Faculty of Electrical Engineering Technology

DEVELOPMENT OF SMART FIRE DETECTION SYSTEM FOR HOUSEHOLD KITCHEN

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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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 (Industrial Powers) with Honours.

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DEDICATION

To my cherished family,

The unwavering love, support, and understanding you have shown me have been the cornerstone of this project's success. Your faith in my abilities inspired me to persevere, even in the face of challenges. I am forever grateful for your encouragement and belief in me.

To my wonderful supervisor,

Your invaluable guidance, expertise, and encouragement have been a beacon throughout this journey. Your constructive feedback and dedication have significantly contributed to the quality and progress of this project. I deeply appreciate your mentorship.

To my amazing colleagues,

This endeavor has been enriched by your unwavering support, insightful brainstorming sessions, and camaraderie. Your encouragement kept me motivated and focused. Thank you for being part of this journey.

To my prestigious college,

I am thankful for the resources, supportive environment, and opportunities provided by this institution. The skills and knowledge I have gained here have shaped me profoundly, and I am grateful for the enriching academic experience.

This project stands as a testament to the collective support I received from my family, supervisor, friends, and university. I am sincerely thankful to everyone who contributed to this milestone in my academic journey.

With heartfelt gratitude,

[NURNAZIRAH BINTI ZAMLI]

ABSTRACT

An important development in home safety technology is the home safety technology is the smart fire detection system for home kitchen which makes use of MQ-2 and DHT11 sensors combined with an Internet of Things (IoT) architecture. Using an intuitive mobile application, this project seeks to improve the accuracy and response times of fire detection while offering real-time monitoring and notifications. While the DHT11 sensor keeps an eye on humidity and temperature, the MQ-2 sensor detects a variety of gases, including smoke. For seamless IoT connectivity, the system is based on an Arduino ATmega2560 microcontroller equipped with Wi- Fi ESP8266. The device instantly notifies the user through the Blynk app on their smartphone when it detects abnormal levels of smoke or temperature allowing for quick response. Furthermore, the extensive testing in a standard residential kitchen setting proved the system's dependability and efficiency in identifying fires. Open-source technologies and reasonably priced sensors work together to make this system feasible and approachable for broad use. In addition to addressing the shortcomings of conventional fire detection techniques, this project makes advantage of Internet of Things capabilities to improve user awareness and safety in residential settings. According to the findings, installing a smart fire detection system can increase kitchen safety and perhaps save lives at a reasonable cost.

ABSTRAK

Perkembangan penting dalam teknologi keselamatan rumah ialah teknologi keselamatan rumah ialah sistem pengesanan kebakaran pintar untuk dapur rumah yang menggunakan penderia MQ-2 dan DHT11 digabungkan dengan seni bina Internet ofThings (IoT). Melalui penggunaan aplikasi mudah alif intuitif, projek ini berusaha untuk meningkatkan ketepatan dan masa tindak balas pengesanan kebakaran sambil menawarkan pemantaun dan pemberitahuan masa nyata. Walaupun sensor DHT11 memerhatikan kelembapan dan suhu, sensor MQ-2 mengesan pelbagai gas, termasuk asap. Untuk sambungan IoT yang lancar, sistem ini berasaskan mikropengawalArduinoATmega2560 yang dilengkapi dengan WiFi ESP8266. Peranti itu memberitahu pengguna serta-merta melalui aplikasi Blynk pada telefon pintar mereka apabila ia mengesan paras asap atau suhu yang tidak normal yang membolehkan tindak balas pantas. Tambahan pula, ujian meluas dalam tetapan dapur kediaman standard membuktikan kebolehpercayaan dan kecekapan sistem dalam mengenal pasti kebakaran. Teknologi sumber terbuka dan penderia harga berpatutan bekerjasama untuk menjadikan sistem ini boleh dilaksanakan dan mudah. Menurut penemuan, memasang sistem pengesanan kebakaran pintar boleh meningkatkan keselamatan dapur dan mungkin menyelamatkan nyawa pada kos yang berpatutan.

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LIST OF ABBREVIATIONS

mL	-	millimeter
cm	-	centimeter
s	-	second
mL/s	-	millimeter/second
cm/s	-	centimeter/second
°C	-	degree in Celsius
%	-	percentage
ppm	-	parts per millions

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CHAPTER 1

INTRODUCTION

1.1 Background

Fires are unfavorable occurrences that cause real harm to both human life and property. In a matter of seconds, a fire can ignite, destroy houses and property, inflict injuries, and claim lives. It can also rage uncontrollably until its fuel supply runs out. It might be difficult in circumstances where the building is empty or where conventional alarm sounds might not work, including in loud places or around people who have hearing impairments. Everything could be destroyed by a wildfire.

The creation of fire detection systems was the subject of research and invention in the early 1900s by 1960s, the commercial smoke detectors are initially made available for purchase. Since that, it has grown to be a crucial safety component in homes and buildings. The invention of smoke detectors which provide early warnings and enable occupants to take prompt action has dramatically decreased the number of fire-related injuries and fatalities.

The development of smart fire detection system for home kitchen a new technology with the concept of IoT (Internet of Things) by integrating a microcontroller device as an input and the output data processor parts such as sensors that have smartphone communication capabilities. It is not only required a precise fire detection system but require for a clever solution. A smoke sensor, an Arduino board and the temperature sensor with addition of other components such as buzzer are some of the hardware and software parts to utilize for smart fire detection system project. When the sensor senses a smoke, the Blynk app on the smartphone is utilized to monitor media in real time.

Lastly, the system is made to make intelligent judgments based on the circumstances where it offers hardware controls and feature-updated alarms. The main goal of the project is to lower the risk of loss of life, reduce the cost of large losses and reduce property damage. This project wants to create a basic Smart Kitchen system that is reasonably priced, simple to operate, easy to install and modify, and reasonably reliable.

1.2 Addressing Global Issue for Smoke Detector

Smoke detectors are safety equipment that have helped to lower the number of fire-related fatalities and injuries worldwide. In addition, smoke detectors play a crucial role in lowering the number of fatalities and injuries caused by fire such as early warning, reduced confusion and panic, improved evacuation time and waking up sleeping occupants. By addressing the global issues which is reasonably priced, conveniently accessible are required to meet these global concerns. The technologies like the Blynk apps-integrated smart fire detection system, it offers a dependable and prompt communication method for alerting people about fire threats.

Besides that, the smokes detector technology has not advanced very quickly in developing nations. This includes using smoke alarms powered by renewable energy sources. It is a complex matter impacted by obstacles related to economics, infrastructure and education. In developing nations, where smoke detectors are not regularly inspected or maintained, it might be a serious problem. One major problem that jeopardizes fire safety and raises the possibility of fire- related incidents is the neglect of smoke detectors in developing countries which results in irregular inspections and maintenance.

In addition, there is a deficiency of knowledge and education regarding the significance of smoke detectors. For educational initiatives should be put in place to teach people about the advantages of smoke detectors and how to use them correctly. These efforts have the potential to greatly improve fire safety through targeted group collaboration, practical information sharing, awareness-raising, right usage promotion and stakeholder collaboration. The result is a decrease in fire- related accidents and their destructive effects as well as improved safety, community, resilience and long-term cost savings.

In conclusion, resolving worldwide concerns about smoke detectors requires a multimodal strategy that takes accessibility, technology, upkeep, instruction, and legislation into account. A multimodal approach that incorporates accessibility, technology, maintenance, education and law is necessary to address concerns concerning smoke detectors around the world. By lowering the cost and increasing the accessibility of smoke detectors, utilizing cutting-edge technologies, guaranteeing routine maintenance, raising public awareness and putting in place sensible legislation.

1.3 Problem Statement

Despite technological progress and increased public knowledge of fire safety, the house kitchens remain popular locations for unintentional fires that frequently result in serious property damage, injuries and even fatalities. There are many key issues the fire detection happened at home kitchen for example frequent false alarms, delayed detection, lack of smart integration, maintenance issues or limited accessibility and awareness.

In Malaysia, one of the most frequent categories of home fires is caused by cooking A sizable fraction of residential fire events, according to the Fire and Rescue Department of Malaysia (Bomba) from kitchen fires. Therefore, kitchen fires accounted for almost 30% of all recorded residential fire events between 2016 and 2020.

Besides, many injuries from home fires are caused by cooking fires in Malaysia. When locals attempt to put out the fires themselves, many get hurt. While comparatively infrequent, kitchen fire deaths are nevertheless noteworthy where several incidents are documented each year. In addition, the fires in kitchens can seriously harm property. The tens of thousands of Malaysian Ringgit (MYR) worth of property damage can be caused by a single kitchen fire incident on average. In 2019, kitchen fires resulted in an estimated MYR 15 million in property damage.

In Malaysia, the hours of greatest kitchen fires coincide with meal preparation between from 6 to 9 p.m. Due to consistent with global trends, unattended cooking is the leading cause of kitchen fires. The frequency of kitchen fires is also influenced by the usage of outdated or malfunctioning cooking appliances.

Due to increasing the population densities, it increased usage of gas stoves and electric cooking appliances and higher rates of kitchen fires, Malaysian cities have higher rates of kitchen fires. Although there may be fewer kitchen fires in rural regions, the usage of traditional cooking methods puts residents at serious risk. In other words, the lack of access to contemporary fire detection systems and often utilize older, less dependable cooking appliances, lower-income homes in Malaysia are more vulnerable. Kitchen fire incidents are more common in public housing communities which are home to many low-income households.

In Malaysia, a sizable portion of residences lack of kitchen smoke alarms which causes fire damage to increase and detection delays. The installation of smoke detectors in residential areas is generally not enforced or given enough awareness. However, a smoke detector was frequently neglected and not properly inspected by leaving it inoperable in the event of a fire.

According to the United Nations, to improve global health outcomes. 146 out of 200 countries or areas have already met or are on track to meet the under-5 mortality target. Besides that, effective HIV treatment has cut global aids-related deaths by 52% since 2010. Through this, at least one neglected tropical disease has been eliminated in 47 countries. According to statistics, 381 million people (4.9% of the population) have out of pocket payments for health pushed or further pushed into extreme poverty. Next, almost 25 million children missed out on important routine immunizations in 2021 and 6 million more than in 2019.

Every year starting from 2019, 2020 and 2021, the malaria cases have surged worldwide. The data from those years increases slowly. From those problems, a woman dies every two minutes from preventable causes related to pregnancy and childbirth in 2020.

According to the United Nations too, to make cities and human settlements inclusive, safe, resilient and sustainable. Based on statistics, in 2020, 1.1 billion urban residents are living in slums and 2 billion more are expected in the next 30 years. Air pollution is no longer an exclusively urban problem because of towns experiencing poorer air quality according than cities in eastern and south-eastern Asia records in 2019. Global records in 2022, only one in two urban residents have convenient access to public transport. Not only that, 3 in 4 cities have less than 20% of their area dedicated to public spaces and streets, it is much lower than the target of 45-50% in 2020 globally.

1.4 Project Objective

The main aim of this project is to propose to detect a fire detection at home kitchen with Blynk app notification, the system's efficiency by utilizing from Arduino Uno. Specifically, the objectives are as follows:

a) To study and examine the current fire detection system by enhancing the safety and reliability of fire detection systems in home kitchen.

b) To develop smart fire detection circuit IoT notifications.

c) To evaluate performance of the smart fire detection circuit with functionality to make improvements over traditional fire detection systems.

1.5 Scope of Project

The scope of this project are as follows:

No	Scopes	Purpose
1	Circuit Design	The system is designed to detect the fire using MQ-2 and DHT11 sensor to alert the smoke or temperature and the notification through Blynk apps.
2	Program Development	By using the Arduino IDE software for create a program that will operate the system and hardware.
3.	Software Development	To design and link the circuits by using Proteus which can display the output for this design the circuit

4.	Hardware Development	The power supply is needed to deliver the power for Arduino board.
5.	Environment for Testing	The location of testing this project in real home kitchen environment to ensure its effectiveness and reliability.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Based on Berita Harian news on 12 February 2024, there is a case of an elderly woman with burns after her kitchen caught fire at Midland Court Apartments in the morning. In the incident at about 8.30 a.m., the 79 years old victim lady who lived alone was said to be baking bread in the kitchen. A Bagan Jermal Fire and Rescue Station (BBP) Operations Officer said a team of firefighters went to the scene of the incident after receiving an emergency call at 8.40 a.m., regarding the incident. He said the fire was found to have occurred in the kitchen area of the 10x10 square feet with a 10 percent fire estimate. He said there was an elderly female victim who suffered an injury to her right arm, the victim is said to be baking bread using a toaster and it is believed that the fire is started from there. The victim was taken to Penang Hospital (HPP) for further treatment. Figure 2 shows the explosion that happened at her apartment.

Figure 2.1 Explosion

According to New Straits Times (30 April 2023), this morning, a fire that started in the kitchen of a home at Taman Overseas Union claimed the life of 47 years old lady. The woman's body was discovered dead in a room next to the kitchen of the Jalan Rahmat 3 home, her identification has not yet been made public. The operation commander of the incident and Rescue Department reported that at 8.43 a.m., the department received a distress call regarding the incident via the MERS999 hotline. He claimed that nine firefighters from the Sri Peta ling station hurried over to the spot right away in a fire rescue tender. But it turned out that the neighbors had already extinguished the fire. The kitchens, which were only approximately 10 by 10 feet, were destroyed in the fire. However, more inspections revealed a woman's body in a room next to the kitchen. The victim has been identified as a 47-year-old woman, without disclosing the victim's identity. He noted that the source of the fire was still being investigated but that the operation ended at 8.53 a.m.

Based on both stories above, there are many challenges of claiming insurance after a home fire. Firstly, comprehensive paperwork is needed by insurers such as receipts or values, comprehensive descriptions of damaged property and evidence of ownership for damaged objects. After a fire, compiling this information can be quite difficult. For accurately filling out the required papers and documents is essential. Errors or omissions may cause the claim to be denied or to be delayed. Besides, an insurance adjuster may need some time to examine and evaluate the damage, particularly if there are several claims being handled in the region at once. To make sure that carelessness or deliberate actions were not the cause of the fire, insurers may investigate its origin. This can make the procedure take longer and result in more stress. Then, the maximum amount that policies will pay for a given kind of damage or item is limited. If the damage is greater than these caps, it might have to pay for it out of pocket. There are several plans that could have exclusions for kinds of losses or requirements that must be fulfilled for a claim to be approved. For instance, certain natural disasters or damage resulting from poor maintenance may not be covered.

Moreover, the depreciation is frequently computed by insurers which can drastically lower the payout when compared to the item's initial worth or replacement cost. The worth of certain objects or the cost of repairs may be points of contention between the insured and the insurance. Next, additional living expenses are usually covered by policies, however there are restrictions. It is essential to make sure these costs are properly recorded and submitted for reimbursement. Besides that, it may be challenging to concentrate on the minute details of the insurance procedure due to the trauma of the fire and having to leave your house. It can be difficult to communicate clearly and consistently with insurance reps when you are already under stress and handling a lot of problems.

Furthermore, there are many effects of not using a smart fire detection system in home kitchens. Firstly, one may become aware of a fire later whether it they conventional fire detection devices installed or none. Small flames have the potential to grow into larger, more devastating blazes before anyone notices them, if they are not promptly detected. The kitchen fires can spread quickly if they are not detected in a timely manner, especially when flammable items like cooking oils and wooden cabinets are present. This raises the possibility that strong fires will result in substantial damage. If a fire is not discovered quickly, it may burn for prolonged periods of time until help arrives, severely damaging kitchen equipment, cabinets and the home's structural components. Without early detection systems, the cost of correcting fire damage might be high. These covers repairing water and smoke damage from battling fires in addition to replacing burned goods.

Then, there is a greater chance of injuries or fatalities if there is a delayed evacuation due to delayed fire discovery. In extreme circumstances, smoke inhalation may cause people to feel imprisoned or overpowered. The emergency response teams might not be contacted promptly in the absence of timely alerts, which could delay their arrival and the start of firefighting operations. For homeowners, the expense of maintenance, short-term lodging and replacing personal items can be disastrous. Insurance may help with some of these fees but there may be large out-of-pocket costs due to deductibles and coverage limitations. A home fire can cause stress, personal belonging loss and disturbance to everyday life, all of which can have long-term emotional and psychological effects on the household.

Besides that, without early notice to rebuilding and recovering from a kitchen fire can require a significant amount of time and energy. Work, family routines and other activities may be interfered with by this. The severe dire damage may result in higher insurance costs for homeowners which could raise their long- term financial burden. When plastics, chemicals and other items burn, dangerous poisons can be released into the air in kitchen fires. The release of these toxins may be more widespread in the absence of prompt detection and control. Due to the need to repair and dispose of damaged materials and goods, extensive fire damage generates a large amount of garbage that goes into the environment. The sophisticated capabilities of smart systems such real time alerts, remote monitoring and interaction with other smart home appliances are absent from traditional fire detection systems. This lowers overall safety and emergency response times in the event of a fire.

2.2 Overview of Existing Project

This section will go through the literature review project designs and implementation related to this project system. There are many researchers who have spent many years determining the best way to optimize smart fire detection systems and devices.

2.2.1 Home Security and Fire Detection System Design using IoT-based Microcontroller Atmega2560

After the PIR sensor is idle, the sensor will send a signal to the microcontroller and activate the relay to turn on the LED as a indicator for any object passing in front of the PIR sensor to detect motion after a 10 second delay. The user will receive a message, "Object Detected" on Blynk apps. "No Object Detected" appears in the notification if no motion detected. Then, the Blynk displays the message "Alarm Asap Stop" if MQ-2 sensor is idle or fails to detect any smoke. The microcontroller receives the signal from sensor if it detects smoke over the predetermined threshold (in this case >100 ppm), the relay activates the smoke alarm's LED and buzzer. The further the objects from the sensor, the greater and the motion will be not detected at all. The optimal distance is up to 6.5 meters. If no moving item is detected, the output of PIR sensor will shift from 0 V to 3.32 V. The farther an object from PIR sensor, the longer the time delay becomes.

2.2.2 Automation and Monitoring Smart Kitchen based on Internet of Things (IoT)

When the DHT11 sensor detects an air temperature of more than 25 °C, the MQ- 135 sensor detects an LPG gas leak, the IR flame sensor detects a fire, and the Arduino receives a command, the Fan will be activated. A smartphone goes Cayenne server and alarm sounds of a fire or gas leak. After processing the data, Cayenne is shown on the dashboard. The application displays the data received by the dashboard server with cayenne. The Cayenne server's associated components are also controlled by a part of the dashboard. The fan relay in this arrangement is controlled by the Cayenne. Based on sensor readings, the trigger function will send out messages via email and SMS. Via the Cayenne server, the mobile device acts as the smart kitchen system's receiver and information viewer. The Cayenne's data shown on dashboard. By selecting the chart menu located in the upper right corner of each sensor data on a dashboard, one can view the stored data. The dashboard in Cayenne app on a mobile device also shows the data that Cayenne received. The alert system for gas leaks and fires functions properly via SMS and email, the system will notify mobile devices of impending danger.

2.2.3 Wireless Kitchen Fire Prevention System using Electrochemical Carbon Dioxide Gas Sensor for Smart Home

For sensor module, CO2 concentration monitored by the module, which is powered by a 12-V supply voltage that is converted from the 220 V household supply voltage using a power adaptor. The CO2-sensing unit's low-dropout regulator supplies the construction blocks with a 3.3-V supply voltage. For alarm module, the PIR sensor recognizes when people are near the module. The wake-up signal from the PIR-sensing device is utilized to turn on and off the MCU and LED. When the wake-up signal is raised high, it indicates a user is in proximity and activates the LED. The LED can then be switched on or left off based on the data received about the gas stove's condition. For wireless communication, the receiver begins reading the data when the ID in the received data matches its ID. If there is a problem in the data that was received, the checksum bit indicates it. By determining whether the amount is unusual, the recipient investigates the error. When the transmitter determines the gas stove's condition, it transmits the data symbol without providing any concentration data. Only roughly 0.2 mA are used by the warning module when the OOK receiver is off, and 5.9 mA are used when communication is taking place. The MCU turns on and reads the data from the OOK receiver when the PIR sensor detects a person. The alarm module uses 7.6 mA at that point. The alarm module uses its maximum current of 13.1 mA under these circumstances. Consequently, the battery life can be increased by significantly lowering the current consumption from 13.1 to 0.2 mA during the majority of the time when the user is not in close proximity to the receiver.

2.2.4 Automatic Fire Detection and Notification System based on ImprovedYOLOv4 for the Blind and Visually Impaired

For the fire detection task, by employed YOLOv4, an expansion of the YOLOv3 model. The security cameras and smart glasses record video and take picture frames during the fire prediction stage. These are then forwarded to the AI server for processing. After receiving the picture frames, the AI server resizes them to 608 × 608 pixels. Upon detection of fire regions, the AI server initiates two distinct activities for the fire notification stage, first by sending text and voice messages to the user's smartphone and second, by sending a discovered fire image to the fire department. Regarding the first action, BVI individuals can use smart glasses to regulate the environment and distinguish between dangerous flames and fires that occur in regular life. Using the object mapping strategy, the fire and object detection models functioned accurately. Even in situations where there were several objects, object mapping and detection performed well. Experiments have demonstrated that, independent of the time of day or the size or shape of the fire, our suggested strategy may lessen the worries of blind users and enable early suppression and quick response.

2.2.5 Application of Internet of Things in a Kitchen Fire Prevention System

Arduino connects with D1 Mini to enable notification and turns on the flash and sound alarm features. To open the door and turn off the gas main switch, it is connected to an electrical appliance. A Web Duino is to carry out the reelevates remote invalidation controls without using Wi-Fi. The MQ-4 gas sensor is used to activate the gas sensor, it mimicked the liquefied petroleum gas or natural gas using gas created by a lighter. From that, the hot air from the hair dryer, and the powerful light from mobile phone flashlight to activate the temperature sensor, gas sensor and flame detector after connecting and testing the sensors, control board, and controlled devices. The main entrance door automatically unlocked, the gas shutoff turned 90 degrees to cut off the gas supply and user receive the messages via mobile phone. The alarm system, line notification, door lock opening and gas shutoff activated right away if the system detects a value that is higher than the safe range around 5 seconds. The shutdown mechanism turns 90 degrees clockwise to cut off the gas supply, protecting inhabitants when the sensors detect fires, excessive temperature or a gas leak. The temperature and flame sensors used for sounds an alarm, send notification messages, turn off the gas supply and open the door lock when temperature or flame intensity reaches the set value.

2.2.6 A Smart Fire Detection System using IoT Technology with Automatic Water Sprinkler

The sensors are controlled by an Arduino Mega. The temperature sensor, gas sensor and flame sensor act as a threshold to verify the potentiality and criticality of fire. The water system turns on to stop the threat if the thresholds were reached. Water is drawn from the tank by a 12 V pump and sent through the conduit to the sprinkler head. The water level in the tank is determined by ultrasonic sensor. The feedback is connected to Internet of Things updates that manage the water pump using additional fire-detection sensors. Furthermore, the system uses buzzers and LEDs to indicate danger visually. On a smartphone, the node MCU keeps data and displays it continuously. The data from the sensors is shown on the Unidos dashboard which is connected to Arduino code. There are three indicators which are temperature, gas and flame sensors. When a flame sensor detects light in the 760 nm to 1100 nm range, fire is detected, and the data is collected into the platform of Unidos to send SMS messages. When water flows to the bucket, the water tank is positioned on top to make use of gravity. The sensors for temperature, gas, and flame are installed in the testing chamber. The water unit has a water pump connected to a water sprinkler as well as two waters containers. With IoT, the electronics function act as operation's brain.

2.2.7 Design of a Home Fire Detection System Using Arduino and SMS Gateway

When the Arduino system is turned on, it moves on the following phase. In this step, an Arduino and an SMS gateway detect the room temperature and the presence of LPG gas in a room. The system initializes an Arduino device's GSM module which transmits brief messages. The Arduino device use and an SMS gateway acts as an alarm, a buzzer initialize by the system at this stage. When the detection system is turned on, the fifth phase involves interpreting the data from the DS18B20 sensor. The temperature and LPG gas detection sensors' reading function accordance with preset parameters, in which case the gadget sounds an alarm and delivers a brief message. While the testing period for gas detection is only 30 minutes, the room temperature detection testing requires 60 minutes since heating the room takes longer than releasing gas into the space.

2.2.8 Dependable Fire Detection System with Multifunctional Artificial Intelligence Framework

The AI framework receives the data gathered from heterogeneous sensors such as temperature, humidity, gas sensors and webcams via IoT gateways. An adaptive fuzzy algorithm which adjusts the dynamic fuzzy factor combines the fire probabilities for each sensor measured through MLs into a single fire probability. The MQTT protocol, a broker-based middleware that can lead to bottleneck issues and data transmission delays, is used for fire detection system to convey data. By using the data transmission path distribution technique to address the bottleneck issue, the SDN controller reduces this data transfer time. The IoT gateways and the fire detection server are connected directly by the SDN controller. In comparison to the previous fire detection systems, MAI-FDS lowered the end- to- end transfer delay by 67% and obtained an average fire detection accuracy of above 95%.

2.2.9 Smart Fire Detection and Deterrent System for Human Savior by Using Internet of Things (IoT)

The temperature, humidity, and smoke sensors begin to sense the surroundings and record the inputs if the fire sensor senses the presence of fire. The AI fuzzy logic techniques used to detect the severity of the fire in this case. Fuzzy inference is then done to determine the degree to which the input data matches predefined rules in the fuzzy logic, and it is chosen which predefined rule is to be fulfilled depending on the input values. The output decision value is then obtained by applying the centroid defuzzification method. Either the water sprinkler was start or an alert is sent by the system; if the issue is under control, the system waits for the next result before sending another alert or stopping the sprinkler. Following the hardware setup of every sensor with the microcontroller, the Arduino IDE 1.8.5 was utilized to read and record the sensor values. C code was generated for this purpose, and the DHT22 library was the sole one employed to sense the temperature and humidity. In MATLAB viewer, the experiment 1 findings are discussed. The value of the temperature (Temp-S) is 10 ◦C. The reported values for smoke (Smoke-S) and humidity (Humidity-S) are 0% and 29%, respectively. With a 10-minute duration and a 10.3% production, the likelihood of a fire occurring is quite low. In MATLAB viewer, the experiment 2 results are discussed. 35 °C is the reported temperature (Temp-S) value. The reported values for smoke (Smoke-S) and humidity (Humidity-S) are 300 and 10%, respectively. After 10 minutes, the production is 55.8%, indicating a very low likelihood ofa fire. Next, the Viewer for MATLAB Rules in representation. The temperature sensor recorded value (Temp-S) in the first column is set to 60 °C. The humidity by (Humidity- S) sensor is displayed in the second column, where it is set at 5%. In turn, the fourth column indicates the time, which is set at 20 minutes, and the third column represents the (Smoke-

S) sensor, which is set to 305. The output column is the fifth column, which is referred to as Fire-Chances.

2.2.10 Sensor Based Smart Fire Detection and Fire Alarm System

A temperature and smoke detector, a microcontroller, an alert response system and a fire-retardant system are part of the IoT based on fire alarm prototype system. The temperature is detected using an LM35 temperature sensor. Upon detecting a temperature threshold of 104°F or higher, the system notifies customers through an LCD display and simultaneously sends them an SMS alert regarding the elevated temperature within the house. It was noted that the smoke detector signal time was clearly dependent on the location of the fire, ranging from 20 seconds to 10 minutes, whereas the temperature sensor signal time was approximately 5 minutes.

2.2.11 A Smart Fire Detector IoT System with Extinguisher Class Recommendation using Deep Learning

A powerful quad-core ARM A57 CPU running at 1.43 GHz, 4 GB of RAM, a 128-core Maxwell graphics processing unit (GPU), a micro-SD card slot, USB ports, GPIO and several integrated hardware peripherals are all included in the Jetson Nano TM Developer Kit. The FLIR Lepton® thermal camera (Teledyne FLIR LLC, Wilsonville, ORUSA) datasheet states that every pixel in a picture is calibrated, noncontact, and accurate temperature data is captured. The Jetson Nano is linked to an eight-megapixel RGB camera over the Camera Serial Interface (CSI). A Network Interface Card (NIC) with Bluetooth and Wi-Fi capability is plugged into the Jetson Nano's M.2 socket to provide wireless connectivity. The Jetson Nano's heartbeat LED is an LED that interfaces with a GPIO pin to function as a program status indicator. A 110 V AC to 5 V4ADC converter powers the device, and a cooling fan with pulse width modulation (PWM)-based speed control is placed above the CPU to keep it at the ideal working temperature. The steps take 65ms on average to complete on the Jetson Nano device. 52ms of this 65ms are devoted to common item detection using the SSD Inception- V2 model.

2.2.12 Design and Implementation of Real-Time Kitchen Monitoring and Automation System Based on Internet of Things

A GUI application on the mobile phone operating on the transmitter end sends on/off commands to the receiver where the loads are attached and vice versa, while the Arduino board located at the reception end communicates with the Internet. By tapping the appropriate spot on the GUI, users can remotely turn on and off the loads thanks to this technology. Relays are used by the Arduino board to control the loads. Two, four, and six houses were considered in the simulation. Every home typically has two kitchens, two living areas, one guest room, two bathrooms, and two bedrooms. The following was considered for each house's average. Eight 60-watt lights used daily for 4/12 (4 lights on for 12 hours a day or 2 lights for 24 hours a day) were supposed to be utilized by each residence. This translates to 60 × 2 = 120 watts. Additionally, two fans are used daily for 2/24 like 3 fans used daily for about 24 hours a day and 2 × 120 = 240 watts. 360 watts of electricity are thus used per day for the lights and fans. Moreover, an additional 340 watts are used by appliances like stoves, refrigerators, and irons. As a result, each home uses about 800 watts per day.

2.2.13 Design of IoT-Based Home Fire Detection System Equipped with a Data Logger

The Arduino Mega 2560 board serves as the primary controller. When the Arduino Mega2560 utilizes the AT instruction to gain Wi-Fi access, the ESP 8266 board acts as a client of the Wi-Fi router. In the IoT prototype, on the Arduino Mega 2560 board, the analog pin number 15 is connected to the gas's sensor while digital pin number 22 is connected to the fire sensor. The things to note that is the MQ6 gas sensor and the fire sensor are attached to the analog and digital pins, respectively. The Arduino IDE sketch fragment and the BLYNK application GUI display on smartphones are examples of software design. The Virtual Button application illuminates red when a candle flame such as a fire flame ignites signifying the fire sensor's effectiveness. The virtual level shifts to the left indicating a drop in the voltage of the fire sensor and the virtual button appears on the right. The voltage of the fire sensor is in a LOW logic condition when it senses a fire. Throughout the data retrieval process, a continuous graph of the flame sensor's working voltage vs. time function is shown. Based on the graph, it seems that the datalogger's recording of the fire sensor's operating voltage for a single day indicates that the graph rises and falls within the region of low voltage conditions.

2.2.14 A Novel Method for Smart Fire Detection using Acoustic Measurements and Machine Learning: Proof of Concept

The cone calorimeter is used for fire research. The process has been standardized in ISO 5660 and ASTM E1354, the device used as a radiative panel without any weight loss, heat release rate or effluent gas measurements. When the cone heats in the sample holder and recording devices are set up. The experiment was then set to begin by placing the sample holder beneath the pre-heated cone by opening the aperture that separated the sample from the radiative cone and beginning the recording. When the aperture opens, the timing begins. The objective of classifying fire event detection is defined by the gathered auditory signals. When the threshold is set to 0.5, these fire events are demonstrated to be detectable with an accuracy of 97.3%, precision of 98.4%, recall of 98.4% and F- score of 98.4%.

2.2.15 Smart Kitchen System using IoT

When gas leaks, the MQ5 gas sensor alerts the microcontroller with a digital pulse. A notification regarding a gas leak was mailed to the authorized user. If a short circuit results from gas leaking and starts a fire, the flame sensor detects it and alerts the microcontroller to the fire. The user receives an alert, a buzzer alarm sound and the main power supply will cut off. The microcontroller receives the data from load cell also known as a weight sensor. The user receives an alert to remind that reserve gas when threshold value falls below the set value. The DHT11 humidity and temperature sensor will check and analyze the ambient temperature and humidity before sending the signal to the microcontroller. An alarm message by mail notifying the authorized user to reserve gas will be sent when the gas level drops below the cylinder's typical weight.

2.2.16 Intelligent Smoke Alarm System with Wireless Sensor Network using ZigBee

For wireless communication module, the Cortex-M0 core of the CC2630 dual ARM core 32-bit CPU chip architecture handles wireless communication processing, while the Cortex-M3 core serves as the primary CPU and handles ZigBee protocol processing. This system makes use of dust, pressure, and humidity sensors, among other types of sensors. The mistakes made by the single indications in the previous section are avoided by using a variety of sensor types. Additionally, the environment acquisition module's practicability is substantially increased by the ability to collect environmental data in real-time by placing itself with the user at random via wireless communication. To assess the power consumption of the three WLAN (ZigBee, Bluetooth, and Wi- Fi) technologies during sleep interval by creating a virtual system in MATLAB. In all sleep intervals, fire smoke, fumes, and water mist, ZigBee uses less power than Wi-Fi. Upon examining the categorization outcomes, it was discovered that the mistake rate was zero. The results of randomly selected

Woodland identification shows the features of the air under each of these four indications are depicted in the figure.

2.2.17 Arduino based Fire Detection and Alarm System Using Smoke Sensor

An Arduino controller is used in this system design and development of a smoke and fire detection system. The Arduino controller is the main controller of the system. A temperature and humidity sensor are utilized to establish wireless communication between an Android phone and controller while a buzzer serves as an alarm. Additionally, the controller will use the GSM module to deliver commands regarding smoke and fire detection to an Android phone's virtual terminal. Numerous elements including the building's geometry, dimensions, layout and usage can influence the spread of fire and smoke within it. Alarm goes off to alert people within the building to the possibility of a fire and to evacuate if a detector picks up heat or smoke or if someone breaks a pane of glass.

2.2.18 GPS-based Fire Detection System (Global Positioning System) and SMS Gateway

An Arduino Uno microcontroller can operate by detecting temperature circumstances that must be able to handle the type of fire. The microcontroller program application detects fires. Any temperature rise brought on by the fire must be detachable by the Arduino Uno microcontroller. The device must also be able to read any smoke that the fire produces. When the temperature rises above 35°C, the DHT 11 and MQ 2 sensors which can identify smoke levels more than 50 parts per million. It will be activated by the system based on the program inputs. The Global Positioning System (GPS) will then supply the user with information in the form of a fire's coordinate point of location through the SIMSI GSM Module via Short Message Service (SMS). The system will first activate the buzzer as a warning sound. The message notification will send via SMS. For example, the notification of coordinate position

-3.05,104.78 where the coordinate point is made up of longitude (104.78) and latitude (-3.05). Then, open the Google Maps app and paste the coordinates in the search box at the top. When wax and anti-mosquito burn were used in a fire simulation showing by monitor serial. The temperature value = 38°C, mq2 = 128ppm and GPS data with latitude coordinates of -3.04798388 and longitude coordinates of 104. 78263092. As a result of the data showing that the temperature value reached over 35°C and the mq2 value has exceeded 50ppm, the detector emits a buzzer and sends out a coordinate point warning with the message "FIRE ADA" and the GPS coordinates of the fire's location.

2.2.19 Home Security System with IoT Based Sensors Running on House Infra Structure Platform

MQ2 sensors that are linked to the home infrastructure via TTGO modules are used to detect the presence of gas because of leakage. A module that functions as a receiver will be a part of a premises controller and the TTGO attached to a sensor operates as a data transmitter. In the computer engineering lab, system component tests were conducted to verify the Lora wan module's functionality as a crucial component of the TTGO module. The digital indicator is delivered straight to gateway or concentrator as soon as it triggered. Given how highly flammable LPG, the sensor placed close to the gas source as feasible to reduce the risk of gas burns and explosions. In the event of many sensors, TTGO might transmit data to the cluster controller via the premises controller where it could be recorded in a database or trigger an auditory warning. It took less than 5s to burn the gas if the fire source was positioned 5cm from the LPG source. The LPG took more than 50 s to burn if the fire source was moved 10 cm away from the gas source. It produced an explosive roar along with a sizable flame. The LPG gas was already toxic and explosive if it flowed for longer than 60 s.

2.2.20 LPG Gas Leakage Monitoring and Alert System using Arduino

Make sure the connections of buzzer, LCD display and LPG gas sensor are safe and correctly wired. After uploading Arduino code, turn on the system and make sure the gas sensor is correctly detecting the concentrations of gas. The alarm and warning messages sound should be verified as intended for introducing controlled gas leaks. By enabling remote monitoring and notifications, choose and integrate the relevant wireless communication module such as Bluetooth, GSM or Wi-Fi. After attaching the wireless module to the Arduino board, install the required code to enable wireless connection. For guarantee that notifications are reliably transmitted to distant devices, test the wireless communication feature. When it detects gas or smoke, it activates the LED, sends a message to the buzzer and LCD screen, and uses the GSM module to notify the relevant parties about the leak of LPG. It lessens the labor of humans. It is simple to manage in every way.

2.2.21 Development of a Fuzzy Decision Logic-based Fire and Gas Detection System for a Smart Kitchen

The connection of the various devices to the MCU. When it linked and the hardware implementation and C-written code uploaded to the MCU. The gas sensor is in thin air, meaning there is no hazardous gas in the kitchen thus when the LCD is checked with air, it prints "normal." The threat is printed on the LCD based on its level. As a result of the gas level exceeding the threshold, the communication and alarm units are activated. Next, the SMS registered by user receives the communication unit (GSM Module) sends. Then, the system is examined for fire using flame sensors. When a flame is detected in the kitchen, the system is configured to turn on the DC pump. To test the system for water spraying activation, the DC pump was submerged in a container of water and a lighter was used to simulate a fire. The system sounds the buzzer and notifies the user and other registered contacts when it detects a fire. The gas sensor can detect an average of 85% of LPG gas and 66% of CO gas when 100% of the gas is present in the region. This is because there is air in the vicinity which causes the gas sensor to register lower-value gases than those that are being supplied. During the FGDS development process, the flame sensor's sensitivity was plotted versus the total number of trials conducted. The flame sensor has a wavelength range of 0 to 1100 nm for detecting flames and radiation. When no flame detected between 0 and 759 nm shown in the table as "0", while flame is present between 760 and 1100 nm shown as "1".

2.2.22 IoT-Based Intelligent Modelling of Smart Home Environment for Fire Prevention and Safety

Using the Fire Dynamic Simulator often known as FDS, to mimic a fire in a smart house to access the effectiveness and efficiency. For temperature, gas, and smoke sensors, the initial sensor inputs were 25 ◦C, 15 ppm and 60 ppm, respectively. After we set the kitchen on fire, we estimated that it had begun 30 minutes after the simulation had started. The fire began and spread at a 1500 KW/m2 rate. We also used the C++ programming language to implement our suggested method to assess the effectiveness of our work. A computer with the specifications "Intel(R) Core (TM) i5-3570 CPU @ 3.40 GHz 3.80 GHz and RAM 16 GB" is where we installed our simulation environment and visual language. The additional sensors that were placed in the TV lounge, living room, and bedroom began to register a temperature increase after 8, 14, and 18 minutes respectively, as the fire and heat spread. The GSM communication simulation results applied in Visual Studio that was utilized to validate our algorithm. By determined the average power usage of the ZigBee sensors at 50% and 100% duty cycles over a 12-hour period. The 50% and 100% duty cycles show how long the radio interface is in the active state. A communication stack that is energy-efficient has a duty cycle of less than 1%. Each room's sensors required two AA batteries with a capacity of 3000mAh. For both 50% and 100% duty cycles, the sensors' total energy consumption over the course of a 12-hour period was computed.

2.2.23 Improved-Real Time House Fire Detection System Performance with Image Classification Using Mobilenetv2 Model

It is said that after the camera is turned on, it will take a picture. The image's color should then be converted to RGB. When using the fire detection function, the text that appears is "Aman" if there is no fire and "Kabalarian" if a fire is found. Telegram bots are used to send fire alerts. The user's Telegram will receive a text notification from the system informing them of a fire. The Play sound library is used by the fire alarm feature. A fire will be detected by the system, and an alert will sound. The accuracy of the system remains constant at 99.99% up to 4 meters but gradually declines from 5 to 7 meters. The accuracy drastically decreases between 8 and 9 meters away. The device loses its ability to detect fires from 10 meters away. According to the test results, a fire can be detected up to 300 cm away by a fire detection system that uses picture classification and the MobileNetV2 approach. The distance of 7 meters yields the longest average response time, whereas 9 meters yields the fastest.

2.2.24 Design of Multi-Information Fusion Based Intelligent Electrical Fire Detection System for Green Buildings

The gravity method, weighted summation method, area method and other techniques are frequently employed for de-fuzzification. A commonly used technique for resolving the ambiguous association between defects and symptoms is the application of fuzzy logic reasoning and membership function in fuzzy set theory. Initially, the characteristic quantities of the arc fault are extracted based on many experimental results and professional experience. The validity and flaws of each characteristic quantity as the criterion are then established. Second, data fusion is preprocessed to acquire complete information for fault arc identification based on the derived fault arc characteristics. Lastly, the fuzzy logic inference system employs the forward reasoning approach to create the fuzzy logic system to detect the fault arcs and produce real-time inferences for the failure's probability based on the gathered signal characteristics. The 10 inputs in all are used to get the results in terms of various parameters. The output that is produced at different inputs varies. Graphs with well-defined points efficiently depict variation in the output according to different parameters. The percentage disagreement was computed by dividing the disagreement count by the total number of tested samples. There has been a noticeable decline in both the FIS and the classifiers' disagreement amount; the FIS results have been steady over the years. The white and light-spotted classes had far more evenly distributed disagreements in the FIS, and the grading of the FIS exhibited no systematic bias.

2.2.25 Hardware Module Design and Software Implementation of Multisensory Fire Detection and Notification System Using Fuzzy Logic and Convolutional Neural Networks (CNNs)

Experiments were conducted in a lab setting to test the sensor-based fire detection device. The smoke sensor was activated by strong odors from the methylated spirit, the flame and temperature sensors by matchstick flames. The sensor measurements were recorded and stored in files. To confirm whether the fire detector sent SMS alerts in such cases, we also turned off the Internet connection on it. Field tests were carried out in the hallway and in the lobby outside the lab. navigation to the detected fire's location was made possible by the Google API. The output range produced by the on-board ADC is 0 to 4096. Based on the temperature sensor's output, we saw an error margin of ±2°C for every reading. A greater result for the smoke sensor denotes more smoke concentration, and vice versa. The fuzzy logic method has three output states, and it only triggers fire warnings when the prospective fire state or fire state pertinence are both high.

2.2.26 Constructing An Integrated IoT-based Smart Home with An Automated Fire and Smoke Security Alert System

For automated door lock system, there will be a sound to notify the owner if someone is at the door. The owner of the mobile app can then position the camera in front of the door and take a photo of the subject standing outside. The owner can then tap the ON button in the mobile app to open the door. The owner can further confirm by clicking on several pictures of that individual. The automated door lock is usable. For automated smoke and detection alert system with location sending, the owner will receive an automatic alarm if any smoke or fire is detected by the sensors positioned throughout the house. This function enables our system to identify any fire or smoke leak and notify the owner. Additionally, the location of the incident will be sent. Every time a human or moving object is detected by the sensor within a 300–500 cm range, the automatic door opens. The Arduino will alert home users by sounding an alarm and signaling the owner when the temperature rises above about 70°C. The alarm sensor will be activated when the smoke density is between 250 and 400. It automatically snaps a picture when it gets within 8–12 cm of an object or person. This distance is determined by the sensor's range. As the range increases, so does the captured power.

2.2.27 Implementation of Internet of Thing on Fire Home Information Systems for Multi Room Applications

The Ethernet output block of the module serves as the data sender for the data that has been processed from Arduino. Another output that the Arduino can produce is an electric local alarm. The wireless router allows data to be delivered to the house fire information system over a computer network. Through internet hosting, the information system redistributes data it receives to other computers within the same computer network as the fire or distribution information system. The operation of a home fire information system requires several components on the server side of PC-based machines that are utilized as servers. The fire detector or client system contacts the PHP engine, saves data to the MySQL database, and issues sensor data from my SQL database in the process of obtaining and saving fire data. As observed in the Arduino IDE Monitor, the test indicates that the fire detection system detected smoke and flames. However, information on the date, time, location of the house, room, fire, and smoke will be produced by the information system based on the smoke and fire data that has been sent in. Images of smoke and fire icons are represented by information and smoke.

2.2.28 Fire Early Warning System Using Fire Sensors, Microcontroller and SMS Gateway

By using sensors, the device can identify temperatures, gases and smoke that are higher than usual. The sensor can send ATEMega8 its detection data. The ATEMega8 can convert data from the detection sensor into information about early detection. The Wavecut Modem can receive commands from the ATEMega8 in the form of sensor- derived detection information data. An SMS gateway can be used by the Wavecut Modem to transmit data from the ATEMega8 to a mobile device, such as a fire department or homeowner's phone. The buzzer can be instructed by ATEMega8 if it detects any fire- related symptoms. According to the results of this test, provider D has the quickest message delivery response time. The voltage at point A on the potentiometer increases to 0.60 V in the observation data. Based on the observation data at point B, it can be determined that the voltage increases progressively from 0.296 V to 1.315 V (the point at which the temperature reaches its maximum) and that the difference between each data point is then measured. Then, this test demonstrates that the V Comparator out indicates a value of 0.034V, which activates the indicator if the sensor senses heat above 53.2 °C. If the detected gas level exceeds 900 parts per million (> 900 parts per million), the QM-6 Gas Sensor will identify hazardous gas levels. The sensor identifies normal gas levels if the gas level is less than 900 ppm (<900 ppm). If the detected smoke level exceeds 900 parts per million (> 900 parts per million), the TGS 2600 smoke sensor will identify hazardous smoke levels. The sensor detects normal smoke levels if the level of smoke is less than 900parts per million (<900ppm).

2.2.29 An Intelligent Fire Warning Application Using IoT and an Adaptive Neuro-Fuzzy Inference System

Sensor data from the Arduino UNO is collected and sent to a Microsoft Excel sheet using the PLX-DAQ Macro following a successful configuration with the Arduino UNO microcontroller. The computer USB port, which shows up as a virtual COM on the PLX-DAQ, is connected to the UNO serial port, such as COM3, via the AT MEGA328p. To train the proposed FDWS reading of the sensor data collected in real-time under various circumstances, such as reading in normal settings, severe conditions, and critical severe conditions, the training data set is necessary for ANFIS training in MATLAB. To train ANFIS data, the real data collected from temperature, humidity, flame, and smoke sensors is obtained in an Excel sheet under all circumstances. The information is acquired by two distinct experiments. The time interval for the fire to occur is shown in the first column, and the second. The temperature change rate in Celsius is shown in the column. The humidity change rate is shown in the third column, and the smoke change rate in parts per million when there is a fire is shown in the fourth. When there is no fire in the experiment's initial iteration, the rates of change for the temperature, humidity, and smoke are all 0. In the second iteration with the fire present, the temperature is raised to 2C, the humidity is adjusted to 2%, and the smoke rate is adjusted to 3.8 ppm.

2.2.30 Design of the Early Fire Detection Based Fuzzy Logic using Multisensor

The MQ-9 smoke sensor, the DS18B20 temperature sensor and the KY-026 fire sensor make up the input portion. This system's processing portion uses an Arduino Nano with an ATmega328 microcontroller as its base. For this system's output, which is a firm value ranging from 1 to 5 based on the defuzzification outcome. In fuzzy control, each subprocess has a function that is related to other subprocesses so that the last subprocess. When it arises, it will get input from the subsequent subprocess until it is the system's final output. The explicit values that are currently part of the membership function or degree of membership will be modified by the fuzzification subprocess. The three inputs are used by the system which is temperature, smoke content in the design and fire data. The four categories are used to categorize the fire data, which is close, relatively close, far and not detected. The five criteria are used to categorize the temperature data, which is cold, cool, pleasant, warm and hot. Additionally, the smoke data is categorized according to five criteria which are very concentrated, tenuous, moderate, intense and no smoke. To identify the input class, the membership value of each piece of input data will be examined. Based on the outcomes of multisensory testing conducted with and without gas derived from matches, the findings of multisensory testing conducted without gas reveal results of outputs valued between 2.50 and 3.00. There is an additional gas input from matches in this test, the results yield a value of more than three dollars. Based on the created fuzzy criteria, the fuzzy output will typically result in a value greater than 3.00 if the system detects a fire and there is a significant enough gas content. Comparing the fuzzy output from MATLAB and Arduino allows for fuzzy testing. With MATLAB software, the number of errors in the reading of fuzzy outputs on modules with fuzzy

output can be ascertained by computing the difference between the two test results.

2.3 Comparison of Literature Review

The MQ-2 and DHT11 sensors together with IoT integration to create a smart fire detection system for residential kitchens, stand out because it offers a workable, dependable and affordable solution. In the realm of home safety, it addresses the shortcomings of current technology while building on their virtues. The significance and possible influence of effort in developing home fire detection systems are highlighted by this comparative analysis. A comparison of the parts used in the related project previously mentioned is shown in

Table 2.1 Comparison of Review

Title of Research	Arduino ATmega2560	Web Duino	Display	ATmega328	MQ-2 sensor	Relay 2 channel	Flame Detector	IP Camera	Sound and Light Alarm	DHT-11 sensor	NodeMCU	PIR sensor	MQ-4 sensor	Jumper Cable	Breadboard	LED	Buzzer	Gas Shutoff Device	Door Lock
Home Security and Fire Detection System Design using IoT-based Microcontroller ATmega2560	✓				✓	✓						✓		✓	✓	✓	✓		
Automation and Monitoring Smart Kitchen based on Internet of	✓									✓									

Things (IoT)																			
Application of Internet of Things in a Kitchen Fire Prevention System																			
A Smart Fire Detection System using IoT Technology with Automatic Water Sprinkler																			
Design of a Home Fire Detection System using Arduino and SMS Gateway																			
Smart Fire Detection and Deterrent System for Human Savior by using Internet of Things (IoT)																			

Design and Implementation Real- Time Kitchen Monitoring and Automation System based on Internet of Things																			
Smart Kitchen System using IoT																			
Development of a Fuzzy Decision Logic-based Fire and Gas Detection System for a Smart Kitchen																			
Constructing An Integrated IoT-based Smart Home with an Automated Fire and Smoke Security Alert System																			

2.4 Summary

According to the literature research, there are number of shortcomings in convectional fire detection techniques that are addressed by the smart fire detection system for home kitchens that integrates IoT and uses MQ-2 and DHT11 sensors. This system is a vital development in home safety solutions since it uses contemporary sensor technology and IoT frameworks to provide better detection accuracy, real-time monitoring and user-friendly notifications. It is possible impact is emphasized by the comparative study which also points out areas in which innovation and improvement can yet occur.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In general, this chapter outlines the project's methodology. The two components of this project development are software and hardware development. This project's development has considered a few factors for it to function fully. Research and studies have been divided into two sections which are software development and hardware development. This project's development has considered several factors for the targeted research and studies to be fully functional.

3.2 Methodology

In this research, a smart fire detection system is presented to show how it works automatically. This enhancement will mix several elements to finish its task. This system is being improved step by step from the perspectives of research, program development and program utilization, all of which are mentioned in this chapter. Figure 3.1 shows the methodology flow in this chapter.

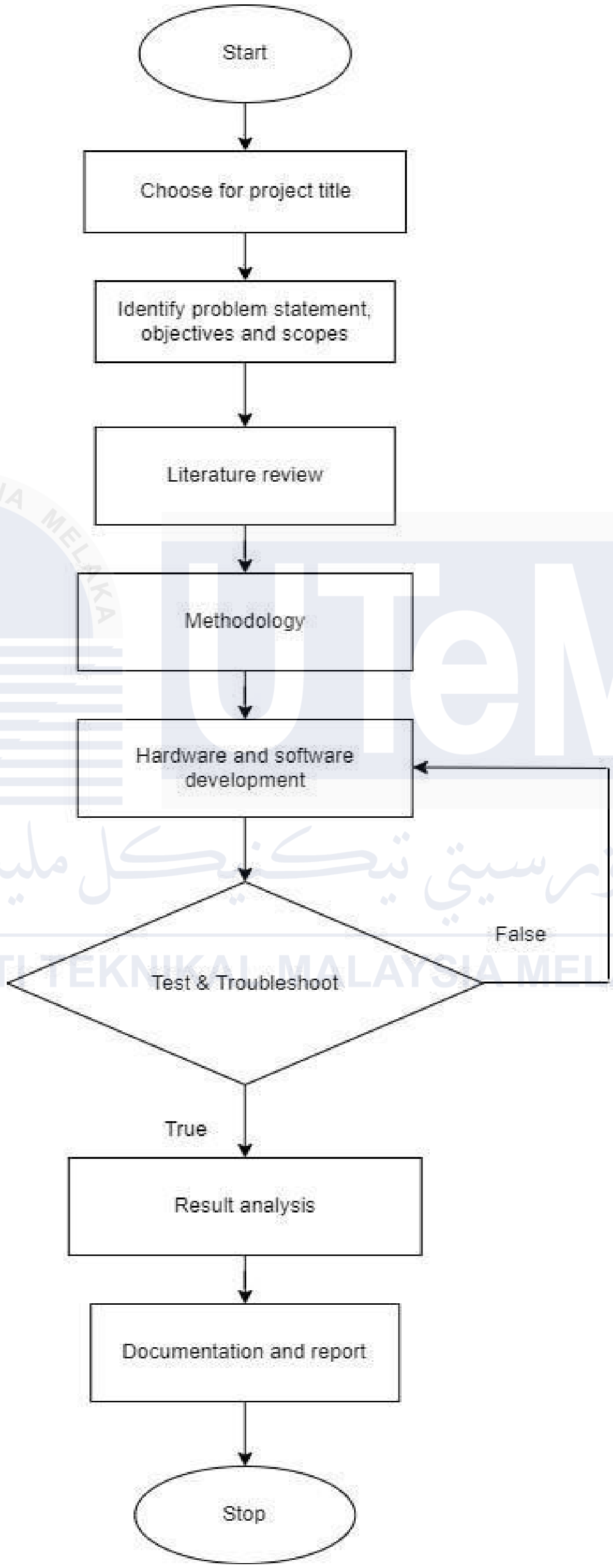

Figure 3.1 Methodology Flow

3.2.1 Project System Flowchart

A smart fire detection system's hardware flowchart gives a visual depiction of the various hardware components 'interactions and sequence of operations. Firstly, initializing the condition of the system. After that, insert smoke and temperature value. From that, the MQ-2 smoke sensor detected the smoke. If true, it is printed 'SMOKE DETECTED' while if false it will print 'TEMPERATURE DETECTED'. After that, when both sensors detected. The buzzer and LED will turn ON to send the notification to the Blynk apps. Figure 3.2 below shows the project system flowchart.

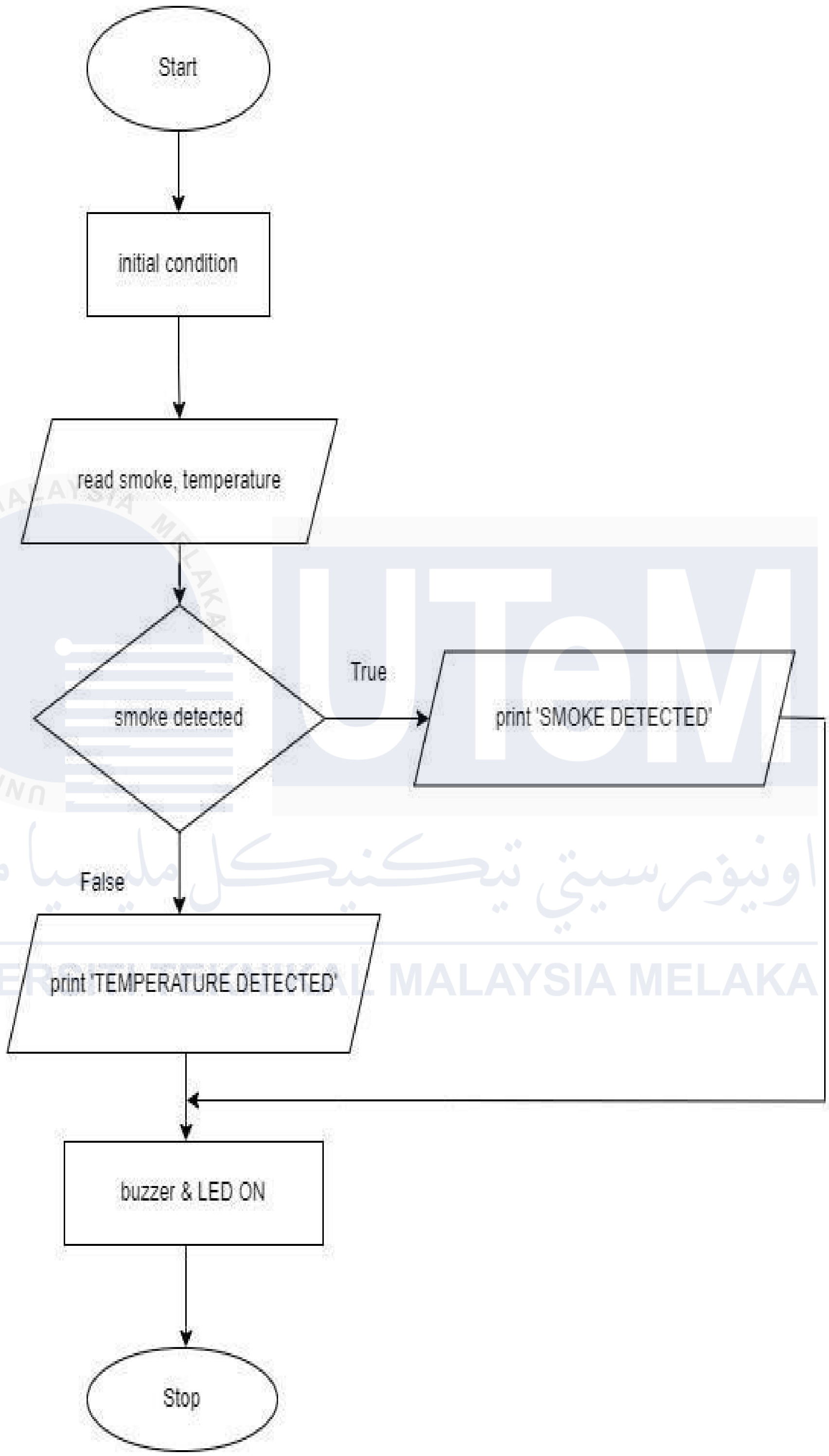

Figure 3.2 Project System Flowchart

3.3 Schematic Diagram

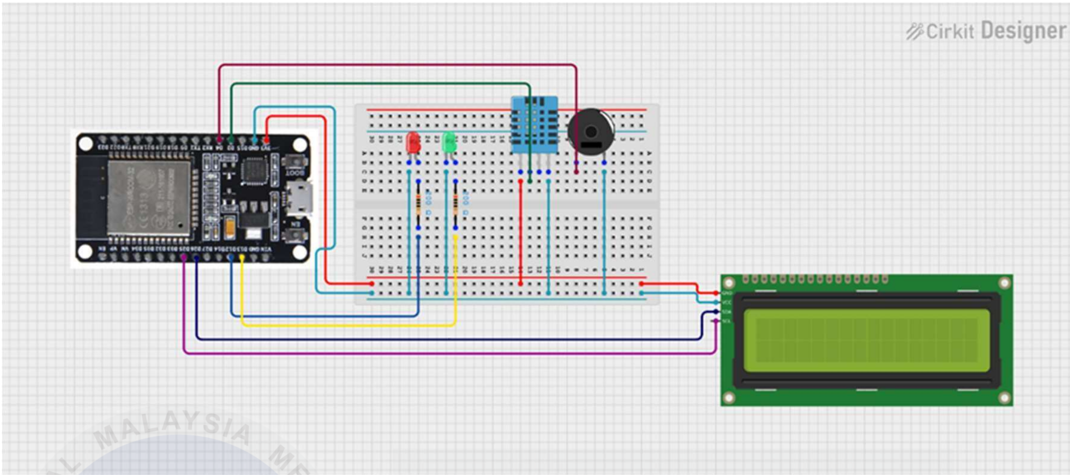

Figure 3.3 Schematic Diagram

Figure 3.3 of the schematic diagram above shows the ESP32 microcontroller, which acts as the operation's brain, is at the center of the system shown in the design. The job of this microcontroller is to control the several parts that are attached to it. These components are arranged and connected on the breadboard, making assembly and modification simple.

A DHT11 sensor is integrated into the system to measure temperature and humidity, providing useful environmental data. For applications involving fire safety, the inclusion of an MQ-2 gas sensor is essential for detecting the presence of flammable gases. The main interface is the LCD display, which shows data including alerts, system status, and current sensor readings. In the event of hazardous circumstances, such as elevated gas levels or unusual temperature measurements, a buzzer is built in to produce auditory warnings. Finally, the addition of red and green LEDs offers a visual representation of the system's condition, possibly indicating either an alarm or regular operation.

To improve readability and maintainability, jumper wires are used to link these parts, and color coding is used. Potential future enhancements or modifications to the system's functionality are made possible by the flexibility and ease of modification provided by this design style.

In general, the diagram indicates a system intended for environmental surveillance and maybe fire detection. The system is a useful tool for improving safety and security since it can collect vital data and react appropriately thanks to the integration of several sensors and the ESP32's computing capabilities.

3.4 Software Development

The software development for this project involves initializing and reading data from various sensors to assure accomplishments of the systems functionality. In this part, it is using only three software development which are Proteus 8, Arduino IDE and Blynk IoT application. Not only that, but it is also required to sketch the circuit diagrams, simulation, the coding for Arduino UNO microcontroller and the development of an application for controlling the system’s function.

3.4.1 Arduino IDE

The Arduino Integrated Development (IDE) is a program to write, compile and upload code to microcontroller boards that are compatible with Arduino. The development of software for Arduino hardware is supported by the straightforward and user-friendly interface offered by the Arduino IDE. Arduino is also known as the programmer. It can be updated with new code that simply a USB cable as opposed to separate piece of hardware like most previous programmable circuit boards. In addition, condensed C++ is used by the Arduino IDE which simplifies learning to program. Lastly, the Arduino provides a common form factor that decouples the functionality of the microcontroller into a more convenient package. Figure 3.4 shows the Arduino IDE software.

Figure 3.4 Arduino IDE

3.4.2 Blynk IoT

Blynk is an Internet of Things (IoT) platform for iOS and Android smartphones. The users can control Arduino, Raspberry Pi and NodeMCU remotely. With this help of this application, a graphical user interface (HMI) may be created by gathering and supplying the correct address on the accessible widgets. It consists of three major components which are Blynk app, Blynk server and Blynk libraries. Firstly, the Blynk app is used to develop stunning interfaces with the help of numerous widgets. After that, blynk server or known as blynk cloud is responsible for all the communications between the smartphone and and hardware. Lastly, blynk libraries enable communication to all popular hardware platforms with the server and process and process all the incoming and outcoming commands. Figure 3.5 shows the blynk apps in mobile.

Figure 3.5 Blynk Apps

3.5 Hardware Development

This section shows the components that have been used in this project to develop a smart fire detection system project. The main components used are MQ- 2 sensor, DHT-11 sensor, buzzer and LED.

3.5.1 MQ-2 Sensor

The MQ-2 sensor can detect additional gases that are frequently present in smoke from fires, it is widely utilized as a smoke sensor in a variety of applications. The MQ-2 sensor has a sensitive layer made from tin dioxide (SNO2) with poor conductivity in pure air. The presence of smoke or other gases interacts with the sensitive layer, it changes by its resistance. In addition, this sensor has a heating element that heats the sensitive layer. The gas molecules are helped to evaporate by this heating which facilitates the interaction with the sensitive layer. However, the sensitive layer's resistance lowers in the presence of smoke to changing the voltage across the sensor. Figure 3.6 shows the hardware of MQ-2 sensor.

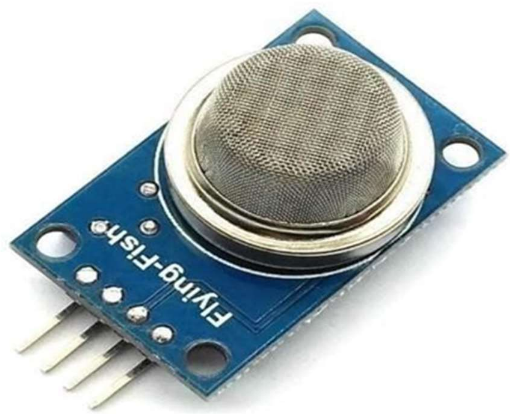

Figure 3.6 MQ-2 sensor

3.5.2 DHT-11 Sensor

The DHT11sensor is a well-liked and frequently used sensor to determine the humidity and temperature. It is renowned for being affordable, straightforward and simple to integrate with microcontrollers such as Arduino. It combines a capacitive humidity sensor with a thermistor for temperature measurement. Therefore, the DHT11 has a digital output to read the data with a microcontroller is simple and eliminates the requirement for an analog-to-digital converter (ADC). Figure 3.7 shows DHT-11 sensor hardware.

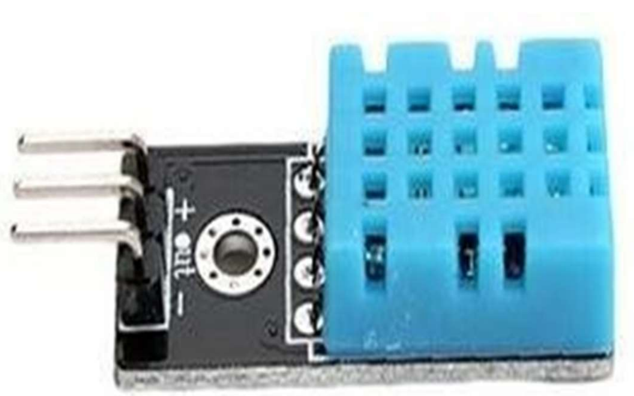

Figure 3.7 DHT-11 sensor

3.5.3 ESP32 Development Board

With its integration of Bluetooth and Wi-Fi, the ESP32 Development Board with Type-C USB and CH340C provides a flexible platform for Internet of Things applications. Its central component, the ESP32-WROOM-32 module, has a dual-core processor with a clock speed range of 80 MHz to 240 MHz that can be adjusted. It also supports low-power modes, which makes it appropriate for energy-efficient projects.

This development board's Type-C USB connector ensures reliable power and data transfer, and the CH340C USB-to-serial converter ensures compatibility with a variety of operating systems. The board's numerous GPIO pins and accompanying interfaces, which include SPI, I2C, and UART, facilitate the connection of sensors, actuators, and other peripherals. Because of its compact size and wide range of features, it is ideal for developing wearable technology, smart home appliances, and other Internet of Thing's applications. Figure 3.8 and 3.9 shows the expansion board and ESP32-CH340C-TYPEC respectively.

Figure 3.8 Expansion Board

Figure 3.9 ESP32-CH340C-TYPEC

3.5.4 LCD 16x2 i2c

A popular display module for electronics projects, the 16x2 I2C LCD can show 16 characters on two lines. By an I2C (Inter-Integrated Circuit) interface, the number of microcontroller pins needed for operation is greatly decreased, usually to just two data lines (SDA and SCL) plus power (VCC) and ground (GND) terminals.

This simplified connectivity saves important I/O resources for other devices and makes integration into a variety of projects easier. To improve visibility in a variety of lighting circumstances, the display frequently has a backlight and adjustable contrast. It is a flexible option for displaying text, numbers, and basic custom characters in a variety of applications, such as do-it-yourself electronics, instructional resources, and prototype projects, thanks to its interoperability with well-known microcontrollers like Arduino and Raspberry Pi. Figure 3.10 below shows LCD 16x2 i2c.

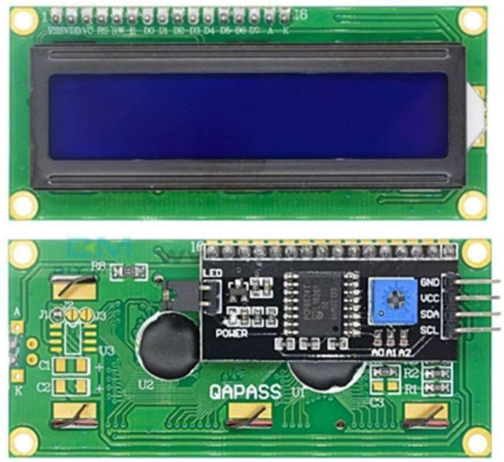

Figure 3.10 LCD 16x2 i2c

3.5.5 Buzzer

An electromechanical or electronic buzzer is a device that produces sound and is usually used for alerting or signaling. The buzzers are frequently used in a variety of applications, including timers, alarms and user input confirmation. Firstly, the buzzer can run at a variety of voltage levels usually between 3 and 12 volts or higher. Next, the buzzer's loudness is indicated by SPL which is expressed in decibels (dB). The louder noises correspond to higher SPL values. Besides that, the pitch is determined by a buzzer's sound frequency which is expressed in hertz (Hz). The buzzers can function at a set frequency or within a range depending on the design. Moreover, the amount of power consumed by buzzers varies. In general, piezoelectric buzzers use less energy than magnetic buzzers. Figure 3.11 shows the buzzer components.

Figure 3.11 Buzzer

3.5.6 Jumper Cable (Female to Female)

Female-to-female jumper wires are crucial parts of the development and prototyping of electronics. Designed to connect two male header pins without the need for soldering, these flexible, insulated wires include female connectors on both ends. This architecture makes it easier to quickly and reliably connect components, including modules to development boards or different parts of a breadboard.

These jumper wires are generally compatible with male headers that have a standard pitch of 2.54 mm (0.1 inch), guaranteeing wide application in a variety of electronic projects. They come in a variety of colors and lengths, often between 10 and 20 centimeters. This variant makes it easier to arrange and identify connections in intricate circuits. To accommodate a wide range of prototyping requirements, the wires are frequently packaged in sets, such as 40-piece bundles.

Female-to-female jumper wires are an essential tool for engineers, hobbyists, and anybody conducting electronics experiments due to their variety and simplicity of usage. They make it possible to quickly assemble and modify circuits, which expedites the development process and makes it easier to test and iterate electrical ideas. Figure 3.12 shows the jumper wire of female to female that used in this project.

Figure 3.12 Jumper Wire

3.5.7 USB Cable Type-C

A USB Type-C cable is a multipurpose connector that is frequently used in contemporary electronic gadgets for power delivery and data transfer. Because of its reversible 24-pin design, it is simple to insert and does not have the orientation problems that older USB connectors had. A wide variety of devices, including laptops and smartphones, may be charged thanks to USB-C connections' scalable power delivery capabilities. Standard cables can handle up to 3A (60W), while specialist ones can handle up to 5A (100W).

Depending on their requirements, USB-C cables can transport data at different speeds in addition to power. Some are made for USB 3.1 or higher, providing data transfer rates of at least 10 Gbps, while others support USB 2.0 speeds up to 480 Mbps. As a result, they can be used for connecting peripherals, visual output, and high-speed data transmission.

Direct connections to external displays are made possible by the USB Type-C standard's capability for other modes, which allow the cable to transmit non-USB signals like DisplayPort or HDMI. USB Type-C has become a universal standard in hardware development due to its multifunctionality, extensive compatibility, and small form size, which simplifies connecting across a variety of platforms and devices. Figure 3.13 shows USB Cable Type-C wire.

Figure 3.13 USB Cable Type-C

3.5.8 PVC Enclosure Box

In hardware development, a PVC enclosure box is a protective shell composed of polyvinyl chloride (PVC) plastic that is used to house and protect electronic circuits and components. Electrical junctions, control panels, and outdoor devices are just a few of the many uses for these enclosures, which are prized for their robustness, corrosion resistance, and simplicity of construction.

To meet the needs of diverse projects, PVC enclosures are available in a range of sizes and configurations, including wall-mountable, floor-standing, and handheld designs. They frequently include detachable or molded covers that make it simple to access internal parts. To make installation easier, certain versions come with gland entrances or pre- molded knockouts for cable management. Furthermore, a lot of PVC enclosures have environmental ratings, like NEMA 4X, which means they are appropriate for outdoor use and can resist exposure to ice, snow, and rain. Figure 3.14 below shows the PVC enclosure box in this project.

Figure 3.14 PVC Enclosure Box

3.6 Construction of Prototype

Some of the images in this part provide visual documentation of the Smart Fire Detection System prototype's construction process. The process from idea to reality is depicted in these pictures.

Figure 3.15 The Holes Drill for PVC Box

The holes drilled in the enclosure are crucial for integrating the PVC pipes into the final assembly. These holes serve multiple purposes. Firstly, they enable the secure mounting of the enclosure to a wall or other surface using the PVC pipes as structural supports. Secondly, they facilitate the efficient and organized routing of cables within the enclosure or between the enclosure and other components. By incorporating the PVC pipes in this manner, the project ensures a robust and well-organized installation.

Figure 3.16 Hand Saw to Cut a Piece of Wood

The picture of 3.16 illustrates how to use a hand saw to cut a piece of wood. The project's base or mounting platform will probably be made of wood that is being cut. The electronics, enclosure, and other parts will have a sturdy platform thanks to this one. To guarantee that every part fits snugly and that the finished assembly is sturdy and useful, it is essential to cut the wood to the right size and shape. This stage illustrates the meticulous preparation and attention to detail needed to successfully assemble the prototype.

Figure 3.17 A Pipe Cutter to Cut PVC pipe

The picture of 3.17 illustrates how to use a pipe cutter to cut PVC pipe. PVC pipes most likely have several uses in the project, including attaching sensors, routing cables, and supporting the enclosure structurally. A precise and clean cut is guaranteed by the pipe cutter, which is essential for a safe and polished installation. This phase shows how to utilize the right tools and pay attention to detail to produce a high-quality product.

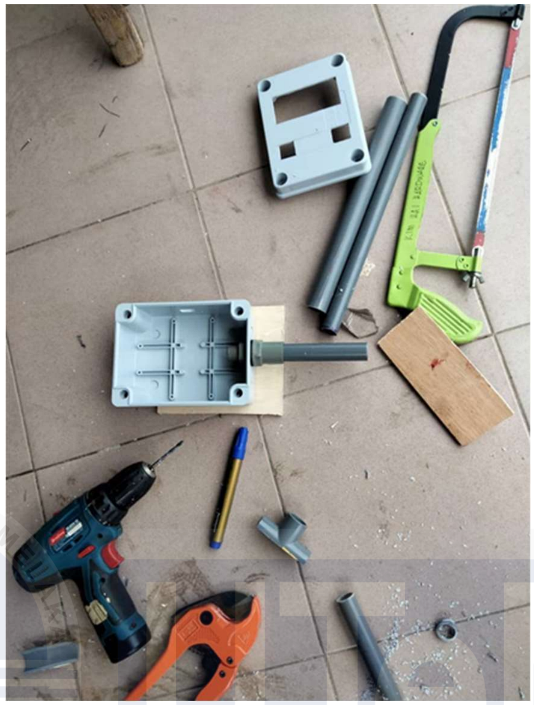

Figure 3.18 Overview Parts and Equipment

This picture shows a quick overview of the different parts and equipment. On a hardwood base, we can see the plastic container that will hold the electronics. There are PVC pipes all over, which are probably going to be used as cable conduits or structural supports. Visible tools like a drill, pipe cutter, and hand saw show the procedures needed to change and assemble the parts. A marking indicates that meticulous measurements and preparation are being made. This picture provides a clear picture of the practical labor required to make the prototype a reality.

3.7 Summary

The kitchen fires present such serious safety threats, sophisticated detection systems must be developed. With the use of MQ-2 smoke and DHT-11 temperature sensors, an Arduino platform and Internet of Things (IoT), this project seeks to develop a smart fire detection system for residential kitchens that would provide real-time monitoring and alarms. Therefore, the inadequacy of current technologies in terms of precision and promptness underscores the necessity of sensor fusion and connectivity. By providing a dependable, all inclusively solution, the suggested method closes these gaps by utilizing contemporary advances. However, the essential sensors and a microcontroller make up the hardware, while the Arduino IDE software enables constant monitoring and prompt notifications via the Blynk app, improving safety and reaction times.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

In delivering precise and timely alarms, the creation and application of a smart fire detection system for residential kitchens that makes use of MQ-2 and DHT11sensors coupled with an IoT framework seeks to improve fie safety. Therefore, the outcomes of the experimental configuration, data gathering, and system performance assessment are shown in this section. However, the intelligent system was engineered to identify temperature fluctuations and smoke, guaranteeing prompt action in the event of a possible fire. The findings center on important performance indicators such as alert reliability, system response time and sensor accuracy. Moreover, the conversation analyzes these results considering current fire safety measures, emphasizing the efficiency of the system, room for advancement and consequences for wider implementation in residential environments.

4.2 Project Testing Result

The outcomes of the project testing show the dynamics of liquid flow over time, emphasizing how the system reacts to environmental changes or releases a fire suppressor. The data trends, which include declining volume and flow rates over time, offer vital information for sensor calibration (MQ-2, DHT-11) and guarantee precise detection and reaction in your GSM-based photoelectric smoke detector. These outcomes improve the system's ability to identify and mitigate fire dangers in residential kitchens by optimizing its dependability, resource consumption, and IoT notification triggers.

4.3 Measurement for Volume

The experiment described the connection between the amount of butane gas delivered from a conventional gas lighter and the length of gas flow. Firstly, marked volume intervals on the gas lighter's scale to carry out this experiment. This acts as a benchmark for calculating the volume of gas emitted. The length of the gas flow was then managed by a timer. 10 seconds, 20 seconds, 30 seconds, 40 seconds, and 50 seconds either 5 seconds, 10 seconds, 15 seconds, 20 seconds, 25 seconds, and 30 seconds were the time intervals used in each of the experiment's phases.

Using the pre-marked scale as a guide, the researcher measured the amount of butane gas that had been dispensed from the lighter at the conclusion of each time interval. The researcher can see how the volume of gas emitted varies with increasing gas flow duration thanks to this experimental setup. An understanding of the lighter's gas flow rate and the possibility of establishing a correlation between time and gas dispensing volume can be obtained by examining the data gathered.

4.3.1 First Analysis

Table 4.1 First Data

Time (s)	Volume (mL)	Flow Rate (mL/s)
10	98	9.8
20	95	4.75
30	93	3.1
40	91	2.275
50	89	1.78
60	84	1.4

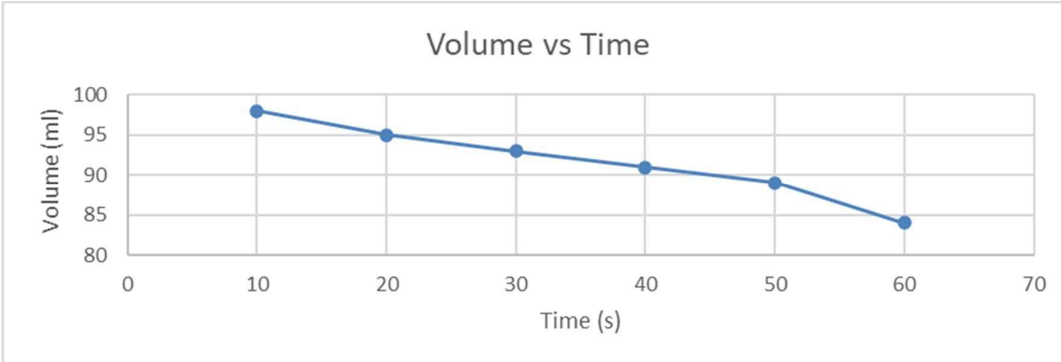

Figure 4.1 Volume vs Time

Clear insights into the dynamics of the system's liquid consumption are provided by the graph, which shows a consistent drop in liquid volume over time. The measurements, which were made five times.

This pattern shows a steady decrease in volume, with the biggest drop happening in the first ten seconds, which indicates a larger flow rate in the early stage. The system's ability to replicate real-world reactions, such releasing a suppressant or detecting changes in the surroundings, may be the cause of the drop in liquid content. The steady decrease indicates efficient and regulated liquid use, which may be modified to maintain operations over time while guaranteeing efficacy in fire detection or mitigation situations. This information is essential for system calibration that strikes a compromise between performance dependability and resource efficiency.

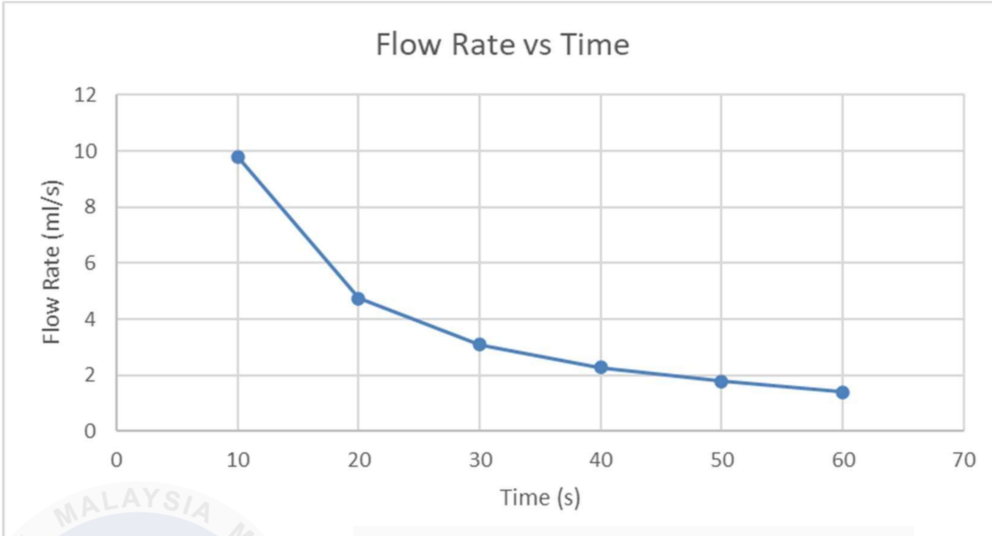

Figure 4.2 Flow Rate vs Time

Starting at 9.8 mL/s at 10 seconds and progressively dropping to 1.4 mL/s by 60 seconds, the flow rate shows a distinct declining tendency over time. Either a purposeful system design to control liquid release gradually or the physical dynamics of liquid flow because of decreasing pressure and volume inside the container are indicated by this behavior.

The system releases liquid at a higher rate when the volume is at its maximum, maybe to handle critical situations more quickly, as indicated by the sharp drop-in flow rate during the early phases. The flow rate tapers off as the volume drops, in accordance with either the decreasing pressure causing the flow or the decreased requirement for liquid. For controlled operations, this slow decline is beneficial since it guarantees resource conservation and long-term system functionality. A smart fire detection system's overall dependability and effectiveness could be improved by such a design, especially in situations where extended operation is required.

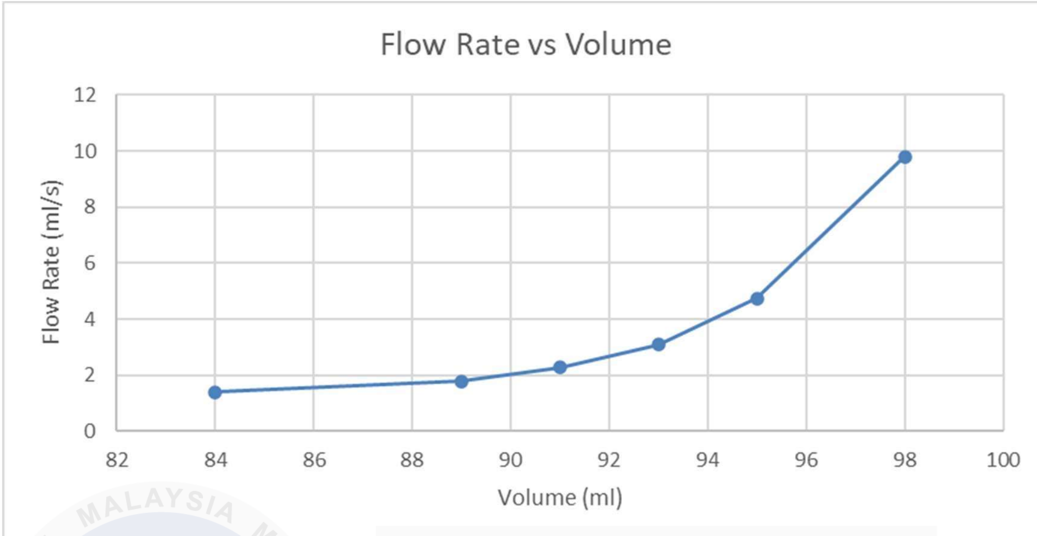

Figure 4.3 Flow Rate vs Volume

A distinct trend can be seen in the graph that illustrates the link between flow rate and liquid volume: as the liquid volume gets closer to its maximum, the flow rate rises. This pattern points to a significant relationship between flow rate and remaining liquid volume, which is probably impacted by both the physical characteristics of the liquid flow and the operating pressure of the system.

When the liquid volume is at its lowest (84 mL), the flow rate is at its lowest. It increases steadily as the volume increases, reaching a high of 9.8 mL/s when the volume is at its maximum (98 mL). This link may be explained by the fact that a higher volume of liquid exerts a greater pressure, which accelerates the flow rate. The operational dynamics of systems such as pumps or gravity-fed mechanisms, where the flow rate is dependent on the liquid level and related pressure, are reflected in this pattern in real-world situations.

Designing systems that need precise liquid discharge control, such fire suppression devices, benefits greatly from this understanding. The system can be adjusted to efficiently use liquid resources by comprehending this relationship, guaranteeing peak performance under demanding circumstances. As a component of a smart fire detection system, this trend also shows how the system can adjust to changing liquid levels while continuing to perform consistently.

4.3.2 Second Analysis

Table 4.2 Second Data

Time (s)	Volume (mL)	Flow Rate (mL/s)
5	83	16.6
10	82	8.2
15	81	5.4
20	80	4.0
25	80	3.2
30	79	2.63

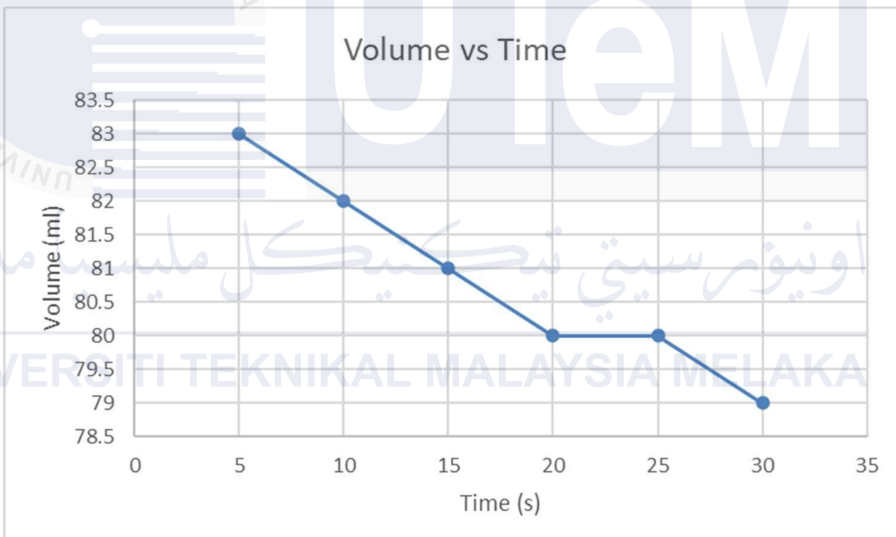

Figure 4.4 Volume vs Time

The system's-controlled discharge mechanism is demonstrated by the liquid volume data, which shows a consistent drop from 83.5 mL at 5 seconds to 79 mL at 30 seconds. This slow decrease mimics how a fire suppression system would work in the real world, where the amount of liquid released is proportionate to the length of time and intensity of the identified hazard. While preserving operational dependability, the consistent rate of volume decrease guarantees resource efficiency.

This behavior is quite like how the MQ-2 gas sensor works. The device may release a liquid suppressant if the MQ-2 detects the concentration of smoke or gas in the surrounding air. For instance, the system may initially release liquid more quickly (as seen at earlier time intervals) if the MQ-2 detects a high concentration of smoke. The release rate slows as the gas concentration stabilizes or the hazard is reduced, which causes the liquid volume to gradually decrease.

The data also shows that even as the liquid volume drops, the system continues to maintain a controlled discharge. This stability points to a sturdy design that can adjust to changing gas levels without releasing too much liquid, saving resources for longer operation. Additionally, the system's overall safety and dependability are increased by combining the MQ-2 sensor with this discharge pattern, which guarantees that liquid is dispensed properly and efficiently in response to certain hazard levels.

By optimizing the system's interaction between the MQ-2 sensor and the liquid discharge mechanism, this research helps to ensure that the system is responsive and resource-efficient during fire detection and suppression operations.

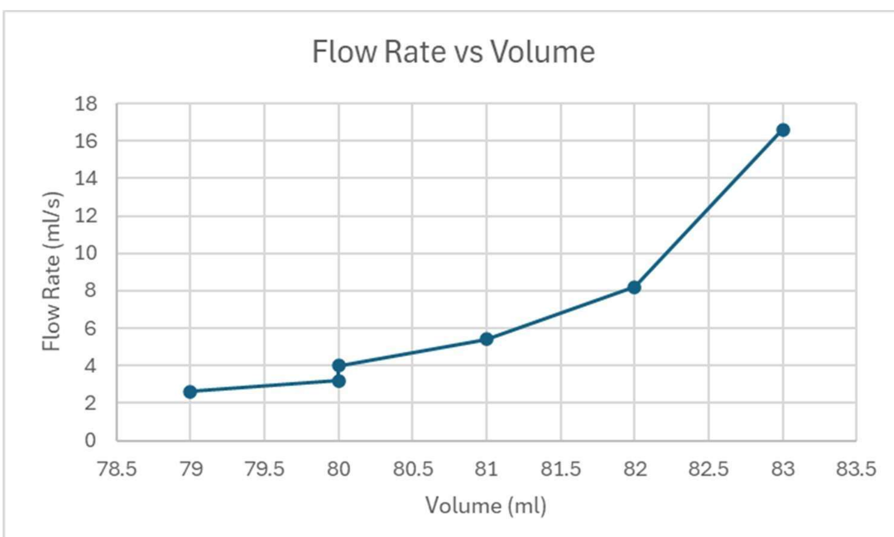

Figure 4.5 Flow Rate vs Volume

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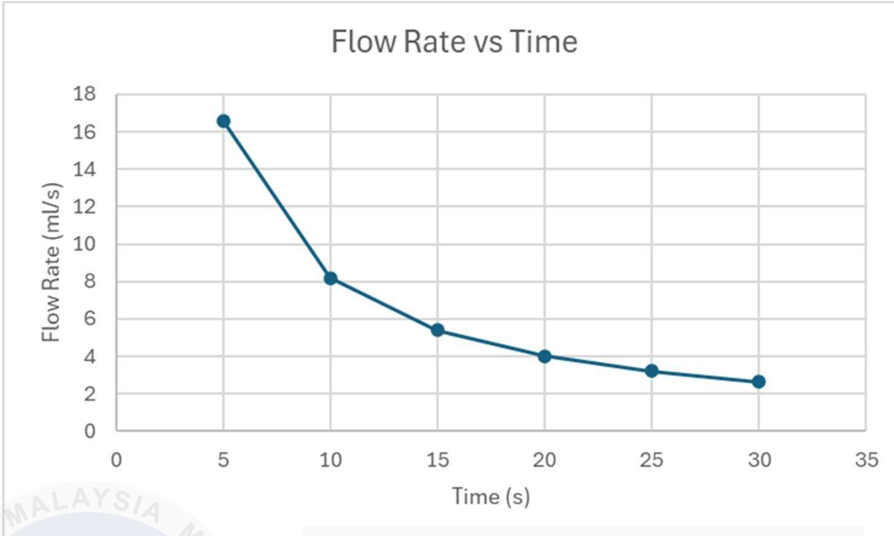

Figure 4.6 Flow Rate vs Time

The flow rate clearly shows a declining tendency over time in the graph. This points to a process in which the fluid movement rate progressively drops. This behavior could be caused by a number of things, including a depletion of the fluid source, an increase in system resistance, or a decreasing pressure difference that drives the flow. Early in the process, a substantial shift in one or more of these variables may be indicated by the initial sharp drop.

4.3.3 Third Analysis

Table 4.3 Third Data

Time (s)	Volume (mL)	Flow Rate (mL/s)
10	79	7.9
20	78	3.9
30	75	2.5
40	73	1.825
50	69	1.38
60	68	1.133

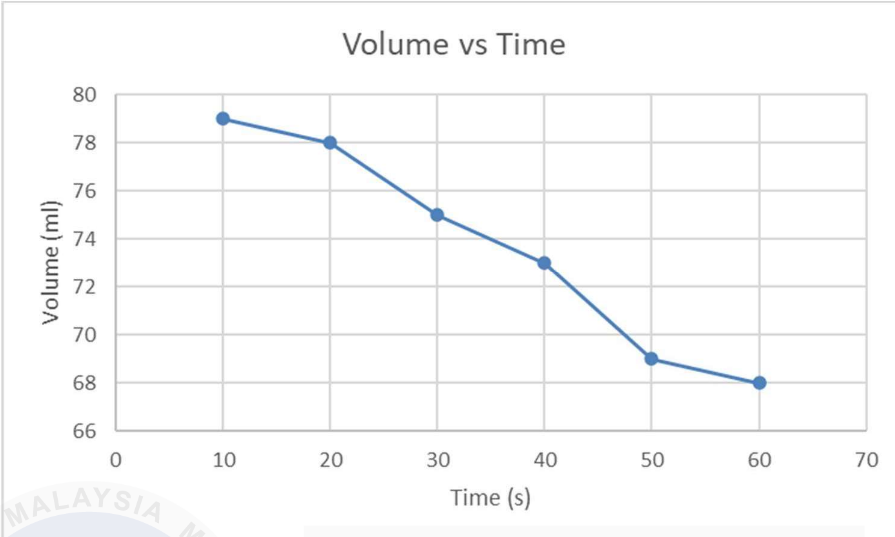

Figure 4.7 Volume vs Time

The liquid volume steadily decreases with time, going from 79 mL at 10 seconds to 68 mL at 60 seconds, as seen by the Volume vs. Time graph. The liquid volume at time intervals is measured in detail in the table. This pattern points to a steady discharge mechanism, meaning that the liquid is delivered at a regulated pace to mimic the functioning of a fire suppression system.

The system's effective use of the suppressant is demonstrated by the slow volume decrease, which prevents an abrupt depletion of resources. The MQ-2 sensor, which detects the presence of smoke or combustible gases, may be responsible for this behavior. The system may begin releasing fluids as a suppressor if a hazard is identified; gradual release will guarantee long-lasting suppression. The system's capacity to sustain a consistent output, which is essential for real-time fire hazard reduction, is also reflected in the relationship between volume and time.

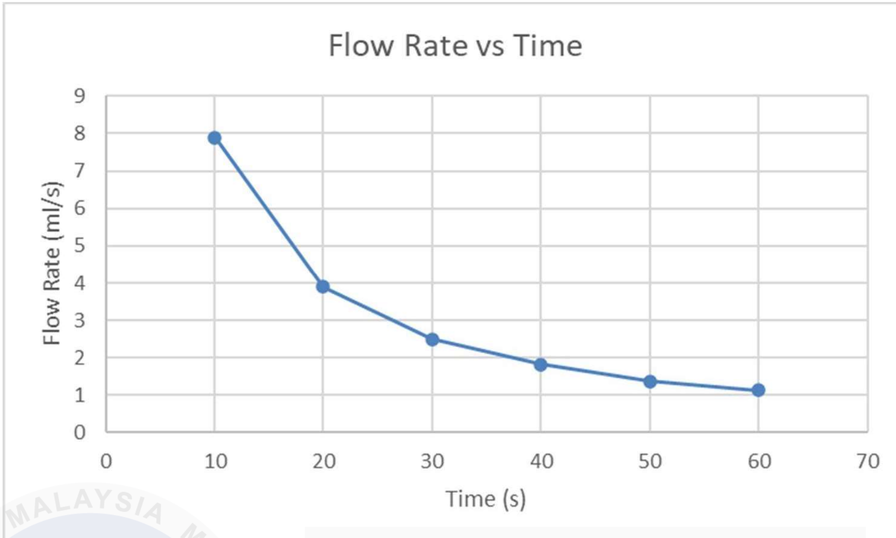

Figure 4.8 Flow Rate vs Time

Starting at 7.9 mL/s at 10 seconds and progressively decreasing to 1.133 mL/s at 60 seconds, the Flow Rate vs. Time graph demonstrates a notable decline in flow rate with time. This decline is illustrated by the numerical values in the table. Since less liquid is left in the system to sustain high flow rates, this tapering flow rate corresponds with the steady decrease in volume and pressure.

The system's design may be reflected in this pattern, where the flow rate is purposefully higher in the early phases of a fire to combat the concentration of smoke or gasses, as measured by the MQ-2 sensor. The flow rate gradually tapers off as the hazard level decreases, preserving the suppressant for extended usage if necessary. The system is kept operational without prematurely depleting its resources thanks to this controlled decline.

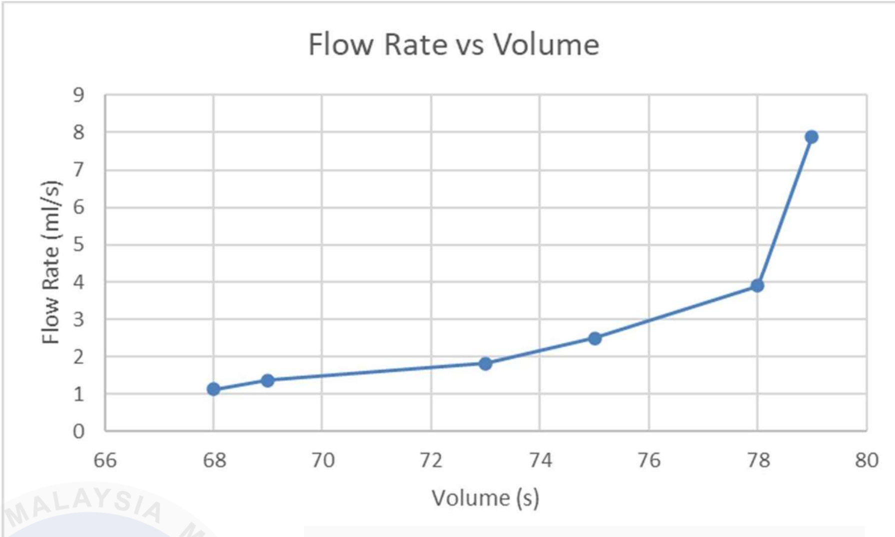

Figure 4.9 Flow Rate vs Volume

The flow rate rises when the liquid volume reaches its maximum and falls as the volume falls, according to the flow rate vs. volume graph. For instance, the flow rate is 7.9 mL/s at the highest capacity of 79 mL and 1.133 mL/s at the lowest volume of 68 millimetre. The precise measurements to confirm this link are given in the table.

Higher volumes exert greater pressure, which leads to higher flow rates. This graph illustrates the natural dynamics of liquid flow. Since the increased flow rate at maximum volume guarantees a robust first response to dangers identified by the MQ-2 sensor, this behaviour can be correlated with the system's functioning. The flow rate drops as the volume does, maximizing the usage of the liquid suppressant while preserving enough output to minimize any residual hazards.

4.3.4 Fourth Analysis

Table 4.4 Fourth Data

Time (s)	Volume (mL)	Flow Rate (mL/s)
5	68	13.6
10	66	6.6
15	65	4.33
20	63	3.15
25	62	2.48
30	60	2.0

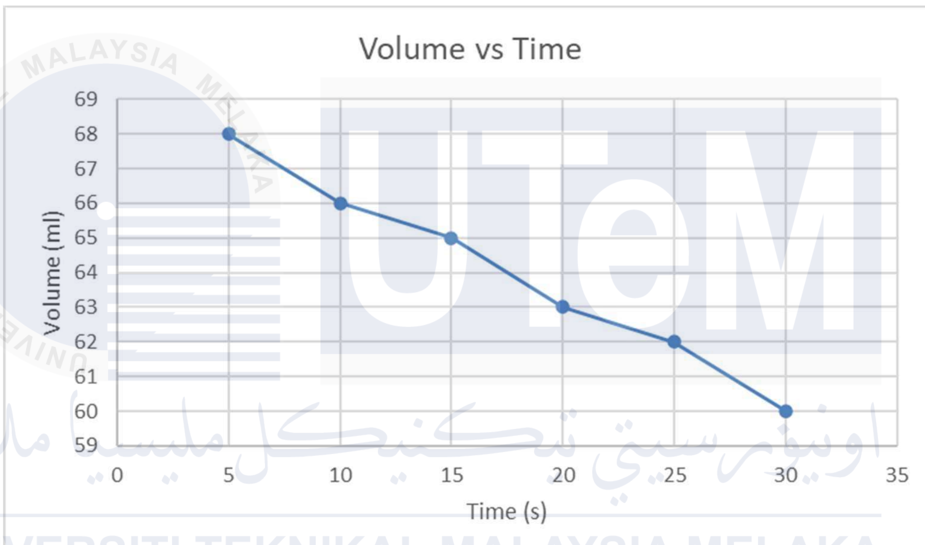

Figure 4.10 Volume vs Time

The liquid volume steadily decreases over time, going from 68 mL at 5 seconds to 60 mL at 30 seconds, according to the Volume vs. Time graph. This progressive reduction is supported by the table data, which shows a controlled liquid discharge that most likely mimics the deployment of a fire suppressor. This decrease shows that the system can sustain a steady output over time, guaranteeing that liquid resources are used effectively and don't abruptly run out.

The function of the MQ-2 sensor in identifying smoke or combustible gasses may be directly linked to this tendency. The system may start a liquid discharge as a suppressor when smoke is detected; the consistent decrease shows that the system is set up to manage the threat for a long time. This guarantees that the suppression system reduces dangers and preserves liquid for extended operation.

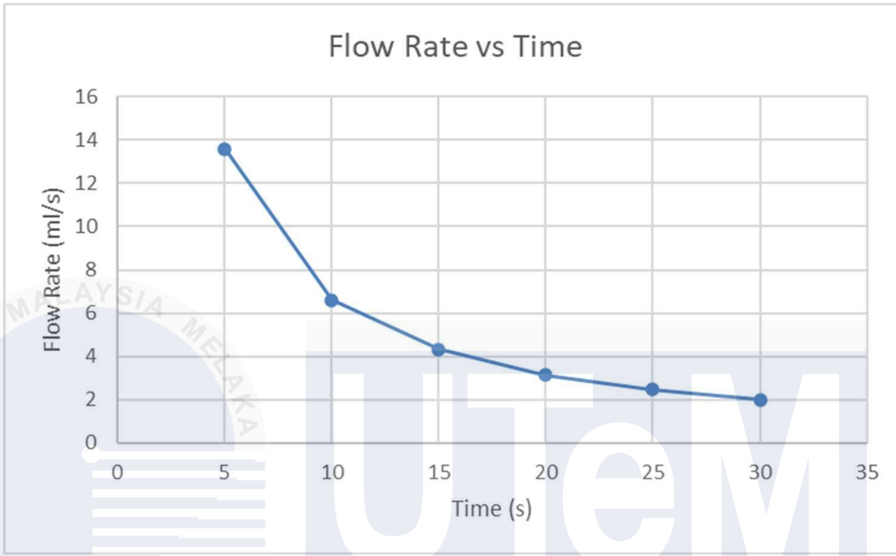

Figure 4.11 Flow Rate vs Time

The flow rate drops sharply from 13.6 mL/s at 5 seconds to 2 mL/s at 30 seconds, as seen in the Flow Rate vs. Time graph. This pattern is supported by the accompanying table. This decrease in flow rate may be a result of the system's pressure dropping as the volume of liquid drops, which is a normal aspect of fluid dynamics.

The system's ability to react dynamically to environmental parameters picked up by the MQ-2 and DHT-11 sensors is consistent with this relationship. While the tapering flow rate conserves the suppressant as the hazard level drops or stabilizes, the larger flow rate at the start guarantees a strong first response to quickly eliminate early-stage hazards.

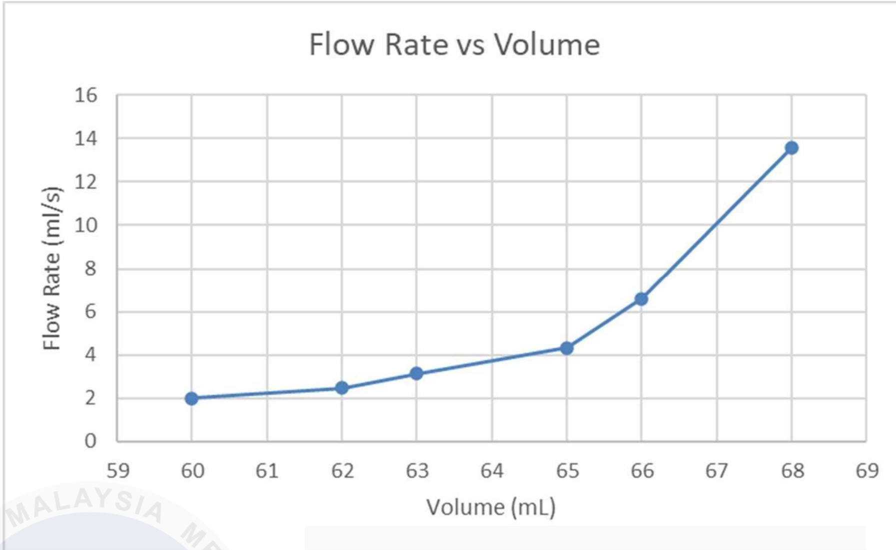

Figure 4.12 Flow Rate vs Volume

The flow rate is higher at maximum liquid quantities and falls as the volume diminishes, according to the flow rate vs. volume graph. For instance, the flow rate drops to 2 mL/s at 60 mL from 13.6 mL/s at 68mL. This pattern emphasizes how liquid volume and flow rate are physically related, with higher volumes producing higher pressure and higher flow rates.

The integration of the DHT-11 and MQ-2 sensors is responsible for this behaviour. The liquid discharge mechanism is activated by the MQ-2 sensor's detection of smoke or gas, and the DHT-11 sensor's temperature and humidity monitoring make sure the discharge rate is modified in response to environmental factors. An effective reaction to fire dangers is ensured by the system's capacity to vary flow rate based on volume, conserving liquid resources while preserving suppression efficacy.

4.3.5 Fifth Analysis

Table 4.5 Fifth Data

Time (s)	Volume (mL)	Flow Rate (mL/s)
10	59	5.9
20	58	2.9
30	57	1.9
40	54	1.35
50	50	1.0
60	49	0.82

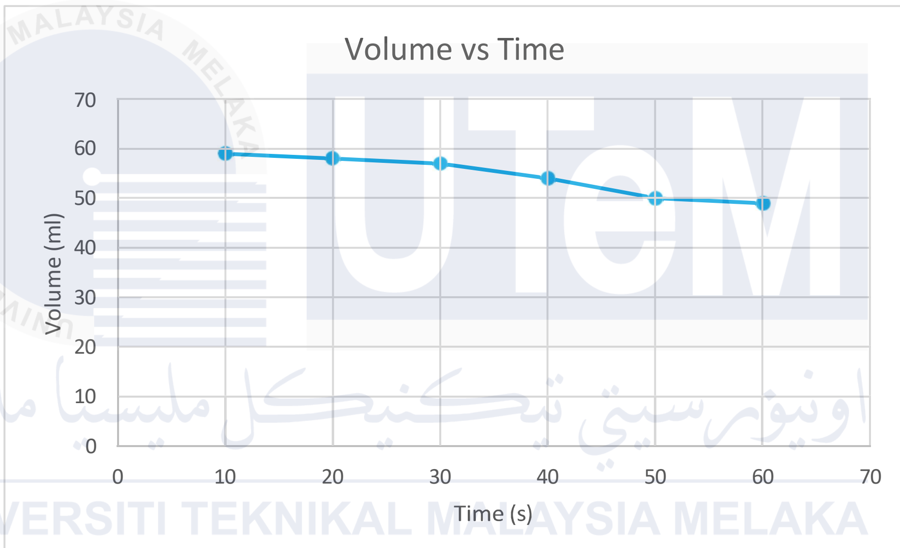

Figure 4.13 Volume vs Time

The liquid volume steadily decreases over time, beginning at 59 mL at 10 seconds and progressively dropping to 49 mL at 60 seconds, as seen by the Volume vs. Time graph. This slow decrease is supported by the accompanying table, which also shows a regulated liquid discharge. This illustrates how the system may sustain a steady discharge rate over time, perhaps mimicking the release of a suppressant in reaction to a hazard that has been detected.

Here, the MQ-2 sensor is essential because it initiates the liquid discharge mechanism when it senses the presence of smoke or combustible gasses. The steady drop in volume guarantees that the system can manage the risk for an extended amount of time, offering a dependable and effective reaction to possible fire situations.

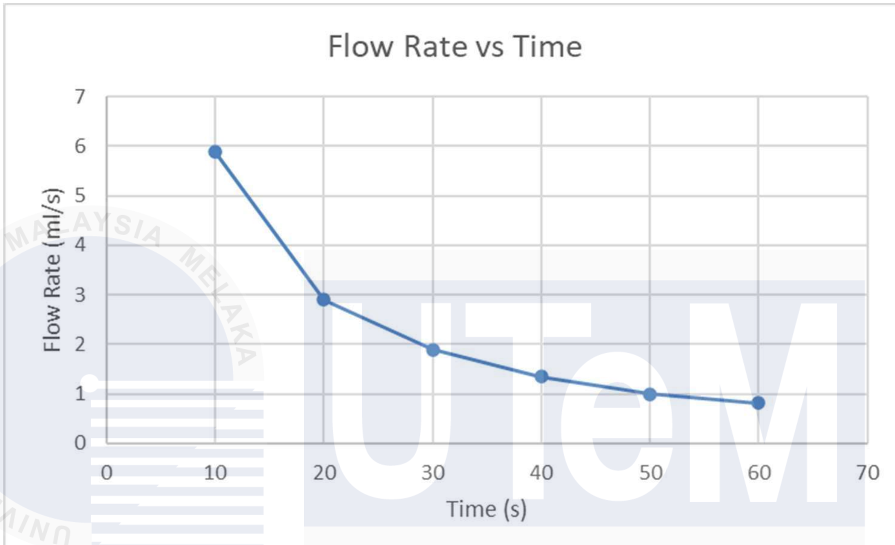

Figure 4.14 Flow Rate vs Time

Starting at 5.9 mL/s at 10 seconds and tapering off to 0.82 mL/s at 60 seconds, the Flow Rate vs. Time graph displays a decreasing trend. This finding is supported by the accompanying table, which displays a decline in flow rate with time. This behaviour may be explained by the fluid dynamics phenomenon of decreasing pressure in the liquid reservoir as the volume decreases over time.

The MQ-2 sensor's function in determining the hazard's intensity can be linked to this dynamic response. To put out a fire or gas leak that is spreading quickly, a larger flow rate can be required at first. The liquid suppressant is conserved as the flow rate decreases as the hazard stabilizes or lessens. To further maximize the system's efficiency, the DHT-11 sensor makes sure that this reaction is adaptive by taking environmental factors like temperature and humidity into account.

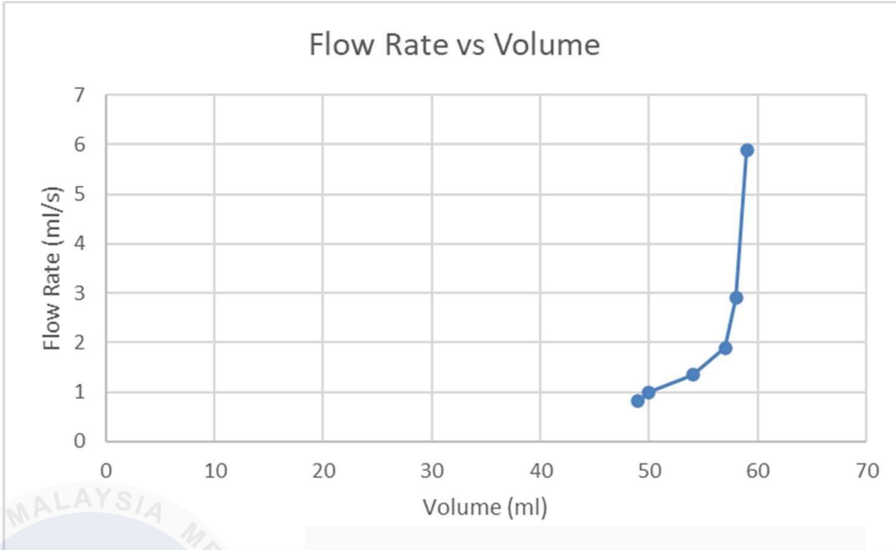

Figure 4.15 Flow Rate vs Volume

The graph showing the relationship between flow rate and volume shows that the flow rate is higher when the liquid volume is close to its maximum and falls as the volume declines. The flow rate, for example, is 5.9 mL/s at 59 mL and drastically decreases to 0.82 mL/s at 49mL. With larger volumes producing higher discharge rates, this relationship illustrates how liquid pressure affects flow rate.

This behaviour is consistent with the system's architecture, which responds proportionately to dangers that are detected. When the danger is first activated, the MQ-2 sensor can pick up more smoke or gas, which would increase the rate of discharge. The flow rate reduces as the volume drops and the risk is reduced, preserving liquid while ensuring sufficient suppression. By modifying flow rates in response to environmental circumstances, the DHT-11 sensor guarantees that the reaction is environmentally responsive.

4.4 Measurement for Distance

The experiment described how long it takes for a buzzer to sound and how far a propelled object is likely a small projectile travel.

Initially, marked precise the distances in cm using a ruler before beginning this experiment. The butane gas from a regular gas lighter is used to drive the object at the start of the experiment. The pre-marked ruler is used to measure the object's distance travelled. When a buzzer sounds, that is the critical moment. Then, set a timer for this exact moment. With this experimental setup, it may see how the pushed object's distance travelled affects how long it takes for the buzzer to sound. It is possible to learn more about the variables influencing the time lag prior to the buzzer activating by examining the data that was gathered.

4.4.1 First Analysis

Table 4.6 First Data

Distance (cm)	**Time (s)**	**Flow Rate (cm/s)**
2	0.93	2.15
4	1.88	2.13
6	3.81	1.57
8	4.70	1.70
10	6.20	1.61
12	8.32	1.44

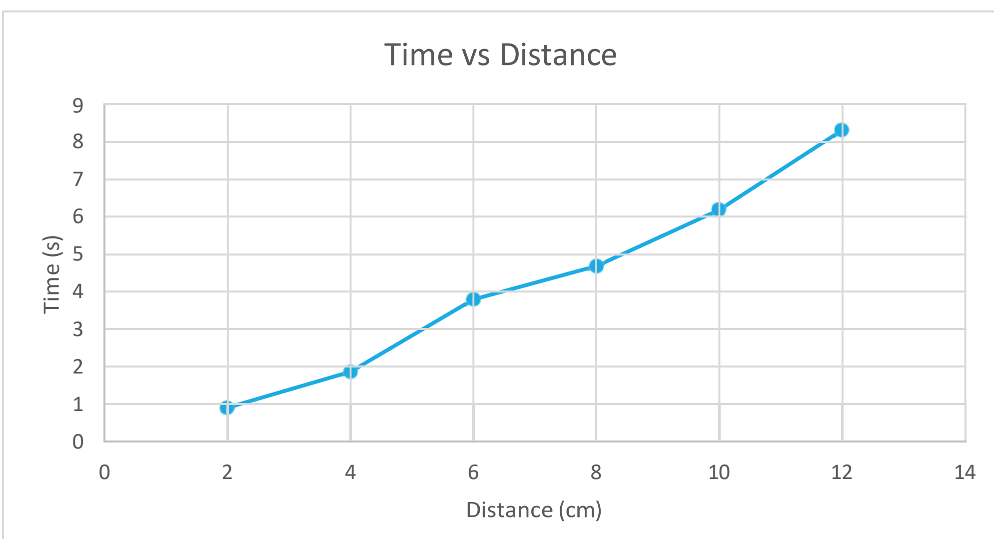

Figure 4.16 Time vs Distance

There is an obvious proportionality between distance and time, as shown by the distance vs time and graph. The time needed for transport or detection grows in tandem with the distance. For example, the time measured is 0.93 seconds at 2 cm and 8.32 seconds at 12 cm. The graph, where the plotted points form a constantly climbing line, graphically supports this tendency and verifies that time increases linearly with distance. This relationship applies to both the MQ-2 and DHT-11 sensors in the context of your project. For the MQ-2 sensor, it illustrates how signals or gas particles travel farther to reach the sensor when the gas source spreads out. The DHT-11 sensor exhibits a similar delay in detecting changes in temperature or humidity as the distance from the source increases. Determining the ideal sensor placement and guaranteeing a quick response time in practical applications require an understanding of this tendency.

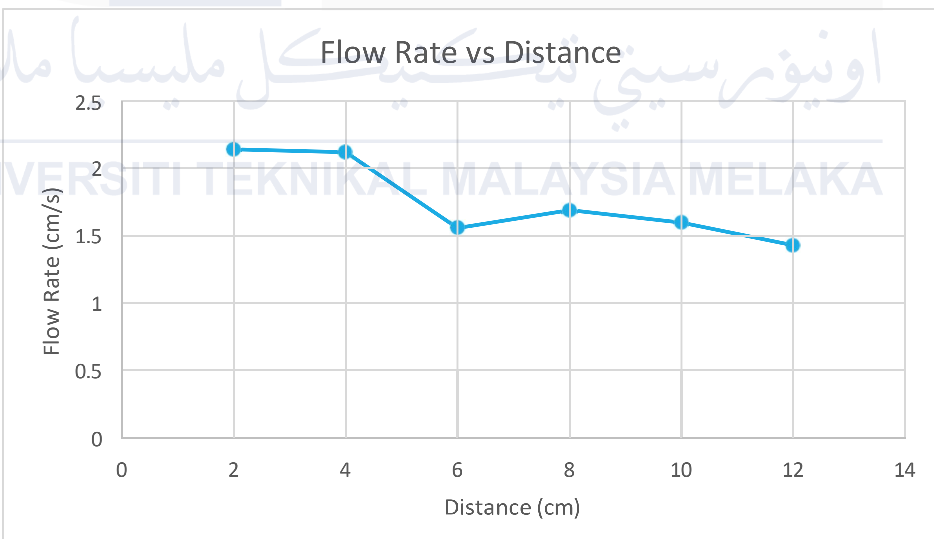

Figure 4.17 Flow Rate vs Distance

Distance and flow rate have an inverse relationship, as shown by the Distance vs. Flow Rate table and graph. The flow rate gradually drops with increasing distance. The flow rate, for instance, is 2.15 cm/s at 2 cm but drops to 1.44 cm/s at 12 cm. This pattern suggests that the intensity or speed of particles, messages, or gas decreases with increasing distance.

This is graphically supported by the graph, which displays a downward-sloping curve that emphasizes the flow rate's progressive decrease with increasing distance.

This relationship is important for both the MQ-2 and DHT-11 sensors in your project. When the gas spreads out further from its source, the concentration of the gas decreases, which could have an impact on the sensitivity of the detection for the MQ-2. It mimics how humidity or airflow spreads over longer distances, which affects sensor accuracy for the DHT-11. This realization highlights how crucial it is to put sensors strategically to ensure efficient detection in home kitchens.

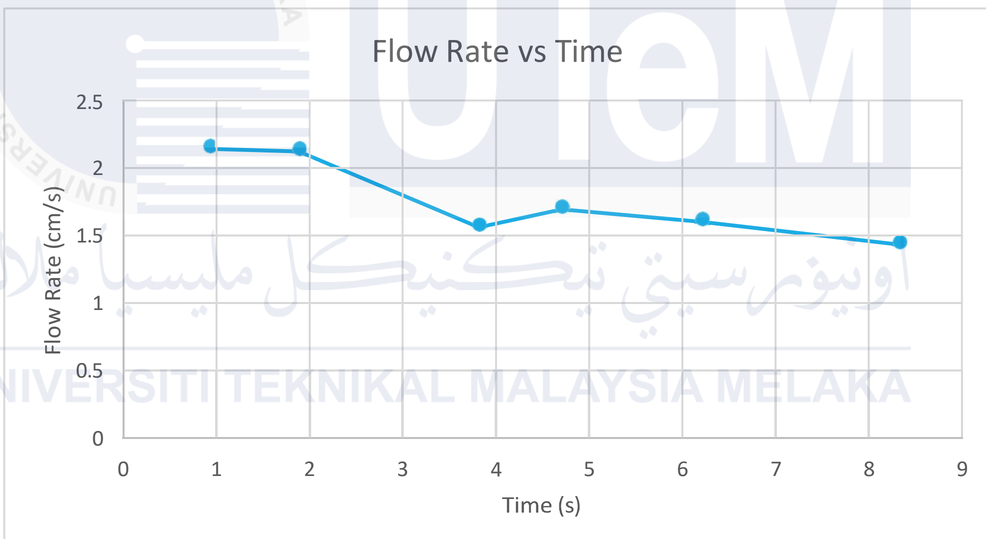

Figure 4.18 Flow Rate vs Time

An inverse relationship between time and flow rate is shown in the Time vs. Flow Rate table and graph, where the flow rate falls with increasing time. For example, the flow rate drops to 1.44 cm/s by 8.32 seconds from 2.15 cm/s at 0.93 seconds. This pattern implies that as particles, gas, or signals stabilize, the flow rate decreases with time, most likely because of dispersion or a reduction of intensity. This finding is supported by the graph's downward-sloping curve, which indicates a consistent drop-in flow rate with increasing time. This relationship applies to both the MQ-2 and DHT-11 sensors in this project. As the gas diffuses throughout the surroundings, the MQ-2 shows how the concentration of the gas gradually drops, which may have an impact on the responsiveness of the sensor. For the DHT-11, it might show that after an initial fluctuation, temperature or humidity variations stabilize over time. Knowing this tendency makes it easier to develop a system that takes time-dependent changes in sensor readings into account, resulting in more accurate and dependable fire detection.

4.4.2 Second Analysis

Table 4.7 Second Data

Distance (cm)	Time (s)	Flow Rate (cm/s)
2	1.11	1.80
4	3.21	1.25
6	4.56	1.32
8	5.06	1.58
10	5.72	1.75
12	9.32	1.29

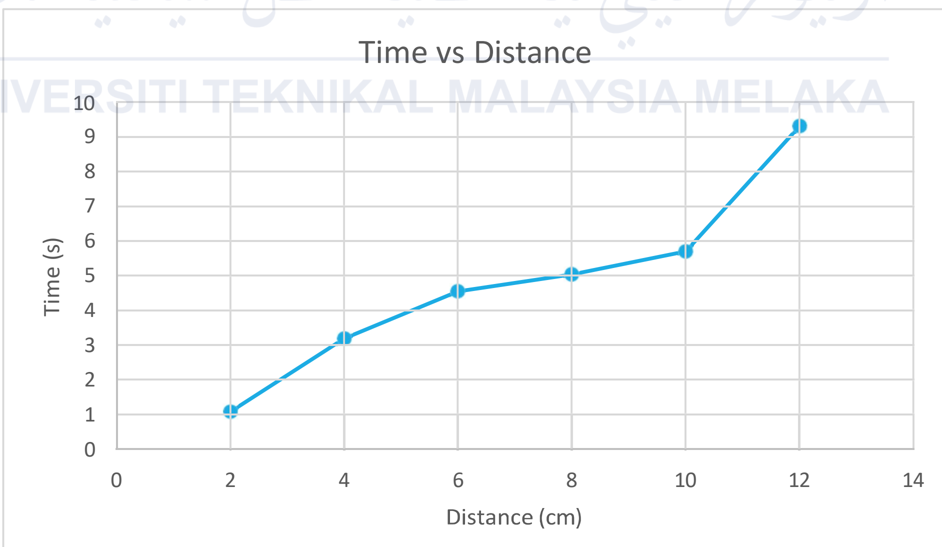

Figure 4.19 Time vs Distance

The graph shows that time and distance have a direct relationship, indicating that as the distance travelled grows, so does the amount of time needed to do so. The idea of speed or velocity can be used to explain this basic notion of motion. The distance travelled in a

A certain amount of time is known as speed. Consequently, an object would have to move faster to cover a larger distance in the same amount of time. On the other hand, traveling a greater distance will take longer if the pace stays the same.

Next, the flow rate may be impacted by the gas concentration in the surrounding air. For instance, a slower flow rate may result from increased flow resistance caused by pollutants or impurities in the gas being monitored. As a result, it would take longer to travel a certain distance. Changes in flow rate and trip time can be correlated with the MQ-2 sensor's ability to detect changes in gas composition.

After then, fluid movement is greatly influenced by temperature and humidity. Higher temperatures cause fluids to become less dense and viscous, which accelerates flow rates. Lower temperatures, on the other hand, may cause viscosity to rise and delay the flow. The flow rate can also be impacted by humidity. Condensation brought on by high humidity levels might impede the flow channel and raise resistance. Temperature and humidity can be measured with the DHT-11 sensor, which enables analysis of their effects on flow rate and trip time.

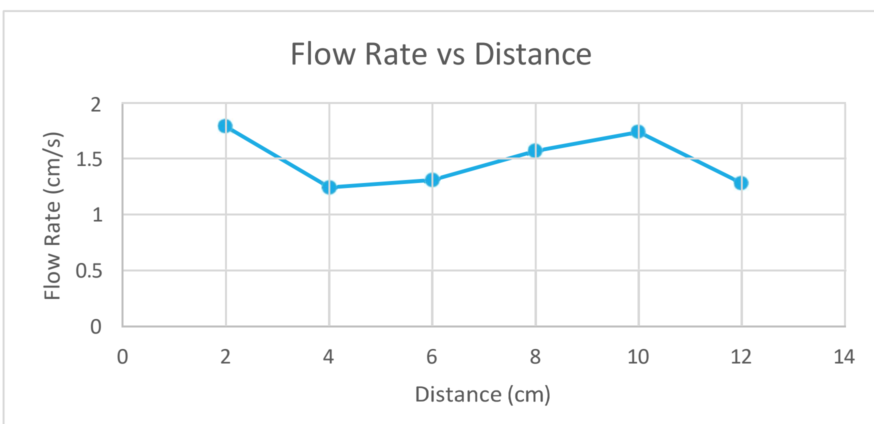

Figure 4.20 Flow Rate vs Distance

The flow rate does not stay constant as the distance grows, as the graph shows. Rather, it shows a pattern of first declining, then slightly increasing, and then decreasing again. This non-linear pattern indicates that the flow is irregular and probably affected by several variables, including fluctuations in temperature, pressure, and fluid flow type.

The MQ-2 gas sensor can give vital information about the fluid composition and any impurities even though it cannot measure flow rate directly. The fluid's density, viscosity, and flow properties can all be changed by the presence of specific gases or contaminants. The MQ-2 sensor can assist in determining probable reasons for variations in flow rate and offer useful information for analysis and optimization by tracking gas concentrations.

Temperature and humidity are two important variables that affect flow rate and are immediately addressed by this sensor. Correlating temperature changes with reported flow rate fluctuations can be aided using DHT-11 temperature sensors. Areas with notable temperature gradients can be located using this information, and steps can be taken to lessen their effects. Because high humidity can cause condensation, which can alter flow rate, humidity readings can also be useful.

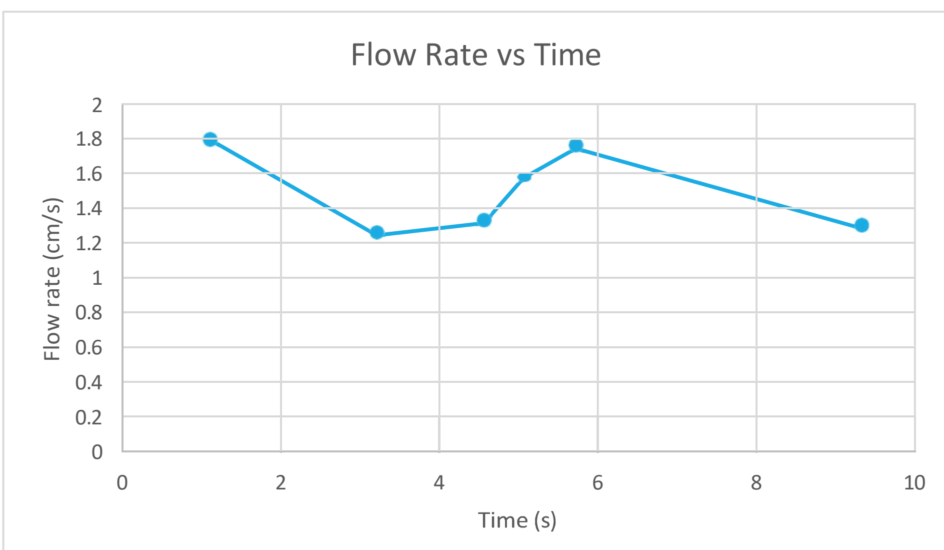

Figure 4.21 Flow Rate vs Time

The patterns seen in the flow rate vs. time and flow rate vs. distance graphs are similar, which implies that the variables affecting flow rate may be dynamic and connected. To put it another way, variations in flow rate rely on both the distance travelled and the time required to do so.

The MQ-2 sensor can then assist in detecting changes in gas composition over time that may be influencing flow rate. For instance, the fluid's characteristics may change over time if the gas being monitored is reacting with the fluid or the surroundings.

Following that, temperature variations over time can be immediately observed by the DHT-11 sensor. The effect of temperature on flow behavior can be evaluated by establishing a correlation between temperature changes and variations in flow rate. Measurements of humidity can also be used to detect possible condensation effects that may be affecting flow rate over time.

4.4.3 Third Analysis

Table 4.8 Third Data

Distance (cm)	Time (s)	Flow Rate (cm/s)
2	1.77	1.13
4	2.76	1.45
6	5.28	1.14
8	6.27	1.28
10	6.84	1.46
12	12.67	0.95

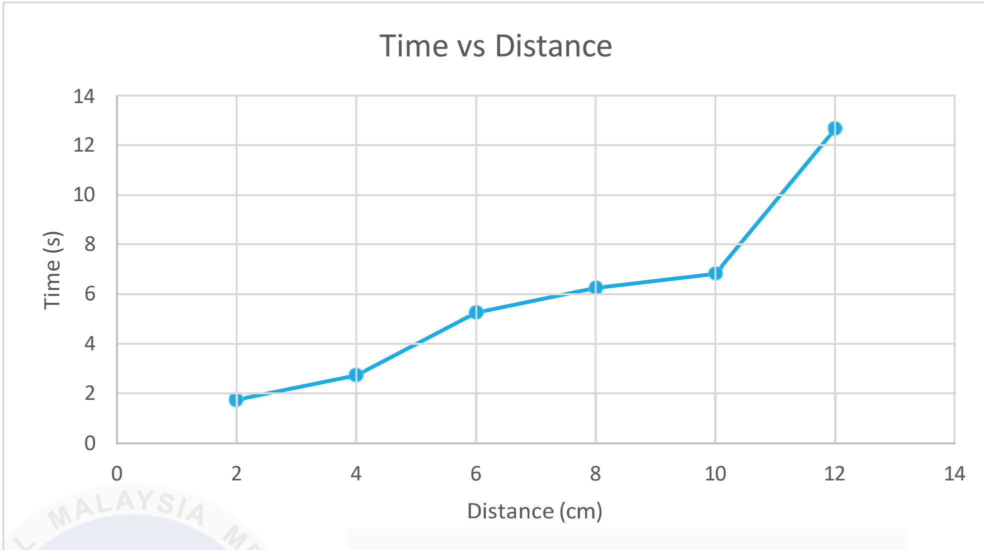

Figure 4.22 Time vs Distance

The fact that time does not rise linearly with distance indicates that the system's overall flow rate is not constant. A constant flow rate would be implied by a linear connection, which would suggest that the distance travelled, and the time required to do so would be exactly proportional. The higher time rise for larger distances, however, suggests that the fluid's flow rate is dropping with distance.

Changes in the composition of the gas that may be causing the flow rate to decrease can be detected with the use of the MQ-2 sensor. For instance, the flow rate may drop if the fluid is absorbing gases that make it denser or more viscous. The MQ-2 sensor can offer important information about these possible causes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. The effect of temperature gradients on flow behavior can be evaluated by establishing a correlation between temperature variations and the observed drop-in flow rate.

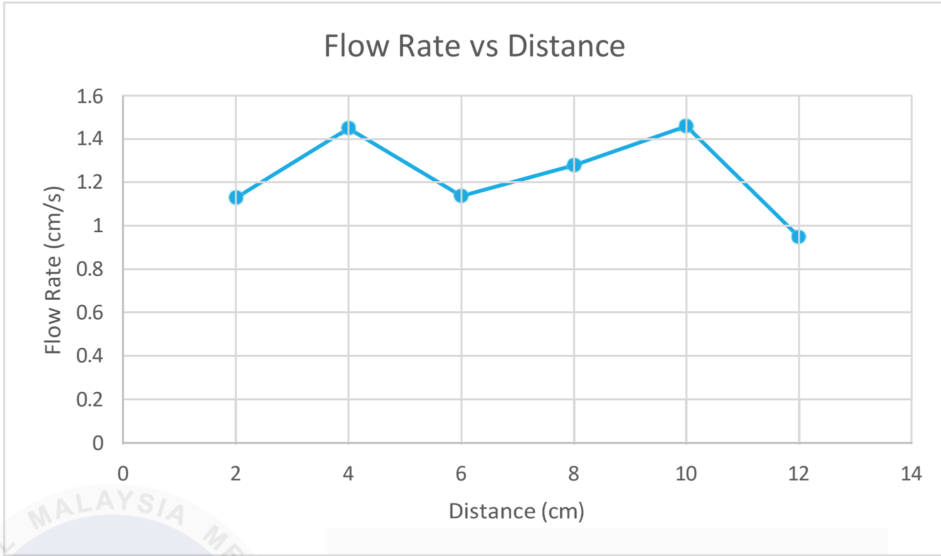

Figure 4.23 Flow Rate vs Distance

Longer lengths cause a noticeable drop-in flow rate, which indicates that the fluid is running into more resistance as it passes through the system. Increased friction, rough pipes, changes in fluid properties, and impediments or limitations are some of the causes of this resistance.

Changes in gas composition that may be impacting fluid characteristics and raising resistance can be detected with the use of the MQ-2 sensor. For instance, the flow rate may drop noticeably if the fluid is absorbing gasses that make it denser or more viscous. The MQ-2 sensor can provide useful information to correlate with the observed flow rate changes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. Changes in fluid density and viscosity brought on by large temperature fluctuations might impact flow resistance. The DHT-11 sensor can assist in determining temperature-related reasons for the declining flow rate by comparing temperature readings with the observed flow rate variations.

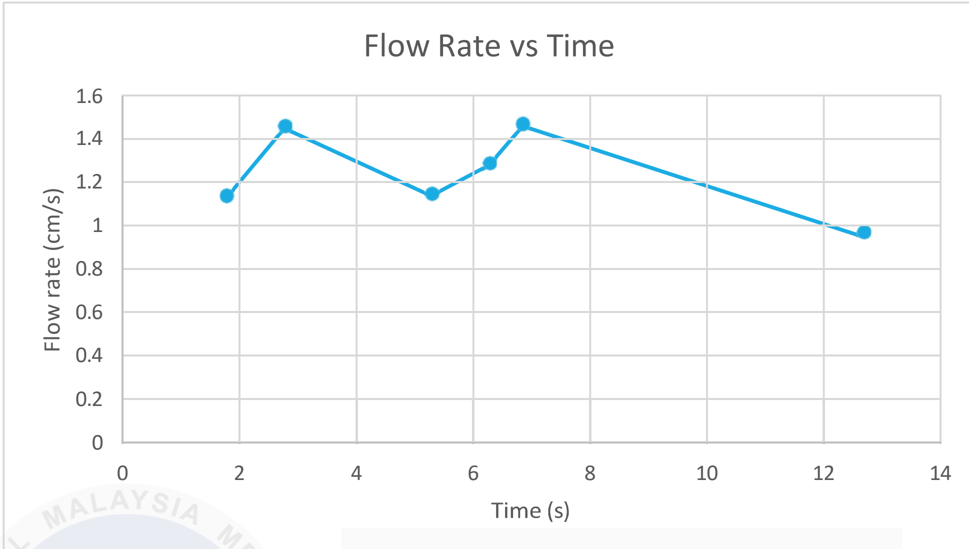

Figure 4.24 Flow Rate vs Time

The patterns seen in the Flow Rate vs. Time and Flow Rate vs. Distance graphs are similar, which strongly implies that the variables affecting flow rate are not time independent. This indicates that variations in flow rate depend not only on the distance travelled but also on the time required to do it.

Time-dependent variations in gas composition that may be influencing flow rate can be found with the aid of the MQ-2 sensor. For instance, the fluid's flow rate may gradually drop if it is absorbing gasses that raise its density or viscosity.

Temperature variations over time can be immediately observed with the DHT-11 sensor. The effect of temperature on flow behaviour can be evaluated by establishing a correlation between temperature changes and variations in flow rate.

4.4.4 Fourth Analysis

Table 4.9 Fourth Data

Distance (cm)	Time (s)	Flow Rate (cm/s)
2	2.17	0.92
4	4.17	0.96
6	5.89	1.02
8	6.43	1.24
10	10.24	0.98
12	10.68	1.12

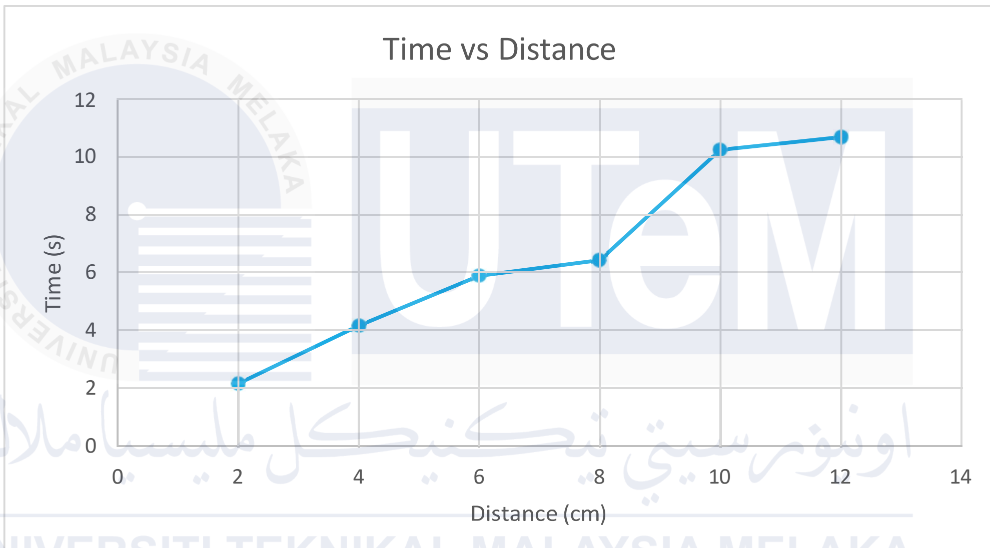

Figure 4.25 Time vs Distance

The fact that time does not rise linearly with distance indicates that the system's overall flow rate is not constant. A constant flow rate would be implied by a linear connection, which would suggest that the distance travelled, and the time required to do so would be exactly proportional. The higher time rise for larger distances, however, suggests that the fluid's flow rate is dropping with distance.

Changes in the composition of the gas that may be causing the flow rate to decrease can be detected with the use of the MQ-2 gas sensor. For instance, the flow rate may drop if the fluid is absorbing gases that make it denser or more viscous. The MQ-2 sensor can offer important information about these possible causes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. The effect of temperature gradients on flow behavior can be evaluated by establishing a correlation between temperature variations and the observed drop-in flow rate.

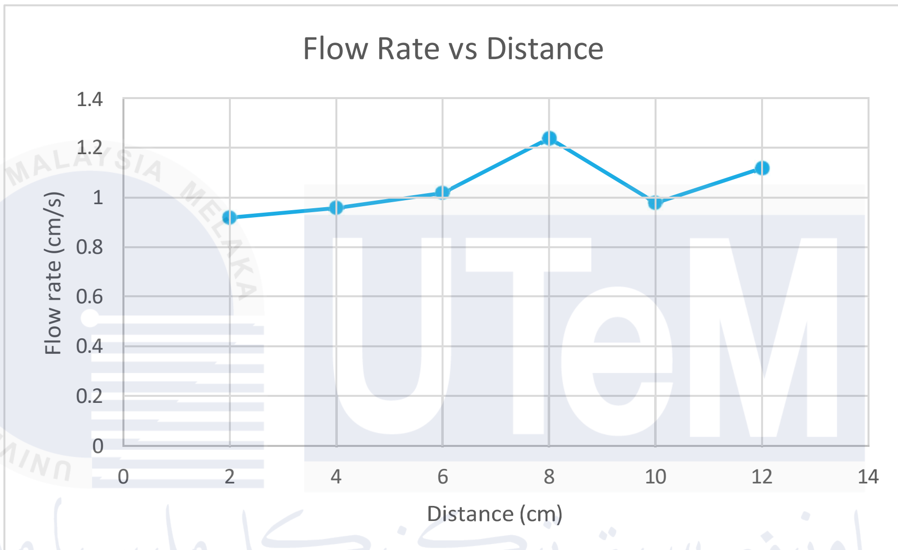

Figure 4.26 Flow Rate vs Distance

Longer lengths cause a noticeable drop-in flow rate, which indicates that the fluid is running into more resistance as it passes through the system. Increased friction, rough pipes, limits or obstacles, and changes in fluid properties are some of the causes of this resistance.

Changes in gas composition that may be impacting fluid characteristics and raising resistance can be detected with the use of the MQ-2 gas sensor. For instance, the flow rate may drop noticeably if the fluid is absorbing gases that make it denser or more viscous. The MQ-2 sensor can provide useful information to correlate with the observed flow rate changes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. Changes in fluid density and viscosity brought on by large temperature fluctuations might impact flow resistance. The DHT-11 sensor can assist in determining temperature-related reasons for the declining flow rate by comparing temperature readings with the observed flow rate variations.

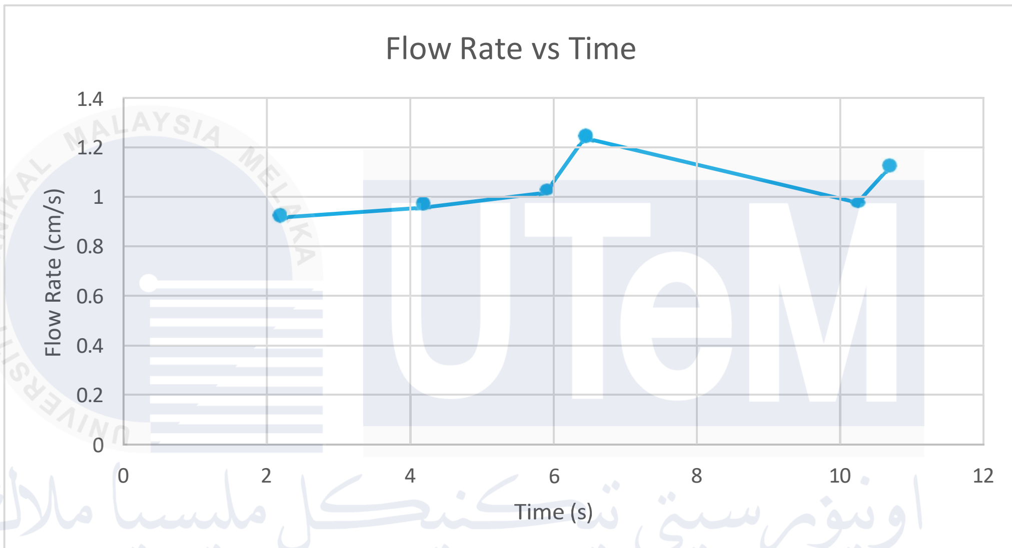

Figure 4.27 Flow Rate vs Time

The patterns seen in the Flow Rate vs. Time and Flow Rate vs. Distance graphs are similar, which strongly implies that the variables affecting flow rate are not time independent. This indicates that variations in flow rate depend not only on the distance travelled but also on the time required to do it.

Time-dependent variations in gas composition that may be influencing flow rate can be found with the aid of the MQ-2 gas sensor. For instance, the fluid's flow rate may gradually drop if it is absorbing gases that raise its density or viscosity.

Temperature variations over time can be immediately observed with the DHT-11 sensor. The effect of temperature on flow behavior can be evaluated by establishing a correlation between temperature changes and variations in flow rate.

4.4.5 Fifth Analysis

Table 4.10 Fifth Data

Distance (cm)	Time (s)	Flow Rate (cm/s)
2	0.79	2.53
4	2.22	1.80
6	3.53	1.70
8	6.75	1.19
10	10.16	0.98
12	43.99	0.27

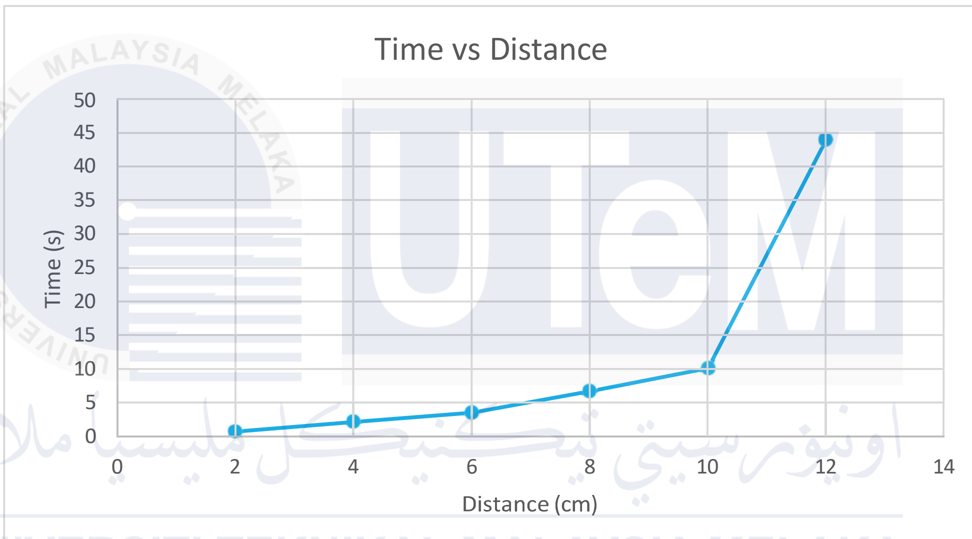

Figure 4.28 Time vs Distance

The fact that time does not rise linearly with distance indicates that the system's overall flow rate is not constant. A constant flow rate would be implied by a linear connection, which would suggest that the distance travelled, and the time required to do so would be exactly proportional. The higher time rise for larger distances, however, suggests that the fluid's flow rate is dropping with distance.

Changes in the composition of the gas that may be causing the flow rate to decrease can be detected with the use of the MQ-2 gas sensor. For instance, the flow rate may drop if the fluid is absorbing gases that make it denser or more viscous. The MQ-2 sensor can offer important information about these possible causes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. The effect of temperature gradients on flow behavior can be evaluated by establishing a correlation between temperature variations and the observed drop-in flow rate.

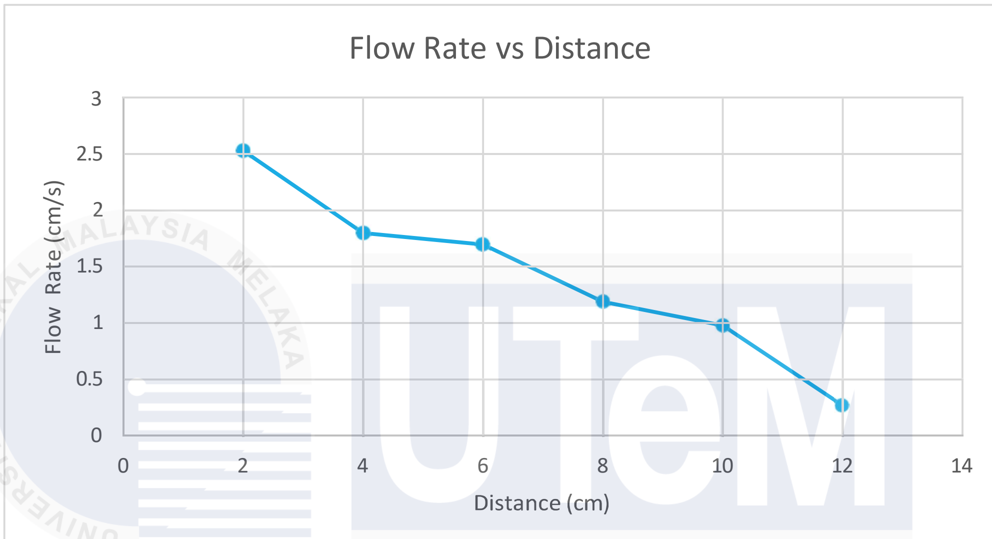

Figure 4.29 Flow Rate vs Distance

Longer lengths cause a noticeable drop-in flow rate, which indicates that the fluid is running into more resistance as it passes through the system. Increased friction, rough pipes, limits or obstacles, and changes in fluid properties are some of the causes of this resistance.

Changes in gas composition that may be impacting fluid characteristics and raising resistance can be detected with the use of the MQ-2 gas sensor. For instance, the flow rate may drop noticeably if the fluid is absorbing gases that make it denser or more viscous. The MQ-2 sensor can provide useful information to correlate with the observed flow rate changes by tracking gas concentrations.

Temperature differences throughout the flow channel can be immediately measured by the DHT-11 sensor. Changes in fluid density and viscosity brought on by large temperature fluctuations might impact flow resistance. The DHT-11 sensor can assist in determining temperature-related reasons for the declining flow rate by comparing temperature readings with the observed flow rate variations.

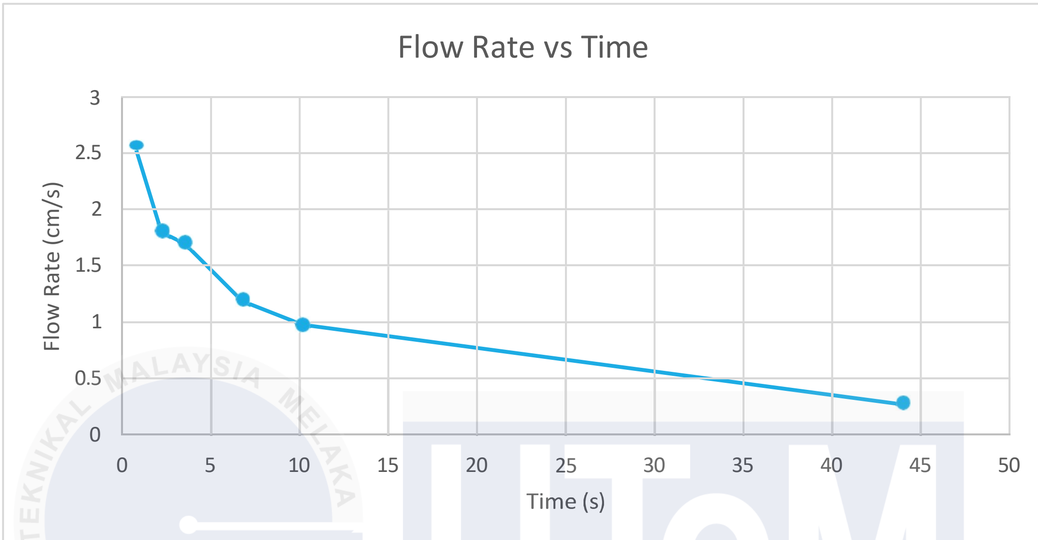

Figure 4.30 Flow Rate vs Time

The patterns seen in the Flow Rate vs. Time and Flow Rate vs. Distance graphs are similar, which strongly implies that the variables affecting flow rate are not time independent. This indicates that variations in flow rate depend not only on the distance travelled but also on the time required to do it.

Time-dependent variations in gas composition that may be influencing flow rate can be found with the aid of the MQ-2 gas sensor. For instance, the fluid's flow rate may gradually drop if it is absorbing gases that raise its density or viscosity.

Temperature variations over time can be immediately observed with the DHT-11 sensor. The effect of temperature on flow behavior can be evaluated by establishing a correlation between temperature changes and variations in flow rate.

4.5 Summary Comparison between Volume and Distance

The connection between flow rate, time, and distance, emphasizing how these factors affect sensor performance. We can optimize sensor location and calibration for precise measurements by examining these correlations. In addition to these considerations, volume is shown to have an additional impact on the system's dynamics. Volume and flow rate are intimately correlated; assuming a constant time frame, a larger volume usually translates into a higher flow rate. As a result, adding volume to the study offers a more thorough comprehension of the behavior of the system.

It is possible to see from studying the relationships between these factors that flow rate typically falls with increasing distance or time. When deploying sensors, this phenomenon also referred to as dispersion or attenuation must be considered. For example, the signal may be considerably weaker by the time it reaches the sensor if it is positioned too far from the flow source, which could result in imprecise observations.

Understanding the intricate interactions between distance, time, flow rate, and volume can help design more efficient monitoring systems that offer precise and insightful information about the system being studied. To guarantee accurate and dependable sensor readings, it is crucial to carefully consider these interdependencies and optimize sensor placement and calibration accordingly, which may involve modifying sensor sensitivity, filtering techniques, or putting in place more robust data acquisition protocols.

4.6 Measurement for Temperature and Humidity

Four different rooms of the house where are the kitchen, living room, master bedroom, and children's bedroom were used to measure the temperature and humidity. Data was gathered at each site using a portable digital hygrometer. To get a picture of the ambient conditions in each space at a particular moment in time, measurements were made concurrently.

Table 4.11 Locations of Measurement

Locations	Temperature (°C)	Humidity (%)
Kitchen	32	79
Living Room	31	75
Master Room	33	75
Kids Room	32	77

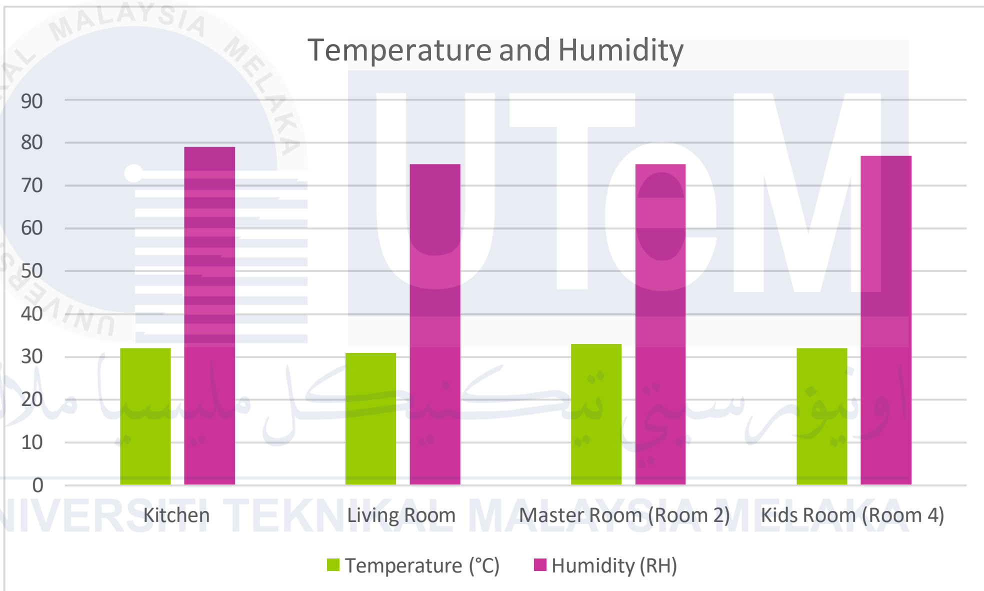

Figure 4.31 Temperature and Humidity

The temperature and humidity levels in several rooms of a house are shown in the bar graph. First, the temperature is generally constant in each room, ranging from about 30°C to 35°C. This implies that a central heating or cooling system that keeps the interior of the house at a somewhat constant temperature is probably installed.

The humidity levels in each room differ significantly. The humidity levels in the living room and kitchen are higher than those in the master bedroom and children's room. A few variables, including ventilation, moisture sources, and sample usage, may be responsible for this variation in humidity. It is because water evaporates while cooking and dishwashing, the kitchen is likely to have higher humidity levels than other areas. In a similar vein, if the living room has houseplants or is regularly used and produces moisture from human activities, its humidity level may be higher. As the air is exchanged with the drier outdoor air, rooms with better ventilation—such as those with windows or doors that are frequently opened will typically have lower humidity levels. Lower humidity levels may result from the master bedroom and children's room having better ventilation than the kitchen and living room. Furthermore, the moisture produced by human breathing and perspiration, rooms with higher occupancy rates and more human activity typically have higher humidity levels.

4.7 Measurement for Temperature and Humidity and Gas Value

Three areas of the house where the kitchen, living room, and master bedroom were used to measure the temperature, humidity, and gas levels. For each parameter, three separate measurements were made at each location to improve data accuracy.

4.7.1 Kitchen

Table 4.12 First Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	4095	32	72
10	4095	32	73
15	4095	33	70
20	4095	33	78
25	4095	33	69

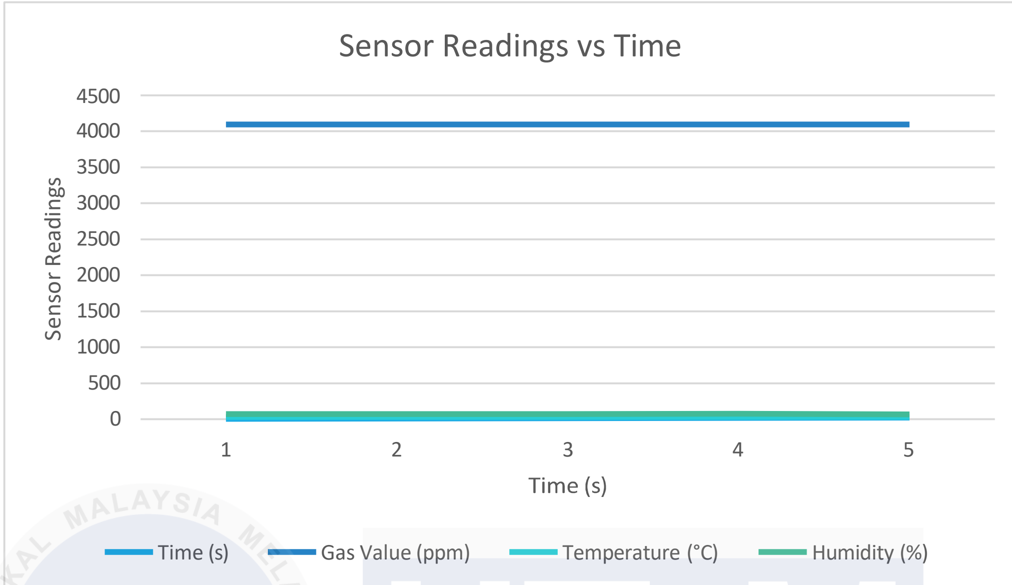

Figure 4.32 Sensor Readings vs Time (1st Reading)

Sensor readings over time are displayed in a table and graph in the attached image. The information contains temperature (°C), humidity (%), and gas value (ppm). Temperature and humidity vary somewhat during the 25-second observation interval, but the gas value stays steady at 4095 ppm. With the temperature and humidity lines displaying slight fluctuations and the gas value line staying flat, the graph graphically depicts this data.

Table 4.13 Second Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	4095	33	69
10	4095	34	69
15	4095	34	68
20	4095	34	67
25	4095	34	66

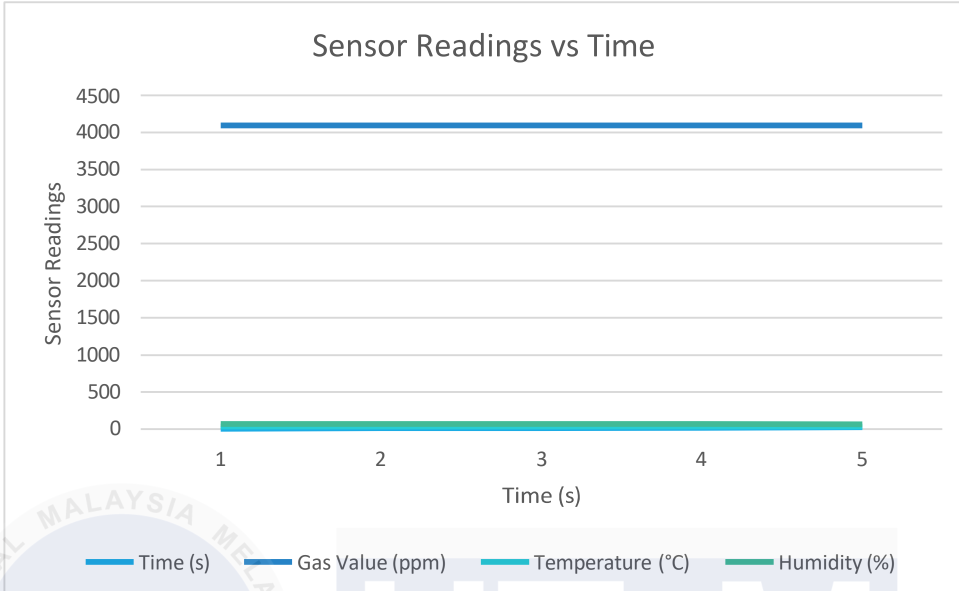

Figure 4.33 Sensor Readings vs Time (2nd Reading)

A table and a graph illustrating sensor readings over time are displayed in the image. The information contains temperature (°C), humidity (%), and gas value (ppm). Temperature and humidity vary somewhat during the 25-second observation interval, but the gas value stays steady at 4095 ppm. With the temperature and humidity lines displaying slight fluctuations and the gas value line staying flat, the graph graphically depicts this data.

Table 4.14 Third Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	4095	35	65
10	4095	35	65
15	4095	35	65
20	4095	35	65
25	4095	34	66

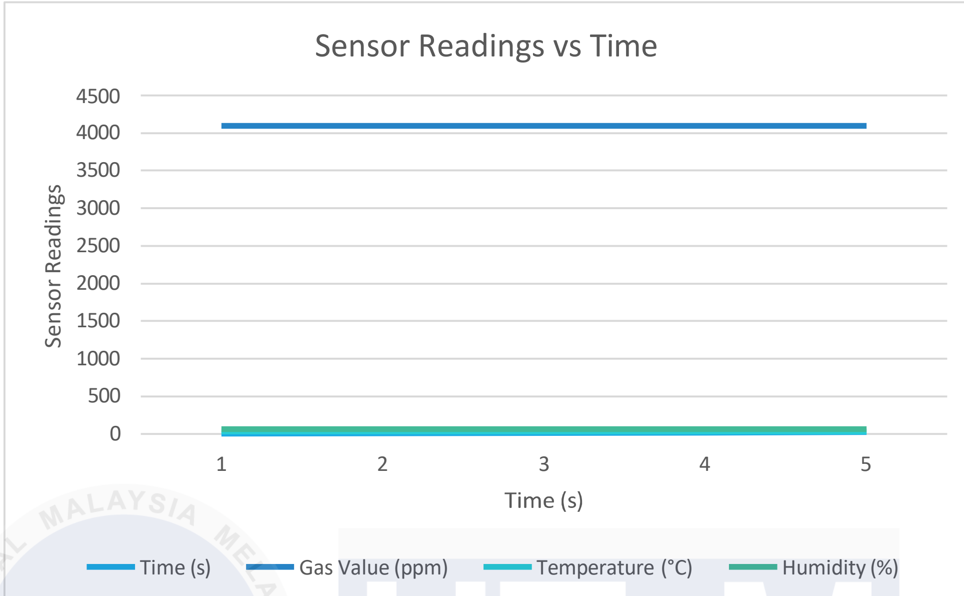

Figure 4.34 Sensor Readings vs Time (3rd Reading)

A table and a graph illustrating sensor readings over time are displayed in the image. The information contains temperature (°C), humidity (%), and gas value (ppm). Temperature and humidity vary somewhat during the 25-second observation interval, but the gas value stays steady at 4095 ppm. With the temperature and humidity lines displaying slight fluctuations and the gas value line staying flat, the graph graphically depicts this data.

4.7.2 Living Room

Table 4.15 First Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	3071	32	77
10	3567	32	76
15	2933	32	77
20	2614	32	77
25	2992	32	77

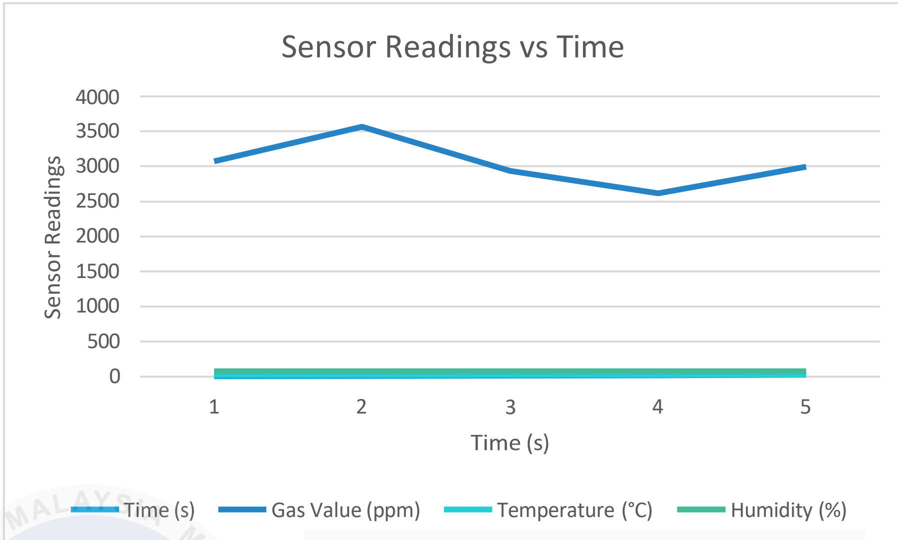

Figure 4.35 Sensor Readings vs Time (1st Reading)

The data indicates that while the temperature and humidity were largely unchanged over time, the gas value decreased slightly. At 5 seconds, the gas value is 3071 ppm; at 25 seconds, it is 2992 ppm. This implies that during the observation period, the concentration of the gas being measured by the sensor in the living room may have decreased. To ascertain the reason behind this decline, more research is required.

Table 4.16 Second Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	3827	32	76
10	2582	32	76
15	3232	32	76
20	3870	32	74
25	3412	33	74

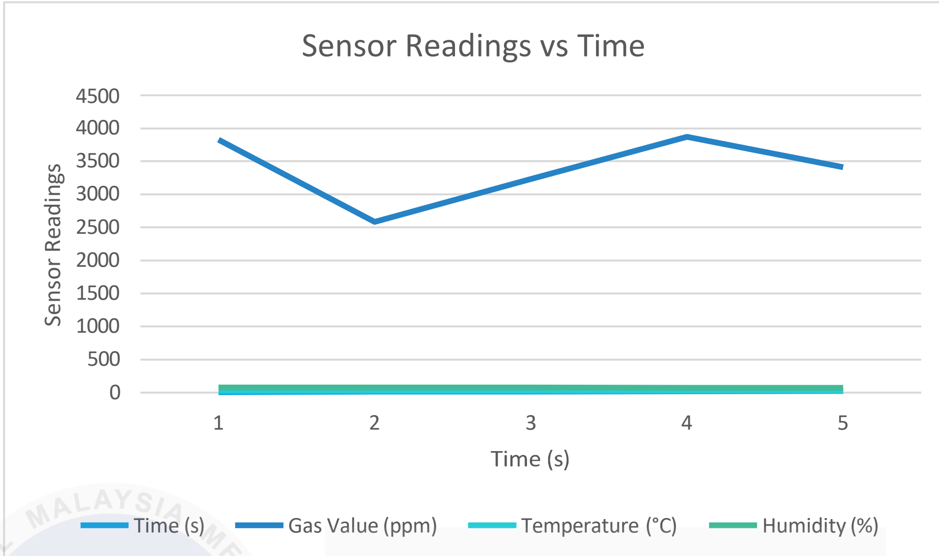

Figure 4.36 Sensor Readings vs Time (2nd Reading)

The data indicates that while the temperature and humidity were relatively steady throughout time, the gas value fluctuated. From 3827 ppm at 5 seconds to 2582 ppm at 10 seconds, the gas value first drops, then rises to 3870 ppm at 20 seconds, and then falls once again to 3412 ppm at 25 seconds. This erratic behavior implies that the gas concentration being monitored by the living room sensor is not constant throughout the observation period. To find out what causes these variations, more research is required.

Table 4.17 Third Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	2857	33	75
10	2448	32	76
15	2278	32	76
20	2519	32	77
25	2303	32	77

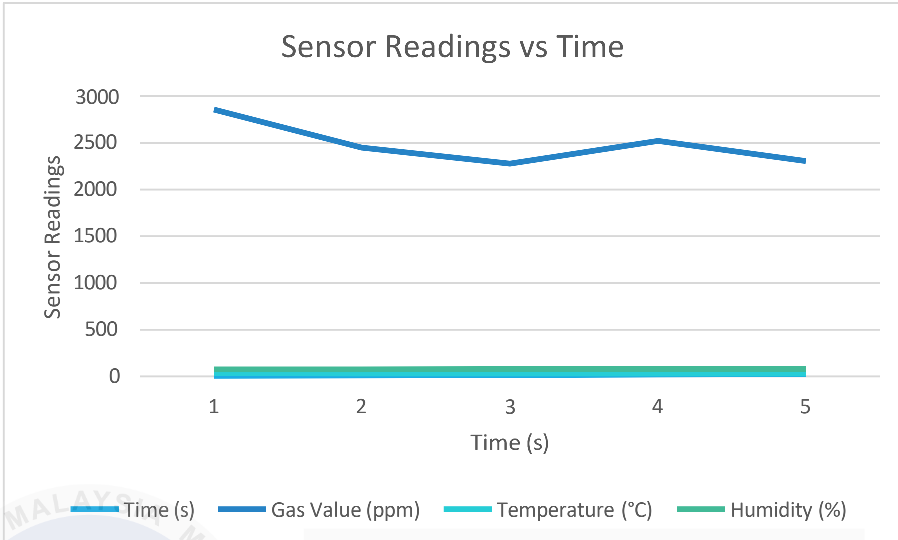

Figure 4.37 Sensor Readings vs Time (3rd Reading)

The data indicates that while the temperature and humidity were largely unchanged over time, the gas value decreased slightly. After 5 seconds, the gas value is 2857 ppm; after 25 seconds, it is 2303 ppm. This implies that during the observation period, the concentration of the gas being measured by the sensor in the living room may have decreased. To ascertain the reason behind this decline, more research is required.

4.7.3 Master Room

Table 4.18 First Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	1879	33	75
10	3578	33	75
15	3034	33	75
20	4007	33	74
25	2942	33	74

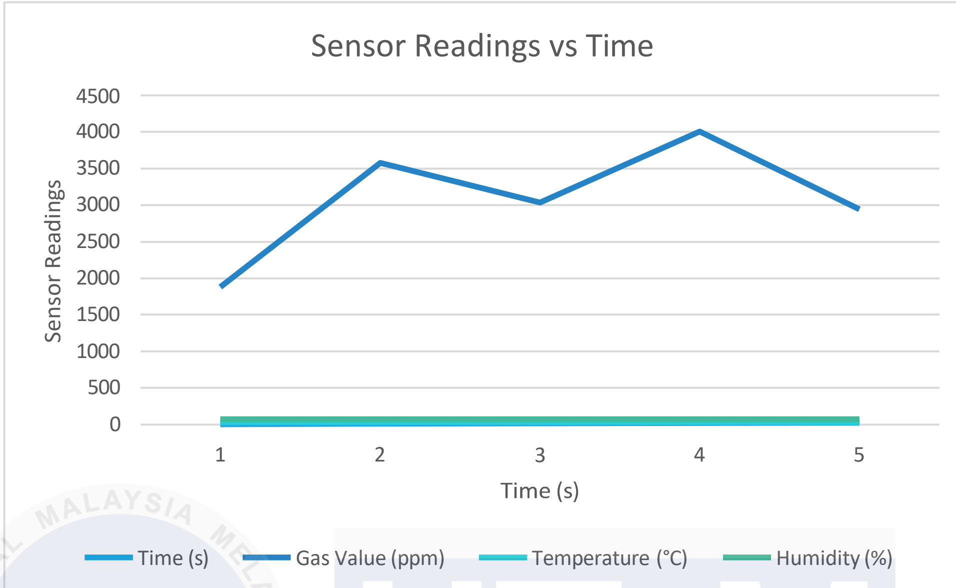

Figure 4.38 Sensors Readings vs Time (1st Reading)

The data indicates that while the temperature and humidity were relatively steady throughout time, the gas value fluctuated. After rising from 1879 ppm at 5 seconds to 3578 ppm at 10 seconds, the gas value eventually falls to 3034 ppm at 15 seconds, rises once more to 4007 ppm at 20 seconds, and then falls to 2942 ppm at 25 seconds. This erratic behaviour indicates that during the observation time, the gas concentration being detected by the sensor in the master bedroom was not constant. To find out what causes these variations, more research is required.

Table 4.19 Second Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	2459	33	74
10	3697	33	74
15	3671	33	75
20	3792	33	74
25	3599	33	74

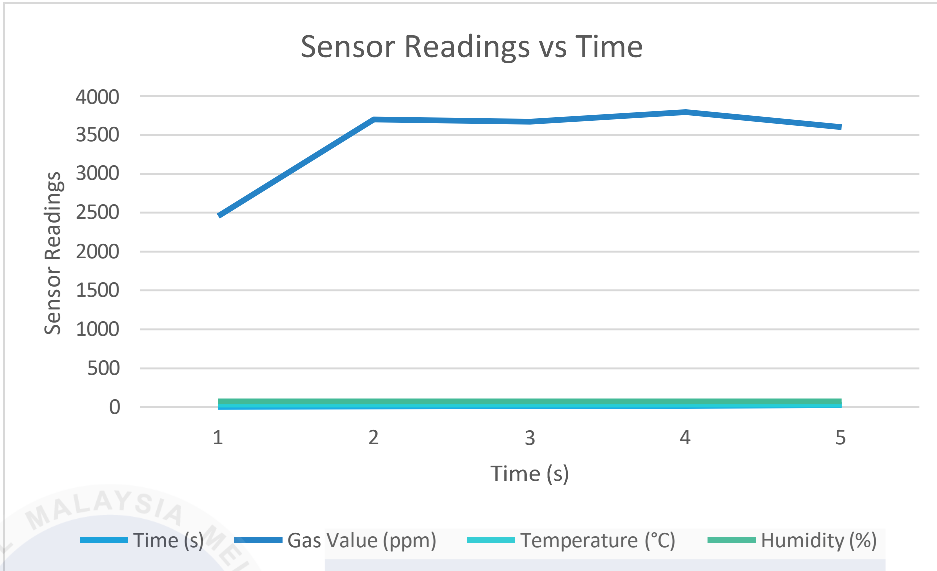

Figure 4.39 Sensor Readings vs Time (2nd Reading)

The data indicates that while the temperature and humidity stayed mostly steady throughout time, the gas value increased somewhat before declining. At 5 seconds, the gas value is 2459 ppm; at 10 seconds, it is 3697 ppm; and at 25 seconds, it drops to 3599 ppm. This implies that during the observation time, the concentration of the gas being measured by the sensor in the master bedroom first rose and then levelled off. To find out what causes these variations, more research is required.

Table 4.20 Second Reading

Time (s)	Gas Value (ppm)	Temperature (°C)	Humidity (%)
5	3397	33	74
10	3892	33	74
15	3218	33	74
20	3933	33	74
25	3675	33	74

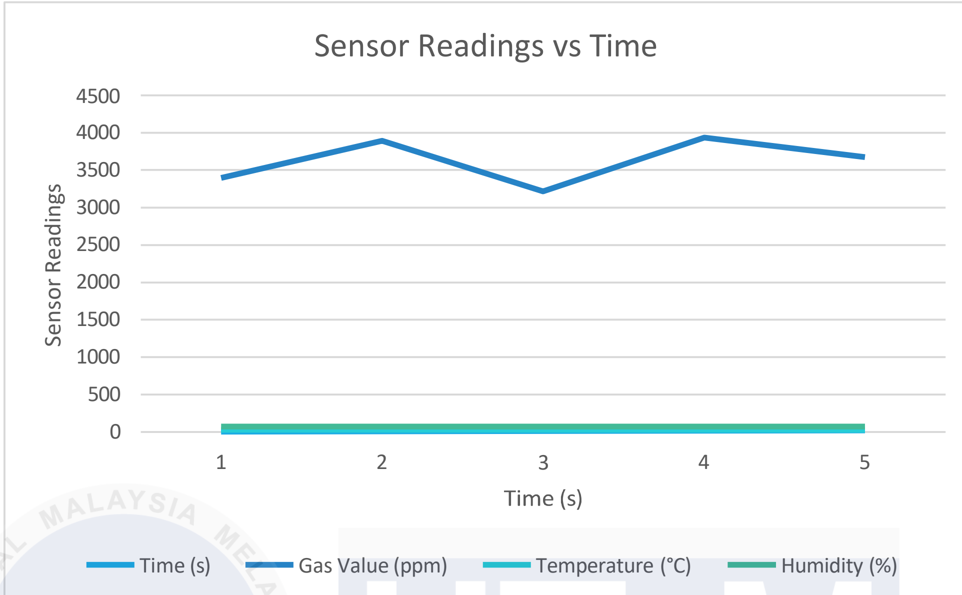

Figure 4.40 Sensor Readings vs Time (3rd Reading)

The data indicates that while the temperature and humidity were relatively steady throughout time, the gas value fluctuated. The gas value drops to 3218 ppm at 15 seconds, rises to 3933 ppm at 20 seconds, and then falls to 3675 ppm at 25 seconds after first rising from 3397 ppm at 5 seconds to 3892 ppm at 10 seconds. This erratic behavior indicates that during the observation time, the gas concentration being detected by the sensor in the master bedroom was not constant. To find out what causes these variations, more research is required.

4.8 Blynk Application

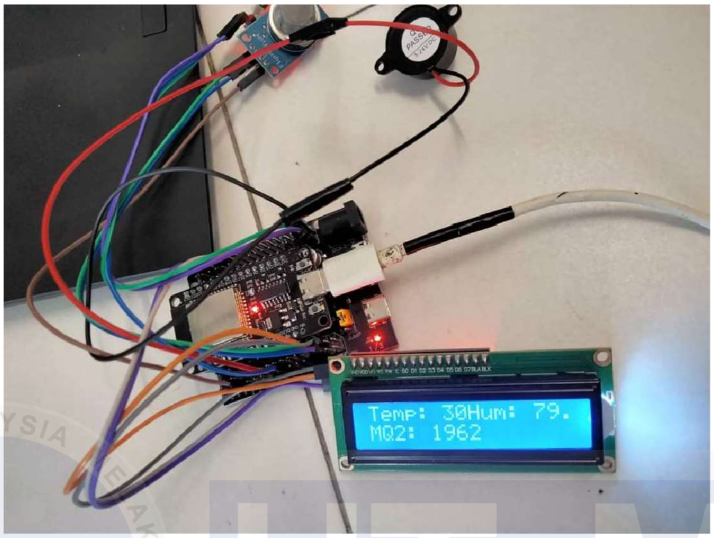

Figure 4.41 Testing of the Program

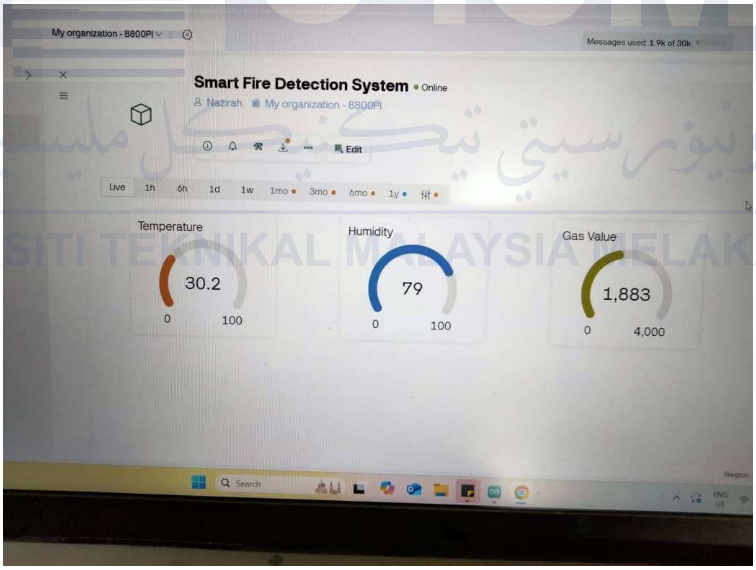

Figure 4.42 Blynk Console

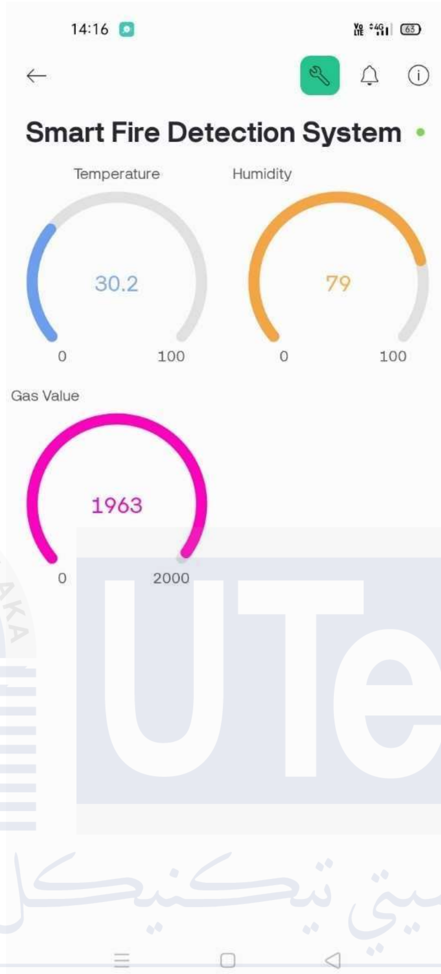

Figure 4.43 Blynk Apps

The pictures depict a system intended for monitoring and detecting fires. An ESP32 development board, sensors (DHT11 for temperature and humidity, MQ-2 for gas), a buzzer, and an LCD are among the hardware elements shown in the circuit diagram. Data transmission to the Blynk platform is made possible via this hardware's Wi-Fi internet connection. Screenshots of the Blynk mobile app and website show the system's interaction and visualization features. Circular gauges on the dashboard provide real-time temperature, humidity, and gas level information. It is simple to monitor the environment and identify possible fire hazards thanks to this visual representation.

By linking physical sensors to the internet, the system makes use of the Internet of Things paradigm, allowing for remote control and monitoring. Users may now access environmental data from any location with an internet connection thanks to this connectivity, which offers important insights into possible fire threats. This connection is made easier by the Blynk platform, which offers an intuitive interface for controlling and visualizing data.

In conclusion, this Internet of Things (IoT)-based fire detection system exemplifies the potential of integrating digital and physical components. It provides a useful tool for proactive fire safety monitoring and possible mitigation by utilizing sensors, connectivity, and an intuitive platform.

4.9 Prototype Development

Figure 4.44 Prototype of Project

The picture displays a solidly built Smart Fire Detection System prototype. The electronics are protected while still looking neat and professional thanks to the use of a plastic case. The addition of a button to the front panel implies more features, like manual alert triggering or calibration. Stability is achieved by placing PVC tubing on a strong base. Both practicality and aesthetics are well understood in the overall design. The prototype phase is essential for system testing and improvement. Before completing the design, it enables you to see how the gadget functions in an actual environment, spot any possible problems, and make the required changes.

4.10 Summary

The goal of this project was to create a smart fire detection system that could keep an eye on the surroundings and warn users of possible fire dangers. By precisely sensing temperature, humidity, and gas levels, efficiently showing data on the LCD and the Blynk platform, and setting off warnings in response to preset criteria, the system was able to accomplish its goals. The system's capacity to deliver real-time environmental data and react quickly to conditions that change is one of the main conclusions. Even though the system promises, it is important to consider certain drawbacks such sensor accuracy and ambient influences. Future improvements might involve investigating more sophisticated alerting systems, integrating with other smart home technologies, and applying machine learning algorithms for better risk prediction. The research shows how IoT technology may improve home safety and provide a safer living environment, which has wider ramifications.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This chapter summarizes the development of the smart fire detection system for household kitchens in enhancing home safety through innovative technology. This project effectively combines a DHT-11 temperature and humidity sensor and MQ-2 gas sensor with an Internet of Things-based notification system to offer real-time fire hazard monitoring and alerts. To prevent property damage and save lives, the system makes sure that possible fire situations are detected early. The project tackles a critical safety issue by concentrating on the home kitchen which is a location that is vulnerable to fire threats.

The way the fire detection system works has changed dramatically because of the incorporation of IoT technologies. It allows customers to receive immediate notification using Short Message Service (SMS) alerts, guaranteeing that they are swiftly alerted to possible threats, even while they are not at home. By including a layer of connectivity and remote monitoring, this method improves the responsiveness and dependability of conventional fire detection systems. In additionally, the system's accuracy and efficacy in recognizing fire threats are greatly increased by its capacity to detect both smoke and crucial temperature thresholds.

The designed system was found to perform better than conventional fire detection systems in terms of speed, dependability and user ease. The system's architecture and goals were validated when the smart fire detection circuit successfully showed that it could identify early warning indicators of fire threats and quickly alert users. Furthermore, the system's

Affordability and scalability are guaranteed using inexpensive sensors and Internet of Things components, making it available to a variety of families.

In summary, this project not only accomplishes its main goal of increasing the security and dependability of fire detection systems, but it also lays the groundwork for further advancements and integrations. The smart fire detection system's successful development and assessment demonstrate its potential as a useful instrument for reducing home fire risks. This invention creates opportunities for more research and development in smart home safety systems and is a step forward in using technology to make living spaces safer.

5.2 Project Objectives

The project's objectives only have three primary goals are reviewed and explained briefly below.

5.2.1 To study and examine the current fire detection system by enhancing the safety and reliability of fire detection system in household kitchen

To understanding the shortcomings and difficulties of current fire detection systems, especially in residential kitchens, is the main goal of this project. It entails examining the current system's fire detection capabilities, reaction times and dependability under various conditions. By identifying these gaps, the study intends to suggest improvements that improve fire detection's safety and reliability while addressing kitchen hazards like cooking smoke and temperature fluctuations.

5.2.2 To develop smart fire detection circuit IoT notifications

This goal places a strong emphasis on developing a cutting-edge fire detection system that uses Internet of Things technology to deliver alarms in real time. Sensors such as the

DHT-11 for temperature and humidity monitoring and the MQ-2 for gas and smoke detection are integrated into the smart fire detection circuit. Together, these elements help detect possible fire threats early. The technology ensures that users are instantly warned of harmful conditions, even if they are not physically present, by sending fast notifications such as SMS alerts through IoT connectivity.

5.2.3 To evaluate performance of the smart fire detection circuit with functionality to make improvements over traditional fire detection systems

By evaluating the proposed system's performance in comparison to conventional fire detection systems is the third goal. This entails evaluating its responsiveness, sensitivity and dependability in a range of scenarios. Through comprehensive assessments, the project pinpoints its advantages and any shortcomings. The system may be improved to be more effective, user-friendly and able to produce better safety results than current solutions thanks to the insights gathered.

5.3 Project Limitation

The project's dependence on the MQ-2 and DHT-11 sensor's sensitivity and accuracy are one of its limitations, in some situations such as when detecting smoke from routine cooking activities, these sensors may generate false positives or negatives. Furthermore, reliable IoT connectivity is essential to the system's operation to provide real-time warnings, interruptions in the internet connection may cause notifications to be delayed or stopped. Additionally, the project's focus is restricted to home kitchens, which might not take into consideration other fire-prone locations or extensive applications. In addition, environmental elements like excessive humidity or dust buildup may have an impact on the sensor's long-term dependability, necessitating routine calibration and maintenance to guarantee steady operation.

5.4 Recommendations

To investigating the use of more sophisticated and accurate sensors to improve the system's accuracy and lower false positives is one of the project's main recommendations. For example, combining gas-specific sensors or optical smoke sensors may increase the sensitivity and dependability of detection. To further reduce false alarms, the system may be able to differentiate between real fire dangers and typical kitchen operations like cooking smoke by incorporating machine learning techniques.

Next, to improve the system's IoT capabilities is another suggestion. The system may become more adaptable and user-friendly if the notifications, mobile app alerts and interaction with smart home systems like Google Home or Alexa. Furthermore, the system might be enhanced to give users access to real-time environmental data via a dashboard, enabling them to remotely monitor kitchen conditions in real-time.

Then, enhancing the system's endurance and resilience is another crucial area of attention. The lifespan and dependability of the system would be improved by making sure the sensors and electronics could survive challenging kitchen conditions like high humidity and grease buildup. The system's dependability would be further increased by adding a self-diagnostic capability that periodically assesses the sensor's performance and alerts users when calibration or maintenance is required.

Finally, the system might be made flexible and scalable for settings other than home kitchens, like workplaces, restaurants, and industrial facilities. This would make the system a more all-encompassing fire safety solution by customizing the detection criteria and notifications to particular use cases. The smart fire detection system can develop into a more dependable, effective, and used technology by putting these suggestions into practice.

5.5 Project Potential

A home kitchen smart fire detection system sets the stage for several exciting initiatives that could increase its use and influence. The creation of an all-inclusive smart home security system that incorporates fire detection with additional safety features like carbon monoxide monitoring, gas leak detection, and intruder alarms is one project. This system may provide homeowners with a one-stop shop for monitoring and protecting their homes by integrating several safety features into a single IoT-enabled platform.

The development of an intelligent fire detection system for restaurants or commercial kitchens is another endeavor. Due to the frequent use of flammable oils and high-temperature cooking equipment, commercial kitchens frequently present special fire risks. A customized version of the system might be made to identify these dangers, giving companies better safety precautions while adhering to strict industry standards.

Then, to go even farther, it may investigate a cloud-based analytics and monitoring platform for fire detection systems. A centralized platform would be established as part of this project so that various fire detection equipment could transmit real-time data for analysis, trend tracking, and predictive maintenance. A platform like this might help businesses, homeowners, and even local government agencies by facilitating proactive steps to raise safety standards and stop fires.

In working on a smart fire detection and suppression system is an additional fascinating option. This project would combine automated fire suppression systems, like gas-based extinguishers or sprinklers, with your detecting technologies. In addition to warning users of a fire hazard, the system might rapidly initiate suppression procedures to put out the fire and reduce any potential damage.

Lastly, a low-cost safety solution for underserved or rural areas might be inspired by the method. This project's emphasis on affordability and ease of use could give communities without access to sophisticated safety systems vital fire detection capabilities, saving lives and property in environments with limited resources.

Each of these projects offers chances for creativity and influence in fire safety technology while examining new applications and functionalities and building on the strengths of the existing work.

REFERENCES

[1] M. G. A. Rhizma and C. Suhendar, “Home Security and Fire Detection System Design Using IoT-based Microcontroller ATmega2560,” GCISTEM Proceeding, vol. 1, 2022, doi: 10.56573/gcistem.v1i.10.

[2] F. Nugroho and A. B. Pantjawati, “Automation and Monitoring Smart Kitchen Based on Internet of Things (IoT),” in IOP Conference Series: Materials Science and Engineering, 2018. doi: 10.1088/1757-899X/384/1/012007.

[3] S. J. Kweon, J. H. Park, C. O. Park, H. J. Yoo, and S. Ha, “Wireless Kitchen Fire Prevention System Using Electrochemical Carbon Dioxide Gas Sensor for Smart Home,” Sensors, vol. 22, no. 11, 2022, doi: 10.3390/s22113965.

[4] M. Mukhiddinov, A. B. Abdusalomov, and J. Cho, “Automatic Fire Detection and Notification System Based on Improved YOLOv4 for the Blind and Visually Impaired,” Sensors, vol. 22, no. 9, 2022, doi: 10.3390/s22093307.

[5] W. L. Hsu, J. Y. Jhuang, C. S. Huang, C. K. Liang, and Y. C. Shiau, “Application of Internet of Things in a kitchen fire prevention system,” Applied Sciences (Switzerland), vol. 9, no. 17, 2019, doi: 10.3390/app9173520.

[6] H. Alqourabah, A. Muneer, and S. M. Fati, “A smart fire detection system using IoT technology with automatic water sprinkler,” International Journal of Electrical and Computer Engineering, vol. 11, no. 4, 2021, doi: 10.11591/ijece.v11i4.pp2994- 3002.

[7] S. Suwarjono et al., “Design of a Home Fire Detection System Using Arduino and SMS Gateway,” Knowledge, vol. 1, no. 1, 2021, doi: 10.3390/knowledge1010007.

[8] J. H. Park, S. Lee, S. Yun, H. Kim, and W. T. Kim, “Dependable fire detection system with multifunctional artificial intelligence framework,” Sensors (Switzerland), vol. 19, no. 9, 2019, doi: 10.3390/s19092025.

[9] A. Rehman et al., “Smart fire detection and deterrent system for human savior by using internet of things (IoT),” Energies (Basel), vol. 14, no. 17, 2021, doi: 10.3390/en14175500.
[10] R. Yadav and P. Rani, “Sensor Based Smart Fire Detection and Fire Alarm System,” SSRN Electronic Journal, 2020, doi: 10.2139/ssrn.3724291.

[11] T. Khan, “A Smart Fire Detector IoT System with Extinguisher Class Recommendation Using Deep Learning,” Internet of Things, vol. 4, no. 4, 2023, doi: 10.3390/iot4040024.

[12] C. A. U. Hassan et al., “Design and Implementation of Real-Time Kitchen Monitoring and Automation System Based on Internet of Things,” Energies (Basel), vol. 15, no. 18, 2022, doi: 10.3390/en15186778.

[13] T. Juwariyah, S. Prayitno, L. Krisnawati, and S. Sulasminingsih, “Design of IoT- Based Home Fire Detection System Equipped with a Data Logger,” IOP Conf Ser Mater Sci Eng, vol. 1125, no. 1, 2021, doi: 10.1088/1757-899x/1125/1/012079.

[14] J. Martinsson, M. Runefors, H. Frantzich, D. Glebe, M. McNamee, and O. Mogren, “A Novel Method for Smart Fire Detection Using Acoustic Measurements and Machine Learning: Proof of Concept,” Fire Technol, vol. 58, no. 6, 2022, doi: 10.1007/s10694-022-01307-1.

[15] V. R. Palandurkar, S. J. Mascarenhas, N. D. Nadaf, and R. A. Kunwar, “SMART KITCHEN SYSTEM USING IOT,” International Journal of Engineering Applied Sciences and Technology, vol. 04, no. 11, 2020, doi: 10.33564/ijeast.2020.v04i11.067.

[16] Q. Wu et al., “Intelligent Smoke Alarm System with Wireless Sensor Network Using ZigBee,” Wirel Commun Mob Comput, vol. 2018, 2018, doi: 10.1155/2018/8235127.

[17] M. Z. Tun and H. Myint, “Arduino based Fire Detection and Alarm System Using Smoke Sensor,” International Journal of Advances in Scientific Research and Engineering, vol. 06, no. 04, 2020, doi: 10.31695/ijasre.2020.33792.

[18] A. Aryanti, I. Mekongga, and R. S. Dewi, "GPS-based fire detection system (Global Positioning System) and SMS Gateway," IOP Conf Ser Mater Sci Eng, vol. 1108, no. 1, 2021, doi: 10.1088/1757-899x/1108/1/012023.

[19] L. Tanutama and W. Atmadja, "Home Security System with IOT Based Sensors Running on House Infra Structure Platform," in IOP Conference Series: Earth and Environmental Science, 2020. doi: 10.1088/1755-1315/426/1/012151.

[20] Mr. B B. Gopnarayan, Vishal V. Thavare, Suraj J. Dudhal, Kiran B. Waghmode, and Kishor P. Avalekar, "LPG Gas Leakage Monitoring and Alert System using Arduino," International Journal of Advanced Research in Science, Communication and Technology, 2023, doi: 10.48175/ijarsct-12033.

[21] B. U. Umar, A. A. Alfa, M. O. Olaniyi, E. M. Dogo, and C. P. Okoro, "Development of a Fuzzy Decision Logic-Based Fire and Gas Detection System for a Smart Kitchen," SSRN Electronic Journal, 2022, doi: 10.2139/ssrn.4141069.

[22] F. Saeed, A. Paul, A. Rehman, W. H. Hong, and H. Seo, "IoT-Based intelligent modeling of smart home environment for fire prevention and safety," Journal of Sensor and Actuator Networks, vol. 7, no. 1, 2018, doi: 10.3390/jsan7010011.

[23] M. Faris, E. Ariyanto, and Y. A. S. Yudo, "IMPROVED REAL-TIME HOUSE FIRE DETECTION SYSTEM PERFORMANCE WITH IMAGE CLASSIFICATION USING MOBILENETV2 MODEL," JIPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika), vol. 8, no. 2, 2023, doi: 10.29100/jipi.v8i2.3803.

[24] X. Ren et al., "Design of multi-information fusion based intelligent electrical fire detection system for green buildings," Sustainability (Switzerland), vol. 13, no. 6, 2021, doi: 10.3390/su13063405.

[25] R. A. Sowah, K. Apeadu, F. Gatsi, K. O. Ampadu, and B. S. Mensah, "Hardware Module Design and Software Implementation of Multisensor Fire Detection and Notification System Using Fuzzy Logic and Convolutional Neural Networks (CNNs)," Journal of Engineering (United Kingdom), vol. 2020, 2020, doi: 10.1155/2020/3645729.

[26] T. Hasan, Muhammad Aumlanul Abrar, Md Zillur Rahman Saimon, Md. Sayeduzzaman, and Md. Siyamul Islam, “Constructing An Integrated IoT-based Smart Home with An Automated Fire and Smoke Security Alert System,” Malaysian Journal of Science and Advanced Technology, 2023, doi: 10.56532/mjsat.v3i1.125.

[27] S. S. Dewi, D. Satria, D. Mulyati, D. Sugiyanto, and E. Yusibani, “Implementation of Internet of Thing on Fire Home Information Systems for Multi Room applications,” in Journal of Physics: Conference Series, 2019. doi: 10.1088/1742- 6596/1232/1/012026.

[28] R. S. Kharisma and A. Setiyansah, “Fire early warning system using fire sensors, microcontroller, and SMS gateway,” Journal of Robotics and Control (JRC), vol. 2, no. 3, 2021, doi: 10.18196/jrc.2372.

[29] B. Sarwar, I. S. Bajwa, N. Jamil, S. Ramzan, and N. Sarwar, “An intelligent fire warning application using IoT and an adaptive neuro-fuzzy inference system,” Sensors (Switzerland), vol. 19, no. 14, 2019, doi: 10.3390/s19143150.

[30] F. Z. Rachman et al., “Design of the early fire detection based fuzzy logic using multisensor,” in IOP Conference Series: Materials Science and Engineering, 2020. doi: 10.1088/1757-899X/732/

APPENDICES

Appendix A Gantt Chart

Gantt Chart																												
Project Activity	WEEK (PSM1)														WEEK (PSM2)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Topic Selection	■																											
Discussion with Supervisor	■																											
Literature Review of related project		■	■	■	■	■																						
Development of design				■	■	■	■	■																				
Development of programming							■	■	■	■	■	■																
Project Presentation & Report Submission													■	■														
Prototype Contruction															■	■	■	■	■									
Analysis of the project																		■	■	■	■	■	■					
Final Report & Dissemination of Project Finding																				■	■	■	■	■	■	■		
Project Presentation & Report Submission																											■	■

Appendix B Program Code

```
#define BLYNK_TEMPLATE_ID "TMPL6OIy-kSG8"
#define BLYNK_TEMPLATE_NAME "Smart Fire Detection System"
#define BLYNK_AUTH_TOKEN "ehWpuj6B8hcrvH9DM1-Y_lWmq9pK60_n"

#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <BlynkSimpleEsp32.h>
#include <WiFi.h>
#include "DHT.h"

// Define I2C pins for ESP32
#define SDA_PIN 21
#define SCL_PIN 22

// MQ-2 Sensor pin
#define MQ2_PIN 34 // Use an analog pin of ESP32

// Buzzer pin
#define BUZZER_PIN 26 // Use a digital pin of ESP32

// DHT11 Sensor pin and type
#define DHT_PIN 27 // Use a digital pin for DHT11
#define DHT_TYPE DHT11

// Threshold for gas detection (adjust as needed)
#define GAS_THRESHOLD 2000

// Initialize the I2C LCD (address 0x27, 16 columns, 2 rows)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Initialize the DHT sensor
DHT dht(DHT_PIN, DHT_TYPE);

```

```
// Blynk virtual pins
#define VIRTUAL_PIN_TEMP V0
#define VIRTUAL_PIN_HUM V1
#define VIRTUAL_PIN_GAS V2

void setup() {
  // Initialize I2C with specified SDA and SCL pins
  Wire.begin(SDA_PIN, SCL_PIN);

  // Initialize LCD
  lcd.begin();
  lcd.backlight();
  lcd.print("Initializing...");
  delay(2000);
  lcd.clear();

  // Initialize buzzer pin as output
  pinMode(BUZZER_PIN, OUTPUT);
  digitalWrite(BUZZER_PIN, LOW); // Ensure buzzer is off initially

  // Initialize the DHT sensor
  dht.begin();

  // Initialize Blynk and check WiFi connection
  lcd.print("Connecting WiFi");
  Blynk.begin(BLYNK_AUTH_TOKEN, "BlackPearl", "MDF772606");

  // Wait for WiFi connection
  while (WiFi.status() != WL_CONNECTED) {
    lcd.setCursor(0, 1);
    lcd.print(".");
    delay(500);
  }
```

```

  // Display WiFi connected message
  lcd.clear();
  lcd.print("WiFi Connected");
  delay(2000);
  lcd.clear();
}

void loop() {
  // Run Blynk
  Blynk.run();

  // Read the analog value from the MQ-2 sensor
  int sensorValue = analogRead(MQ2_PIN);

  // Convert the analog value to voltage (ESP32 uses 3.3V reference)
  float voltage = (sensorValue / 4095.0) * 3.3;

  // Read temperature and humidity from DHT11
  float temperature = dht.readTemperature();
  float humidity = dht.readHumidity();

  // Check if DHT11 readings are valid
  if (isnan(temperature) || isnan(humidity)) {
    lcd.setCursor(0, 0);
    lcd.print("DHT Error");
  } else {
    // Display temperature and humidity on the LCD
    lcd.setCursor(0, 0);
    lcd.print("Temp: ");
```

```
    lcd.print(temperature, 1); // Display temperature with 1 decimal place
    lcd.print("C ");

    lcd.setCursor(8, 0); // Adjust display for humidity
    lcd.print("Hum: ");
    lcd.print(humidity, 1); // Display humidity with 1 decimal place
    lcd.print("%");

    // Send temperature and humidity to Blynk
    Blynk.virtualWrite(VIRTUAL_PIN_TEMP, temperature);
    Blynk.virtualWrite(VIRTUAL_PIN_HUM, humidity);
  }

  // Display MQ-2 sensor value on the LCD
  lcd.setCursor(0, 1);
  lcd.print("MQ2: ");
  lcd.print(sensorValue);
  lcd.print("  ");

  // Send gas sensor value to Blynk
  Blynk.virtualWrite(VIRTUAL_PIN_GAS, sensorValue);

  // Check if the sensor value exceeds the threshold
  if (sensorValue > GAS_THRESHOLD) {
    // Turn on the buzzer and display "Gas Detected!"
    digitalWrite(BUZZER_PIN, HIGH);
    lcd.setCursor(10, 1); // Position to display "Gas Detected!"
    lcd.print("Gas Detected!");

    // Trigger Blynk notification
    Blynk.logEvent("gas_alert", "Gas detected! Please check immediately!");
  } else {
    // Turn off the buzzer
    digitalWrite(BUZZER_PIN, LOW);
    lcd.setCursor(10, 1);
    lcd.print("                "); // Clear "Gas Detected!" message
  }

  delay(2000); // Update every 2 seconds
}
```