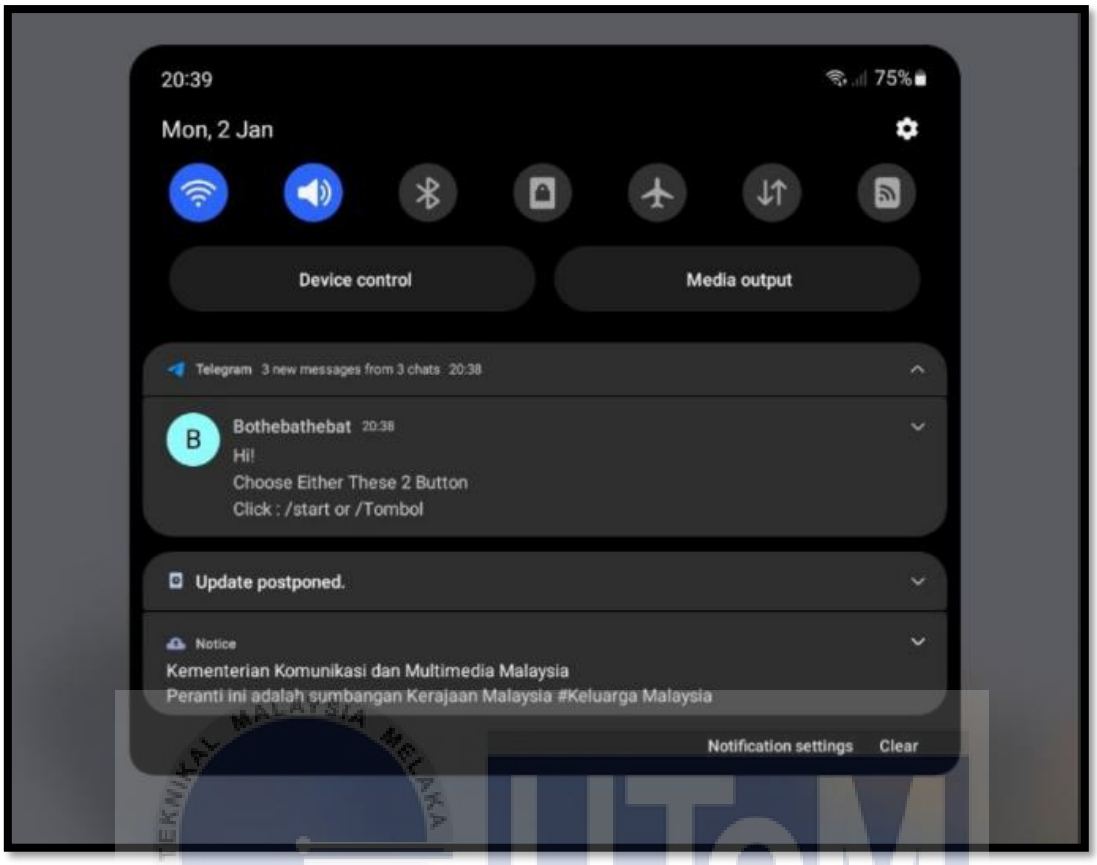

Figure 4. 8 Notification that indicate the system have been activated

By holding a lighter in close proximity to the flame sensor, the user of this project has the opportunity to experiment with activating the flame sensor. After the fire has been generated, the data of the flame presence will be sending to the telegram and the user will be able to see a notification message that has been sent via telegram bot showing the emergence of fire in the residence as long the user have the access to the internet. The notification that the user will receive after the outbreak of fire is depicted in figure 4.10 of this section.

Figure 4. 9 Flame sensor been trigger

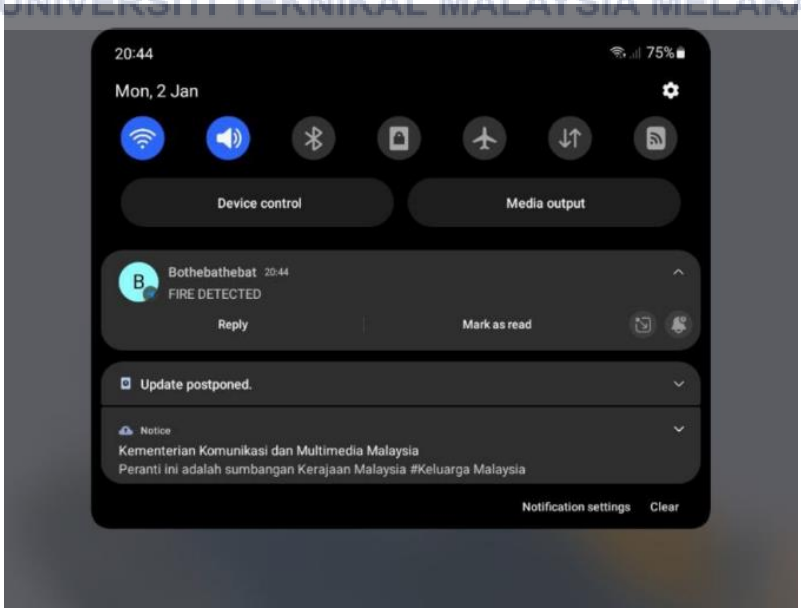

Figure 4. 10 Notification after the outbreak of fire

Additionally, the equipment in the house, such as the solenoid door lock will be unlocked, the exhaust fan will be switched on, a buzzer will be switched on and the water sprinkler model will flow a water after the fire had occurred. Figures 4.11 through figure 4.13 depict the activation of the home appliance model.

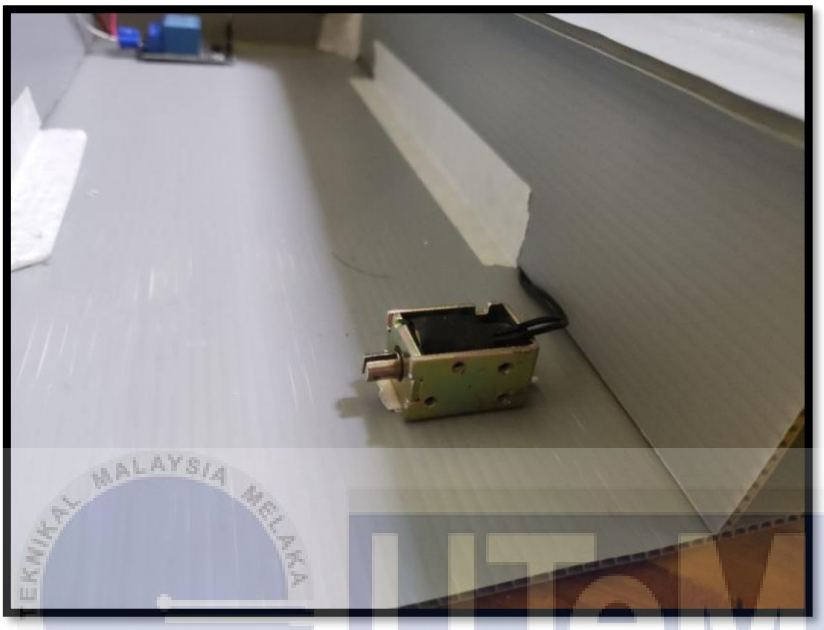

Figure 4. 11 Solenoid door lock being unlocked

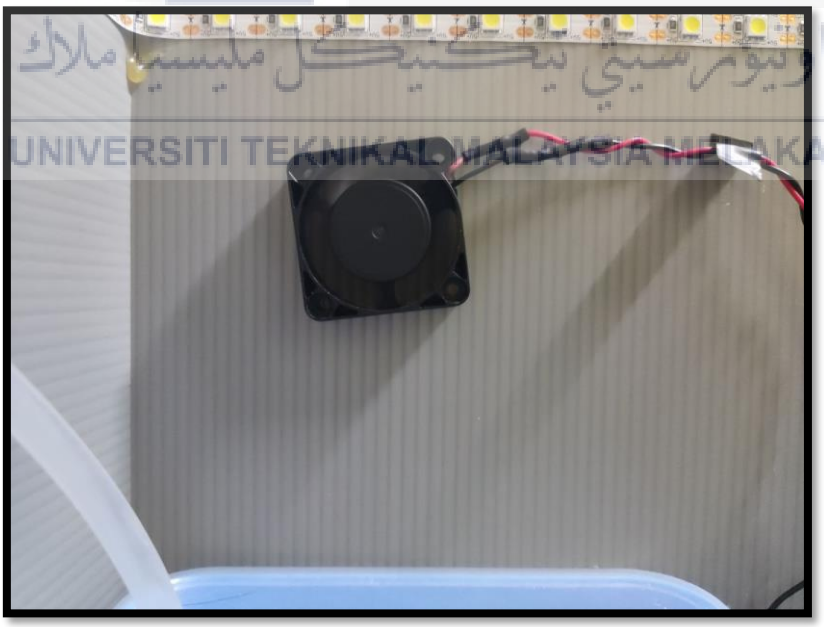

Figure 4. 12 Exhaust fan being activated

Figure 4. 13 Water sprinkler being activated

Next, testing of the MQ2 gas sensor is performed utilizing the smoke presences. If there is a smoke in the house, which is indicated by the light on the sensor LED, then a notification message regarding of it will be sent out via bot telegram after receiving data of the gas or smoke that appear in residence. Besides, if the event that there is a gas leak and smoke is present inside the house, the only component in the system that will function automatically is the exhaust fan and buzzer. The activation of the sensor as a result of the presence of smoke is depicted in figure 4.14.

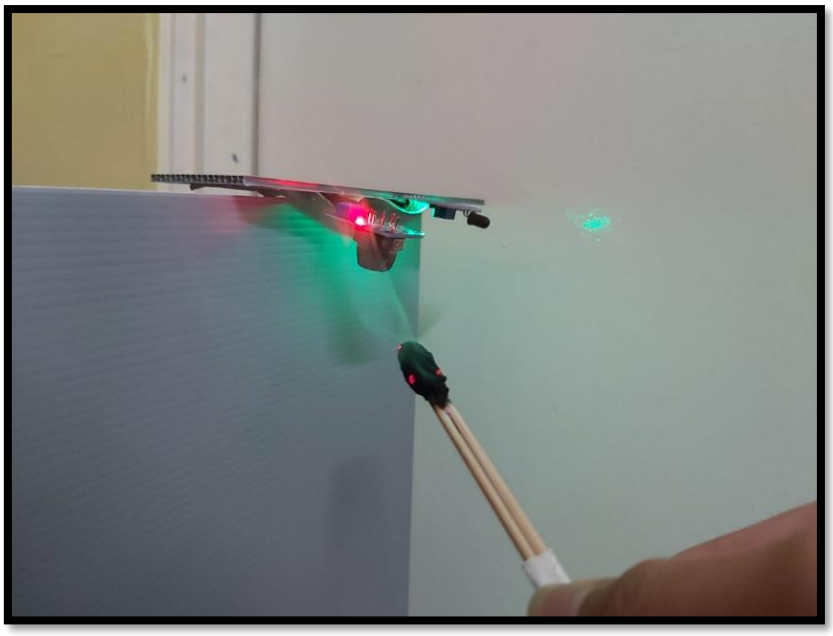

Figure 4. 14 Smoke sensor (MQ2 gas sensor) being triggered

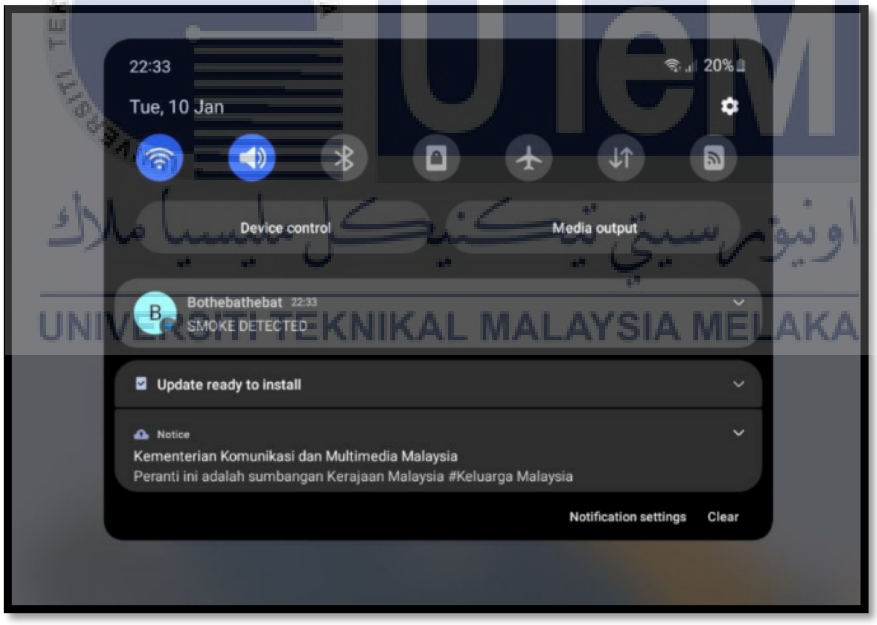

Figure 4. 15 Notification after smoke sensor (MQ2 gas sensor) being triggered

In a different scenario, if the flame sensor and the MQ2 gas sensor are both activated at the same time, the user in the house will be able to receive notifications regarding the start of a fire as well as the presence of smoke. This condition will act as a trigger for the smart home devices that are related to the safety measures in the such as the solenoid door lock will be unlocked, the exhaust fan will be switched on, a buzzer will be switched on, and the water sprinkler model will flow a water after the situation has already taken place. Figure 4.1 displays a notification that was generated as a result of both sensors being activated at the same time.

Figure 4. 16 Notification after flame sensor and smoke sensor (MQ2 gas sensor) being triggered simultaneously

Moving on the Smart home features included in the system, simply by sending a message to telegram bot, users will be able to see the options for controlling the appliances. This is due to the ESP32 board that receives the message and process the command that already program on IDE to display an option for the smart home features on the bot. The user then can select the option that corresponds to their preference in order to activate an appliance in the home. Not only the access limited here, but every piece of equipment that is mentioned can have its status monitored by clicking on a button that stated a status. A function such as this one will be able to inform the user whether or not they have turned on the device being used.

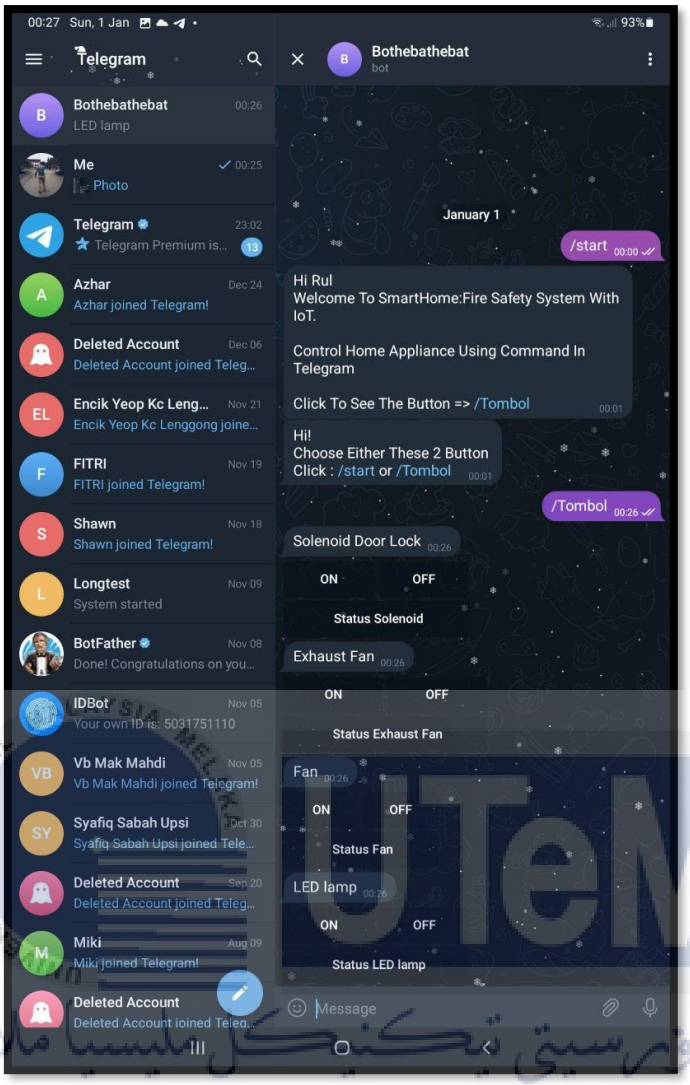

Figure 4. 17 Control option on telegram bot

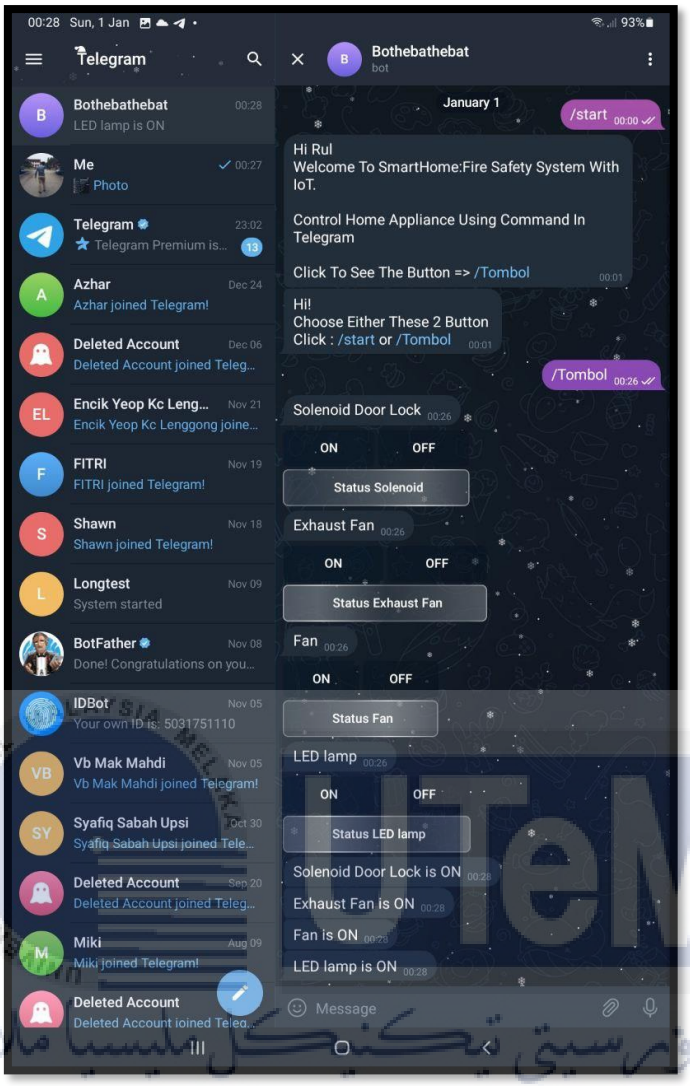

Figure 4. 18 Status of smart home appliances on telegram bot

Finally, the user can use the bot to unlock the solenoid door lock, turn on the exhaust fan, turn on the fan or switch on the lamp. These are the options that are available in this system. Within this process, the ESP32 board receives the message from the button that the user click on the bot and it will turn on the appliances that already mentioned. The components of a smart home that are included in the system are illustrated in figure 4.19 until figure 4.22.

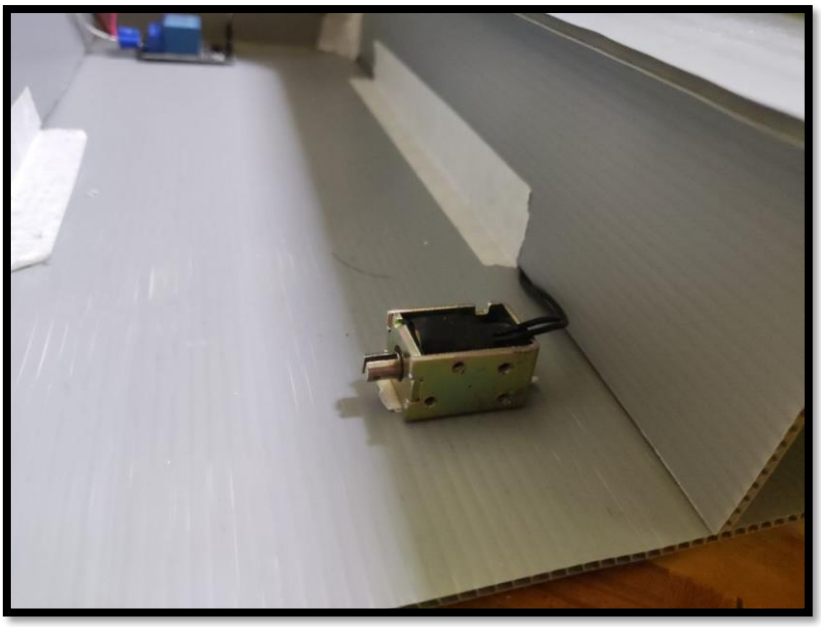

Figure 4. 19 Solenoid door lock

Figure 4. 20 Exhaust fan

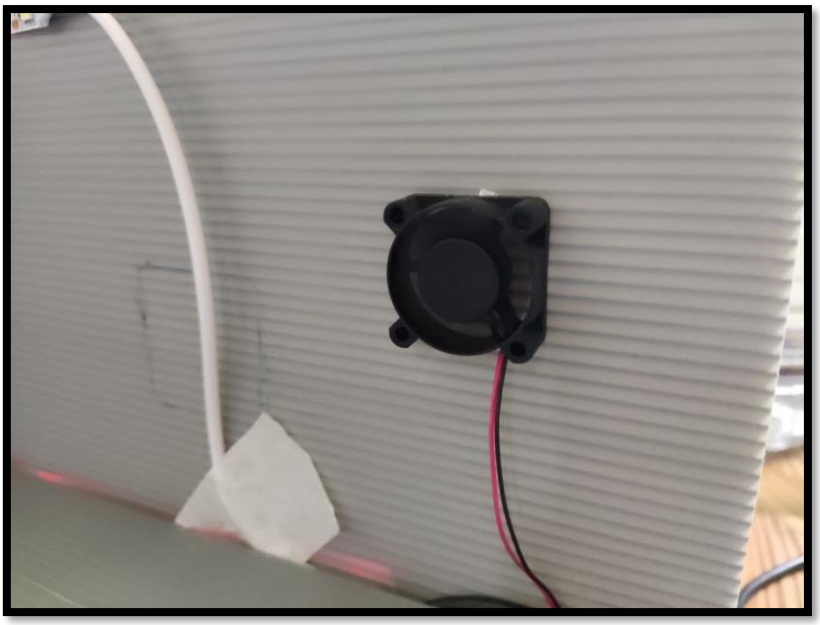

Figure 4. 21 Fan

Figure 4. 22 LED lamp

4.7 Data Analysis

This project is evaluated by measuring the flame sensor detection result, the MQ2 sensor detection result, the response time for the smartphone to receive the notification message, and the response time for a telegram bot to communicate with an ESP32 for controlling home appliances. This section will explain the recorded data in detail.

4.7.1 Flame Detection Result

Due to its program, a flame sensor can only detect fires that fall within a specific wavelength range. The sensor's analog readings range from 0 to 4023. A higher reading indicates that no flame is present or that the flame is further from the sensor. A lower reading indicates closer proximity of the flame to the sensor. According to the experiment conducted for this project, the acceptable detection range is up to 25 cm using a small lighter. The figure 4.23 depicts the initial analog value and the Serial plotter of the sensor based on the distance between the sensor and the flame.

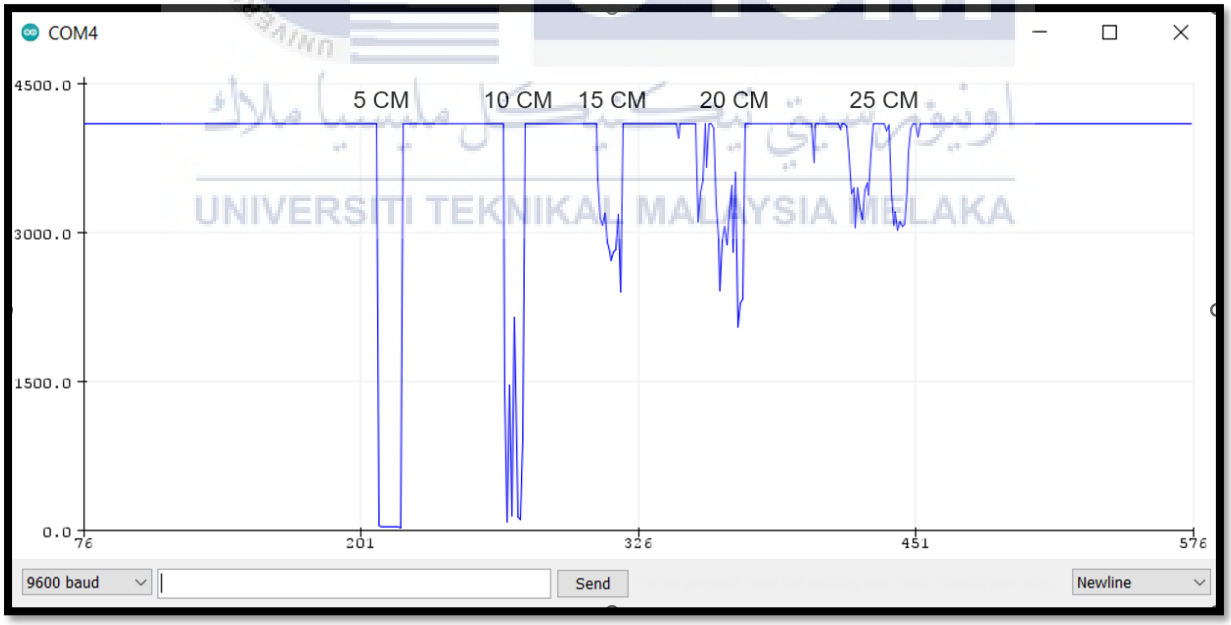

Figure 4. 23 Serial plotter graph

4.7.2 Smoke/Gas Detection Result

Figure 4.24 to 4.25 demonstrate that any increase in voltage corresponds to an increase in gas concentration. MQ-2 can detect LPG, butane, and smoke. Using the program in the Arduino IDE, the sensor functions according to its sensitivity by using a formula to convert the voltage into estimated numbers of gas concentration.

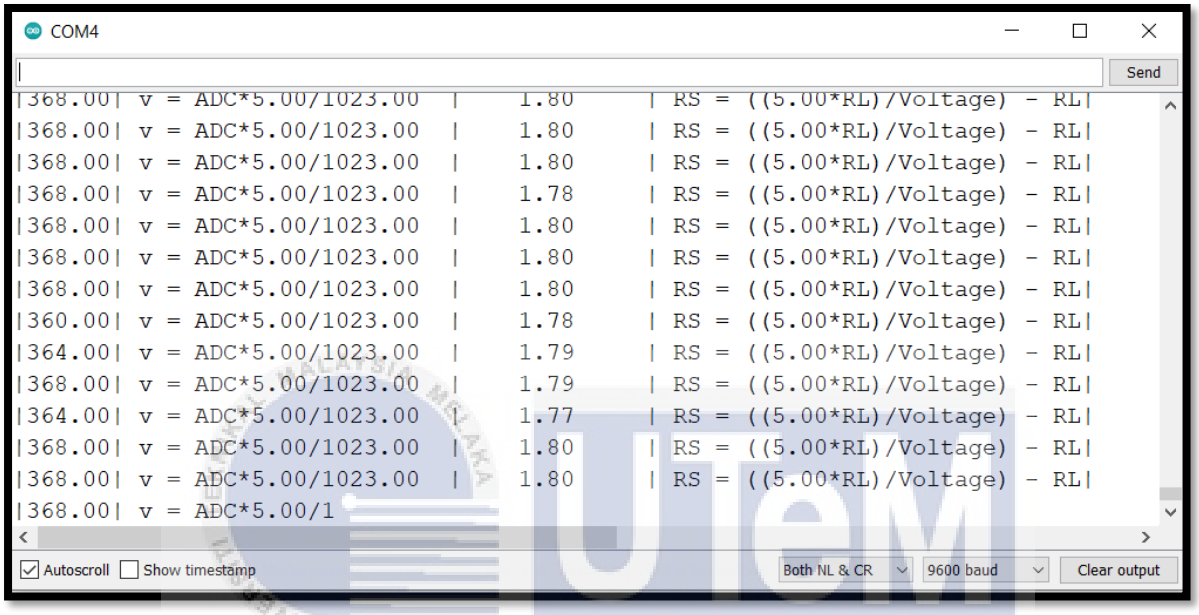

Figure 4. 24 Initial value of concentration

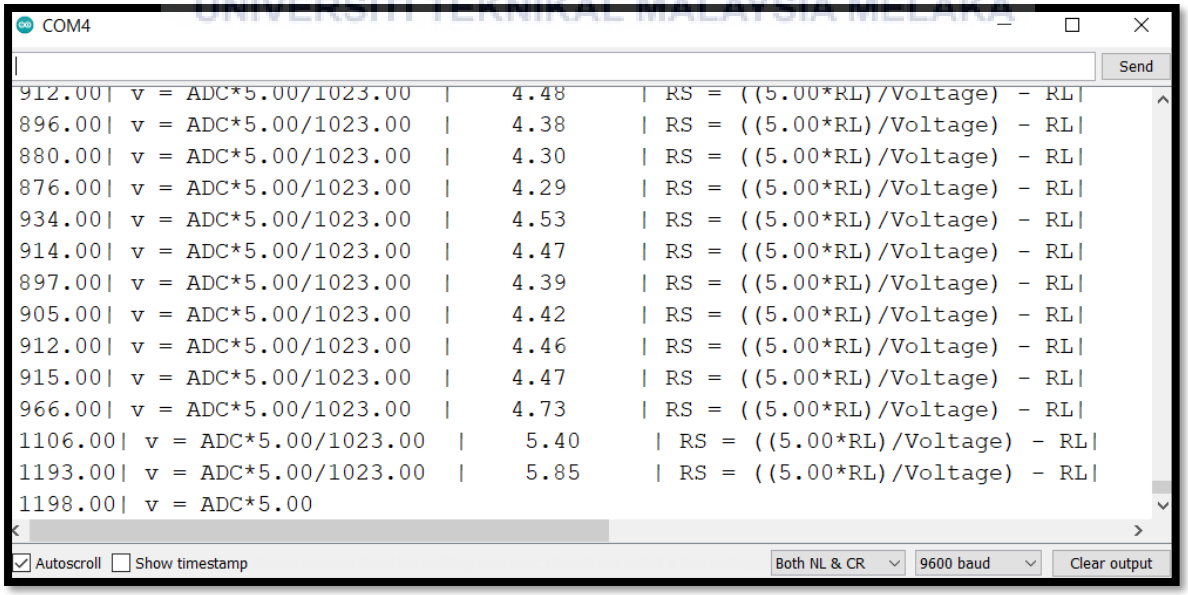

Figure 4. 25 Value of concentration after smoke presence

It has been determined through the investigation that the sensor that was being preheated at the beginning still has a value due to the mechanism of the sensor itself detecting the concentration in the environment place, despite the fact that there is no smoke triggering it. The information that was recorded in the table 4.1 demonstrates the number of concentrations beginning with the initial after being preheated and continuing until there is smoke in the project after reach a value of 1000 that indicate the presence of smoke and the figure 4.26 shown a line graph plotted against the gas concentration at a voltage change.

Table 4. 1 Experimental result using MQ2 gas sensor

Voltage Change on sensor (V)	Gas Concentration
1.80 V	368
3.21 V	656
4.30 V	880
5.40 V	1106
5.85 V	1198

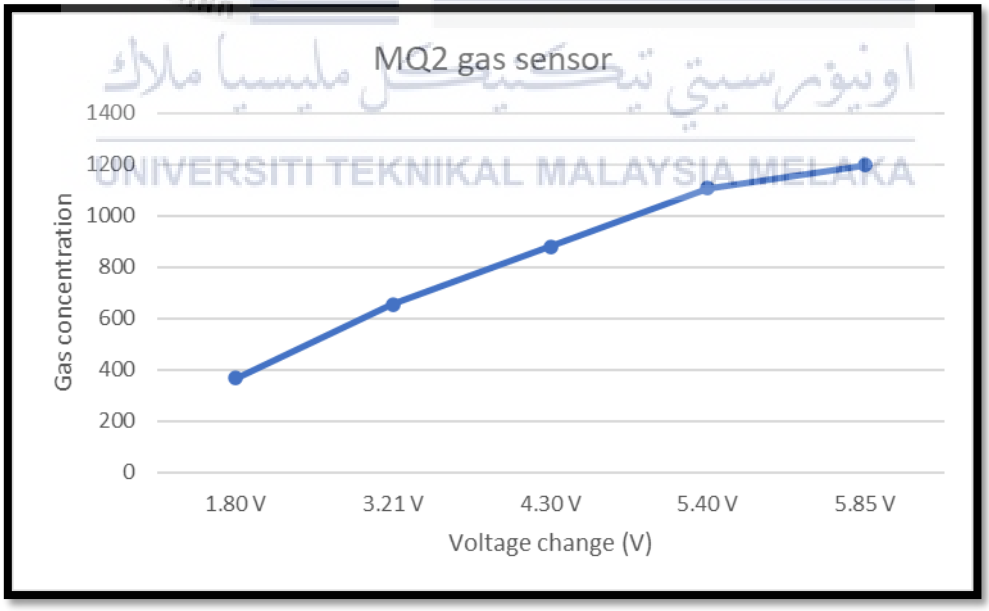

Figure 4. 26 Line graph for MQ2 gas sensor

4.7.3 Response Time For Telegram Notification To Reach Smartphone

The response time of the sensor is used to determine how long it will take for the notification to be delivered to the user. The flame sensor and the MQ2 gas sensor are each put through approximately five tests as part of this experiment. The results of these evaluations are recorded in table 4.2, along with the data and the average amount of time it takes for notifications to be delivered to users.

Table 4. 2 Recorded data and average time response for the telegram bot to push notification

Testing	Response time (s)
First testing	1.6
Second testing	1.8
Third testing	2.1
Fourth testing	1.5
Fifth testing	1.7
	Average response time = 1.74 s

According to the observations made, the various time responses in the project are as a result of the many different technical issues that are related. It is possible to ascertain, right off the bat, that one of the problems is related to the internet connection. It is necessary to have a reliable internet connection in order to use a system that sends push notifications via telegram bot. This is done to ensure that the notifications can be received on the user's smartphone. Not to mention the fact that the server of Telegram itself can also become a problem, possibly causing the response time of the Telegram bot to become a little bit slower. This is because the Telegram application itself is one of the services that is being used in the project, and the developer of this Smart Home : Fire safety system using IoT did not create these services. The only thing in Telegram that was created by the developer of this project was a bot for Telegram. In order to come to a conclusion regarding this section of the analysis, the difference in response times does not significantly feel different due to the fact that the range is so small. If a fire or smoke is detected by the sensor, the typical response time, from which a conclusion can be drawn, is approximately 1.74 second for the information to reach the user's smartphone.

4.7.4 Response Time For User to Control The Home Appliances

In this data analysis, the response time for the user to control home appliances is taken when the user clicks the telegram bot's control function. As can be seen, the button in the telegram bot can be clicked either to turn the appliances of the smart home on or off. After running the experiment five times, the data were recorded and an average time was calculated to determine how long it takes the telegram bot to respond to a request from a user and then send that request to an ESP32 board so that the appliances can be controlled to switch on or off. The data of responses time and the average of response time is shown in table 4.3.

Table 4. 3 Recorded data and average time response for user to control home appliances using telegram bot

Testing	Response time (s)
First testing	1.6
Second testing	1.8
Third testing	2.2
Fourth testing	2.3
Fifth testing	1.8
	Average response time = 1.94 s

According to the findings of the investigation, there are a variety of response times available for users to control the appliances in their homes, despite the fact that the variation in response times is so small after a number of tests have been carried out. One of the primary reasons that can be seen is possibly because of the internet connection of the user's smartphone, which sometimes triggered the response time. Additionally, it involved the ESP32 microcontroller in order to receive a data from the Telegram bot after the user made a request. One more plausible explanation is that the server that supports the Telegram app itself is currently overloaded, or that it is experiencing some other kind of technical difficulty. As a conclusion to this data analysis, it is possible to draw the conclusion that there is not a significant gap between the response time for users to control their home appliances and the results of the five experiments that have been carried out. Users can use the option on the Telegram bot to request either turning on or turning off the devices without encountering any problems, and the average time required for this is around 1.94 seconds.

4.8 Summary

One of the project's completed deliverables is discussed in this chapter. The results of simulating the process of constructing a Smart Home: Fire Safety System Using IoT and the data analysis of the project are presented.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

Generally, the final chapter of a report or thesis is the conclusion. Its primary purpose is to summarize the findings and give suggestions for further research and make future recommendations.

5.2 Conclusion

A fire that breaks out in a home can be a disastrous occurrence. Every home should be equipped with a fire detection system to prevent such incidents. The specified fire detection system can alert the occupants if something unexpected occurs. The system also differs from other conventional systems in that it not only uses an alarm as a warning to the residents but also has the advantage that comes with the Internet of Things in that users receive early notifications on their smartphones. In the meantime, this system also includes the control of household appliances, a feature of the smart home that has become the norm in the contemporary world. As a result, it is anticipated that the functionalities accessible on this system will be able to provide a novel approach to solving current fire concerns.

5.3 Project Potential

This prototype meets several criteria that will improve overall performance, such as the selection of appropriate sensors, low cost, ease of handling, multifunction, and, most importantly, the ability to conduct more improvements without increasing the level of complexity. As a consequence of this, the project is able to make effective use of the technologies that are available at the moment and provide the appropriate signals in addition to effectively managing and analyzing the information that is gathered from sensors for research and development (R&D). The project has many different potentials that will assist a wide variety of parties in monitoring the situation in the home or building to ensure that

appropriate precautions are taken. Any organization that deals with security systems assists people in detecting fires, notifying residents of a house or building, and assisting people in simply controlling the utilities and features of their homes through the use of the internet to make their lives easier and safer. In addition, the system is beneficial for anybody who needs assistance in monitoring the situation in their home and controlling the utilities in their house from any location. It can do both of these things.

5.4 Future Works

For future improvement, the efficiency of the Smart Home: Fire Safety System Using IoT could be enhanced as follows:

I. Adding more features on telegram bot.
II. Improve the interfacing of the telegram bot for controlling home appliances.

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