Faculty of Electronics and Computer Engineering and Technology

DEVELOPMENT OF A COST-EFFECTIVE GAS LEAKAGE NOTIFICATION SYSTEM BASED ON IOT TECHNOLOGY

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEVELOPMENT OF A COST-EFFECTIVE GAS LEAKAGE NOTIFICATION SYSTEM BASED ON IOT TECHNOLOGY

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A project report submitted
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DEDICATION

I would like to dedicate my Bachelor Degree to my beloved family, for their endless encouragement, belief in my abilities and the one that give me an inspiration for not giving up in life and also who worked hard to give me some advices and financial support to finish my studies. To my supervisor, Ts. Dr. Suraya Binti Zainuddin that always taught some knowledge to complete this project. To my friends and all people that had guide me through completion of this project. This project represents an acknowledgement to the collective efforts that made it possible.

ABSTRACT

A gas leakage caused damages to premises when there is no fast action taken. Besides, high concentration of harmful gases in the surrounding air might become poisonous, lead to fires or suffocation, and most likely, if no action is taken it might lead to injury or even death. Hence, this project aims to develop a gas leakage detection and notification system based in Internet of Things (IoT). This system will help to alerts premise's owners through mobile application if a gas leakage occurs. Ultimately, it provides a faster notification and expedites the safety action by owners. Leaks of petrol in houses and automobiles are a serious safety concern. Because gas leaks are deadly, a dependable gas leak notification system is required. This idea calls for an IoT-based gas leak detection system. The recommended system includes petrol sensors in several gas-leak-prone areas. When a gas leak is detected, a microcontroller will analyse sensor data and transmit Blynk messages. The system includes a web interface for monitoring gas sensors in real time. This gadget monitors gas concentration and alerts you when it surpasses a certain level. The outcome presented the successfulness of the proposed to detect gas leakage. The suggested technology outperforms existing gas leak detection systems. First, IoT technology improves dependability and efficiency by providing real-time data and notifications. Next, it is inexpensive and does not need the use of wiring or specialists. Finally, because of its ease of installation and operation, this system is appropriate for gas-powered automobiles and residences. The problem is solved with IoT-based gas leak notification. The system is simple to setup and operate, and it provides real-time data and notifications. This device guards against gas leaks and protects persons and property.

ABSTRAK

Kebocoran gas mudah menyebabkan kerosakan kepada premis apabila tiada tindakan pantas diambil. Selain itu, kepekatan gas berbahaya yang tinggi di udara sekitarnya mungkin menjadi beracun, menyebabkan kebakaran atau lemas, dan kemungkinan besar, jika tiada tindakan diambil, ia mungkin membawa kepada kecederaan atau kematian. Oleh itu, projek ini bertujuan untuk membangunkan sistem pengesanan kebocoran gas dan pemberitahuan yang berpusat di Internet of Things (IoT). Sistem ini akan membantu memberi amaran kepada pemilik premis melalui aplikasi mudah alih jika berlaku kebocoran gas. Pada akhirnya, ia memberikan pemberitahuan yang lebih cepat dan mempercepatkan tindakan keselamatan oleh pemilik. Kebocoran petrol di rumah dan kereta adalah kebimbangan keselamatan yang serius. Kerana kebocoran gas mematikan, sistem pemberitahuan kebocoran gas yang boleh dipercayai diperlukan. Idea ini memerlukan sistem pengesanan kebocoran gas berasaskan IoT. Sistem yang disyorkan termasuk sensor petrol di beberapa kawasan yang terdedah kepada kebocoran gas. Apabila kebocoran gas dikesan, mikropengawal akan menganalisis data sensor dan menghantar mesej Blynk. Sistem ini termasuk antara muka web untuk memantau sensor gas dalam masa nyata. Alat ini memantau kepekatan gas dan memberi amaran kepada anda apabila ia melepasi tahap tertentu. Teknologi yang dicadangkan mengatasi sistem pengesanan kebocoran gas sedia ada. Hasil kajian menunjukkan kejayaan yang dicadangkan untuk mengesan kebocoran gas. Pertama, teknologi IoT meningkatkan kebolehpercayaan dan kecekapan dengan menyediakan data dan pemberitahuan masa nyata. Seterusnya, ia murah dan tidak memerlukan penggunaan pendawaian atau pakar. Akhirnya, kerana kemudahan pemasangan dan operasi, sistem ini sesuai untuk kereta dan kediaman berkuasa gas. Masalahnya diselesaikan dengan pemberitahuan kebocoran gas berasaskan IoT. Sistem ini mudah disediakan dan dikendalikan, dan ia menyediakan data dan pemberitahuan masa nyata. Peranti ini mengawal kebocoran gas dan melindungi orang dan harta benda.

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LIST OF SYMBOLS

°C	-	Celcius
°F	-	Fahrenheit

LIST OF ABBREVIATIONS

WHO	-	World Health Organization
ESP32	-	Espressif32
LPG	-	Liquefied Petroleum Gas
LED	-	Light Emitting Diode
IoT	-	Internet of Things
H2	-	Hydrogen
CH4	-	Methane
CO	-	Carbon Monoxide
RTD	-	Resistance Temperature Detector
SMS	-	Short Message Service
MOS	-	Metal Oxide Semiconductor
GSM	-	Global System for Mobile Communication
ARM	-	Advanced RISC Machine
SIM	-	Subscriber Identity Module
LCD	-	Liquid Crystal Display
I2C	-	Inter-Integrated Circuit
AVR	-	Advanced virtual RISC
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
SRAM	-	Static Random Access Memory
USART	-	Universal Synchronous/Asynchronous Receiver/Transmitter
MIPS	-	Million Instructions Per Second
PWM	-	Pulse Width Modulation
USB	-	Universal Serial Bus
ICSP	-	In-circuit Serial Programming
AC	-	Alternating Current
DC	-	Direct current
Wi-Fi	-	Wireless Fidelity
CRT	-	Cathode Ray Tube
CPU	-	Central Processing Unit
PPM	-	Part Per Million
CNG	-	Compressed Natural Gas
ADC	-	Analogue to Digital Converter
IC	-	Integrated Circuit
iOS	-	iPhone Operating System

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CHAPTER 1

INTRODUCTION

1.1 Background

A gas leak is dangerous to the public because when one occurs in a residential location, the area will burn, and the victim will suffer significant financial losses. Gas leaks can occur for a variety of causes, including inadequate maintenance, pipeline damage, or equipment failure. Gas leaks, for example, might occur even if the hose gets loose due to of pushing or pulling while cleaning a dirty kitchen. Unfortunately, because many of us are unaware of situations like this, actions like these will lead to carelessness and increase the possibility of gas leaks without our knowledge. As a result, in this situation where the system is built on Internet of Things (IoT), a gas leakage notification system was required.

There exist multiple classifications of sensors, among which is the gas sensor. Liquefied petroleum gas (LPG) gas sensor detectors are used to detect the existence of liquefied petroleum gas leaks, which could create a risk, and to help prevent information from being delayed at the fire station in the event of an accident. This gas leak system will detect the presence of gas using the MQ-2 sensor. If the sensor detects that the gas level is higher than normal, the gas leak system will send information via a phone application applying the Internet of Things (IoT). The MQ-2 gas sensor detects gases in the air, specifically hydrogen (H_2), liquefied petroleum gas (LPG), methane (CH_4), carbon monoxide (CO), alcohol, and propane. Because the MQ-2 gas sensor has high sensitivity and a quick response time, measurements can be conducted as soon as possible. In addition, the sensitivity of this sensor can be modified using a potentiometer to achieve the desired level of sensitivity.

Next, DHT11 will be applied to detect an increase in environmental temperature if there is a fire, and it will send a warning message to us via IoT over an Android or iPhone application. It detects high temperatures or positive temperature changes and sends a pulse to the microcontroller. This DHT11 sensor includes a calibrated digital temperature output as well as a calibrated digital humidity signal.

Then, the flame sensor in an IoT-based gas leakage system serves as a specialised component that is specifically designed to detect flames that occur as a result of gas leaks. It can improve the functionality of the gas sensors by increasing safety measures, enabling early detection of fires, and triggering quick responses to prevent potential hazards. Combining gas and flame sensors improves the ability and effectiveness of safety systems in situations where gas leaks may provide a hazard.

1.2 Societal and Global Issues

The need for improved safety and environmental protection in the context of gas leaks is a global or current issue related to the development of Internet of Things (IoT) technology for gas leak notification systems. Systems for notifying about gas leaks that are based on the Internet of Things (IoT) can be highly beneficial in minimizing hazards, detecting leaks quickly, and improving overall safety procedures.

Gas leaks can have serious consequences in terms of safety improvement, such as fire threats, explosions, and health issues. Gas leak warning systems can offer real-time monitoring and immediate alerts to people, businesses, and relevant authorities by utilizing IoT technologies. As a result, safety is improved and perhaps lives are saved through speedy response times, evacuation plans, and preventive measures. Gas leaks contribute to the release of dangerous gases, such as methane, a powerful greenhouse gas, which is a concern for environmental protection. IoT-based gas leak notification systems may help in early detection and quick reaction to accidents, lowering the length of gases released and minimizing environmental damage. These systems help with maintaining the environment's sustainability and reducing the effects of climate change by limiting or minimizing the emission of hazardous gases into the atmosphere.

Traditional methods to detect gas leaks tend to depend on time-consuming, ineffective, and likely to result in human error manual inspections or periodic checks. Continuous monitoring and remote sensing of gas leaks are made possible by IoT technology, which allows for more effective resource allocation and improved reaction plans. For gas distribution providers and end customers, this can lead to cost savings, decreased maintenance requirements, and improved overall operating efficiency. Gas leak notification systems with IoT capabilities produce lots of real-time data. This data can be processed and analysed to find patterns, trends, and possible areas of concern using advanced analytics and machine learning techniques. These insights can assist stakeholders in making knowledgeable decisions, improving infrastructure design, and applying safety measures in place to reduce hazards related with gas leaks.

In order to increase safety, protect the environment, and manage gas leaks effectively, IoT technology for gas leak notification systems can be developed and used by focusing on some of these factors.

1.3 Problem Statement

From studies, the finding is that gas leakage is a major issue in the twenty-first century. Customers are unaware of their safety during illicit gas cylinder filling. Problems arise when liquefied petroleum gas (LPG) consumers are worn-out regulators. When there is a lack of information about the use of gas cylinders, risks increase. Again, people with busy schedules do not have time to check the gas available in the cylinder and frequently forget to book for a new cylinder. In recent years, the number of injuries caused by gas cylinder explosions has increased.

Liquefied Petroleum Gas (LPG) is a highly flammable chemical composed of a propane-butane combination. LPG is used for cooking at home, restaurants, and certain uses in industry. However, it has disadvantages that might result in gas leakage. Normally, those close to the site may smell a gas leak, and if no one is around, the leak cannot be spotted. Given that some of individuals have a poor sense of smell, so they may be unable to detect the smell of a gas leak. As a result, this gas leak detection system will aid in detecting the presence of a gas leak while also providing us with an early warning.

1.4 Project Objective

In general, this project intended to build an IoT based gas leakage notification system prototype that fulfils the following objectives:

i. To develop the prototype of gas leakage notification system utilizing a microcontroller.

ii. To design a mobile application for gas reading level monitoring and notification system by using Blynk.

iii. To validate the functionality of the developed system.

1.5 Scope of Project

The scope of this project is entirely on achieving the objectives of this project. The focus is on the development and build of a prototype for a gas leak detection system (LPG) using a MQ-2 gas sensor to detect the presence of a gas leak, a DHT-11 temperature sensor and flame sensor that is controlled by an ESP32. The ESP32 will be also utilised as a Wi-Fi module, and Blynk is the software will be used to display all readings, in order to provide real-time response promptly. This system is simple to operate because it can be used in residential areas, small industries, or restaurants. Furthermore, this system intends to inform the community on the need of using gas leak detectors (LPG) because they may prevent any danger related to gas leaks, which can harm not only users but also other people, in addition helping to improve the safety around us.

The scope of work for the project are as follows:

a) The MQ-2, DHT11 and flame sensor was connected together with an ESP32 to create a sensing circuit to collect data on gas concentration levels and to detect the temperature in the surrounding environment.

b) Create mobile application with Blynk that allows for the monitoring of gas PPM levels, temperature and the presence of flames.

c) Sensing circuit was tested in a prototype house to obtain the real-time data.

d) The sensing circuit was be placed inside the prototype house to make it easier for the sensor to detect if there have any gas leakage or temperature rise in the surrounding environment for early detection and minimizing damage and loss.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The gas detection system is very helpful to the community since it detects gas that humans are unable to smell at work or at home. Because of unknown workplace environment conditions and surroundings, such as some hazardous work sites and workplaces, gas leak detection systems can be disrupted and suffer physical or sensor damage. Workers will be exposed to gas pollution if the gas sensor used to detect gas leaks is damaged, which has the potential to injure and harm workers in the area. This chapter will go through earlier projects as well as various journals linked to those initiatives. These journals and reports are thoroughly examined in order to improve the project efficacy and quality.

2.2 Current Issue Related to Gas Leaks

The gas leak in Pasir Gudang, Johor in 2019 was one major incident. Thousands of individuals were affected by a gas leak from a chemical company, including respiratory issues, nausea, and vomiting. Schools were temporarily closed as a result of the event, and people were evacuated [1]. Another incident occurred in 2022, when a family of five was injured in an explosion thought to be caused by a cooking gas leak at their home in Taman Cenderawasih, Nibong Tebal in Penang. The explosion caused by the gas leak also damaged at least two dwellings, as well as a motorbike and a car parked in the back and in front of the house. Five people were taken to Penang Hospital as a result of this incident. [2]. On December 15, 2022, a woman went into a coma after the cooking gas tank in her house exploded as she was cooking breakfast at Taman Sena Permai, causing 70 percent of her body to burn. Looking at the aftermath of the explosion, the victim's younger brother speculated that the effects of the leak may have spread gradually in the house the night before the incident occurred [3]. On October 10, 2022, a gas leak occurred at an outlet for fast food in Pandan Jaya, resulting in three individuals experiencing loss of consciousness. Three individuals, comprising of two restaurant employees and a Health Ministry representative, become unconscious and afterwards transported to a medical facility for medical attention after being involved to provide aid to the mentioned restaurant workers. As per the statement of Norazam Khamis, the chief of Selangor Fire and Rescue Department, the incident was caused by a gas leakage at the outlet [4].

It should be noted that gas leaks can be extremely harmful and have serious effects. It is critical to take the required precautions to avoid gas leaks and to have safety procedures in place in the event of an occurrence. All of these situations show the importance of having reliable gas leak detection and notification systems in place, as well as correct handling and storage methods for hazardous products. It is also critical to have emergency response strategies in place to minimize the impact of such tragedies on the population and the environment. Gas leakage detection systems are an essential component of a safety system, serving as the first line of defence against potential gas leakage disasters. It detects gas leaks and activates an alert system to take safety actions. Some leaks are too small to smell or are of an unscented gas, thus installing a gas leak detection system is a necessary expenditure. Gas is increasingly being used in both industrial and household settings. Gas is mostly used to generate energy and as a process need in the industrial industry. Regardless of the size of the leak, the consequences can be fatal [5].

Explosions caused by gas leaks at home have caused numerous injuries and deaths in Malaysia throughout the years. Gas explosions are currently one of the leading causes of admission to the nation's burn units. since of the intricacy and severity of the situations, the majority of them must be managed in government institutions since they require high-level critical care. The death rate is quite high and roughly proportional to the body surface area involved [6]. The government of Malaysia and many businesses have taken initiatives to strengthen safety measures and reduce the risk of such tragedies occurring. This includes stricter rules for hazardous material handling and transportation, regular safety audits, and the implementation of emergency response plans. Various gas detection and warning systems are also being developed and implemented to aid in the detection and response to gas leaks more rapidly and effectively. According to the 2016 fact page of the World Health Organisation (WHO), burns are a public health hazard that has a global impact and are accountable for approximately 265,000 fatalities annually. A significant proportion of these instances are concentrated in low and middle-income countries, with more than 50% of them being reported in the South-East Asian region. Non-fatal burns are a significant cause of morbidity, resulting in increased hospitalization, physical disfigurement, and disability. Additionally, individuals who suffer from burns often experience feelings of shame and social rejection. Although cooking gas has no fragrance, mercaptan is added to it to identify leakage. Almost every Malaysian family has at least one gas cooker, yet there is little information and education available to customers about how to operate and maintain cooking gas cylinders. Furthermore, many of the cylinders in operation may be old, corroded, and poorly maintained [7].

2.3 Overview of IoT Technology of a Gas Leakage Notification System

Keeping petrol levels under control saves lives and allows businesses to operate in accordance with the law. In today's society, safety is crucial, and some solutions must be adopted in places of work and residence [8]. Working or living in hazardous settings, whether with electricity or oil and gas, necessitates particular safety practises. Liquified

Petroleum Gas (LPG) refers to a type of natural gas that goes through the process of liquefaction through the application of high pressure, and is subsequently stored in a metallic cylinder. Liquefied Petroleum Gas (LPG) possesses a high degree of flammability and has the potential to result in significant loss of life if it comes into contact with any fire starter in the absence of appropriate safety measures. Liquefied Petroleum Gas (LPG) is a prevalent form of natural gas that is primarily utilised for culinary purposes. Regrettably, the prevalent utilisation of gas causes a gas leak or explosion a commonplace occurrence. Consequently, the implementation of a system for detecting and monitoring gas leaks is deemed necessary. Numerous commercial establishments, including hotels and fast food establishments, utilise flammable gases such as carbon dioxide, LPG, and ammonia to enhance the quality of customer service they offer. The utilisation of observed gases is inevitable. Nevertheless, they have raised the risk and danger to human existence. Companies that deal with gas are required to follow certain protocols to ensure that work is completed as safely as possible, with safety being their main concern.

A gas detection system was required in such accident-prone places to ensure continuous monitoring of any type of leakage, regardless of human senses. The system in [9] is designed to continuously monitor the surroundings for any leakage and deliver a warning to the user. The user will receive notifications regarding environmental factors, such as temperature and gas levels, through the utilisation of an Ethernet shield module and an Android application. The proposed system for gas detection will employ a MQ6 sensor for the purpose of detecting leakage of LPG. Additionally, the system will incorporate a Global System for Mobile communication (GSM) Module and an Advanced RISC Machine (ARM) based microprocessor to facilitate end-to-end communication. Upon exceeding a certain limit, the system transmits a notification to the user, who may subsequently regulate the devices through a relay system to trigger the closure of the gas valve. According to article

[10], gas leakage and its fatal consequences are a major worry around the world because many people are dead and countless assets have been damaged as a result of fires caused by gas leaking. The author in [10] proposed the development and deployment of a gas leakage detection system and corresponding preventative measures are of paramount importance. Specifically, the creation and execution of an intelligent Internet of Things (IoT) prototype designed to detect gas leakage and mitigate the risk of fire resulting from such leakage is of significant academic interest. The objective of this system is to reduce the effects of gas leakage through the implementation of protective measures. Upon detection of a gas leak, the solenoid valve initiates the closure of the gas line, and the exhaust fan is activated. Upon detection of a fire by the flame sensor, the fire extinguishing balls are deployed towards the source of the fire. The GSM SIM module employs short message service (SMS) to alert the user on their smartphone of any notifications, while the buzzer is activated in the event of an error. Additionally, the Liquid-crystal display (LCD) panel consistently displays the system's status.

The primary goal of the project in [11] is to design and implement a gas detection and alerting system utilising microcontrollers with the ability to detect hazardous gases. The ultrasonic sensor utilises sound wave analysis to discern the presence or absence of gas within a given environment. The MQ-135 gas sensor is utilised for the purpose of gas leak detection. The Internet of Things (IoT) module of the system is in charge of establishing a connection between the entire system and the Blynk platform through the Wi-Fi module of the NodeMCU microcontroller. Automated emergency protocols are activated in the event of a gas leak, with detection being anticipated through the utilisation of two predetermined threshold values for gas pressure. The system is designed to detect and notify the presence of gas leaks in industrial settings, thereby enabling prompt response to such incidents and minimising the likelihood of accidents. The utilisation of the Blynk cloud platform facilitates the process of data collection and acquisition of pertinent insights. The data collected by the ultrasonic sensor enables the automation of security operations prior to the an increase of conditions beyond manageable levels. The Internet of Things (IoT) component of the system discussed in [11] is accountable for establishing a connection between the entire system and the Blynk platform, utilising the Wi-Fi module of the NodeMCU microcontroller. The digital platform will provide a diverse range of employment opportunities that are capable of being fulfilled. From data visualisation to automation, Blynk offers a variety of services to help carry out the project's critical activities. The web portal aids in reading, recording, and analysing data from the microcontroller unit. This online mobile application also sends out e-mail notifications. In Table 2.1 show the LPG index precautious level from [12], and in Table 2.2 show the index precautious level for temperature from [13].

Table 2.1: LPG index precautious level

Level	Light Indicator	LPG (PPM)
Safety	Green	<350-500
Precaution	Yellow	>=500 <=1000
Dangerous	Red	>1000

Table 2.2: Temperature index precautious level

Temperature	Risk Level
< 91°F	Low
91°F to 103°F	Moderate
103°F to 115°F	High
>115°F	Extreme

2.4 Concept of a Gas Leakage Notification System

A gas leakage notification system's main goal is to improve safety through the early detection of gas leaks as well as accurate notifications to avoid accidents, property damage, and potential danger to individuals in addition to build and construct a low-cost gas and temperature monitoring system with effective and competitive application. The system provides quick responses and effective mitigation measures by combining advanced sensor technologies, real-time monitoring, and effective alerting methods. The technology was developed to make any procedure safer and more user-friendly. The project is also intended to demonstrate a concept of working with minimal technology and at a low processing level. This system was designed for specific applications and is divided into three components, which are the input, controller circuit, and output. The input and output sections are linked to the controller circuit, which controls the operation of the system.

2.4.1 Input Appliances

As an input to the gas leakage system, a sensor or detector device, such as a gas and temperature detector, is being used. In the market, heat detectors are categorised as "thermistor," "thermocouple," "resistance temperature device," and "diode-based temperature sensor," respectively. All of these devices have advantages and disadvantages, but in this gas leakage system, we will concentrate on certain devices that best match the system's criteria.

2.4.1.1 Thermocouple

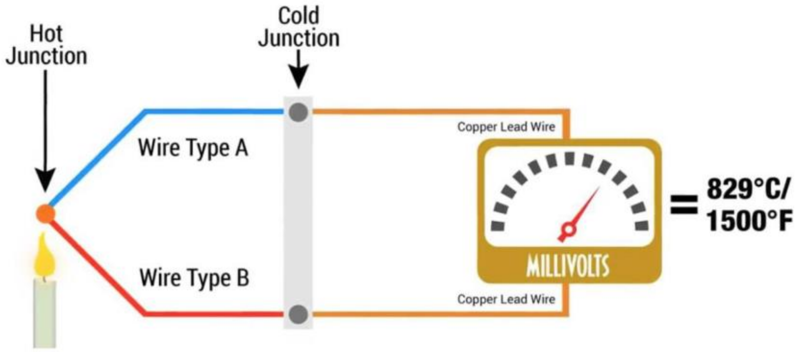

Figure 2.1: Thermocouple

One sort of temperature sensor is the thermocouple. It is constructed of two different metals that are connected at one end. A voltage is created that may be used to determine the temperature when the connection of the two metals is heated or cooled. A thermocouple is a straightforward, reliable, and affordable temperature sensor that is used in many different temperature measurement processes. Thermocouples are often used in many different applications. It is essential to understand thermocouples' fundamental structure, function, and ranges in order to correctly choose the appropriate thermocouple type and material for an application due to their wide variety of models and technical requirements [14].

2.4.1.2 Temperature Resistance Devices Sensor (RTDs)

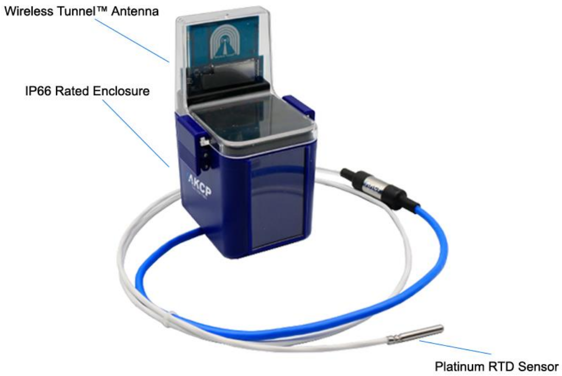

Figure 2.2: Temperature Resistance Devices

A sensor known as a resistance temperature detector (RTD) experiences resistance changes as a function of temperature. As the temperature of the sensor rises, the resistance rises as well. Resistance and temperature have a well-established and consistent connection. A passive device is an RTD. It doesn't produce an output by itself. By passing a modest electrical current through the sensor to produce a voltage, external electronic equipment may measure the sensor's resistance. To prevent self-heating, typical measurement currents are 1 mA or less and no more than 5 mA [15].

2.4.1.3 Thermistor

Figure 2.3: Thermistor

Thermistors are a particular kind of variable resistive element whose physical resistance alters in response to temperature changes. Thermistors are temperature-sensitive solid-state temperature sensor components that perform similarly to electrical resistors. Sensors are thermoresistors, which may be used to generate an analogue output voltage in reaction to changes in the surrounding temperature. This is because a change in heat's physical and exterior features results in a change in its electrical properties [16].

2.4.1.4 DHT11 Sensor

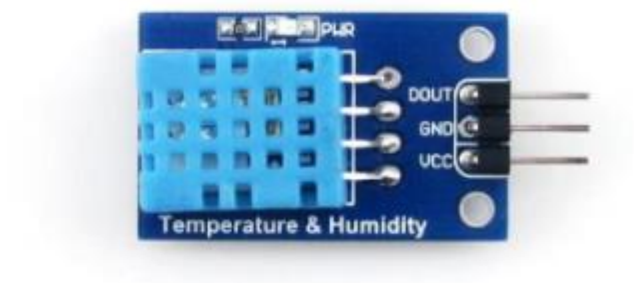

Figure 2.4: DHT11

The DHT11 sensor is an economical digital device that measures both temperature and humidity. The sensor can be conveniently integrated with various microcontrollers, such as Arduino and Raspberry Pi, to obtain real-time measurements of humidity and temperature. The DHT11 sensor, which measures humidity and temperature, is available in two forms, as a single sensor and as a module. The sensor can be distinguished from the module by the presence of a pull-up resistor and a power-on LED. The DHT11 sensor is capable of quantifying the level of relative humidity. The sensor employs a thermistor and a capacitive humidity sensor to quantify the ambient air [17].

2.4.1.5 Gas Sensor MQ-2

Figure 2.5: MQ-2

The MQ2 sensor is widely recognised as a prominent member of the MQ sensor family, which is characterised by Metal Oxide Semiconductor (MOS) technology. Metal oxide sensors are commonly referred to as Chemiresistors due to the fact that the resistance of the sensing material undergoes alterations upon exposure to gases. The MQ2 gas sensor operates on a direct current of 5 volts and has a power consumption of approximately 800 milliwatts. The device exhibits a detection range spanning from 200 to 10000 parts per million (ppm) for various gases, including liquefied petroleum gas (LPG), smoke, alcohol, propane, hydrogen, methane, and carbon monoxide [18]. The controller circuit is a chip that stores various communication data, time measurements, and an on or off control switch. The ATmega328P Microcontroller and Arduino are two examples of controller circuits.

2.4.2 Controller Circuit

The controller circuit is a chip that stores various communication data, time measurements, and an on or off control switch. The ATmega328 Microcontroller and Arduino are two examples of controller circuits.

2.4.2.1 Microcontroller ATmega328

The ATmega328 microcontroller is classified as an Advanced Virtual RISC (AVR) device. The device has the capability to perform data processing with an 8-bit resolution. The ATmega-328 possesses an internal flash memory capacity of 32 kilobytes. The ATmega328 microcontroller possesses a 1 kilobyte capacity of Electrically Erasable Programmable Read-Only Memory (EEPROM). The aforementioned characteristic denotes the microcontroller's ability to retain information and generate outcomes subsequent to the cessation of its power supply, provided that it is subsequently re-energized. Moreover, the ATmega-328 microcontroller possesses a 2KB capacity of static random access memory

(SRAM). The ATmega 328 is a highly desired device in the current market due to its diverse range of features. The features of this device include an Advanced RISC architecture, which provides outstanding performance as well as low power consumption. Additionally, it boasts a real timer counter with a separate oscillator, 6 PWM pins, and a programmable Serial USART. For enhanced software security, it also includes a programming lock. With a throughput of up to 20 MIPS, this device offers impressive capabilities [19].

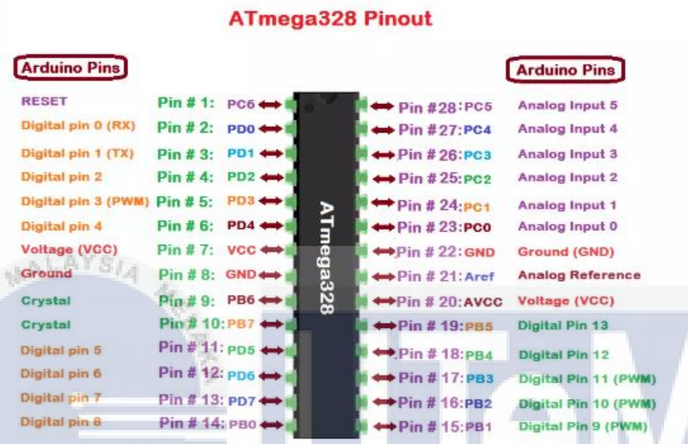

Figure 2.6: ATmega328 Microcontroller

2.4.2.2 Arduino Uno Board

The microcontroller board known as Arduino UNO is based on ATmega328P. The device comprises of a total of 14 pins that can either function as digital inputs or outputs. Out of these, six pins are capable of generating pulse width modulation (PWM) outputs. Additionally, the device also features six analogue inputs, a 16 MHz ceramic resonator, a universal serial bus (USB) connection, a power jack, an in-circuit serial programming (ICSP) header, and a reset button. The kit is equipped with all the necessary components to facilitate the operation of the microcontroller. It can be effortlessly linked to a computer via USB or powered by an AC-to-DC adapter or battery to initiate its functionality. The Arduino Uno microcontroller board can be manipulated experimentally without concern for committing errors or encountering adverse outcomes [20].

Figure 2.7: Arduino Uno

2.4.3 Output Circuit

Light emitting diode (LED), Liquid Crystal Display (LCD), buzzer, and WiFi module as output appliances. The complete output appliance will operate in accordance with the instructions stored in the controller.

2.4.3.1 Buzzer

At its fundamental level, a piezo buzzer is an electronic apparatus that generates an audible signal, warning, or acoustic emission. The product is characterised by its low weight, uncomplicated design, and frequently affordable price point. The reliability of piezo ceramic buzzers is contingent upon their parameters, which enable them to be constructed in diverse sizes that operate across a range of frequencies, thereby producing distinct sound outputs. The buzzer is an apparatus that generates noise through the conversion of audio signals into sound signals [21]. Commonly, it is energised by a direct current (DC). The utilisation of sound device is a common practise in various electronic devices such as alarm clocks, computers, printers, and others. The buzzer is commonly categorised as either a piezoelectric or electromagnetic type, and can be identified in the circuit by the symbols "H" or "HA". The auditory output of a buzzer is contingent upon its specific configuration and intended use, encompassing an array of possibilities such as musical tones, sirens, buzzes, alarms, and electric bells.

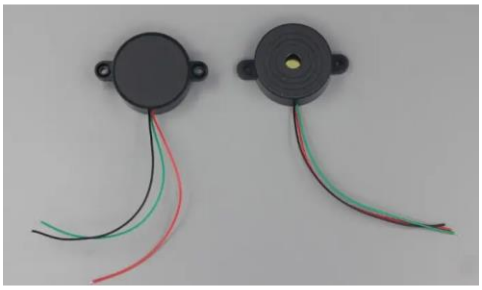

Figure 2.8: Piezo Buzzer

2.4.3.2 Liquid Crystal Display

The Liquid Crystal Display (LCD) is a flat panel display technology that predominantly utilises liquid crystals for its operation. LEDs have a diverse array of applications for both individual and commercial use, as they are frequently utilised in various electronic devices such as mobile phones, televisions, computer monitors, and instrument panels. The technologies that LCD screens superseded, such as LED and gas-plasma displays, represented a significant advancement. The utilisation of LCD technology facilitated the creation of displays that are significantly slimmer in comparison to those produced by cathode ray tube (CRT) technology. LCD screens consume significantly lower power compared to LED and gas-display screens due to their light-blocking mechanism instead of light emission. The process by which an LED produces light differs from that of an LCD, where the liquid crystals rely on a backlight to generate an image [22].

Figure 2.9: LCD Display

2.5 Previous Research

In 2022, Chourasia et al. developed a gas leakage detection system that utilises sensors. The objective of this study is to develop a gas leakage detection system that possesses the capability to autonomously identify, notify, and regulate gas leakage [23]. The system is equipped with an alert mechanism for users, which is triggered by a sensor capable of detecting gas leaks with ease.

In June 2022, Mani Tripathi P, Saket Kumar, Kumar S, Bhalke V, and Prof Vidyashree K N developed a gas leak detection, prediction, and alerting system with Raspberry Pi and cloud computing. The installation of gas leakage detection systems in sensitive areas is a recommended preventive measure to reduce the occurrence of hazardous incidents resulting from gas leakage, which is a common problem in numerous locations. The objective of the Internet of Things (IoT) initiatives is to develop a system that can autonomously identify, notify, and reduce potential hazards [24].

In 2020, Farhan Alshammari B and Tajammal Chughtai M developed an Internet of Things (IoT) gas leakage detector and alert generator. The project proposes an IoT-based industrial monitoring system design [25]. The data acquired from the gas sensor, specifically the MQ-5, is transmitted and stored in a cloud-based data repository. Under normal atmospheric conditions, the sensor is capable of detecting gas leaks. The Arduino Uno functions as the primary central processing unit (CPU) unit, controlling all of the components in the setup. Upon detection of a gas leak by the sensor, an auditory alert in the form of a buzzer is activated. The alarm system is equipped with a liquid crystal display (LCD) that provides visual indication of the location of the gas leak, notifies the observer, and triggers the exhaust fan in the designated area to remove the leaked gas. A continuous monitoring of the environment and prevention of gas leakage are essential functions of a gas detection system, as they serve to mitigate the potential hazards of fire and damage.

An IoT-based smart gas leak detection and alarm system was created in 2021 by Parashar A, Rai C, Pokhariyal S, and Prof. Sejal Shah. In our daily lives, fuels and gases are commonly used in places like homes and business. However, if utilised incorrectly, it might lead to significant issues. It was frequently the primary cause of accidents in the past. This initiative aims to locate gas leaks, stop leaks in high-risk regions, and avoid accidents. Included in this is the MQ6 gas sensor, which among other things is perfect for detecting LPG, butane, hydrogen, methane, smoke, and alcohol as well as gas leaks in residences and businesses. The exact gas concentration is not stated, though. It only displays the gas level trend within a tolerable error range. To prevent mishaps, this gadget takes action on its own and briefly switches off the primary power source. Include the WiFi module as well, which will act promptly by sending the owner an alarm SMS [26].

In 2019, Siddik Hasibuan M, Syafriwel, and Idris I developed an intelligent tool for detecting LPG gas leaks, which includes an SMS notification system. The purpose of this device is to effectively manage and mitigate the risks associated with gas leaks and flames. The aforementioned challenge was successfully addressed through the creation of a sophisticated device utilising Arduino technology. The aforementioned device is equipped with gas sensors, namely MQ-2 and SIM800L, as well as a buzzer. The embedded device's system is capable of converting input data obtained from the MQ-2 sensor, which is designed to detect propane and butane gas. The system subsequently transmits the actual data in the form of short messages (SMS) to a registered mobile number. In addition to its SMS transmission capabilities, the device also produces an auditory alert through the use of a buzzer-generated sound [27].

On October 8, 2022, a gas leakage detector with a monitoring system was designed by N. Asafe Y, J. Oyeranmi A, A. Olamide O, and O. Abigail A. The present study involves the development of a gas leak detection device that aims to promptly notify the proprietors of potential gas leaks, thereby mitigating the adverse consequences associated with such incidents. The system is constructed with a microcontroller that encompasses a gas sensor, a GSM module, an LCD display, and a buzzer. The present study details the development of a gas leak monitoring system that utilises an Arduino microcontroller in conjunction with a MQ2 gas sensor and a buzzer to facilitate the transmission of SMS alerts. The electronic system comprises of a microcontroller, MQ2 gas sensor, buzzer, liquid crystal display (LCD), and GSM module. Upon detection of gas leakage, the sensor relays the information to the microcontroller, which subsequently processes the data and issues a warning message to the user via SMS to a mobile device, thereby enabling prompt and appropriate action to be taken. The results of this study will have significant implications for mitigating the challenges associated with gas leaks in the future [28].

2.5.1 Microcontroller Based Monitoring and Controlling of LPG Leaks Using Internet of Things [29]

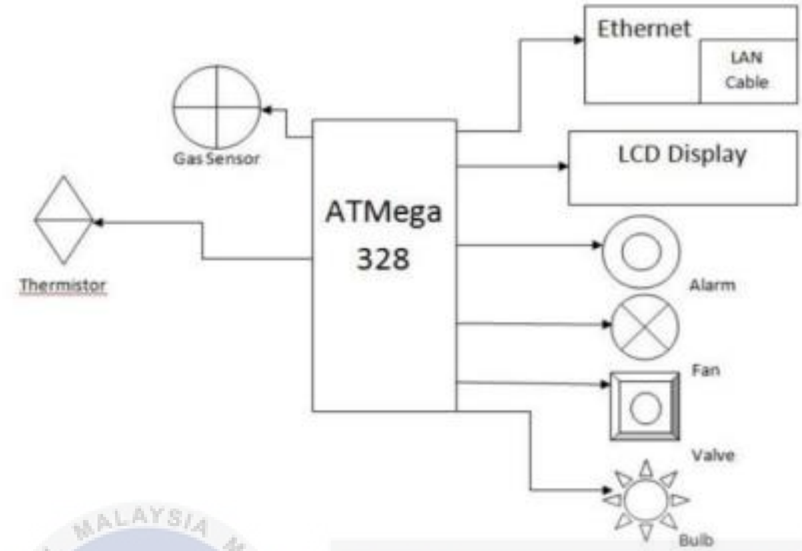

Figure 2.10: Block diagram of LPG Lekas Monitoring and Controlling

The system is equipped with a thermostat that is linked to a MQ-6 gas sensor. Both devices possess the capability to detect the gas level and temperature of the surrounding environment in which the system is installed, and subsequently exhibit the readings on the liquid crystal display (LCD). The software code incorporates the Arduino Uno board to establish a connection between the Ethernet shield and the system, thereby facilitating the issuance of a terminating user warning. The proposed system's transmitter is designed to notify the user when the gas level surpasses the predetermined threshold of 250 parts per million. The system is designed to enable user control over a range of devices, including but not limited to a fan, a smoke alarm, an alarm, a motor, and a gas shutoff valve. The devices can be activated or deactivated in tandem with the thermostat through utilisation of the Android software that facilitates the Arduino configuration, namely the Blynk application. Both devices possess the capability to detect the gas level and temperature of the surrounding environment in which the system is installed, and subsequently exhibit the obtained readings on the liquid crystal display. Incorporate software programming to facilitate the dissemination of cautionary notifications to end-users. The proposed system incorporates a transmitter that is designed to notify the user when the concentration of gas surpasses the predetermined threshold of 250 parts per million. The system is designed to enable user control over various components, including a fan, smoke alarm, alarm, motor, and gas shutoff valve. The devices can be activated or deactivated by the user through an Android application that facilitates the configuration of Arduino, namely the Blynk application.

2.5.2 Gas Leakage Detection and Alert System using IoT [30]

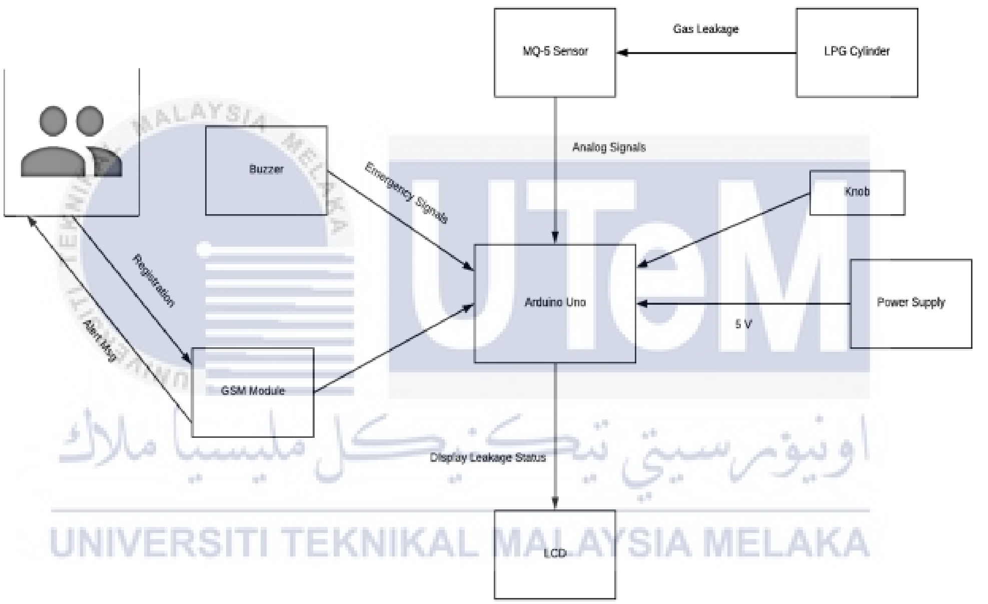

Figure 2.11: Block Diagram of Gas Leakage Detection Alert System

Liquefied petroleum gas (LPG) and compressed natural gas (CNG) are most typically used in residential and commercial settings for cooking and in various vehicles as a substitute for expensive fuels such as diesel and petrol. These gases are contained in cylinders that are easily unbreakable. However, leakage can occur through pipes, regulators, or knobs, resulting in incidents such as asphyxia, uneasiness, or even catching fire and short circuiting. The primary goal of this research is to create a system that can detect gas leaks. When it detects something, it sends an short message service (SMS) alert and automatically turns off the cylinder's gas supply knob.

2.5.3 Sensor-Based Gas Leakage Detector System [31]

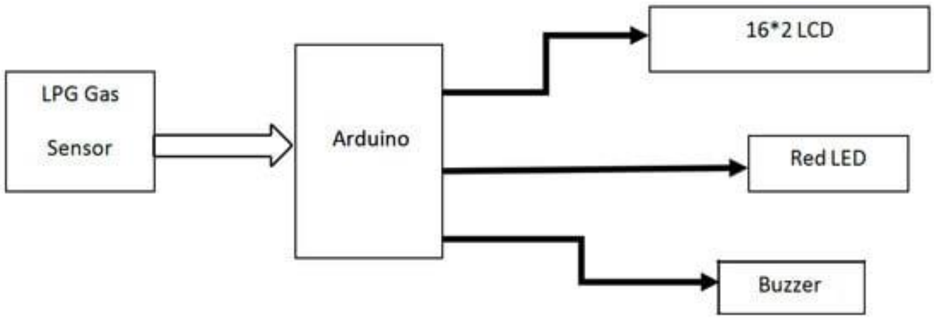

Figure 2.12: Block diagram of Sensor-Based gas Leakage Detector System

The present system is constructed utilising an Arduino UNO R3 microcontroller and a MQ-6 gas sensor. In the event that the sensor detects the presence of gas within its surroundings, it will generate a binary output of 1. Conversely, if no gas is detected, the sensor will produce a binary output of 0. The digital input of the Arduino will receive the output of the sensor. In the event that the output of the sensor is elevated, the buzzer will initiate a tuning sequence, simultaneously with the liquid crystal display (LCD) exhibiting the corresponding numerical value. In the event that the sensor output registers as low, the buzzer will fail to emit a sound and the output will be exhibited on the liquid crystal display.

2.6 Comparison of Previous Research

The comparison was about the components used and the method of system. As some of the component used was different for each project, the result will be slightly different based on the system. Table 2.1 will show the comparison summary of previous research.

Table 2.3: Summary of Previous Research

No	Project Title	Article	Components	Advantage	Disadvantage
1	Sensor Based Gas Leakage Detector System	Chourasia N, Ajmire P, Shambharkar S, Khobragade S, Bhajgaware S, and Janbandhu S, 2022 [23]	MQ-2, Arduino Uno, NodeMCU, LCD, Mobile Application	The utilisation of a mobile application enables users to remotely monitor gas levels, receive notifications or alerts, and exert control over the system via their smartphones, thereby offering convenience and accessibility.	The process of including various components such as the gas sensor, Arduino Uno, NodeMCU, LCD, and mobile application, might require specialised knowledge and proficiency in programming. Facilitating effective communication and synchronisation among these constituents can pose a formidable task.
2	Gas Leakage Detection, Prediction and Alert System Using Raspberry Pi and Cloud Computing	Mani Tripathi P, Saket Kumar, Kumar S, Bhalke V, and Prof Vidyashree K N, 2022 [24]	MQ-5, MQ-2, Raspberry Pi, WiFi Module, Buzzer, HiveMO App	The gas data can be stored and analysed in a centralised manner by applying cloud computing technology. The previous features facilitate distant accessibility, recording of data, retrospective examination, and possible integration with additional services or systems.	The consideration of data security and privacy is imperative in the realm of cloud computing. It is imperative to implement appropriate measures, such as encryption and secure authentication, in order to safeguard sensitive data and thwart unauthorised access.

No	Project Title	Article	Components	Advantage	Disadvantage
3	IoT Gas Leakage Detector and Warning Generator	Farhan Alshammari B and Tajammal Chughtai M, 2020 [25]	MQ-9, Arduino Uno, WiFi Module, LCD, LED, Fan, Email	The MQ-9 gas sensor exhibits a broad capacity for detecting various gases, thereby giving a versatile gas detection capability.	Gas detectors are able to detect false alarms caused by several reasons, such as ambient conditions or interference, which may not always indicate the presence of real gas leaks. Undertaking actions to minimise false alarms is crucial, as they might lead to discomfort or reduce faith in the system.
4	IoT Based Smart Gas Leakage Detection and Alert System	Parashar A, Rai C, Pokhariyal S, and Prof Sejal Shah, 2021 [26]	MQ-6, Arduino Uno, ESP8266 Wifi Module, LCD, Buzzer, Exhaust Fan, Email	The system can establish an IoT connection through the utilisation of the ESP8266 WiFi Module and Arduino Uno. This enables remote access, monitoring, and control of the gas leakage detector from any location with an internet connection.	The technical complexity of the process of establishing IoT connectivity, programming the Arduino Uno, and integrating multiple components cannot be understated.
5	Intelligent LPG Gas Leak Detection Tool with SMS Notification	Siddik Hasibuan M, Syafriwel, and Idris I, 2019 [27]	MQ-2, Arduino Uno, SIM800L GSM Module, SMS, Buzzer, LCD	The system employs a range of components, namely MQ-2, Arduino Uno, SIM800L GSM Module, Buzzer, and LCD, which are economically viable, rendering it a cost-efficient alternative for detecting and alerting gas leaks.	The system utilises Short Message Service (SMS) technology as its notification method to update users. While it ensures reliable connection, it may lack the ability to provide detailed information or real-time monitoring features that are available through other communication routes.

No	Project Title	Article	Components	Advantage	Disadvantage
6	Gas Leakage Detector and Monitoring System	N. Asafe Y, J. Oyeranmi A, A. Olamide O, and O. Abigail A, 2022 [28]	MQ-3, Arduino Uno, SIM900A GSM Module, SMS, Buzzer, LCD	The incorporation of the SIM900A GSM Module facilitates the transmission of SMS notifications by the system, thereby ensuring dependable communication in regions lacking internet connectivity.	The proper functioning of the system is contingent upon the maintenance of a consistent power source for both the Arduino Uno and SIM900A GSM Module. Furthermore, in the event of prolonged power outages, it is important to take consideration the battery life of the system if it is battery-operated.
7	Microcontroller Based Monitoring and Controlling of LPG Leaks Using Internet of Things	Anuradha P, Arabelli R, Rajkumar K, Ravichander J, 2020 [29]	MQ-6, ATMega328, Ethernet, LCD, Alarm, Fan, Blynk App	The system can establish an Internet of Things (IoT) connection through the utilisation of the Ethernet module and ATMega328 microcontroller. This enables remote access, monitoring, and control of the gas leakage system from any location with an internet connection.	The comprehensive expense of the system, that includes every component and supplementary device such as the Alarm, Fan, and Ethernet module, may prove to be costly.
8	Gas Leakage Detection and Alert System using IoT	Joshi S, Munjal S, Karanje U, 2019 [30]	MQ-5, Arduino Uno R3, SIM900 GSM Module, SMS, Buzzer, LCD	The system employs the MQ-5 gas sensor, which is engineered to identify various combustible gases and has the capability to detect gas leaks in their nascent stages. This feature facilitates timely interventions to avoid incidents, protect human lives, and avoid damage to assets.	The functionality of the system is based upon the availability of cellular network coverage, which is necessary for both SMS notifications and IoT connectivity. The efficacy of the system may be undermined in regions that exhibit inadequate or non-existent network coverage.

2.7 Summary

This chapter discussed the application which are frequently used in the development of Internet of Things (IoT) technology of gas leakage notification system. It is a lot of implementations in the circuit due to growing technology like the Internet of Things (IoT) by referring to the method and technologies used can help to choose a better schematic to make a project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The research method describes how and why the design is generated. This chapter is crucial for completing the study objectives successfully. Among the topics covered in this chapter are aspects of research design. The process of determining relevant components and materials for a project's accomplishment is known as research. It is critical to start a study as soon as feasible to avoid issues later. The development of an IoT gas leak notification system involves integrating several technologies and components to produce a dependable and effective solution for detecting and alerting gas leakage situations. ESP-32 will handle the sensor's reading and data processing using analog and digital input pins. The data will be processed and converted to parts per million (ppm) and degrees Celsius, respectively and detect the presence of flame. The IoT platform will monitor and display the data received. When the sensor reading exceeds the limit, a notification alert wirelessly using the IoT platform will be sent through ESP-32. The research methodology consists of the project's planning, design development, and project management of the project.

3.2 Project planning and Gantt Chart

The gantt chart implemented for project planning and scheduling is available for reference in Appendix A. The Y-axis represents the many tasks planned for the project, while the X-axis displays the timeline in weeks. The schedule for the many tasks related to a project is detailed in the Gantt chart and project planning provided in Appendix A. The green bars on the graphic indicate the specific time range allocated to each activity. The bars also display the starting point and completion dates of the activity. The chart provides a visual representation of the project's time line, facilitating better understanding of the specific tasks to be completed over different time periods. It is a beneficial tool for planning, monitoring, and tracking the progress of a project. It is practical to use the chart to evaluate the possibility of facing delays and then change the timetable accordingly. Furthermore, it aids in identifying the connections among jobs and ensures timely completion of the project.

3.3 Methodology

The simulation technique is discussed in this chapter in order to develop an IoT gas leakage notification system to create a solution. Figure 3.1 shows a flow chart for project design from the beginning of the project, using research data to determine the most appropriate project to perform through reviewing and referring to past research papers. Figure 3.2 shows the circuit connection for project design. The next step is to pick and list all components required for the selected project design and then to build the desired circuit. The next stage is to develop coding for the ESP-32 and ensure that there are no errors in the coding or that the coding needs to be rewritten till it can run successfully. Following the successful execution of the Arduino coding, the following step attempts to create the circuit on a breadboard. The connection between the components must be carefully checked to ensure it is put correctly to prevent circuit failure. When the circuit works properly, the next step is to create the parameter on the IoT platform (Blynk).

Figure 3.3 shows the project procedure flow chart when the gas leakage detecting device detects the presence of a gas leak. Here is the overview of how the system functions:

1. Sensing and detection.
   - Gas sensor: The presence of gas in the environment is detected by a gas sensor, such as a methane or carbon monoxide sensor. It continuously monitors the levels of gas concentration.
   - Temperature sensor: The ambient temperature is measured by a temperature sensor, such as a thermistor or a digital temperature sensor like the TMP36.
   - Flame sensor: The flame sensor generates a binary signal upon detecting the presence of a flame or intense illumination. The microcontroller

which is ESP32 can use this signal to detect the existence of a potential fire incident.

2. Data collection.

   The gas, temperature and flame sensors are linked to the development board of choice, an ESP32. The development board will read sensor data regularly or in real-time using the proper analog or digital input pins. Then, the sensor data is translated to usable values using calibration or conversion techniques.

3. Data processing and decision making

   The development board microcontroller analyses the sensor data acquired and makes the appropriate computations or comparisons.

   - Gas leakage detection: The system compares the gas concentration level and a set threshold. If the gas concentration exceeds the threshold, the system considers it a gas leakage occurrence.
   - Temperature monitoring: The technology compares the outside temperature and a set safe range. There is a temperature irregularity when the temperature rises above the safe level.
   - Flame monitoring: The system detect constantly monitors the surrounding for the existence of flames or strong lightning emission within its designed area. The flame sensor produces a signal to indicate the detection of possibly fire when it senses flames or intense light source that exceed a specific threshold.

4. Notification alert

- Blynk: The data obtained will be monitored and displayed by the Blynk programme. When the sensor reading exceeds the specified limit, a notification alert will be sent wirelessly via the Blynk application via ESP32.
- LCD I2C Display: The system updates the Liquid Crystal Display (LCD) to show relevant data information such as the status of the gas leak, temperature data, or warning messages.

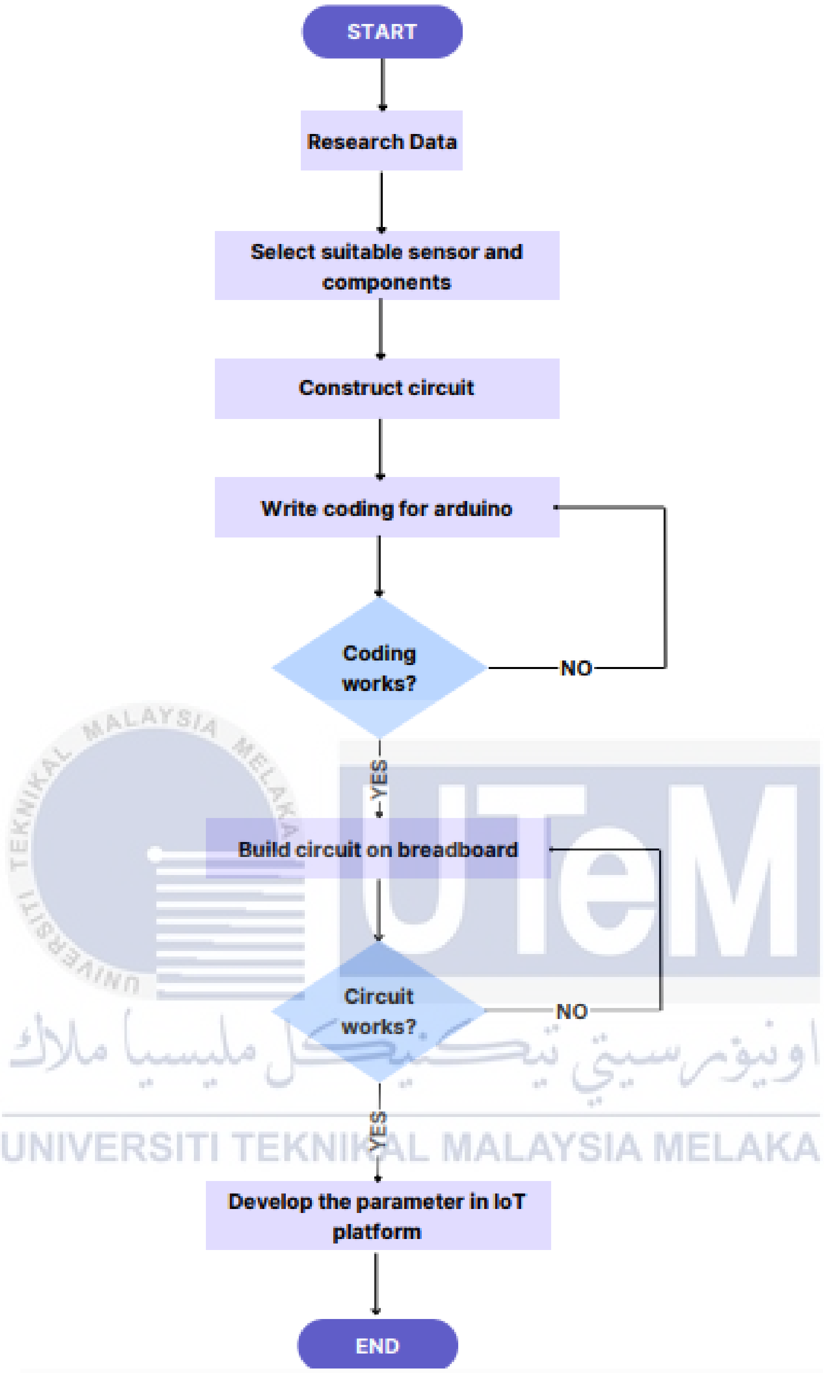

Figure 3.1: General process flow for IoT Technology of a Gas Leakage Notification System

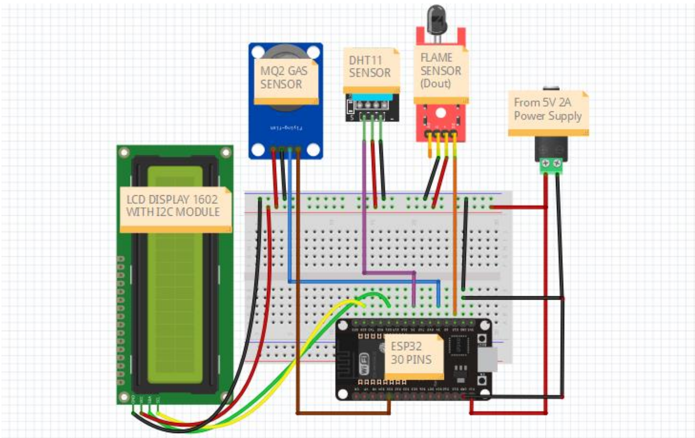

Figure 3.2: The circuit connection for IoT Technology of a Gas Leakage Notification System

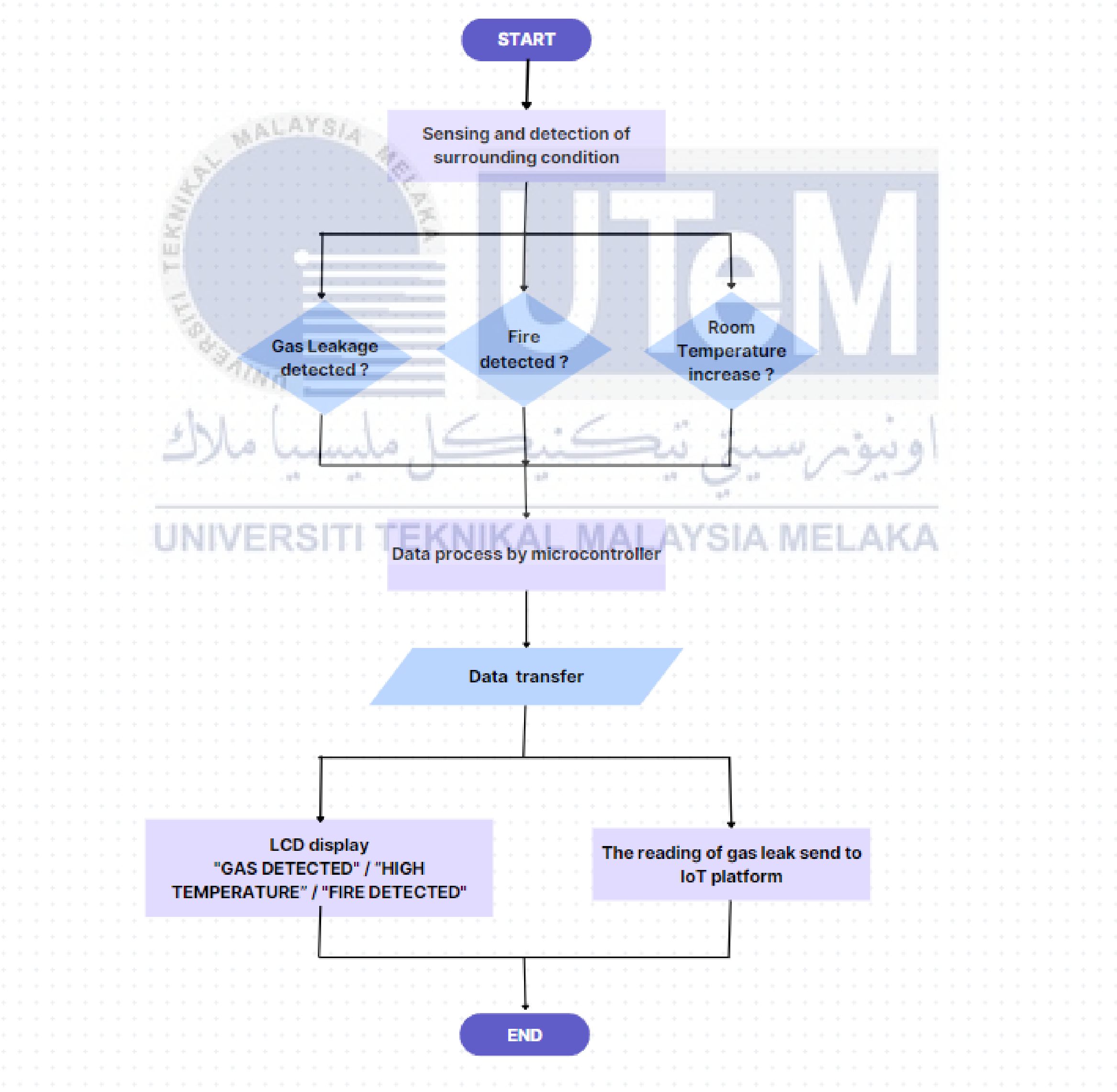

Figure 3.3: Propose process flow for IoT Technology of a Gas Leakage Notification System

3.3.1 Block Diagram

Figure 3.4 displays the block diagram of the proposed system. The proposed system will develop using hardware and software as per discussed in section 3.3.1.1 and 3.3.1.2.

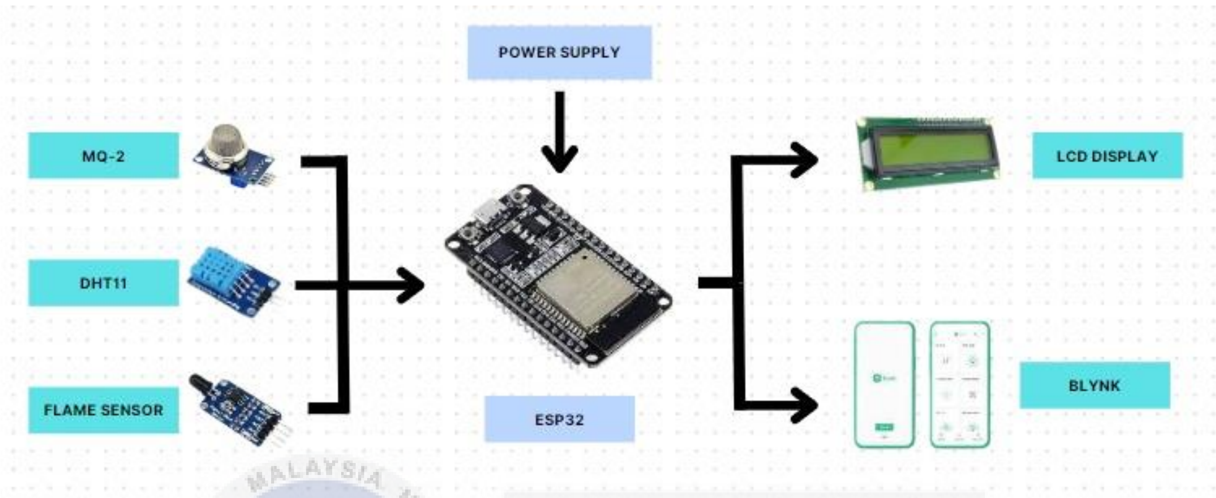

Figure 3.4: Block diagram of the proposed IoT Technology of a Gas Leakage Notification System

3.3.1.1 Hardware

The gas detector (MQ-2), temperature sensor (DHT11) and flame sensor initial elements of this project, which will be activated by the microcontroller to regulate the output based on certain conditions or programming. The microcontroller is configured to determine how the output is generated. By utilising an ESP32, the design can be divided into two parts which are hardware and software. Hardware will be built and will be integrated module by module for easier troubleshooting and testing.

The project output appliance systems design can be divided into several primary components of ESP32, Liquid Crystal Display (LCD I2C) and sensor module. The integration of module-generating systems can be divided into two stages, which are the intelligent application system output and the awareness system.

a**. ESP-32 Microcontroller**

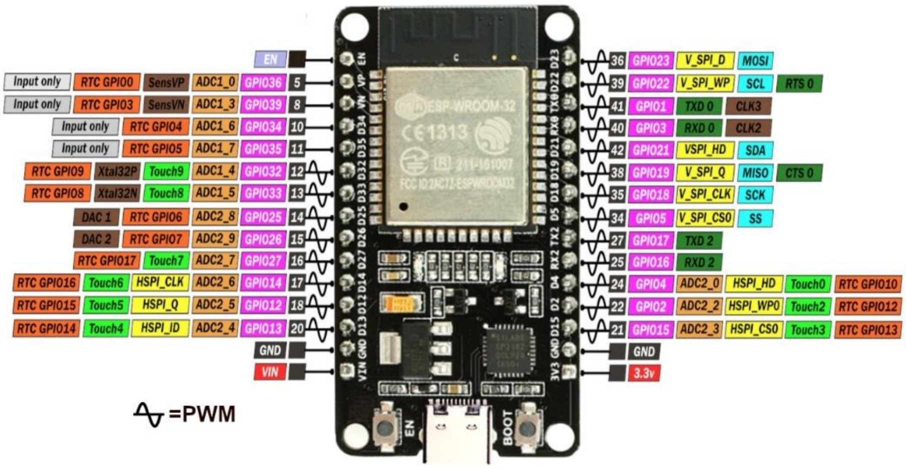

Figure 3.5: Surface of ESP32

The ESP32 microcontroller functions as the central hub, coordinating the integration of gas, temperature, and flame sensors. It also manages the outputs to an LCD display utilizing I2C connection and the Blynk IoT platform for remote monitoring and alarms. The main purpose of the device is to connect with the gas sensor (MQ2), temperature sensor (DHT11), and flame sensor. It collects real-time data from each sensor at regular intervals. The acquired data is subjected to extensive processing, wherein sensor readings are compared to predefined criteria in order to identify suspected gas leaks, aberrant temperatures, or flame occurrences. The ESP32 subsequently updates an LCD display in real-time using I2C, demonstrating the current state of the sensor. At the same time, it seamlessly connects with the Blynk platform, allowing for the transmission of sensor data for remote visualization and facilitating user engagement. By leveraging Blynk's notification capabilities, the ESP32 promptly generates notifications within the application or via email or SMS when sensor thresholds indicate potential dangers, guaranteeing timely awareness and response. The ESP32 enables full safety monitoring, data visualization, and timely notifications in the IoT gas sensor leakage notification system, due to its continuous monitoring, adaptive threshold settings, and accurate safety protocols that enhance reliability.

c. Liquid Crystal Display Inter-Integrated Circuit (LCD I2C)

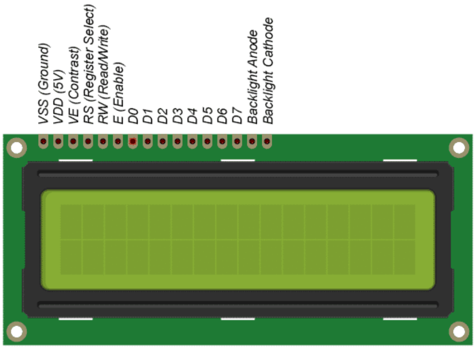

Figure 3.6: Surface of LCD I2C

The LCD I2C module is an important part of the Blynk platform for showing outputs. It works with the ESP32 microprocessor to handle sensor inputs for gas, temperature, and flame. These sensors send real-time data to the ESP32, which checks the temperature, gas levels, and state of the flame detectors. The sensor data is compared to predefined limits to find possible dangers like gas leaks, temperatures that aren't normal, or fires. After processing the data, the ESP32 sends it to the LCD I2C module. It does this by using libraries like LiquidCrystal_I2C to show the current sensor state and readings in a way that is easy for humans to understand for local monitoring. The ESP32 talks to the Blynk platform at the same time, sending sensor data so that it can be viewed, controlled, and accessed from afar. Blynk is an output platform that lets users remotely check sensor data, get alerts, and see notifications sent by the ESP32 based on sensor limits. With the help of the ESP32, the LCD I2C displays important sensor data right away on-site, and Blynk adds to the system's usefulness by allowing remote tracking and alert notifications. Together, these features make the IoT Gas Sensor Leakage Notification System complete. Basically, in this system, the liquid crystal display (LCD) will display the gas concentration level detected by the gas sensor. It provides real-time information about the concentration and presence of gases in the environment. In addition, the LCD will indicate the gas leakage's status as well as alerts or prompts to warn about possibly gas leaks for safety measures.

d. Sensor Module

This system uses three sensors as inputs to ESP32.

i. MQ-2 gas sensor

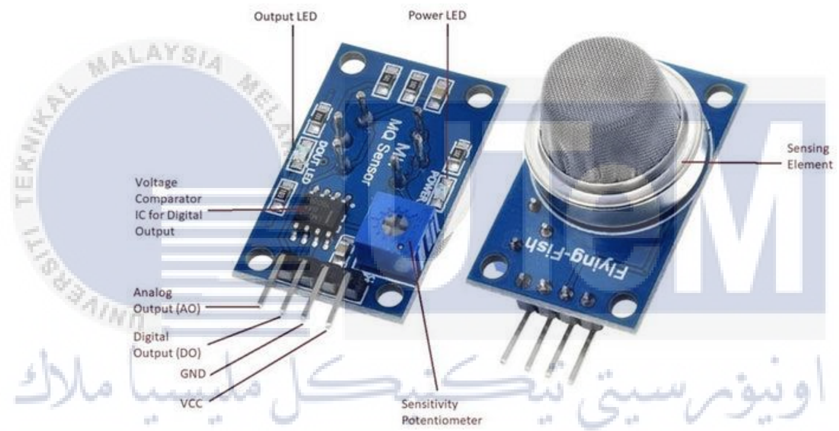

Figure 3.7: Surface of MQ-2 gas sensor

The MQ-2 gas sensor detects the presence of gas leakage in the surrounding area. This sensor detects various gases, including carbon monoxide (CO), flammable gases, and methane (CH_4). It is intended to be highly sensitive to the gases for which it is calibrated. It can detect even low-level gas concentrations, allowing for early identification of gas leaks. This gas sensor outputs an analogue signal that varies with the concentration of the detected gas. A microcontroller or an analogue to digital converter (ADC) can read the analogue output to determine the gas concentration level. MQ-2 may be easily integrated with microcontrollers such as Arduino to process data, make decisions, and read measurements of gas concentration.

ii. DHT11 temperature sensor

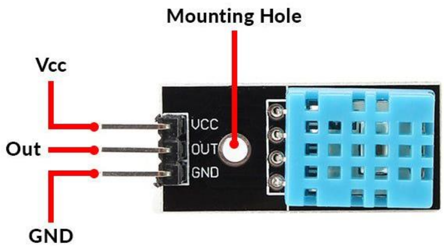

Figure 3.8: Surface of DHT11 sensor

The DHT11 is used to monitor temperature levels in areas where gas leakage is a concern. The primary function of the DHT11 sensor is to measure the ambient temperature properly. It displays temperature values in Celsius (°C) or Fahrenheit (°F). The sensing element in the DHT11 sensor is a thermistor that detects temperature changes and outputs an electrical signal proportional to the measured temperature. Then it connects with a microcontroller using a digital protocol, commonly a one-wire or two-wire interface. It delivers temperature data as a digital signal, which a microcontroller like the Arduino can read and process. Along with the gas sensor values, the DHT11 sensor can be used to monitor the temperature in the surrounding environment.

iii. Flame sensor

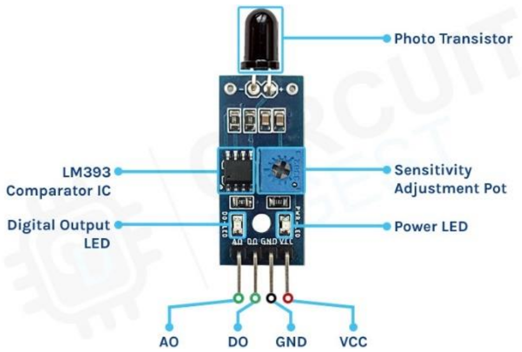

Figure 3.9: Surface of flame sensor

Along with the gas and temperature sensors, the flame sensor is very important. It communicates with the ESP32 microcontroller to improve the ability for monitoring safety. The flame sensor constantly checks the area for flames or bright light sources, giving important information about possible fires. When connected to the ESP32, it helps the system find all kinds of dangers by recognizing flames or bright lights that are brighter than normal. This sensor data, along with readings of gas levels and temperatures, is sent to the ESP32 to be analysed and compared against safety limits that have already been set. When the flame monitor sees a lot of light that could mean there is a fire risk, it tells the ESP32 to start responding right away. As an example of a reaction, the LCD I2C display could be updated to let people on-site know about the detected flame while also sending this important information to the Blynk platform. Through Blynk, users who are not in the same room as the fire get alerts and visual about the possible event. This integration makes it possible to send notifications at the right time, which helps people make quick, well-informed choices about what to do to stop the leak. It also makes sure that there is a full IoT gas sensor leakage notification system that includes flame detection as an important safety feature.

3.3.1.2 Softwares

a. Arduino integrated development environment (IDE)

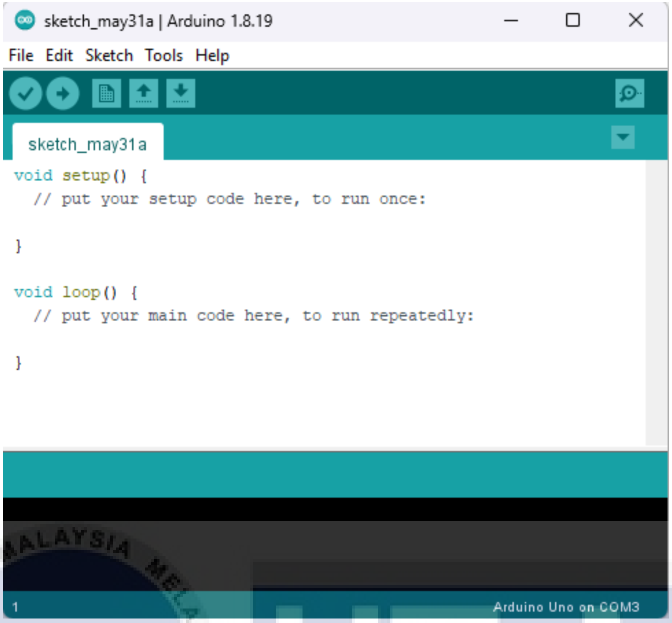

Figure 3.10: Software Arduino IDE

The abbreviation IDE stands for Integrated Development Environment, or simply an integrated development environment. It is called an environment because Arduino is programmed to accomplish tasks encoded in the programming syntax using this software. The Arduino programming language is similar to the C programming language. However, the Arduino programming language has been improved to allow beginners to programme in their native language. The Arduino microcontroller integrated circuit (IC) is placed in bootlader software before being delivered to the public, which bridges between the Arduino compiler and the microcontroller.

b. Blynk

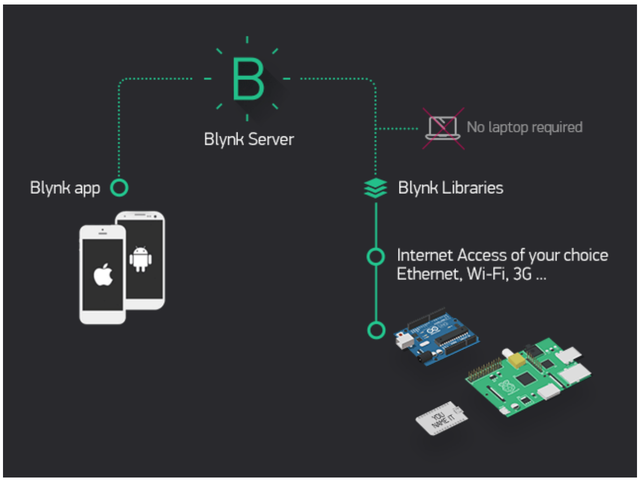

Figure 3.11: Blynk platform

Blynk is a platform that includes the iPhone operating system (iOS) and Android applications for controlling Arduino remotely. It is a computer screen that can use the "drag and drop" method to design a graphic interface for your project. Blynk was designed with the Internet of Things (IoT) in mind. It can control equipment remotely, display data, save data and do a variety of other tasks. The Blynk platform is made up of three major components:

- Blynk application will allow to construct an appealing interface by using the many different kinds of widgets available.
- The Blynk server is in charge of all communication between the smartphone and the ESP32.
- Blynk libraries will allow users to simply create application code on hardware (ESP32).

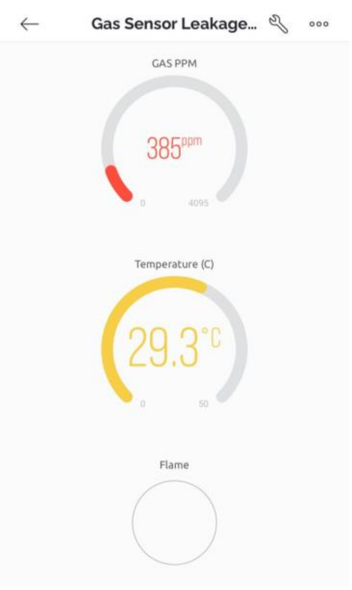

Figure 3.12: System interface in Blynk

The main role of Blynk in this system is based on its ability to provide monitoring of gas levels, temperature, and the presence of fire. Figure 3.12 displays the gas PPM value, temperature in Celsius, and the LED status as indicated by the flame sensor.

3.4 Testing Setup

In this section, we describe how this system was set up to analyse the performance of the system in real-time testing to achieve the objective of this project. As a result, real-time testing will be done indoor since this system primarily due to safety concerns associated with potential gas leaks or hazardous conditions within indoor environments. The sensing circuit was tested in my home as shown in figure 3.13 and figure 3.14 show the flowchart for testing process.

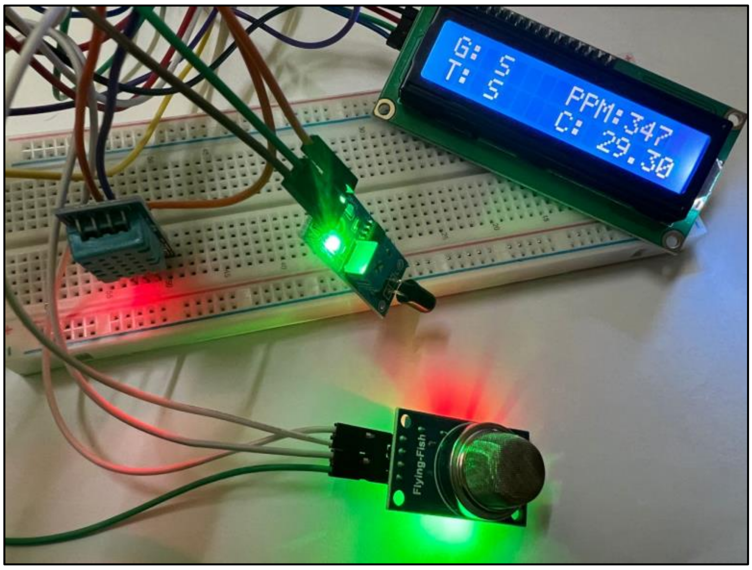

Figure 3.13: Sensing circuit setup

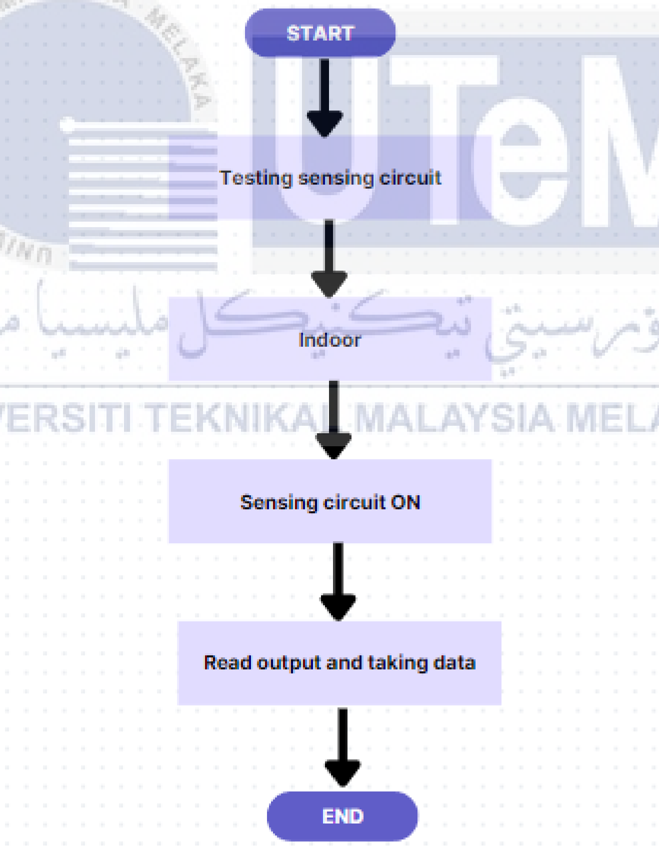

Figure 3.14: Testing process

3.5 Limitation of the proposed methodology

Developing IoT technology for a gas leakage notification system is challenging to propose in terms of deciding which components to use in this system, especially which components will be used and how to send notification alert wirelessly because it has not yet been developed. The process of making an application from Blynk for this gas leakage detection system to the google play store is still under trial. In addition, since this system needs a Wi-Fi connection, it is important to ensure a stable and reliable Wi-Fi connection for the proper functioning of an IoT gas leakage notification system.

3.6 Summary

This chapter presents the proposed methodology in order to develop an IoT technology of a gas leakage notification system on various methods and processes that are already-discussed in Chapter 2. The primary focus of the proposed methodology is to ensure the system will work properly as expected and can prevent significant loss of accuracy of the results. The ESP32 are essential components in an IoT gas leakage notification system. Both components provide the hardware platform and software development environment for implementing the system functionality, ESP32, but the specific operating system or software design used might be different depending on the complexity and requirements of the overall system of the IoT technology of a gas leakage notification system.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and analysis of the development of IoT technology for a gas leakage notification system in real-time. The system functionality has been tested indoor, which simulated the proposed gas leakage system. The results and discussion section of this system presents a thorough analysis and interpretation of the system's performance and implications. The system utilises gas, temperature, and flame sensors in combination with the ESP32 microcontroller, LCD I2C display, and Blynk output platform. This part explains the results obtained from the system's functioning, including the data gathered from the sensors, the processing and decision-making abilities of the ESP32, and the usefulness of the outputs shown on the LCD I2C and shared through the Blynk platform. The assessment evaluates the system's capacity to identify gas leaks, atypical temperature fluctuations, and occurrences of flames, with a focus on the effectiveness of threshold configurations and response mechanisms. Furthermore, the conversation explores the dependability, promptness, and possible areas for enhancement of the system, providing insights into improving the precision of sensors, optimising thresholds, and refining alert/notification features. This part provides a thorough assessment of the system's effectiveness in promptly identifying, informing, and addressing any dangers. It aims to enhance our comprehension of its practicality and consequences in terms of assuring safety and keeping to regulations in indoor environments.

4.2 Results and Analysis

As for this chapter, the system function was tested in real-time. The outcomes of the system, which takes advantage of gas, temperature, and flame sensors connected to the ESP32 microcontroller, together with outputs to an LCD I2C display and the Blynk platform, demonstrate a strong framework for monitoring indoor safety. The system efficiently collected real-time data from the sensors, identifying anomalies such as gas leaks, unusual temperature changes, and flame events. The ESP32's data processing capabilities increased the screening of sensor data based on defined standards, allowing for precise detection of possible dangers. The implementation of the LCD I2C display facilitated real-time monitoring on-site, providing distinct visual representations of sensor statuses and identified problems. In the meantime, the Blynk platform provided remote accessibility, allowing users to keep track of sensor data, receive notifications, and visualise alerts immediately. The investigation demonstrated that the system was reliable in identifying and alerting about potential dangers, guaranteeing immediate response and actions to reduce their impact. However, there are opportunities to enhance the system by adjusting the threshold settings for sensor data, improving the immediacy of messages via Blynk, and investigating methods to optimise system performance during periods of high demand. The system showed great potential in offering a full safety monitoring solution, indicating the need for additional improvements to achieve better accuracy, responsiveness, and adaptability to different indoor conditions and safety standards. The functionality of an Internet of Things (IoT) technology for a gas sensor leakage notification system is outlined in Table 4.1.

Table 4.1: Gas leakage system truth table

Gas sensor	Low	High	Normal
Temperature sensor	Normal	High	Low
Flame sensor	Absent	Present	Absent
ESP32 operation	Normal operation	Alert (Gas Leak)	Normal operation
LCD output	Normal display	Alert on display	Normal display
Blynk output	System monitoring and no alert	System monitoring and alert notification	System monitoring and no alert

4.2.1 Condition 1: Standby Mode

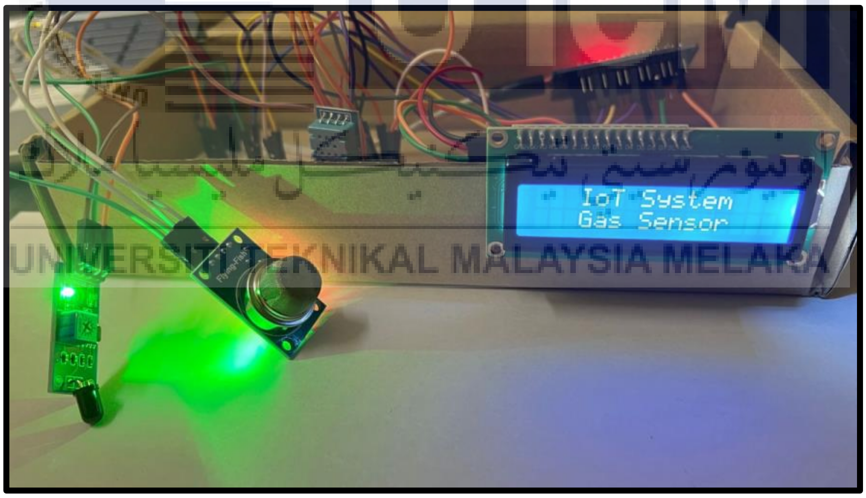

Figure 4.1: Circuit in a standby mode

With reference to the gas sensor leakage notification system, the circuit configuration and standby mode are shown in Figure 4.1. When the system is in standby mode, the initialization process begins to be carried out, and the configuration of important parts, including the gas sensor, DHT sensor, flame sensor, LCD display, and Blynk connection, is performed out. The phrase "IoT System Gas Sensor" is displayed on the LCD display of the system when it is operating in this mode. This is done in order to reveal the current state of the system. "gas_event," "temperature_event," and "flame_event" are the three events that Blynk creates a log entry for when the system is first initialised.

4.2.2 Condition 2: Safe State

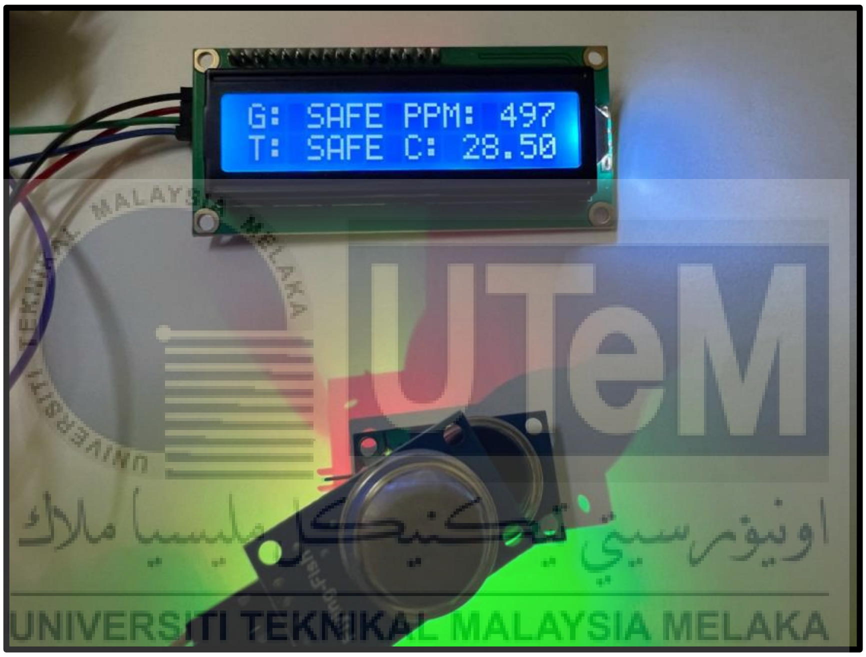

Figure 4.2: Gas and temperature reading in a safe state

According to figure 4.2, the gas level condition stated on the LCD screen was considered safe when the system was in the standard display mode. The outcome occurred because the identified gas level was only 497 PPM, which is below the gas threshold of 600 PPM. The gas level status was determined to be secure. Since the temperature reading was shown on the LCD display, it can be noted that it was also within a safe range, at 28.5 degrees Celsius. Since the temperature threshold is equal to or greater than 35 degrees Celsius, the temperature was within a safe range.

4.2.3 Condition 3: Warning state

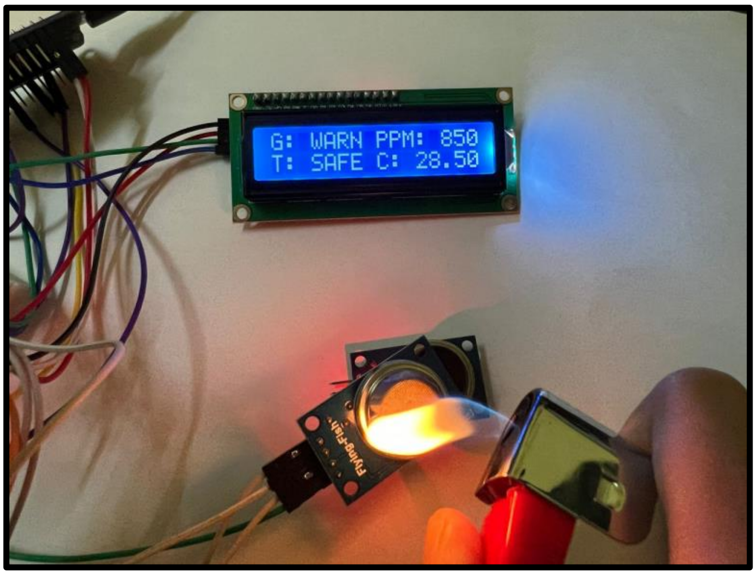

Figure 4.3: Gas reading in a warning state

Figure 4.4: Temperature reading in warning state

Figure 4.3 shows that the reading of the gas level was 850 PPM, which is a number that is higher than the number that is considered to be the gas threshold. Because of this, the "WARN" output will be displayed on the LCD, which is an indication that gas has been detected. The temperature reading that shown on the LCD screen in figure 4.4 is at a level that is considered to be high temperature. As a result, the "WARN" output is displayed on the LCD, which is 36.3 degrees Celsius.

4.2.4 Condition 4: Gas increase detected

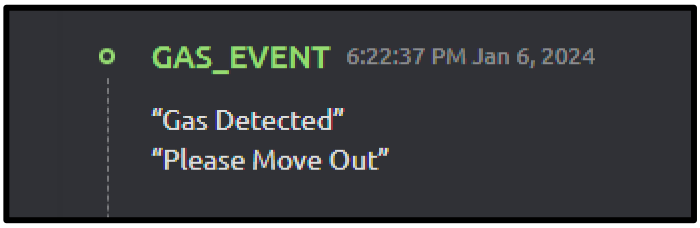

Figure 4.5: Condition when the gas increase is detected

The Blynk mobile application sends a notification when the gas level, measured in parts per million (PPM), over the gas threshold, indicating the occurrence of a gas leak event. According to Figure 4.5, the gas sensor (MQ-2) will send out a warning signal when the gas level exceeds a predetermined threshold. Blynk logs a "gas_event" to notify users of increasing gas levels. The LCD screen shows the message "WARN," and the digital pin is set to a high state. The warning notice displays the phrase "Gas Detected" along with the admonition "Please Move Out" as a safety precaution. The LCD also shows the value of the PPM, an abbreviation for parts per million.

4.2.5 Condition 5: Temperature increase detected

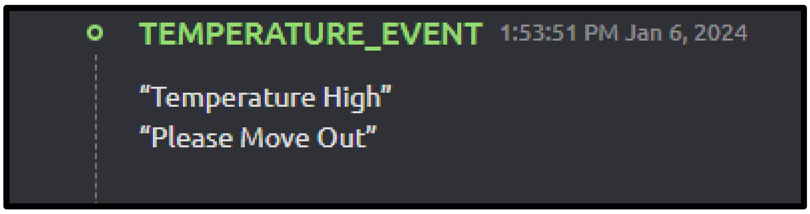

Figure 4.6: Condition when the temperature increase is detected

When the temperature level reaches a threshold that has been set up, the temperature sensor (DHT11) will send out a warning signal, as shown in Figure 4.6. In addition to the digital pin being in a high state, the display on the LCD screen displays the warning phrase

"WARN." The monitoring of a "temperature_event" by Blynk serves to notify users if there is an increase in the temperature. The alert notification displays the phrase "Temperature High" along with the direction "Please Move Out" as an indication of caution. A value in degrees Celsius, represented by the symbol °C, is also displayed on the liquid crystal display.

4.2.6 Condition 6: Flame presence detected

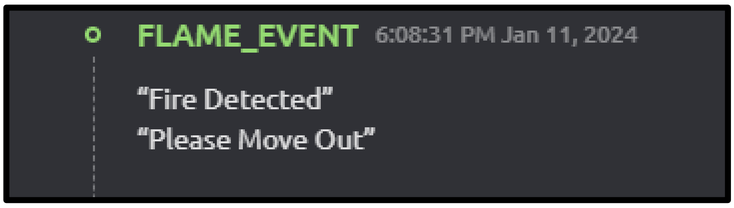

Figure 4.7: Condition when fire is detected

When the flame sensor detects a flame, the system records a "flame_event" and sets the corresponding Blynk virtual pin to a value of 255. This is demonstrated in figure 4.7 to demonstrate how the system works. In the notification, the word "Flame Detected!" is displayed alongside the directive "Please Move Out" as a cautionary instruction.

4.2.7 Condition 7: Monitoring using Blynk

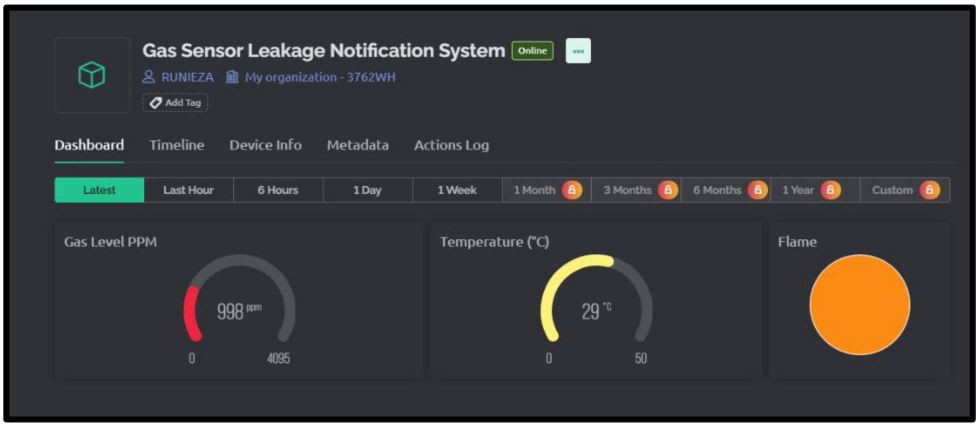

Figure 4 8: Gas sensor with temperature and fire monitoring in Blynk

By utilizing the data provided in figure 4.8, we can effectively monitor the gas concentration in parts per million, the temperature in degrees Celsius, and the existence of the flame. A warning status is currently being displayed in figure 4.8 because the PPM amount indicates that it has higher than the gas threshold. The temperature, on the other hand, remains within a reliable range. Moreover, the LED widget is enabled in order to indicate that there is a fire existing. All of this information may be obtained from the figure.

Figure 4.9: Gas PPM level monitoring graph

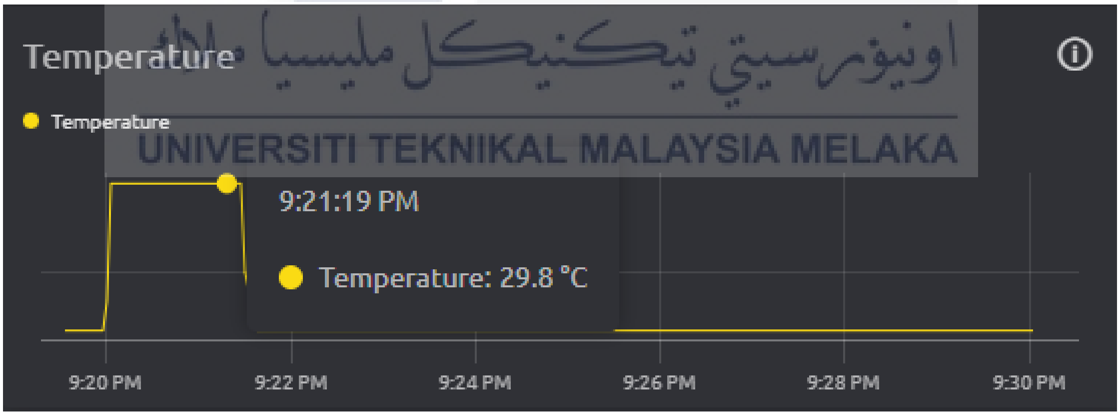

Figure 4.10: Temperature monitoring graph

The graph showed in figures 4.9 and 4.10 displays the monitoring of gas PPM levels and temperature. The graph will display the changes in the parts per million (PPM) value of the gas and the corresponding temperature changes. According to the graph displaying the gas parts per million (PPM) levels, the detected gas is consistently below 300 PPM on average. This level is considered acceptable for indoor situations, such as our own home. According to the temperature graph, there is minimal variation in the temperature readings as they consistently remain at room temperature.

4.3 Summary

This chapter thoroughly demonstrated the operational capability of the gas leakage notification system, highlighting its strength in identifying potential dangers. The data and analysis indicate that the combined input from the gas (MQ2), temperature (DHT11), and flame sensors has a substantial impact on the system's output. The primary goal of the system is to swiftly detect and resolve any gas leaks by actively monitoring and warning about environmental conditions. During the study, the system regularly demonstrated its ability to produce immediate warnings and notifications, hence improving safety measures. The gas sensor's functionality and dependability, crucial for identifying dangerous gas levels, significantly enhanced the system's effectiveness. The demonstrated operational efficiency and production of accurate, dependable data highlight the effective performance of all sensors, confirming the system's ability to provide safety by precisely identifying and responding to gas leaks.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The development and effective implementation of the IoT gas sensor leakage notification system constitute a significant leap in maintaining comprehensive safety precautions for indoor spaces. The integration of advanced components, including the MQ2 gas sensor, DHT11 temperature sensor, flame sensor, ESP32 microcontroller, LCD I2C display, and Blynk notification system, has resulted in a full safety monitoring framework. During its practical demonstration, this system has demonstrated its exceptional capacity to identify and respond to potential dangers, protecting against gas leaks, abnormal temperature changes, and possible flame accidents.

The effectiveness of this complex system is based on its capability to smoothly combine various sensor inputs, coordinating their functions to guarantee a coordinated reaction to safety issues. An outstanding feature is the gas sensor's extraordinary ability to properly detect dangerous gas levels, making it crucial for identifying hazards in advance. The combination of sensors, the ESP32 microcontroller, and output systems has facilitated both on-site monitoring through the LCD I2C display and remote accessible through the Blynk notification platform. The use of this dual strategy has greatly improved the system's efficiency in delivering timely alerts and notifications, enabling users to promptly and knowledgeably respond to possible hazards.

The system considerable capability, confirmed by thorough testing and analysis, highlights its reliability in generating consistent and accurate data. The system's consistent dependability inspires trust in its operational effectiveness, thus enhancing its capacity as a crucial instrument in guaranteeing adherence to safety regulations and implementing risk reduction strategies in different indoor environments.

The IoT gas sensor leakage notification system is an innovative technology that enhances safety measures in indoor spaces. The organization's proactive approach in identifying possible risks, along with its capacity to enable swift responses, establishes it as a fundamental element in promoting safer living and working conditions. In the future, additional improvements and advancements could boost its powers, expanding its potential for use in various indoor environments and strengthening its importance in assuring safety and well-being.

5.2 Limitation

Through this project, the effectiveness of the gas leak notification system using IoT technology was evaluated. However, it is imperative to acknowledge certain limitations that may influence the system overall performance and applicability.

- The sensor may not notice gas leaks or fire presence happening too far from the sensor are placed.
- The sensors may not cover every part of a place, leaving some areas without monitoring making the system less effective.
- The system needs good internet to send alerts and monitored remotely.
- The system needs a constant supply of electricity to work well.

5.3 Recommendation

For future improvements, accuracy of the cost-effective gas leakage notification system results could be enhanced as follows:

- Optimize the placement of sensors to maximize the detection range to help address the limitation of sensors not noticing gas leaks and fires happening too far away.
- Adding more sensors or adjusting their placement to ensure comprehensive coverage of the monitored area.
- Introduce a redundant communication system or local alarms in case of internet connectivity issues and upgrade the Blynk notification system to enable greater customization and provide more detailed alerts.
- Implement power backup solutions such as batteries or alternative power sources to ensure uninterrupted operation during power outages.
- Integrate the system with emergency response systems or processes. Implement automated triggers to immediately alert emergency services or building administration in urgent situations, ensuring fast response to serious risks.

5.4 Project Potential

The development of a cost-effective gas leakage notification system based on IoT technology demonstrates substantial potential for commercialization, offering an innovative and comprehensive solution to address safety concerns associated with gas leaks. The project incorporates key components such as the MQ2 gas sensor, DHT11 temperature and humidity sensor, and a flame sensor, seamlessly integrated into a microcontroller powered by an ESP32.

The MQ2 gas sensor stands out for its ability to detect a wide range of gases, ensuring a robust and versatile gas detection capability. This is crucial for providing users with a comprehensive solution that covers various types of potential gas leaks, enhancing the overall safety of environments where the system is deployed.

The ESP32 microcontroller serves as the central processing unit of the system, orchestrating the collection and analysis of data from the sensors. Its inclusion ensures efficient and reliable performance while maintaining cost-effectiveness. By leveraging the capabilities of the ESP32, the project strikes a balance between functionality and affordability, a key factor in its commercial viability.

In addition to gas detection, the system incorporates a DHT11 sensor to monitor ambient temperature and humidity. This dual functionality adds value by offering users a more comprehensive environmental monitoring solution. Users can not only receive timely gas leak alerts but also stay informed about the surrounding conditions, making it a versatile system suitable for a variety of settings, including homes, industries, and laboratories.

The integration of a flame sensor further enhances the safety features of the system. This sensor can swiftly detect the presence of a flame, providing an additional layer of protection against potential fire hazards associated with gas leaks. The combination of gas, temperature, humidity, and flame detection ensures that the system is equipped to address a range of safety concerns comprehensively.

The user interface is designed for both local and remote monitoring. The LCD provides on-site visibility of gas levels and environmental conditions, catering to scenarios where immediate visual feedback is essential. Simultaneously, the integration of the Blynk application enables users to receive real-time notifications on their smartphones, allowing for remote monitoring and instant response to potential threats.

The cost-effectiveness of the system is rooted in the thoughtful selection of sensors and the utilization of the ESP32 microcontroller. This strategic balance ensures that the solution remains affordable while delivering high-performance capabilities. As safety continues to be a paramount consideration in various sectors, the project's potential for commercialization is evident in its adaptability to different settings, aligning well with the increasing demand for smart and connected safety solutions.

The market appeal of this gas leakage notification system is further strengthened by its ability to cater to diverse applications, its cost-effectiveness, and the growing trend of IoT-enabled devices. With its versatility, affordability, and comprehensive safety features, the system holds significant promise for widespread adoption and commercial success across a range of industries and environments.

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APPENDICES

Appendix A

PROJECT ACTIVITIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
BDP Briefing																
Meeting with supervisor						M										S
Distribution of project titles						I										T
PSM 1 rubrics explanation						D										U
Project planning						S										D
Proposal preparation						E										Y
Abstract						M										
Introduction																
Literature review						B										W
Design project						R										E
Flowchart						E										E
Design software						A										K
Construct the application						K										

PROJECT ACTIVITIES	W 1	W 2	W3	W 4	W5	W 6	W7	W8	W9	W10	W 11	W 12	W13	W14	W15	W 16
BDP 2 briefing								M								S
Meeting with supervisor								I								T
Finalizing componets								D								U
Purchasing components								S								D
Testing and troubleshooting								E								Y
Log book								M								
Building prototype								B								W
Testing prototype								R								E
Presentation								E								E
Final report submission								A								K
Making poster								K								

Appendix B

2 Pin Definitions

2.1 Pin Layout

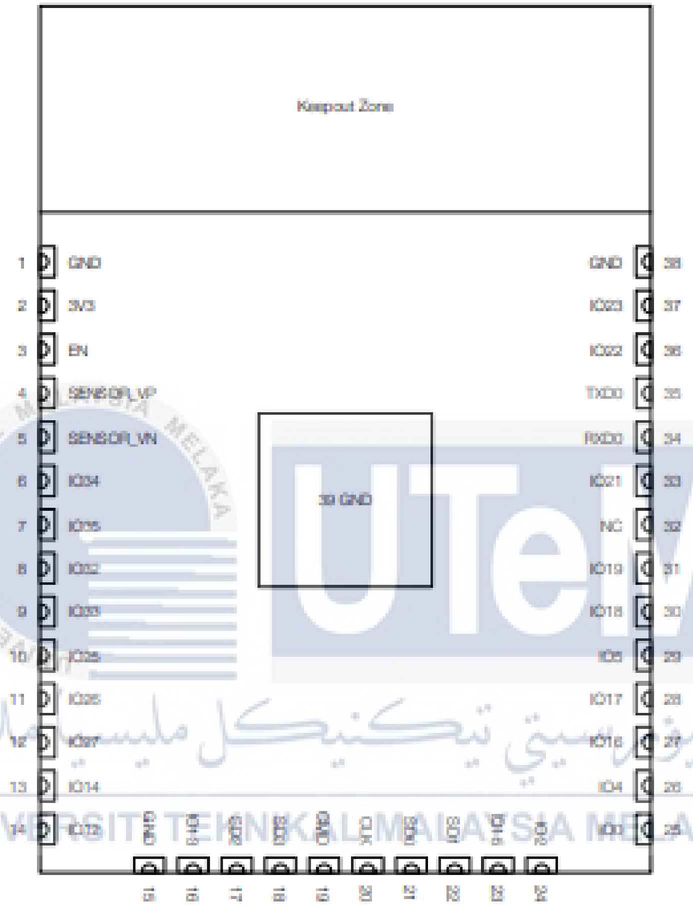

Figure 1: ESP32-WROOM-32 Pin Layout (Top View)

2.2 Pin Description

ESP32-WROOM-32 has 38 pins. See pin definitions in Table 2.

Table 2: Pin Definitions

Name	No.	Type	Function
GND	1	P	Ground
3V3	2	P	Power supply
EN	3	I	Module-enable signal. Active high.

Not Recommended For New Designs (NRND)

Espressif Systems 8 ESP32-WROOM-32 Datasheet v3.4

Name	No.	Type	Function
SENSOR_VP	4	I	GPIO36, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	I	GPIO39, ADC1_CH3, RTC_GPIO3
IO34	6	I	GPIO34, ADC1_CH6, RTC_GPIO4
IO35	7	I	GPIO35, ADC1_CH7, RTC_GPIO5
IO32	8	I/O	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	10	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
IO14	13	I/O	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
IO12	14	I/O	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
GND	15	P	Ground
IO13	16	I/O	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
SHD/SD2*	17	I/O	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
SWP/SD3*	18	I/O	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
SCS/CMD*	19	I/O	GPIO11, SD_CMD, SPICS0, HS1_CMD, U1RTS
SCK/CLK*	20	I/O	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
SDO/SD0*	21	I/O	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
SDI/SD1*	22	I/O	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
IO15	23	I/O	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	24	I/O	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
IO0	25	I/O	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	26	I/O	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
IO16	27	I/O	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT
IO17	28	I/O	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
IO5	29	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
IO18	30	I/O	GPIO18, VSPICLK, HS1_DATA7
IO19	31	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
NC	32	-	-
IO21	33	I/O	GPIO21, VSPIHD, EMAC_TX_EN
RXD0	34	I/O	GPIO3, U0RXD, CLK_OUT2
TXD0	35	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO22	36	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
IO23	37	I/O	GPIO23, VSPID, HS1_STROBE
GND	38	P	Ground

Appendix C

```
#define BLYNK_TEMPLATE_ID "TMPL6MzwfCe02"
#define BLYNK_TEMPLATE_NAME "Gas Sensor Leakage Notification System"
#define BLYNK_AUTH_TOKEN "0aow3HxgBMFBIgQFnMgnGkcwytkUpr-r"
#define BLYNK_PRINT Serial

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

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Bunieza";
char pass[] = "Alieanna25";

#define DHTPIN 5
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

#define ANALOG_PIN 35
#define DIGITAL_PIN 4
#define FLAME_PIN 15
#define I2C_ADDR 0x27
#define LCD_COLS 16
#define LCD_ROWS 2

LiquidCrystal_I2C lcd(I2C_ADDR, LCD_COLS, LCD_ROWS);

int sensorValue = 0;
boolean state = false;
const int sensorMin = 0;
const int sensorMax = 4095;

void setup()
{
  Serial.begin(9600);
  dht.begin();
  pinMode(DIGITAL_PIN, OUTPUT);
  pinMode(FLAME_PIN, INPUT);
  lcd.begin();
  lcd.backlight();
  lcd.setCursor(3, 0);
  lcd.print("IoT System");
  lcd.setCursor(3, 1);
```

```
  lcd.print("Gas Sensor");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0, 1);
  lcd.print("T:  ");
  lcd.setCursor(0, 0);
  lcd.print("G:  ");

  Blynk.begin(auth, ssid, pass);
  Blynk.logEvent("gas_event"); // Send notification when the system starts
}

void loop()
{
  Blynk.run();

  float tempc = dht.readTemperature();
  Blynk.virtualWrite(V2, tempc);

  if (isnan(tempc))
  {
    Serial.println("Failed to read temperature from DHT sensor");
  }
  else
  {
    Serial.print("Temperature: ");
    Serial.print(tempc);
    Serial.println(" °C");
    delay(2000);

    lcd.setCursor(8, 1);
    lcd.print("C: ");
    lcd.print(tempc);

    lcd.setCursor(3, 1);
    if (tempc < 35)
    {
      lcd.print("SAFE");
    }
    else
    {
      lcd.print("WARN");
      Blynk.logEvent("temperature_event"); // Send Blynk notification when
gas is detected
    }
  }

  int sensorValue = analogRead(ANALOG_PIN);
```

```
  Serial.println(sensorValue);

  int threshold = 600;

  if (sensorValue > threshold)
  {
    digitalWrite(DIGITAL_PIN, HIGH);
    Serial.println("Gas detected!");
    lcd.setCursor(3, 0);
    lcd.print("WARN");

    Blynk.logEvent("gas_event"); // Send Blynk notification when gas is
detected
  }
  else
  {
    digitalWrite(DIGITAL_PIN, LOW);
    Serial.println("No gas detected.");
    lcd.setCursor(3, 0);
    lcd.print("SAFE");
  }

  int ppmValue = analogRead(ANALOG_PIN);
  Blynk.virtualWrite(V1, ppmValue);
  lcd.setCursor(8, 0);
  lcd.print("      ");
  lcd.setCursor(8, 0);
  lcd.print("PPM:");
  lcd.print(ppmValue);

  int flameDetected = digitalRead(FLAME_PIN);
  int range = map(flameDetected,  sensorMin, sensorMax, 0, 3);

  if (flameDetected == range)
  {
    Serial.println("Flame detected!");
    Serial.println(flameDetected);
    Blynk.virtualWrite(V3, 255);
    Blynk.logEvent("flame_event"); // Send flame detection notification
  }
  else
  {
    Serial.println("No flame detected.");
    Blynk.virtualWrite(V3, 0);
  }

  delay(1000);
}
```