DEVELOPMENT AND FABRICATION OF AMMONIA GAS LEAKAGE DETECTION AND MONITORING SYSTEM

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ABSTRAK

Dalam industri yang menggunakan gas berbahaya dalam jumlah yang besar untuk pelbagai prosesnya, terdapat pembolehubah berisiko tinggi yang terlibat. Orang ramai mungkin gagal untuk mengesan atau memantau pelepasan gas ini secara tetap sebelum ia menjadi berbahaya. Penderia diperlukan untuk terus memantau kebocoran dan memberitahu pengguna tentang potensi bahaya. Tujuan projek ini adalah untuk menambah baik kaedah pengukuran yang tidak relevan yang dipegang atau dipasang pada dinding dan berfungsi hanya untuk mengukur. Projek ini menggabungkan teknologi italic untuk memantau bacaan sensor dari jarak yang selamat, mencari kawasan di mana gas ammonia bocor berdasarkan bacaan sensor tekanan, dan termasuk sistem pencegahan yang berfungsi sebagai maklum balas yang bertindak balas kepada bacaan sensor untuk mengawal pam air, kipas, dan injap solenoid untuk mengawal kebocoran gas ammonia. Pelbagai nilai sensor diterima dan diproses menggunakan mikropemproses. Ini merupakan reka bentuk projek dan fabrikasi sistem pengesanan dan pemantauan kebocoran gas ammonia yang menggunakan ESP 32 sebagai mikropengawal kerana sistem kuasa rendah, kos rendah yang termasuk Wi-Fi terbina dalam dan Bluetooth dwi-mod. Sensor Kualiti Udara MQ-135 juga berfungsi sebagai Pengesan Gas Ammonia, mengesan kebocoran gas apabila gas ammonia bocor. Sistem projek memberi tumpuan kepada pemindahan data daripada unit penderiaan kepada broker, di mana ia disimpan seketika dalam aplikasi Blynk dan juga boleh disimpan untuk masa yang lama dan dieksport dalam web Thingspeak, serta sistem GPS, memberikan ketepatan maklumat latitud dan longitud. Data dipaparkan pada web dan aplikasi mudah alih, yang boleh digunakan pengguna untuk memantau bacaan penderia. Data dihantar melalui nodeMCU, yang membaca data daripada input dan output dan menghantarnya ke aplikasi Blynk dan protokol Thingspeak. Sensor tekanan digunakan untuk mengenal pasti bahagian tertentu kebocoran gas ammonia. Penggera siren dan LED digunakan untuk memberitahu pekerja atau pegawai. Projek sistem pengesanan dan pemantauan kebocoran gas ammonia ini telah berjaya disiapkan. Terdapat penambahbaikan boleh dilakukan untuk pembangunan masa depan prototaip ini seperti fabrikasi loji ammonia menggunakan bahan tidak menghakis dan menggunakan sensor industri untuk membuat bacaan bagi pengesanan gas ammonia yang tepat.

ABSTRACT

In industries that use hazardous gases in significant amounts for their diverse processes, there are high-risk variables involved. People may fail to detect or monitor the emission of these gases on a regular basis before it becomes dangerous. Sensors are required to continuously monitor leaks and notify users to potential hazards. The purpose of the project is to improve irrelevant measurement methods that are held or installed on walls and serve merely to measure. The project incorporates Internet-of-Thing's technology to monitor sensor readings from a safe distance, locate areas where ammonia gas is leaking based on pressure sensor readings, and includes a prevention system that serves as feedback that responds to sensor readings to control water pumps, fans, and solenoid valves to control ammonia gas leakage. Various sensor values are received and processed using microprocessors. This project design and fabrication of an ammonia gas leakage detection and monitoring system employs the ESP 32 as a microcontroller due to its low-power, low-cost system that includes built-in Wi-Fi and dual-mode Bluetooth. The Air Quality Sensor MQ-135 also serves as an Ammonia Gas Sensor, detecting gas leakage when ammonia gas leaks. The project system focuses on the transfer of data from the sensing unit to the broker, where it is kept momentarily in the Blynk app but can be stored for a long time and exported in the web Thingspeak, as well as the GPS system, gives precise latitude and longitude information. The data is displayed on a mobile web and application, which users can use to monitor sensor readings. Data is transmitted via the nodeMCU, which reads data from inputs and outputs and sends it to Blynk applications and the Thingspeak protocol. The pressure sensor is used to identify specific parts of ammonia gas leakage. The siren alarm and LEDs are used to notify employees or officials. This ammonia gas leakage detection and monitoring system project was completed successfully. There are improvements can be done for future development on this prototype such as to fabrication ammonia plant using non corossive material and use industrial sensor to make reading for accurate ammonia gas detection.

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Bar	Unit pressure
Psi	Unit pressure

LIST OF ABBREVIATIONS

NH_3	Ammonia Gas
IoT	Internet of Things
IP	Internet Protocol
ppm	Parts per million
ADC	Analog-to-Digital Converter
OLED	Organic Light Emitting Diodes
LED	Light Emitting Diode
NodeMCU	Node MicroController Unit
Wi-Fi	Wireless Fidelity
GUI	Graphical User Interface
GPS	Global Positioning System

CHAPTER 1

INTRODUCTION

1.1 Project Background

Ammonia is a chemical with the formula NH3. In ambient temperature, that is a colorless and odorless gas with a distinct, highly unpleasant odour. Ammonia is a base that is moderately corrosive. It is not extremely combustible. Ammonia is a substance that is required for the survival of plants, animals, and humans. It is a naturally occurring component of the atmosphere, water, and soil, and it serves as a nitrogen supply for plants and animals. Ammonia, on the other hand, can be detrimental to human health in large levels.(Rabchuk et al., 2014)

Review for the application history of ammonia in industry, it is used as a nitrogen rich fertilizer. This document summaries the findings of study on gas leakage incidents around the world, including those that occur in our own country. Recently, there have been few cases that involved the ammonium gas leakage in Malaysia. The newest one happened in Johor Baharu on 14th August 2009, 2 factory workers dead due to leakage of ammonia gas at ice factory. Both are currently in poor health and have difficulty breathing.(Brightling, 2018)

In plant, the leakage of ammonia gas is very dangerous and harmful to humans because it is corrosive (high concentration) might cause burning to our face and somehow will direct cause death. This project finds out most of the industry do not have any effective method or precaution to prevent the incident ammonia gas leakage.(Duisters, 2012)

The project propose is using the concept of Ammonia plant system to handle or detect the leakage of ammonia gas so that can prevent the accident occurs. This project will build up a system to detect the leakage of ammonia gas and alert to workers and officials so that they will not direct expose to the ammonia gas.

1.2 Problem Statement

Gas leakage can be very dangerous to human being and others. When leakage of ammonia gas occurs, the safety officer needs to detect the gas by using their device or system which maybe they need to go to the affected area to find out where is the leakage happen, this will cause harm to the safety officer. So, to overcome this problem, we develop detection and precaution system of the ammonia gas leakage accurately. On this solution, the sensors are planted at area where the probability to leakage happen high.

Referring to problem statement at paragraph 1, the safety officer maybe needs to come to the site because their device maybe cannot be monitored from a far and function of their device is so simple which just show the status of parts per million (ppm), so if the safety officer come to the site it will exposed with ammonia gas which is dangerous for them. To overcome this problem, monitoring system with can indicate the safer route to assembly point need to be develop so that the safety officer no need to go to the exposed area and get harmed by the ammonia gas.

The above-mentioned domestic and international gas monitoring equipment, on the other hand, primarily detects basic concentrations and sounds an over-limit alert, but does not include a leakage detector source locating function, which is crucial in fire rescue operations. Ammonia releases have the potential to harm workers. When ammonia is under pressure, the risk of exposure increases because larger quantities of the refrigerant can be released into the air quickly. However, ammonia is also lighter than air, and this means that it can form clouds and travel beyond the perimeters of a fertilizer plant if there is an accidental release. When air is mixed with ammonia clouds, the problem is exacerbated because the cloud remains lower to the ground, posing a risk to workers inside a plant. To overcome this problem, the ammonia sensor located in each place that have ammonia storage. System can be monitoring to locate the exact ammonia gas leakage in each area and alert the workers or officials to act for solve that problem. The monitoring system will alert workers inside the plant by turning on the alarm and emergency lights will be displayed in the ammonia gas leak area.

1.3 Project Objective

This proposed project is to achieve the following objectives:

1. To develop purging system for the ammonia gas leakage to ensure the system can be apply in the industry.
2. To develop GPS system to locate the area of ammonia gas leakage
3. To develop detection and precaution system of the ammonia gas leakage

1.4 Project Scope

The scope of work of this project focuses on designing an ammonia gas leakage detection system which detects ammonia gas leaks of various concentrations ranging from low to high. At the same time, the scope of work also involves the development of detection and precaution system of the ammonia gas leakage accurately. Lastly, the scope of work also includes the development of distant monitoring by using IoT that will be developed on MIT apps inventor which is a for application development and exhibit the safer route to assembly point.

1.5 Significance of study

The significance of this study is to development and fabrication of ammonia gas leakage detection and monitoring system, this is since the leakage of ammonia gas is extremely dangerous and harmful to humans since it is corrosive (high concentration) and may cause burning to our faces or kill human being.

1.6 Thesis organization

Chapter 1 The background research area of ammonia gas leakage detection and monitoring system has been described in this chapter. It has also briefly discussed the problem statement element that industry and safety officers face, such as the need to go to the affected area to find out where the leakage occurred, which may cause harm to the

safety officer, the inability to monitor from a distance, and the lack of a leakage detector source locating function. This project's purpose and project scope were also specified.

Chapter 2 offers an evaluation of the literature in the topic of this research project First and foremost, it will describe existing ammonia projects as well as the application of ammonia in industry. Following that, we'll look at the applications of ammonia sensors in industry, as well as the many types of sensors on the market. The next step is to choose a microcontroller for the ammonia gas leakage detecting system. After that, the selection of motors in the system of ammonia gas prevention continues to spread. Next would be a description of the type of pressure sensor as well as the type of pressure sensor to be used in the project. The GPS in the position monitoring system to identify ammonia gas leaks is next described. Then the general definition of the Internet of things (IoT) used for ammonia gas monitoring systems. And lastly There is little comparison of existing projects based on systems and components.

Chapter 3 describes the proposed development and manufacture of an ammonia gas monitoring system. This chapter will also explain the flowchart for the overall system, as well as how each component of the fabrication system works. Finally, this chapter discusses the cost analysis of the total project of ammonia gas leak detection and monitoring system.

Chapter 4 explain the outcomes achieved from the fabrication of this ammonia plant prototype. Based on the results received from this prototype, a discussion was held. The outcomes demonstrate the functionality of the development of an ammonia gas leak detection and monitoring system fabrication. Issues that arise during data collecting are also addressed.

Chapter 5 explain the project's general finding, including the functionality and efficacy of the system in this project Thus, the attained aims, constraints, and recommendations are also mentioned to make any future improvements to this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will highlight the theory related to the projects including ammonia, gas detector, microcontroller, motor, pressure sensor, global positioning system (GPS), internet of Things (IoT) and existing projects related to the project. The explanation about an existing related project which is ammonia gas detection system that had been research. Besides that, it also will elaborate about the general information regarding water monitoring system and the commonly used sensor devices used for monitoring ammonia gas.

2.2 Ammonia

Ammonia is a chemical with a basic NH3 symbol, in the form of a gas which is very irritating, colourless, and has a very sharp odor (Imelda Olivia, 2007). Ammonia is often found in daily life such as in factory waste, toilets, chicken coops and so on. Most of the ammonia produced is used in agriculture as a source of nitrogen which is essential for plant growth. Ammonia is also used in pH control, in mineral beneficiation, in neutralizing acidic components during petroleum refining and in the treatment of acidic wastes ((Manufacture, n.d.)). The presence of ammonia will easily interact with the air and because of that it can cause unpleasant odor. The emergence of ammonia gas will cause the environment to become unhealthy so that it interferes with the activity of living things around it. The dangerous amount of ammonia exposure to human is at concentration of >2500 ppm for durations of >30 minutes which led to a conclusion of maximum short exposure tolerance of 300 to 500 ppm for 30 minutes to an hour (Ellis et al., 2011). The presence of ammonia gas in the environment needs to be controlled so as not to cause undesirable things such as health problems and so on. Researcher have come

out with proposal of ammonia gas leakage preventive and monitoring system to overcome this problem.

2.2.1 Uses of Ammonia

Ammonia is mostly used as a fertiliser. It is typically administered directly to the soil in the United States from tanks containing liquefied gas. Ammonia salts such as ammonium nitrate, NH4NO3, ammonium sulphate, (NH4)2SO4, and different ammonium phosphates can also exist. Urea, (H2N)2C=O, has been the most generally used potential resource in fertiliser in the world. In addition, ammonia is employed in the production of commercial explosions (e.g., trinitrotoluene [TNT], nitroglycerin, and nitrocellulose) (Mendonça et al., 2021).

Ammonia is used in the textile industry to make synthetic fibres such as nylon and rayon. It is also used in the dyeing and cleaning of cotton, woolen, and linen. In the manufacturing of some synthetic resins, ammonia acts as a catalyst. More importantly, it neutralises acidic by-products of refining process, and it inhibits coagulation of raw latex during transport from plantation to factory in the rubber sector. Ammonia is also utilised in the ammonia-soda process (also known as the Solvay process), a popular method for generating soda ash, and the Ostwald process, which converts ammonia to nitric acid (Mendonça et al., 2021).

2.2.2 Preparation of ammonia

Pure ammonia was originally created in 1774 by English physical scientist Joseph Priestley, and its precise composition was discovered in 1785 by French chemist Claude-Louis Berthollet. Ammonia is frequently ranked as one of the top five chemicals manufactured in the United States. The Haber-Bosch process, which utilises the direct reaction of elemental hydrogen and elemental nitrogen, is the most common industrial way of manufacturing ammonia. This reaction necessitates the use of a catalyst, as well as high pressure (100–1,000 atmospheres) and high temperature (400–550 °C [750–1020 °F]). At low temperatures, the balance between the elements and ammonia favours the creation of ammonia, but high temperatures are necessary to produce a good rate of ammonia formation. Catalysts of various types can be applied. Typically, the catalyst is

iron oxide containing iron. However, as catalysts, magnesium oxide on aluminium activated by alkali metal oxides and ruthenium on carbon have also been used. Ammonia is best generated in the laboratory by hydrolysis of a metal nitride (Gibard et al., 2013).

2.2.3 Physical properties of ammonia

Ammonia is a colourless gas with a strong, pervasive odour. It has a boiling point of 33.35 degrees Celsius (28.03 degrees Fahrenheit) and a freezing point of 77.7 degrees Celsius (107.8 degrees Fahrenheit). It has a high heat of vaporisation (23.3 kilojoules per mole at its boiling point) and can be handled in the laboratory as a liquid in thermally insulated containers. (A material's heat of vaporisation is the number of kilojoules required to evaporate one mole of the substance with no change in temperature.) The three hydrogen atoms and an unshared pair of electrons connected to the nitrogen atom form a trigonal pyramidal structure in the ammonia molecule. It is a polar molecule with a high degree of association due to strong intermolecular hydrogen bonding (Čermák & Dejmal, 2013).

2.2.4 Chemical reactivity of ammonia

Ammonia combustion is challenging; however, it produces nitrogen gas and water. However, with the use of a catalyst and the proper temperature conditions, ammonia interacts with oxygen to form nitric oxide, NO, which is then oxidised to nitrogen dioxide, NO2, and employed in the commercial manufacture of nitric acid. These ammonia aqueous solutions are basic and are occasionally referred to as ammonium hydroxide solutions (NH4OH). However, the equilibrium is such that a 1.0-molar solution of NH3 yields only 4.2 millimoles of hydroxide ion. The hydrates NH3 H2O, 2NH3 H2O, and NH3 2H2O exist and have been demonstrated to be made up of ammonia and water molecules bonded together by intermolecular hydrogen bonds.

As a nonaqueous solvent, liquid ammonia is widely utilised. In liquid ammonia, alkali metals, heavier alkaline-earth metals, and even some inner transition metals dissolve, generating blue solutions. Physical investigations, such as electrical conductivity studies, show that the solvated electron is responsible for the blue colour and electrical current (Valera-Medina et al., 2019).

2.3 Gas detector

A gas detector is a device that detects the presence of gases in each space and is frequently used as part of a safety system. A gas detector can alert operators in the area where the leak is occurring, allowing them time to flee. This type of equipment is necessary since many gases can be detrimental to organic life, such as humans and animals (Paknahad et al., 2017).

Gas detectors can detect combustible, flammable, and poisonous gases, as well as oxygen deficiency. This type of equipment is commonly utilised in industry and can be found in places like oil rigs to monitor production processes and new technologies like photovoltaics. They could be useful in firefighting (Seo et al., 2013).

2.3.1 Gas leak detection

The practise of detecting potentially harmful gas leaks using sensors is known as gas leak detection. A thermal camera can also be used to do visual identification. When a harmful chemical is discovered, these sensors often emit an audible warning to alert people. Toxic gas exposure can also occur during painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, accessing confined spaces, and other activities. Combustible gas sensors, photoionization detectors, infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and metal-oxide-semiconductor sensors are examples of common sensors (MOS sensors). Infrared imaging sensors have recently become popular (Mohebbifar, 2020).

2.3.2 Types of Gas Sensor

Gas detectors can be classified according to the operation mechanism (semiconductors, oxidation, catalytic, photoionization, infrared, etc.). Gas detectors come packaged into two main form factors: portable devices and fixed gas detectors. Portable detectors are used to monitor the atmosphere around personnel and are either hand-held or worn on clothing or on a belt/harness. These gas detectors are usually battery operated. They transmit warnings via audible and visible signals, such as alarms and flashing lights, when dangerous levels of gas vapors are detected. Fixed type gas detectors may be used

for detection of one or more gas types. Fixed type detectors are generally mounted near the process area of a plant or control room, or an area to be protected, such as a residential bedroom. Generally, industrial sensors are installed on fixed type mild steel structures and a cable connects the detectors to a SCADA system for continuous monitoring. A tripping interlock can be activated for an emergency (Hong et al., 2021).

2.3.2.1 Gas Sensor MQ137

This MQ137 module is a sensor board that detects NH3 Ammonia gas as well as other gases. The MQ137 gas sensor's sensitive substance is SnO2, which has a poor conductivity (high resistance) in clean air. When the target sensitive gas is present, the sensor's conductivity increases in tandem with the gas concentration. The board has basic circuitry for changing conductivity or resistance to voltage and outputting it to header pins DO and AO (Hema et al., 2019).

Figure 2.1 Sensor MQ137

The MQ137 gas sensor's sensitive substance is SnO2, which has a reduced conductivity in clean air. When NH3 gas is present, the sensor's conductivity increases in proportion to the gas concentration. A simple circuit can be used to translate the change in conductivity to the corresponding output signal of gas concentration. The MQ137 gas

sensor has a high sensitivity to NH3 gas and can also detect organic amines such as trimethylamine and cholamine. It can detect several gases, including ammonia, and is a low-cost sensor for a variety of applications (Yang & Han, 2014).

2.3.2.2 Gas Sensor MQ135

The MQ135 gas sensor has a high sensitivity to ammonia gas, sulphide, and benzene series steam, as well as the ability to monitor smoke and other dangerous gases. It can detect many harmful gases and is a higher sensor for a variety of applications.

Figure 2.2 Sensor MQ135

As a gas-sensing material, the MQ-135 gas sensor employs SnO2, which has a reduced conductivity in pure air. When there is a polluting gas present in the atmosphere, the conductivity of the gas sensor increases as the concentration of the polluting gas grows. MQ-135 detects smoke and other dangerous gases well, and is especially sensitive to ammonia, sulphide, and benzene steam. MQ-135 is a great alternative for numerous gas detection applications due to its ability to detect various dangerous gases and cheaper cost.

2.4 Microcontroller

A microcontroller (MCU, which stands for microcontroller unit) is a miniature computer that is built on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip. A microcontroller is made up of one or more CPUs (processor cores), memory, and programmable input/output peripherals. A tiny amount of RAM, as well as

programme memory in the form of ferroelectric RAM, NOR flash, or OTP ROM, is frequently provided on chip. Microcontrollers, as opposed to microprocessors used in personal computers or other general-purpose applications, are developed for embedded applications, and are made up of various discrete chips.(Barrett, 2013)

2.4.1 Arduino

Arduino is composed of a physical programmable circuit board (commonly referred to as a microcontroller) and programming software, or IDE (Integrated Development Environment), which can be run on a PC and is used to compose and transfer PC code to the circuit board. It can attain this using the Arduino programming language and the Arduino Software (IDE).

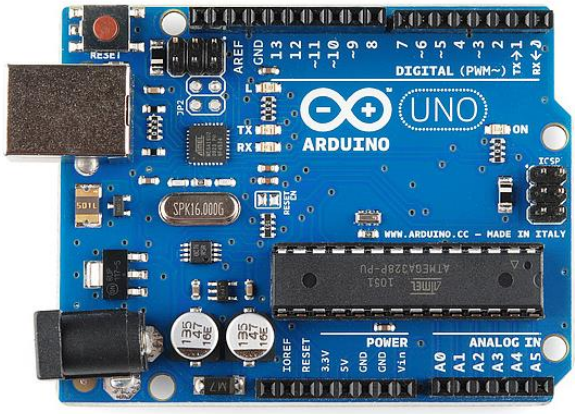

Figure 2.3 Arduino Uno V3

Unlike other programmable circuit boards, the Arduino does not require a separate piece of equipment (known as a software engineer) to upload code to the circuit board; instead, a USB link is used. Furthermore, the Arduino IDE makes programming easier by utilising a rearranged version of C++.In a nutshell, Arduino simplifies the functions of the microcontroller. The Uno is a popular board in the Arduino family and an extraordinary option for beginners (Farnell, 2013).

2.4.1.1 Digital Pins

The digital pins on an Arduino board can be used for general purpose input and output via the pin- Mode (), digitalRead (), and digitalWrite () commands. Each pin has an internal pull-up resistor which can be turned on and off using digitalWrite () (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite () function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.

2.4.1.2 Analog Pins

The analog input pins support 10-bit analog-to-digital conversion (ADC) using the analogRead () function. Most of the analog inputs can also be used as digital pins analog input 0 as digital pin 14 through analog input 5 as digital pin 19.

2.4.1.3 Power Pins

There are several power pins of Arduino:

i. 9V: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). Different boards accept different input voltages ranges.

ii. 5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply

iii. 3V3: (Diecimila-only) A 3.3-volt supply generated by the on-board FTDI chip.

iv. GND: Ground pins.

2.4.2 Raspberry Pi

The Raspberry Pi is a single-board computer, which means it's a computer, just like a desktop, laptop, or smartphone, but it's built on a single printed circuit board. The Raspberry Pi, like most single-board computers, is small roughly the same size as a credit card but that doesn't mean it's not powerful. A Raspberry Pi can do everything a larger and more power-hungry computer can do, though perhaps not as quickly.(Bharathi et al., 2018)

Figure 2.4Raspberry Pi 3

The Raspberry Pi family was created out of a desire to promote more hands-on computer education all over the world. Its creators, who came together to form the non-profit Raspberry Pi Foundation, had no idea how popular it would become: the few thousand built in 2012 to test the waters were quickly sold out, and millions have been shipped all over the world in the years since. These boards have made their way into homes, classrooms, offices, and data centres, factories, and even self-driving boats and space balloons (Bharathi et al., 2018).

2.4.2.1 GPIO Header pins

There are several GPIO header(pins)of Raspberry Pi:

i. 3V3: 3.3 volts power - A permanently-on source of 3.3 V power, the same voltage the Raspberry Pi runs at internally

ii. 5V: 5 volts power - A permanently-on source of 5 V power, the same voltage as the Raspberry Pi takes in at the micro-USB power connector

iii. Ground (GND) - A ground connection, used to complete a circuit connected to power source

iv. GPIO XX -The GPIO pins available for your programs, identified by a number from 2 to 27

v. ID EEPROM - Pins reserved for use with Hardware Attached on Top (HAT) and other accessories.

2.4.3 ESP32

The ESP32 is a single 2.4 GHz Wi-Fi/Bluetooth combo chip built on TSMC's ultra-low-power 40 nm technology. It is intended to provide the best power and RF performance while demonstrating robustness, versatility, and dependability in a wide range of applications and power scenarios (ESP, 2021)

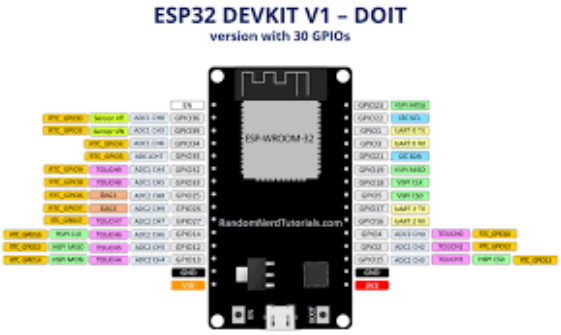

Figure 2.5 NOD MCU ESP32

The ESP32 is a highly integrated solution for Wi-Fi and Bluetooth IoT applications, with approximately 20 external interfaces constituents. The ESP32 includes an antenna switch, an RF balun, a power amplifier, a low noise receive amplifier, filters, and a microcontroller as well as power management modules as a result, the entire solution takes up very little Printed Circuit Board space (PCB)region.

2.4.3.1 Pins

There are several pins of ESP32:

i. Power: - Micro-USB: ESP32 can be powered through USB port

ii. 5V: Regulated 5V can be supplied to this pin which is we be again regulated to 3.3V by on board regulator, to power the board.

iii. 3.3.3V: Regulated 3.3V can be supplied to this pin to power the board.

iv. GND: Ground pins.

v. Enable: The pin and the button reset the microcontroller.

vi. Analog Pins: Used to measure analog voltage in the range of 0-3.3V.12-bit 18 Channel ADC

vii. DAC pins: Used for Digital to analog Conversion

viii. Input/Output Pins: Totally 39 GPIO pins, can be used as input or output pins. 0V (low) and 3.3V (high). But pins 34 to 39 can be used as input only

ix. Capacitive Touch pins: These 10 pins can be used a touch pin normally used for capacitive pads x. RTC GPIO pins: These 18 GPIO pins can be used to wake up the ESP32 from deep sleep mode

x. Serial: Used to receive and transmit TTL serial data.

xi. External Interrupts: Any GPIO can be used to trigger an interrupt.

xii. PWM: 16 independent channel is available for PWM any GPIO can be made to work as PWM though software

xiii. VSPI: Used for SPI-1 communication.

xiv. HSPI: Used for SPI-2 communication.

xv. IIC: Used for I2C communication

xvi. AREF: To provide reference voltage for input voltage

2.5 Motor

A motor is an electrical device that converts electrical energy into mechanical. Motors are designed to produce rotary or linear motion when their electric current and magnetic field interact, a process known as electromagnetic interaction.(Zaki et al., 2018)

2.5.1 DC Motor

A direct current (DC) motor is an electric machine that transforms electrical energy into mechanical energy. Direct current motors use direct current to convert electrical power into mechanical rotation.

Figure 2.6 DC Moter 12V

DC motors use magnetic fields generated by electrical currents to power the movement of a rotor fixed within the output shaft. The output torque and speed are determined by both the electrical input and the motor design.(Hammoodi et al., 2020)

2.5.1.1 Working principle of DC motor

A simple DC motor uses a stationary set of magnets in the stator, and a coil of wire with a current running through it to generate an electromagnetic field aligned with the centre of the coil. One or more windings of insulated wire are wrapped around the core of the motor to concentrate the magnetic field.

The windings of insulated wire are connected to a commutator (a rotary electrical switch), that applies an electrical current to the windings. The commutator enables each armature coil to be energised in turn, resulting in a consistent rotating force (known as torque). When the coils are turned on and off in sequence, a rotating magnetic field is created that interacts with the varying fields of the stator's stationary magnets to produce torque, which causes it to rotate. These key operating principles of direct current motors enable them to convert electrical energy from direct current into mechanical energy via rotating movement, which can then be used for object propulsion

2.5.2 AC motor

An alternating current (AC) motor is a motor that uses electromagnetic induction to convert alternating current into mechanical power. An alternating current drives this motor. The stator and rotor are the two most important components of an alternating current motor. The stator is the motor's stationary component, and the rotor is the motor's rotating component. The alternating current motor can be single phase or three phases.

Figure 2.7 AC Motor 240V

2.5.2.1 Working Principle of a Synchronous Motor

When power is applied to a synchronous motor, a revolving field is created. This field attempts to drag the rotor with it but is unable to do so due to rotor inertia. As a result, no starting torque is produced. As a result, an inherently synchronous motor is not a self-starting motor.

2.5.2.2 Working Principle of an Asynchronous Motor

The armature winding in an induction machine serves as both the armature winding and the field winding. When the stator windings are connected to an alternating current supply, flux is created in the air gap. The flux rotates at a fixed speed known as synchronous speed. This rotating flux causes voltages to be generated in the stator and rotor windings. When the rotor circuit is closed, current flows through the rotor winding and reacts with the rotating flux, producing torque. The rotor rotates at a speed very close to synchronous speed in the steady state

2.6 Pressure sensor

A pressure sensor is a device that converts a physical quantity into a signal. Among other things, we regularly monitor the pressure of liquid air and gases. The pascal is the standard unit of pressure. Pressure sensors are utilised in everything from roadways to machinery, automobiles, laboratories, and weaponry. One pascal equals one newton per metre squared.(Li et al., 2014)

Figure 2.8 Pressure Sensor

A pressure sensor receives an input value from the environment, monitors it, and displays it in one of multiple units throughout the world. In the United States, this is frequently referred to as pascal, bar, PSI, or pounds per square inch. The pressure in a tyre is an excellent example of pressure and how it is measured. As we pump the tyre, the effort exerted on it increases, causing the tyre to inflate. On contemporary automobiles, this is monitored via a pressure sensor located inside the tyre.(Li et al., 2014)

2.6.1 Pressure sensor working

In the net shell, the pressure is converted into a little electrical signal that is transferred and displayed. Because of this, they are also known as pressure transmitters. A 4 to 20 milli amps signal and a 0 to 5 V signal are two common signals. The piezoelectric effect is used in most pressure sensors. When a material responds to stress by generating an electrical charge, this is referred to as polarisation. The most common type of stress is pressure, although it can also include twisting, bending, or vibration. The pressure sensor senses pressure and can be used to indirectly measure flow, speed, water level, and altitude by measuring the electric charge.

2.6.2 Types of Pressure Sensor

Calibration of pressure sensors is required. It converts voltage to pressure because there is a pressure value for every voltage value. This is fundamental zero and spin calibration, often known as minimum and maximum, and is a regular task for maintenance employees. The pressure sensors allow us to measure many forms of pressure. In the industry, there are three forms of pressure that are commonly used:

2.6.2.1 Gauge pressure

This pressure is measured in relation to atmospheric pressure, which is usually 14.7 PSI. When it is above air pressure, it will display positive pressure; when it is below atmospheric pressure, it will show negative pressure.

2.6.2.2 Absolute Pressure

This would be the pressure as defined above absolute suction or comparable to the space suction. A complete vacuum has an absolute pressure of 0 PSIa and rises from there. This is the type of sensor we would use if we needed to read a pressure lower than atmospheric pressure.

2.6.2.3 Differential pressure

The difference between the two pressures sounds exactly like this. In industry, pressure sensors are utilised for a wide range of processes where a pressure is detected, and a reference pressure is set.

Some common applications include measuring steam pressure and relatively inexpensive sensors used for coarse measurement. Steam is commonly used to heat numerous processes in manufacturing facilities, including businesses where steam is used to generate energy. The pressure sensor can be used for a variety of reasons. The first and most obvious is to observe and monitor the pressure by connecting the plc to the scada.

Another function is to control when and where steam can flow, as well as to adjust its pressure. The pressure sensor can be used to detect the pressure of steam, which can build up in a vessel and become dangerous in companies that use steam to generate energy. This procedure of opening and closing the valve may be accomplished with easy programming in the PLC, where we will use ladder logic. Many businesses employed pressure sensors in conjunction with filters. If the filer becomes clogged, the flow will be reduced. Pressure might increase or drop when the flow of the liquid decreases, depending on which side of the filter is monitored.

2.7 Global positioning system (GPS) system

The Global Positioning System (GPS), formerly known as Navstar GPS, is a satellite-based radionavigation system owned by the US government and maintained by the US Space Force. It is one of the global navigation satellite systems (GNSS) that transmits geolocation and time information to a GPS receiver anywhere on or near the Earth where four or more GPS satellites have an unobstructed line of sight. Mountains and buildings, for example, can obstruct the comparatively weak GPS signals.(Wang et al., 2019)

2.7.1 Fundamentals of GPS

Based on data received from several GPS satellites, the GPS receiver estimates its own four-dimensional position in spacetime. Each satellite keeps an accurate record of its position and time, which it communicates to the receiver.(Patire et al., 2015)

The satellites are equipped with extremely stable atomic clocks that are synced with one another and with ground clocks. Any deviation from the time kept on the ground is adjusted regularly. Similarly, satellite locations are known with remarkable precision. GPS receivers also contain clocks, but they are less reliable and precise. Because the speed of radio waves is constant and independent of satellite speed, the time delay between when a signal is transmitted by the satellite and when it is received by the receiver is proportional to the distance between the satellite and the receiver. Four satellites must be visible to the receiver for it to compute four unknown quantities.(Patire et al., 2015)

2.7.2 Type of GPS

One of the four Global Navigation Satellite Systems is GPS, or Global Positioning System. GPS (US), GLONASS (Russia), Galileo (EU), and BeiDou (China) are the four worldwide GNSS systems (China). There are also two regional systems: QZSS (Japan) and IRNSS (NavIC) (India).

2.7.2.1 Global Positioning System (United States)

GPS is the most established GNSS system. It began operations in 1978 and became available for global use in 1994. The need for a self-contained military navigation capability spurred its development. And the US military was the first to notice. As a result, the Transit system was established in 1964 for this purpose. Transit, also known as NAVSAT, used the Doppler Effect to deliver location information and navigation to missile submarines, surface ships, and the US army's hydrographic survey and geodetic surveying. With the passage of time, GPS became available to the general population. GPS now has a 33-satellite constellation, with 31 of them in orbit and active. The US Air Force maintains it and is committed to it.(L. Zhou et al., 2019)

2.7.2.2 GLONASS (Russia)

Worldwide NAvigation Satellite System (GLONASS) is Russia's global navigation system. GLONASS began operations in 1993, with 12 satellites in two orbits at a height of 19,130 kilometres. There are now 27 satellites in orbit, all of which are active. GLONASS is the second alternate navigational system in use, operated by the Russian Aerospace Defence Forces.(Voronov, 2018)

2.7.2.3 Galileo (EU)

Galileo is the European Union's GNSS constellation, which is being built by the European Space Agency and will be operated by the European GNSS Agency. Galileo is a global navigation system that is both civilian and commercially available. The fully deployed Galileo system will have 30 operating satellites and 6 spares in orbit. Now, 22 of the 30 satellites are in orbit. Galileo began providing Early Operational Capability in 2016 and is scheduled to achieve full operational capability by 2020.(Oikonomou, 2017)

2.7.2.4 BeiDou (China)

BeiDou is China's Satellite Navigation System. It now has 22 operational satellites in orbit, with a total of 35 satellites planned for the whole constellation. BeiDou is divided into two constellations: BeiDou-1 and BeiDou-2. BeiDou-1, commonly known as the first generation, was a three-satellite constellation. It went live in the year 2000 and provided limited coverage and navigation services, mostly to customers in China and nearby regions. Beidou-1 was retired at the end of 2012.(M. Li et al., 2014)

2.7.2.5 QZSS (Japan)

The Quasi-Zenith Satellite System is a Japanese regional satellite navigation system that is still being built by the Satellite Positioning Research and Application Center. According to plans, the QZSS constellation will consist of seven satellites, four of which are already in orbit. QZSS is planned to be operational by the end of 2018, providing highly precise and stable positioning services in the Asia-Pacific area. QZSS will be GPS-compatible.(Naqvi et al., 2013)

2.7.2.6 IRNSS — NAVIC (India)

The Indian Regional Navigation Satellite System (IRNSS), later known as NavIC or NAVigation with Indian Constellation, is India's regional satellite navigation system. IRNSS, which was launched and is operated by the Indian Space Research Organization (ISRO), covers India and adjacent territories with a range of up to 1,500 kilometres. All seven satellites are in orbit, but the first – IRNSS A – is no longer operational because ISRO revealed last year that all three atomic clocks on it had failed.(Santra et al., 2019)

2.8 Internet of things (IoT)

The Internet of Things (IoT) refers to physical objects (or groups of such objects) that are integrated with sensors, processing power, software, and other technologies that connect to and exchange data with other devices and systems over the Internet or other communication networks.

Because of the confluence of numerous technologies, such as ubiquitous computing, commodity sensors, increasingly sophisticated embedded systems, and machine learning, the area has progressed. Traditional domains such as embedded systems, wireless sensor networks, control systems, and automation (including home and building automation) enable the Internet of things both separately and jointly. In the consumer market, IoT technology is most closely associated with products related to the concept of the "smart home," such as devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems and can be controlled by devices associated with that ecosystem, such as smartphones and smart speakers. The Internet of Things can also be employed in healthcare systems. (Farooq et al., 2019)

2.8.1 Applications of IoT

The diverse variety of applications for IoT devices is frequently classified as consumer, commercial, industrial, and infrastructural.

2.8.1.1 Environmental monitoring

Environmental monitoring IoT applications often use sensors to aid in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even encompass topics such as tracking wildlife movements and habitats. The development of resource-constrained devices linked to the Internet also means that additional applications, such as earthquake or tsunami early-warning systems, can be employed by emergency services to provide more effective assistance. In this application, IoT devices often cover a vast geographic region and can even be mobile. It has been proposed that the uniformity brought about by IoT will transform wireless sensing.

2.9 Existing related project

2.9.1 Ammonia Gas Leakage Monitoring System Using MQ-137 Sensors, IoT and Framing suitable Reflexive Actions

Based on the research that has been done, there are several similar products related to this current project. One of the projects known as “IJARCCE Ammonia Gas Leakage Monitoring System using MQ-137 Sensors, IoT and Framing suitable Reflexive Actions” by (Srinath et al., 2007).

In this project, Raspberry pi was used as primary microcontroller, which is always online, and it is connected to sensors such as ammonia sensor, pressure sensor and some mechanical part such as actuator like valve system, indicator for alarm and water pump the system. The mechanism of this system work as the measure data of different sensors will be sending to raspberry pi and uploaded to the cloud. Then, the android-based end devices can access the data and take the appropriate actions based on the requirement or the criteria develop by the user(Srinath et al., 2007).

The strength of this project is the implementation of Internet of things (IoT) concept. Android application is used to monitor and control the sensors and actuator that are connected to the microcontroller through the cloud 6 services. This helps the user to access the information about their monitoring and control them from anywhere in the world through internet platform easily. on her project(Srinath et al., 2007).

2.9.2 Implementation of Ammonia Gas Leakage Detection & Monitoring System using Internet of Things

This project made use of a MQ-137 ammonia gas sensor and an Arduino Mega as a microcontroller, both of which were based on the ATmega1280. The project also used a siren and LEDs to signal when an ammonia gas leak was discovered. This system makes advantage of the IoT (Internet of Things) concept(Vijayalakshmi et al., 2019).

The sensor data is sent to an Arduino Mega microcontroller, which relays it through USB. The limitation is that it does not have any safety countermeasures and can only detect ammonia(Vijayalakshmi et al., 2019).

2.9.3 Interfacing of Ammonia Gas Sensors using IoT Technology

This project employed an ammonia gas sensor, the Arduino Mega as a microcontroller both of which were based on the ATmega1280, and the IoT concept (Internet of Things). The project's goal is to find an ammonia gas leak in the refrigeration system. Cloud technology is used to digitally transport or store the data via ThingSpeak. The author proposes using the MQ-137 ammonia gas (NH3) sensor to prevent ammonia gas leakage(Muthukrishnan, 2017).

Table 2.1 Existing of Related Project

No	Title/Year/Authors	Sensor/ Monitoring System	Strength	Weakness
1	"Ammonia Gas Leakage Monitoring System Using MQ-137 Sensors, IoT and Framing suitable Reflexive Actions" By (Vishesh S, Manu Srinath, Nakul R B, Vivek Adithya, Pragathi Prema Kumar, Swathi S, November 2016)	Sensor: MQ-137 Monitoring System Cloud wirelessly using a Wi-Fi module	-The leakage data is recorded for study of the situation and to develop innovative methods to take preventive measures	-The system not clearly state how to pass alert signal to the nearest hospital, fire station, police station and other authorities
2	"Implementation of Ammonia Gas Leakage Detection & Monitoring System using Internet of Things" By (J.Vijayalakshmi, Dr.G.Puthilibhai, .R.Leoram Siddarth, 2019)	Sensor: MQ-137 Monitoring System Laptop/Personal computer/Mobile phone	-Prevent to direct expose to leakage ammonia gas	-Precaution steps are not possible. -No alert notification. -Long monitoring time. -Lot of manual work
3	"Interfacing of Ammonia Gas Sensors Using IoT Technology" By (Tarun George Maddila, Swetha Santhossi.C, Abhishek Muthukrishnan, August 2017)	Sensor: MQ-137 Monitoring System Not stated	-Good in alert system (buzzer + LEDs)	-No stated monitoring system

2.10 Summary

The authors have detailed the ideas and methodologies used in this project to develop an Ammonia Gas Leakage Detection and Monitoring System in this chapter. The suitable components will be chosen in accordance with the project's objectives. Following that, adjustments will be made depending on the data collected on the project connected to the project to be completed.

CHAPTER 3

METHODOLOGY

3.1 Introduction of methodology

This chapter will elaborate in detail about hardware and software development such as coding, equipment, procedure, and design of implementation of the development and fabrication of ammonia gas leakage detecting and monitoring system.

3.2 Flowchart for proposed system

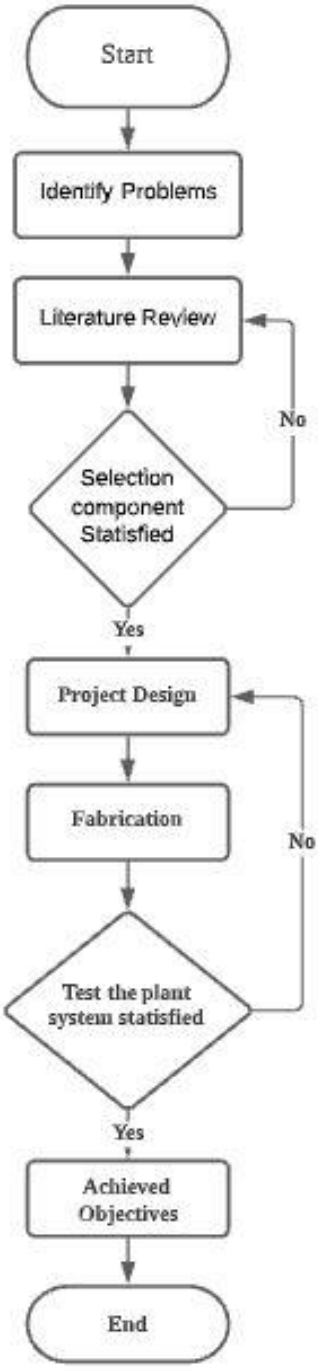

Figure 3.1 Overall research flowchart

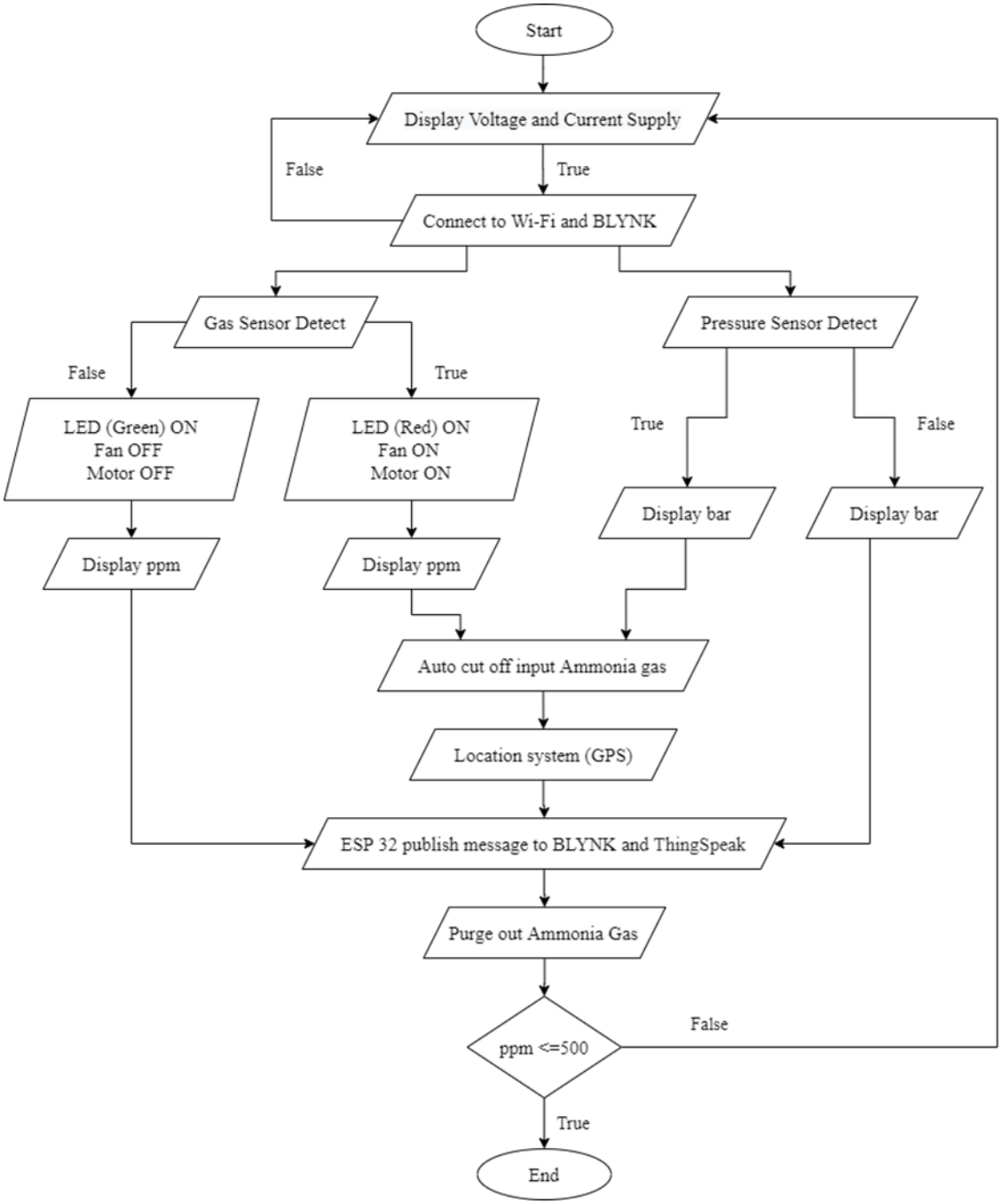

Figure 3.2 Flowchart of system

Figure 3.1 and Figure 3.2 shows the flowchart of proposed system. This proposed system is made up of several functional subsystems, including a detecting system, a precaution system, a purging system, a GPS system, and a monitoring system. A gas

sensor and a pressure sensor are part of the detecting system. The MQ-135 gas sensor detects ammonia gas leakage in units of ppm outside the Storage tank, while the pressure sensor measures the change in ammonia gas pressure in units of bar inside the Tanks. The precaution system includes green and red LEDs and a buzzer to warn workers and officials, as well as a solenoid valve that will immediately cut off the entry of ammonia gas if a leakage develops.

The purging system contains a water spray and fans that are only activated based on the threshold value of the MQ135 sensor, which is set based on the kind of sensor. Simultaneously, the GPS module will transmit the location to the IoT system, which is the monitoring system. Monitoring system based on the Internet of Things concept, comprising of Blynk and ThingSpeak software. When an ammonia gas leak occurs, officials can remotely monitor and check the data flow using the Blynk and ThingSpeak applications for mobile phones and the web. A Wi-Fi connection is essential to guarantee the Monitoring system is operational.

3.3 Fabrication Method

The process to manufacture the prototype of ammonia plant is being done using metal pipes and galvanized. First, the upper and lower surfaces of the iron pipe section are welded in order to make an ammonia storage tank.

The second process is to place the pressure sensor on the ammonia gas storage tank. The ammonia gas storage tank has been punched in the middle of the tank and welded once the sheath to insert the pressure sensor. This procedure ensures that there is no gas leaking around the pressure sensor. The ammonia gas storage tank pipeline connection method will then be welded connected with the storage tank at the bottom of the tank using the pipe connector head procedure.

The final process involved the installation of the MQ135 sensor on the ammonia storage tank, as well as the installation of pipelines for connections on the first and second storage tanks, as well as the installation of a safety valve to act as a pathway for ammonia gas from the supply tank.

3.4 Component selection

3.4.1 Microcontroller

A microcontroller (MCU, which stands for microcontroller unit) is a miniature computer that is built on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip. A microcontroller is made up of one or more CPUs (processor cores), memory, and programmable input/output peripherals. A tiny amount of RAM, as well as programme memory in the form of ferroelectric RAM, NOR flash, or OTP ROM, is frequently provided on chip. Microcontrollers, as opposed to microprocessors used in personal computers or other general-purpose applications, are developed for embedded applications, and are made up of various discrete chips(Bharathi et al., 2018).

3.4.1.1 Raspberry Pi

The Raspberry Pi was designed to be a very flexible and powerful computer that can be used by anyone to solve issues creatively at a fraction of the cost of a standard PC. Its numerous strengths easily outnumber its limits. As a result, it is an easy solution for data storage, such as in field solutions. Reading data from an SD card, on the other hand, necessitates some additional procedures on Mac and Windows operating systems. The Raspberry Pi can also write data to an external hard drive or USB stick plugged into a USB port. However, keep in mind that this will draw current, which is undesirable for battery-powered systems. When connected to the same network, you can also access the Raspberry Pi's data by mounting it as a network drive.

The Raspberry Pi can be configured as a NAS server, offering a low-cost alternative to commercial solutions. The Raspberry Pi can also mount a network drive, which might be a dedicated NAS server or a folder on another networked computer, enabling automatic storage and backup options. When working with an array of connected Raspberry Pis, such a central storage unit is extremely useful. Rsync is a fantastic tool for assisting with the automatic transmission of data across a network. This can also be very useful for remote recording systems with internet connectivity, such as those linked via a mobile network dongle(Bharathi et al., 2018).

3.4.1.2 Esp32 Devkit Doit

This page serves as an introduction to the ESP32 development board. If you've heard of the ESP8266, the ESP32 is its successor. The ESP32 comes with a slew of new features. The most important feature is that it combines WiFi and Bluetooth wireless capabilities and is dual core.

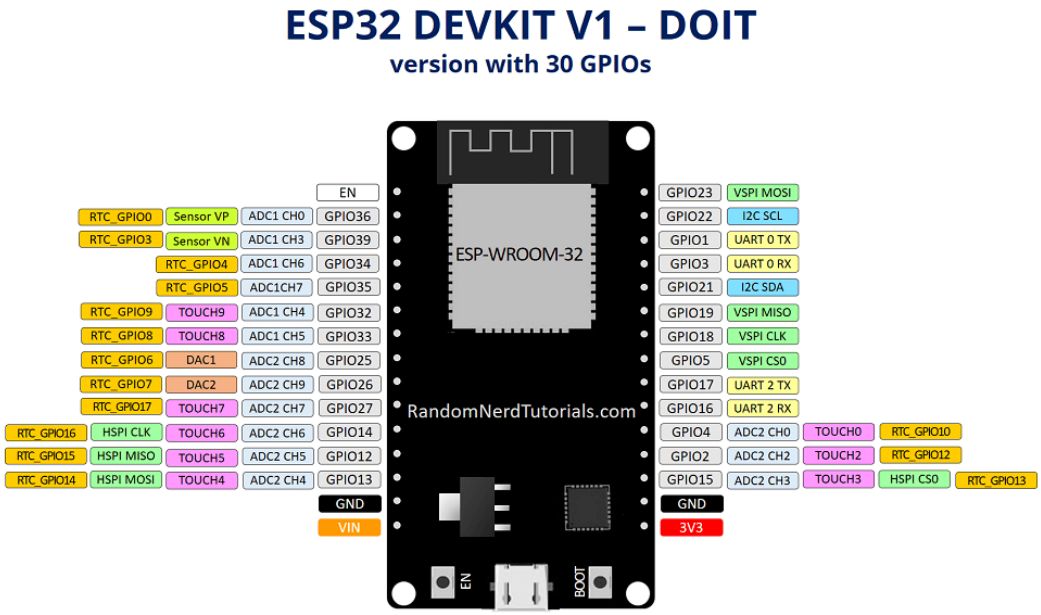

Figure 3.3 ESP-WROOM-32 chip

In this article, we'll be referencing the ESP32 DEVKIT DOIT board. However, the information on this page is also applicable to other ESP32 development boards that use the ESP-WROOM-32 (ESP, 2021).

3.4.2 Sensor MQ135

The MQ135 gas sensor's sensitive substance is SnO2, which has a reduced conductivity in clean air. When the target polluting gas is present, the sensor's conductivity increases in tandem with the gas concentration. A simple circuit can be used to translate the change in conductivity to the corresponding output signal of gas concentration.

The MQ135 gas sensor has a high sensitivity to ammonia gas, sulphide, and benzene series steam, as well as the ability to monitor smoke and other dangerous gases. It can detect many harmful gases and is a low-cost sensor for a variety of applications(Sai et al., 2019).

3.4.3 Voltage Regulator

Voltage regulator is used to make the output voltage stable in a circuit. It is used to step down the 12 V supply from power source to power up the Arduino and servo motor. Voltage regulator will step down the 12 V to 5V. Voltage regulator is used to maintain voltage within a range where it can be supported by the equipment using its voltage. In this project DC-DC step down module LM2596 voltage regulator will be used(Hock et al., 2018).

3.4.4 Indicator

For this project, we will use a piezo buzzer as an indication. In its most basic form, a piezo buzzer is a sort of electronic device that emits a tone, alert, or sound. It is lightweight, has a simplistic design, and is often a low-cost product(J. Zhou et al., 2019).

Figure 3.4 MS-190 Mini Warning Siren Alarm

Because active buzzers include the driving circuitry, a simple active high logic level signal will trigger the buzzer. A piezo buzzer also can support any voltage that is in between 3V to 20V. Due to excellent frequency response, small size, wide voltage usage range, high sound level, less energy usage, and easy compatibility are the main reason for used this type of buzzer. Active Buzzer are the buzzer that we decide to use for this project. A buzzer, often known as a beeper, is a type of auditory signaling device that can be mechanical, electromechanical, or piezoelectric. Alarm devices, timers, and confirmation of human input such as a mouse click, or keystroke are common applications for buzzers and beepers(J. Zhou et al., 2019).

3.4.5 Motor Pump

A direct current (DC) motor is a type of rotary electrical motor that converts direct current electrical energy into mechanical energy. The most prevalent types are based on magnetic field forces. Almost all types of DC motors contain an internal mechanism, either electromechanical or electronic, that changes the direction of current in a portion of the motor on a regular basis. Because they could be supplied by existing direct-current lighting power distribution networks, DC motors were the first type of motor that was widely used. The speed of a direct current motor can be varied over a large range by varying the supply voltage or adjusting the current intensity in its field windings(Workneh et al., 2020).

Figure 3.5 DC Motor

The universal motor is a lightweight brushed motor that can operate on direct current and is used for portable power equipment and appliances. Larger DC motors are being employed in electric vehicle propulsion, elevator and hoist drives, and steel rolling mill drives. With the introduction of power electronics, it is now possible to replace DC motors with AC motors in a wide range of applications. HANPOSE model 775 DC Motor with 12000RPM will be used in this project(Workneh et al., 2020).

3.4.6 Jumper wires

Jumper wires are simply wire with connector pins at either end that can be used to connect two places without soldering. Jumper wires are commonly used with breadboards and other prototyping tools to allow for quick circuit changes as needed. Fairly simple. In fact, it does not get much more basic than jumper wires. Jumper wires are used in circuits to link two places. Jumper wire is available from All Electronics in several lengths and assortments. Frequently used in conjunction with breadboards and other prototyping tools to make it simple to change a circuit as needed. Male-to-male, male-to-female, and female-to-female jumper wires are the most common. The

distinction between the two lies in the wire's terminating point. Male ends feature a protruding pin and can be plugged into items, but female ends do not and are used to plug into objects(Hemmings, 2018).

Figure 3.6 Jumper wires

3.4.7 LED

LED is a two-lead semiconductor light source that emits light. When an appropriate voltage is applied to the LED terminal, then the electrons can recombine with the electron holes within the device and release energy in the form of photons. This effect is known as electroluminescence. The colour of the LED is determined by the energy band gap of the semiconductor. The forward voltage requires to turn ON an LED, depends on the colour of the LED. You can connect an LED straight to the source if you feed the

exact value of forward voltage. If the voltage is too high, connect a resistor to the LED in series(Wu et al., 2018).

Figure 3.7 LED

3.4.8 Electric solenoid valves

The Brass - Series Semi-Direct acting, 2 Way General Purpose Solenoid Valves provide and on-off control of inherit liquids and gases. Suitable for commercial and residential applications. This valve type is gravity feed capable and is deal for low pressure fluid appliations. Available in sizes from 3/8" - 2" in both Normally Closed and Normally Open operating positions(McLean et al., 2021).

Figure 3.8 Two Way Brass Electric Solenoid Valve Normally Closed

Not intended for continuous use (not a 100 percent duty cycle). Under normal working conditions, the solenoid valve will become HOT while energised. The coil will attain a maximum temperature of approximately 176°F (80°C), completely complying with the national standard: JB/T7352-2010. If the coil is continually energised for more than 8 hours, it may burn(McLean et al., 2021).

3.4.9 8 Channel 5V Relay Module

This is an 8-channel LOW level trigger relay that can be used with the ESP32. Relays can be used to power high-power electronic devices such as lights, electric fans, and air conditioners. By connecting it to an MCU, a relay can be used to regulate high voltages with a low voltage(Qin et al., 2020).

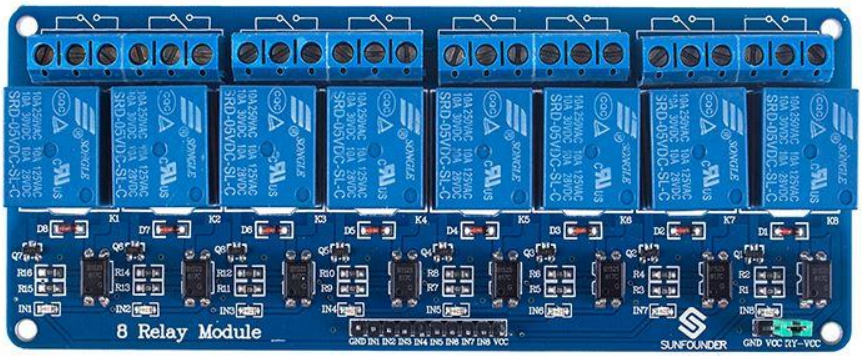

Figure 3.9 8 Channel 5V Relay Module

3.4.10 Momentary Push Button Switch

A push button switch generates a transient change in an electrical circuit only when the switch is pushed. A spring immediately returns the switch to its original position. The pushbutton is usually constructed of plastic or metal and can be flat or curved to the finger or hand(Klamka & Dachselt, 2018).

Figure 3.10 Push Button Switch

They are developed and manufactured to the highest quality requirements and are also known as momentary switches. We provide push button switch kinds ranging from ordinary to IP-rated. Alcoswitch and KISSLING switches are part of our range, and frequent applications include emergency stop (e-stop) and alarm switches, calculator buttons, doorbells, and refrigerator light switches(Klamka & Dachselt, 2018).

3.4.11 One Way Gas Check Valve

A check valve, non-return valve, reflux valve, retention valve, foot valve, or one-way valve is a valve that generally enables fluid (liquid or gas) to flow through it in only one direction. Check valves are two-port valves, which means they have two openings in the body, one for fluid to enter and one for fluid to exit. Check valves come in several styles and are utilised in a wide range of applications. Check valves are frequently found in everyday household products(Dokoupil et al., 2019).

Figure 3.11 Gas Check Valve

Check valves, despite being available in a wide range of sizes and prices, are often quite small, basic, and affordable. Check valves operate automatically and are not controlled by a person or any external control; as a result, most lack a valve handle or stem. Most check valve bodies (external shells) are constructed of plastic or metal. The cracking pressure, which is the lowest differential upstream pressure between the intake and exit at which the valve will operate, is an important concept in check valves. The check valve is often constructed for, and so can be specified for, a specific cracking pressure(Dokoupil et al., 2019).

3.4.12 Pressure Transducer Sender Sensor

A pressure sensor can detect pressure degradation caused by a system leak. This is generally accomplished by comparing differential pressure to a known leak or by using the pressure sensor to monitor pressure change over time(Mishra et al., 2021).

Figure 3.12 Pressure Transducer Sender Sensor

3.5 Budget analysis

This section will go into the costs of purchasing hardware and software, such as equipment, as well as the design and execution of ammonia gas leakage detection and monitoring systems that show in Table 3.1.

Table 3.1 Cost analysis

NO	ITEM	PRICE(RM)
1	Raspberry Pi 4	RM 189
2	Jumper wire, MQ135	RM 31.30
3	Raspberry Pi 4 Display	RM 82.15
4	ESP32	RM 29.50
5	Trigger switch relay, jumper wire, breadboard, esp32, water pump motor, GPS module	RM 97.40
6	Warning siren alarm	RM 26.28
7	Pressure Transcunder Sender Sensor	RM 69.36
8	Electric Solenoid Valve	RM 45.41
9	Air compressor pressure gauge	RM 24.60
10	Water sprinkle	RM 33.21
11	Electric solenoid valve & gas check valve	RM 29.85
12	Cylinder Adapter connector converter	RM 15
13	Electric solenoid valve	RM 17.41
14	GP back up battery 12V	RM 40.80
15	Push button switch connector, push button momentary electrical screw terminal block	RM 25.35
16	Dc 12v 2 PIN Desktop/ CPU cooling fan	RM 12.50
17	Acrylic Sheet/Perspex A3/A2	RM 125.40
		RM 896.52

3.6 Summary

In this chapter, the author has explained about flow, method and material that used to design the fabrication of ammonia gas leakage detection and monitoring system.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter explain about results obtained based on the fabrication in this prototype of ammonia plant. Discussion was made based on the results which was obtained through this prototype.

4.2 Final design

This system contained several functional subsystems, including a detecting system, a precaution system, a purging system, a GPS system, and a monitoring system. The detection system is based on a gas sensor and a pressure sensor. The MQ-135 gas sensor detects ammonia gas leakage in units of ppm outside the Tanks, while the pressure sensor measures the change in ammonia gas pressure in units of bar inside the Tanks. The precaution system includes Green Red LEDs and a Siren Alarm to warn workers and officials, as well as a solenoid valve that will automatically cut off the entry of ammonia gas if a leak develops. The purging system, which includes a water sprinkler pump and fans, is only activated when the sensors detect something, with the threshold value varied based on the type of sensor. Simultaneously, the GPS module will transmit the location to the IoT system, which is the monitoring system. Monitoring system based on the IoT concept, comprising of Blynk and ThingSpeak. When an ammonia gas leak occurs, officials can remotely monitor and check the data exchange using Blynk and ThingSpeak on mobile phones and the web. A Wi-Fi connection is essential to guarantee the Monitoring system is operational, reference to the Figure 4.1 and to Appendix A.

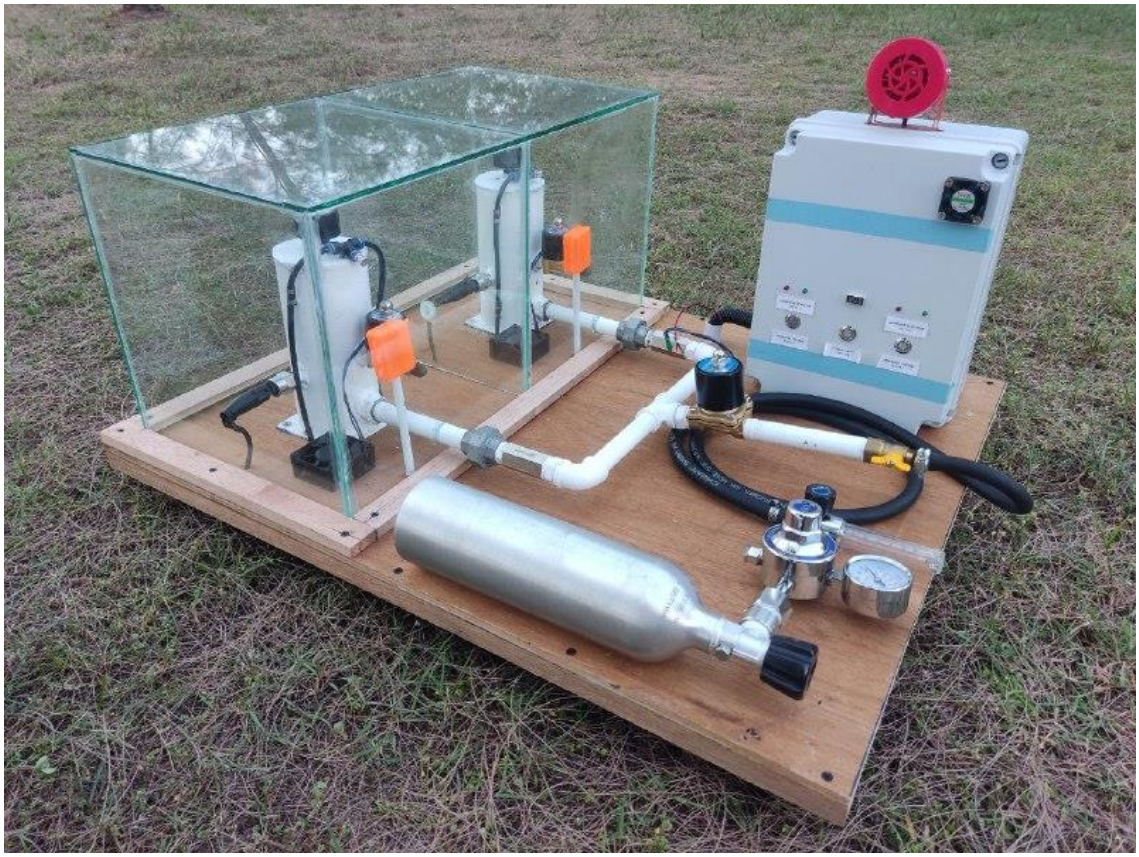

Figure 4.1 Fabrication for ammonia plant system.

The suggested system is designed in the prototype as two semi-enclosed rooms, each containing one Tank. The pressure sensor is installed inside both tanks to measure the change in ammonia gas pressure inside the tanks. The gas sensor is installed on the outside of both tanks to ensure that the environment around the tanks is safe and clean. The prototype contains three solenoid valves, one of which is used to cut off the inflow of ammonia gas and the other two of which are used to leak the ammonia gas from the Tank. When you press the proposed system's start button, the control box will display the voltage and current supply values to check that the power supply is sufficient to run the entire proposed system. The proposed system connects to Wi-Fi and Blynk when the power supply is turned on. The gas and pressure sensors will begin to function. Ammonia gas is supplied into two tanks via a solenoid valve and then passed through a one-way valve. The control box contains two buttons for controlling the leakage of ammonia gas via a solenoid valve

4.2.1 Circuit of system

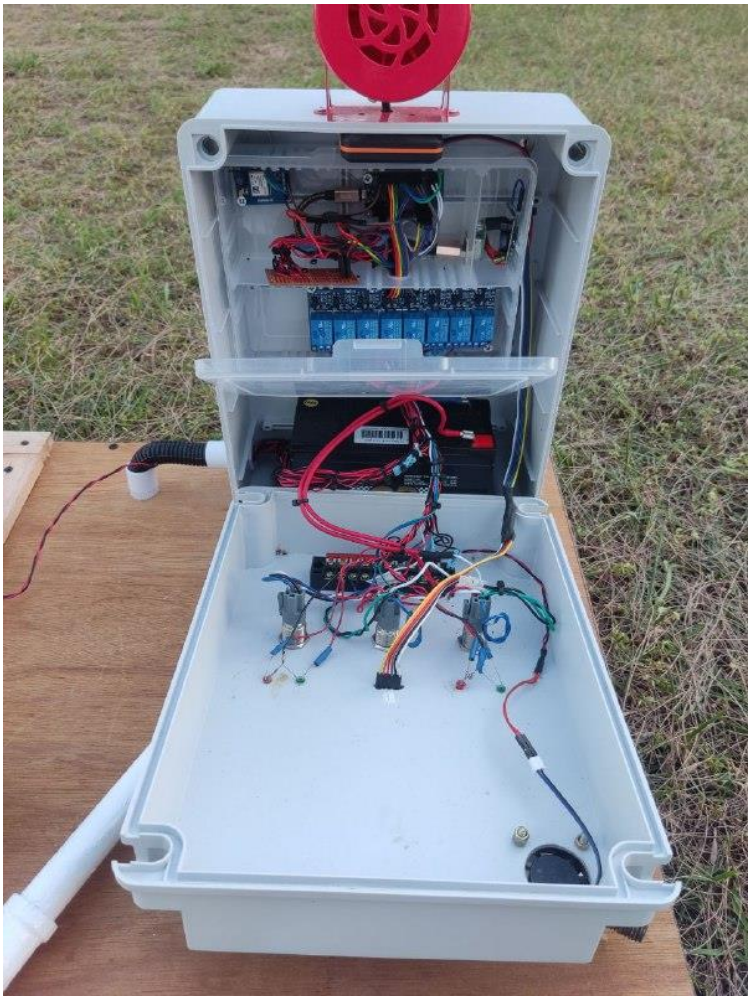

Figure 4.2 The connection from the supply to the esp32 and all output system.

The Figure 4.2 show wiring circuit for the entire ammonia gas leak detection system makes full use of the power supply from the 12V dc battery, which will begin by connecting the supply to the system's main switch, which will split into two circuit paths, the first of which will be connected at the output supply for each output device of the 8-way relay module including buzzer, motor pump, safety valve, ventilation fan, and another circuit will continue to enter the voltage regulator on the next circuit route, which serves to reduce the supply voltage value from 12V dc to 5V dc. The power to switch on the microcontroller node mcu ESP32 and GPS will be drawn from the voltage value that has been decreased to 5V.

4.2.2 Ammonia storage tanks

Figure 4.3 In storage room also will be put vantilation fan and MQ135.

Figure 4.3 depicts an overview of the arrangement of two sensors, namely the pressure sensor and the MQ135 sensor, as well as two purging systems in each room of the ammonia gas storage tank, each of which is a water sprinkler to function as an absorber of ammonia gas that is released excessively during leakage by absorbing molecules. In the ammonia gas storage tank chamber, ammonia gas penetrates the water that has been sprayed in all directions. Following that are ventilation fans that suck up ammonia gas that has accumulated in the storage tank room by removing excess ammonia gas to the open space region.

4.2.3 Pipeline system

Figure 4.4 Show the pipeline sytem from the input system gas

The Figure 4.4 show the system is designed in the prototype as two semi-enclosed rooms, each containing one Tank. The pressure sensor is installed inside both tanks to measure the change in ammonia gas pressure inside the tanks. The gas sensor is installed on the outside of both tanks to ensure that the environment around the tanks is safe and clean. The prototype contains three solenoid valves, one of which is used to cut off the

inflow of ammonia gas and the other two of which are used to leak the ammonia gas from the Tank.

4.2.4 Ammonia supply tank

Figure 4.5 The gas regulator for reduce the pressure of gas from 1000psi to 100psi

The ammonia gas supply tank operating system, depicted in Figure 4.5, will be integrated into the ammonia gas storage tank manufacturing system. The pressure in the distribution tank is 1000 psi and must be decreased to 150 psi to avoid damage to the pressure sensor component. Additionally, high pressure can reduce the longevity of the ammonia storage tank. Thus, at the initial exit route of ammonia gas from the distribution

tank, there is a regulator gas that will only allow a specified pressure rate to reach the ammonia storage tank.

4.2.5 Purging system

Figure 4.6 System for reduce the ppm of ammonia gas in the storage room.

The purging system, which includes a water sprinkler pump and fans, is only activated when the sensors detect something, with the threshold value varying based on the type of sensor. Simultaneously, the GPS module will transmit the location to the IoT system, which is the monitoring system. Monitoring system based on the IoT concept,

comprising of Blynk and ThingSpeak. When an ammonia gas leak occurs, officials can remotely monitor and check the data exchange using Blynk and ThingSpeak on mobile phones and the web.

4.3 Final fabrication

In this section, gas ammonia at a pressure of 100 PSI will be fed through the system pipeline directly to the first and second storage tanks. The pressure readings will be recorded by the pressure sensor and displayed on the Blynk system. next the gas leakage system will be turned on to remove ammonia gas in the storage tank to test the gas ammonia detection system.

Figure 4.7 Show the final process for testing the fabrication sytem.

4.4 Overall result of the system

The user interface implemented is an open-source platform, with Blynk serving as the initial platform for application monitoring and ThingSpeak serving as the second platform for web monitoring. A broker/microcontroller is required to obtain the data for the sensor readings to be relayed through Blynk and ThingSpeak. The broker facilitates connectivity between the device and the IoT. Without the broker, data transmission and reception are impossible. As a result, we chose Nodemcu ESP32 as a wireless data

transmission broker. The NodeMCU ESP32 is a moderate, low-power system-on-a-chip microcontroller with Wi-Fi and dual-mode Bluetooth built in. Since it has Wi-Fi and dual-mode Bluetooth, it can be used. It can link to Blynk and ThingSpeak to gather data from sensors because it has Wi-Fi and dual-mode Bluetooth.

4.4.1 ThingSpeak

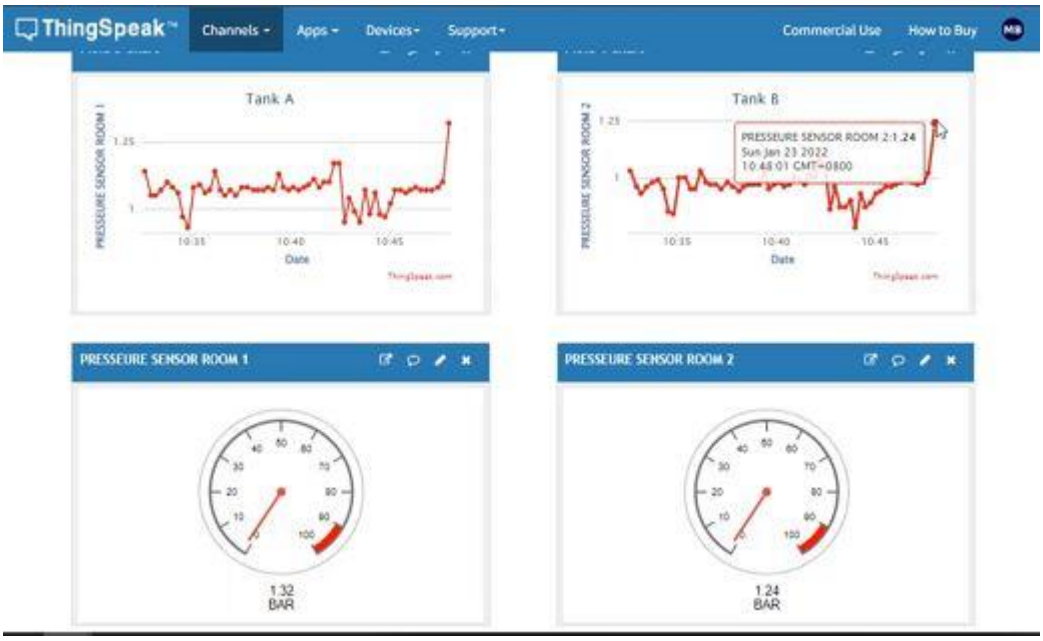

Figure 4.8 Pressure of gas increasing in the storage tank results in ThingSpeak

Before gas leakage occurs, the monitoring system for the detection system of the prototype project on ThingSpeak web is displayed shows in Figure 4.8. The results of pressure sensors identified in Room A are displayed on the left side of the GUI, while the results of pressure sensors identified in Room B are displayed on the right side. Pressure measurements on the graft and metre gauges have showed that when the gas storage system is completed to store ammonia gas from the distribution tank to each storage tank in each room, pressure readings have increased on a regular basis. When the pressure sensor detects the existence of ammonia gas pressure in rooms A and B, the system records the value of the pressure observed in each storage tank.

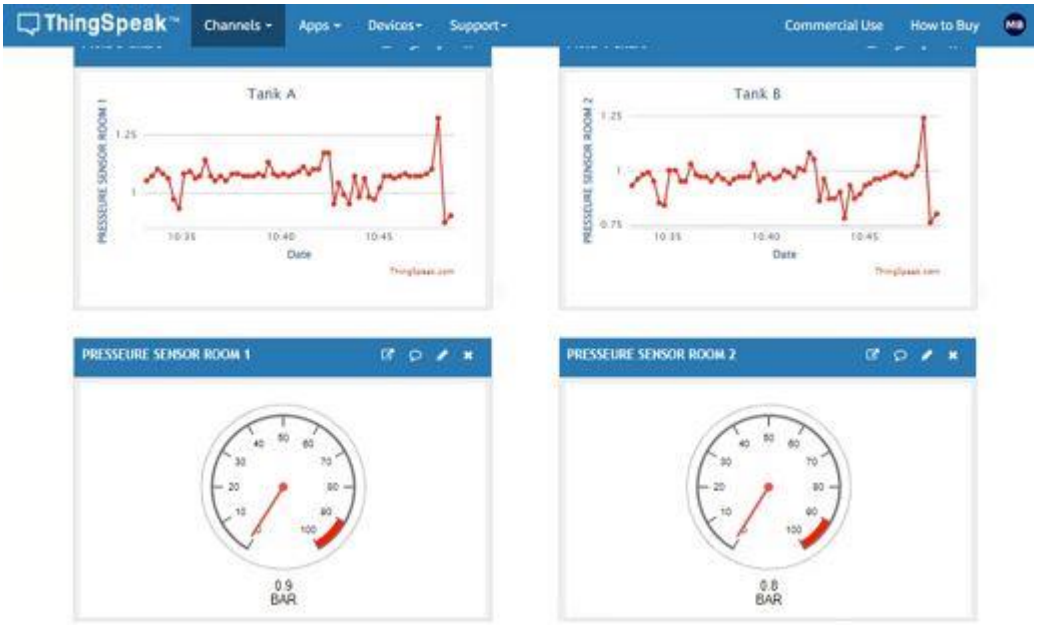

Figure 4.9 Pressure sensor detection gas leackage in tanks results in ThingSpeak

Figure 4.9 displays the monitoring system for the detection system of the prototype project on ThingSpeak web. The pressure sensor's initial findings in Room A are presented on the left side of the GUI, while the pressure sensor's initial results in Room B are displayed on the right side. The pressure readings on the graft and gauge dropped drastically when an ammonia gas leak occurred in the gas storage tank. When the pressure sensor detects the existence of low ammonia gas pressure in rooms A and B, the system records the value of the remaining pressure in each storage tank. Users can validate the location of the leak between the ammonia storage tanks here.

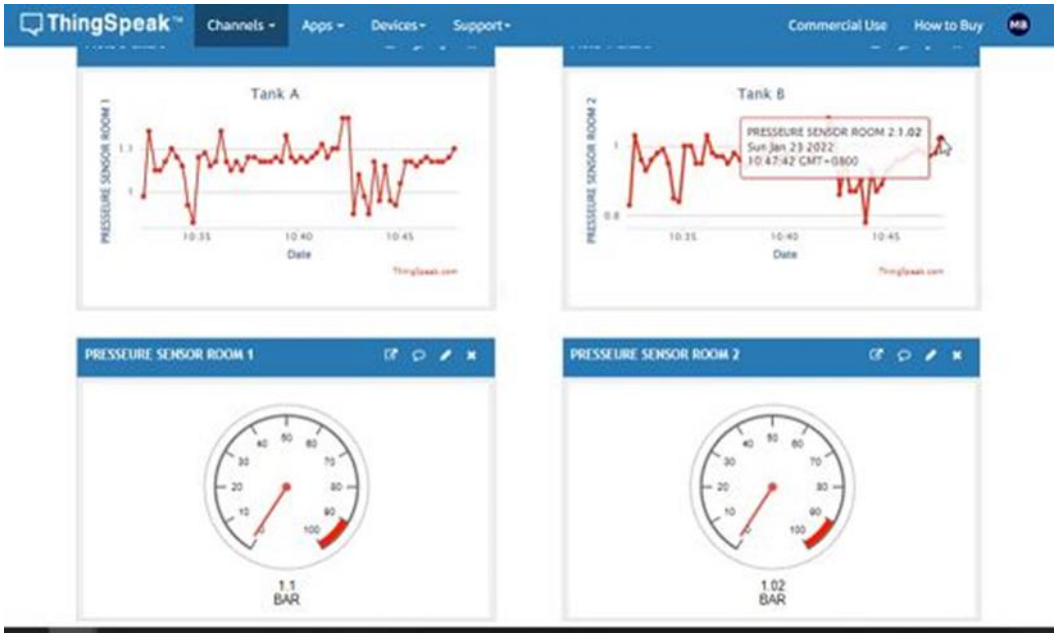

Figure 4.10 Pressure sensor detection after purging system results in ThingSpeak

Figure 4.10 shows illustrates that the graft and pressure gauge readings do not continue to fall significantly, as well as the pressure rate that persists after the cleaning system is triggered after the pressure sensor detects ammonia gas leaks in rooms A and B. It has been demonstrated here that ammonia gas leaks may be regulated and recognised. Each storage tank's ammonia gas pressure is measured using a purging mechanism.

Figure 4.11 Gas sensor before detecting any leaks in ThingSpeak

Figure 4.11 captures the monitoring systems for the prototype project's detection system in ThingSpeak site. The upper side of the GUI displays the initial result of the MQ-135 sensor in Room A, while the lower side displays the initial result of the MQ-135 sensor in Room B. Before a leak in the gas storage tank between rooms A and B, the graft reading on the MQ135 gas sensor was at an optimal rate. Following that, the ppi metre reading revealed no change in the gas content in each room, indicating that it had no longer entered the reading at a harmful level.

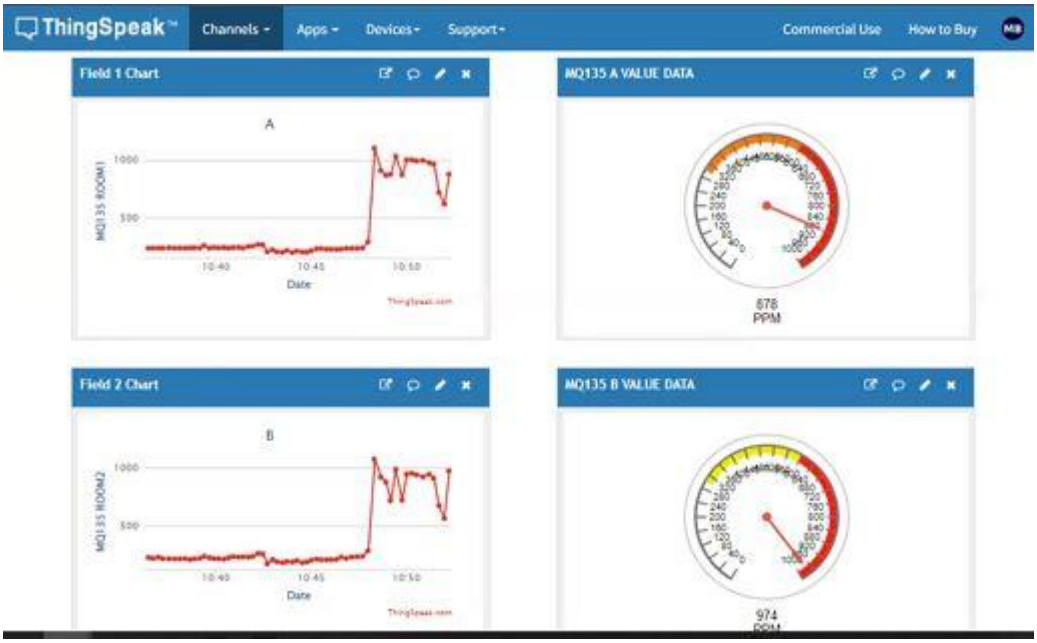

Figure 4.12 Gas sensor detection during leackage results in ThingSpeak

Once ammonia gas leakage occurs, the monitoring system for the detection system of the prototype project on ThingSpeak web is displayed in Figure 4.12. The results of MQ-135 sensors in Room A are displayed on the upper side of the GUI, while the results of MQ-135 sensors in Room B are displayed on the below side. During the occurrence of a leak in the gas storage tank between rooms A and B, the graft reading on the MQ135 gas sensor rises. The ppi metre reading then displays an increase in the amount of gas in each area until it reaches a dangerous level.

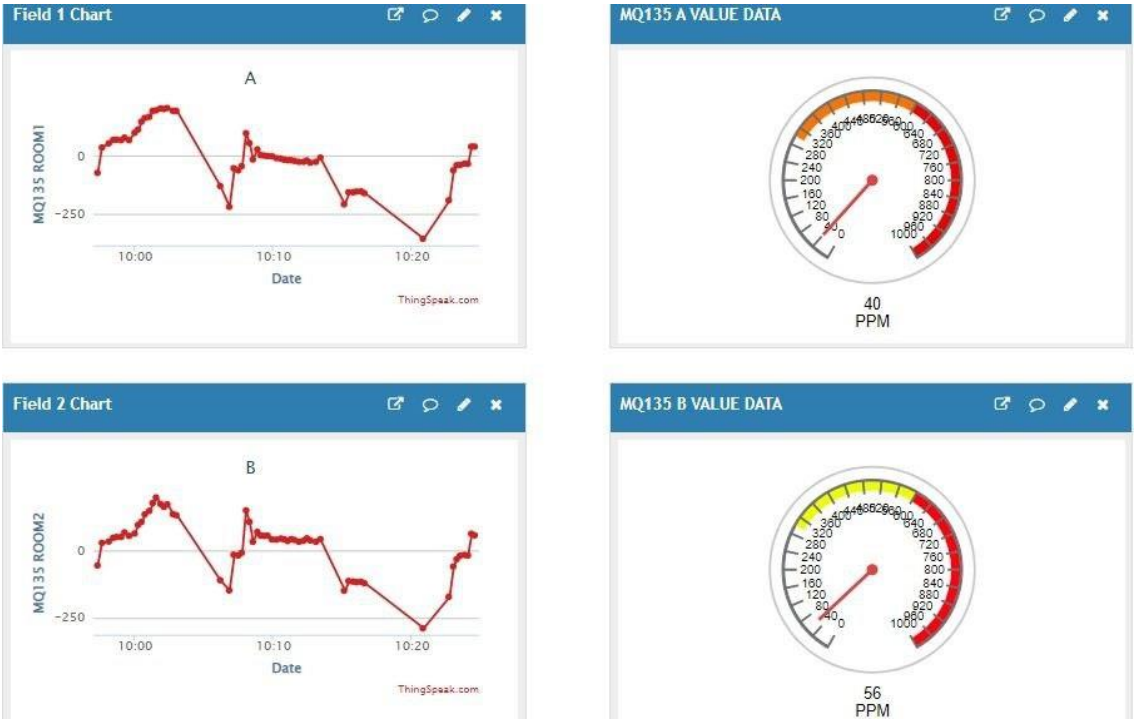

Figure 4.13 Gas sensor detection after purging system results in ThingSpeak

Figure 4.13 indicates that the graft and gauge readings reduced on a regular basis after the purging system was activated after the MQ135 sensor identified ammonia gas leakage in each room A and room B. It can be demonstrated here that ammonia gas leakage may be regulated and identified utilising a purging system.

4.4.2 Blynk

Figure 4.14 Preliminary results before the leak occurred in Blynk

Figure 4.14 show the monitoring system for the prototype project's detection system in the Blynk application. The upper side of the GUI displays the early results of MQ-135 sensors, while the lower side displays the early results of pressure sensors. The initial reading indicates that the ppi rate of ammonia gas in each room is low because there is no ammonia gas leakage in each room, whereas the reading on the guage pressure indicates that the pressure rate in the ammonia gas storage tank has increased due to the process of distributing ammonia gas from the distribution tank to each storage tank in room A and room B.

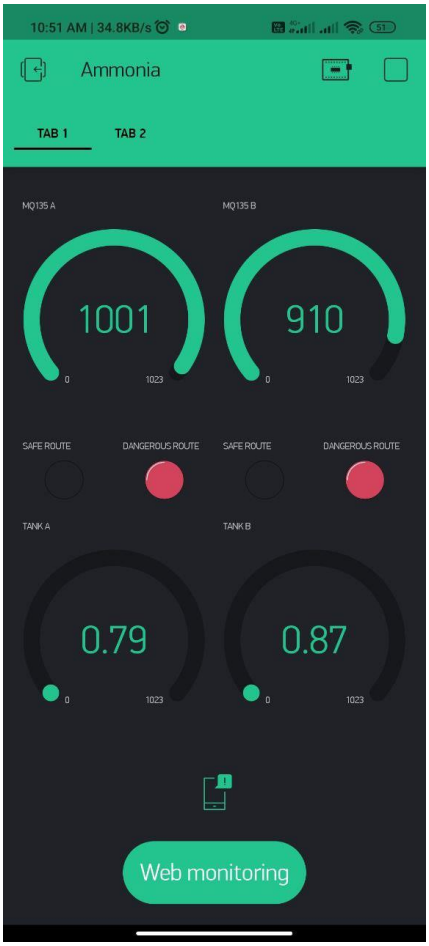

Figure 4.15 System detected the leakage and pressure drop results in Blynk

When ammonia gas leaks occur, the distant monitoring system is depicted in Figure 4.15 for the detection system of the prototype project in the Blynk application. The upper side of the GUI displays the detected results of MQ-135 air quality sensors, while the lower side displays the detected results of pressure sensors.

The values of the gas sensor are high due to the detection of leakages outside the Tank of prototype. However, the values of the pressure sensor are fairly low compared to the beginning values because the air pressure inside the tank decreases as ammonia gas leakages occur.

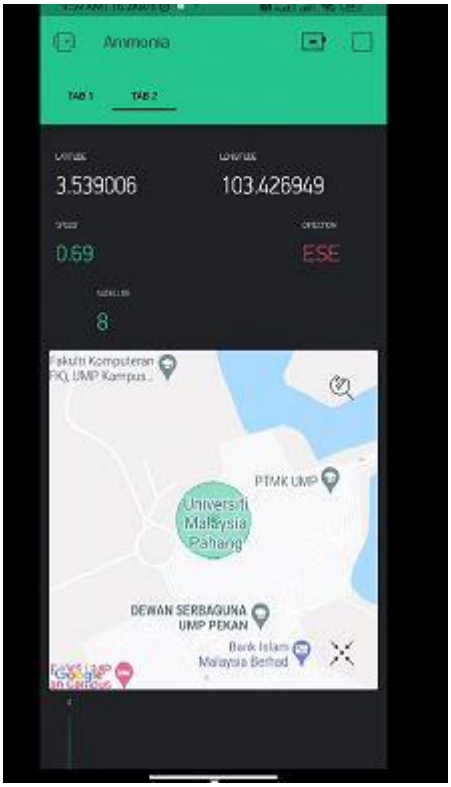

Figure 4.16 Location for area of the ammonia gas leackage results in Blynk

Figure 4.16 depicts the current location of the ammonia gas leak area identified by the MQ135 sensor, as well as the falling pressure rate from each storage tank in either room A or room B. The longitude and latitude presented in the blynk system can be seen in this system. This, in turn, will make it easier for personnel to adopt immediate safety measures.

4.5 Summary

In this chapter, the authors explain the final outcomes of the ammonia plant system fabrication project, as well as ThingSpeak and Blynk web development. ThingSpeak and Blynk's ammonia monitoring systems and GUI interfaces display detailed results. By the end of this chapter, the results demonstrate the system's ability to identify the presence of ammonia utilising ThingSpeak and Blynk ammonia leakage and monitoring systems.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter concludes the project's overall findings. Furthermore, the objectives are checked in this chapter to see if they have been met. This section also discusses the research's contribution, constraints, and recommendations for further work.

5.2 Conclusion

The development and fabrication of ammonia gas dection and monitoring system has been successfully achieved as the proposed system is able to develop detection and precaution system of the ammonia gas leakage by development the ammonia monitoring system on Blynk and ThingSpeak to display data from the MQ135 sensor and pressure sensor. The flow can be developed to manage and process MQ135 sensor and pressure sensor data with Blynk and ThingSpeak, and then set the condition to alert users to a potentially hazardous atmosphere via an ammonia monitoring system. Furthemore, to develop GPS system to locate the area of ammonia gas leakage by by constructing a GPS position tracking system utilising the Blynk application to identify the area of ammonia gas leakage in the ammonia plant area and may directly help security affairs to effectively find the reason and specific location of ammonia gas leakage in the plant. The purging system, which includes sprinkler pumps and fans, is designed to lower the rate of ammonia gas content in the ammonia gas storage tank room, whereas the ammonia gas leak detection system identifies any leaks that have occurred are one of achievment to develop purging system for the ammonia gas leakage to ensure the system can be apply in the industry.

There are several factors and requirements that must considered when designing an ammonia plant. The amount of high-pressure resistance required is one of the most important factors. It should also have high corrosion resistance to avoid being corroded

by ammonia gas. Some examples include shape, geometry, material, stiffness, and weight characteristics that appear to be important in the design and selection of ammonia plant styles. Consideration of the manipulation criteria and their limitations, such as the selection of the manipulated material, is another important factor to consider when selecting an appropriate design for an ammonia plant.

5.3 Recommendation

There are improvements can be done for future development on this prototype such as.

a) Fabrication ammonia plant using non corossive material

b) Improve connection of pipeline.

c) Redesign fabrication plant by that not corrosive to the ammonia.

d) Use industrial sensor to make reading for accurate for detecting the ammonia.

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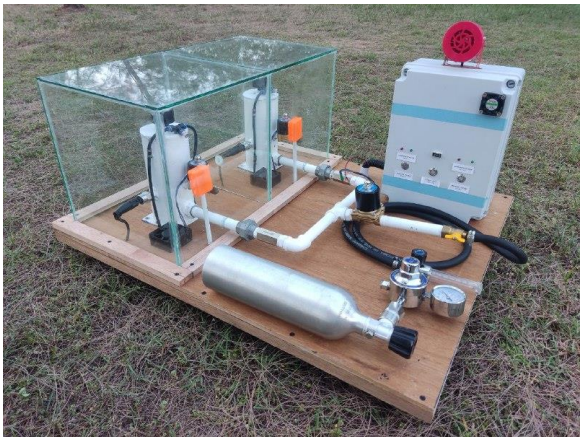
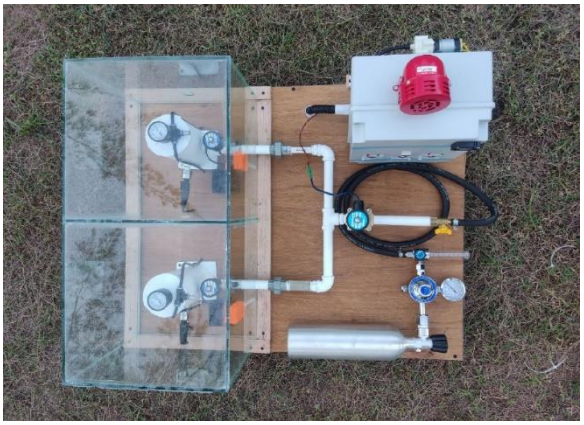
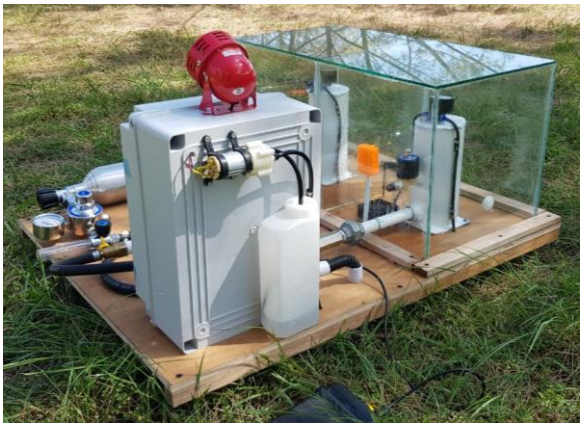
APPENDICES

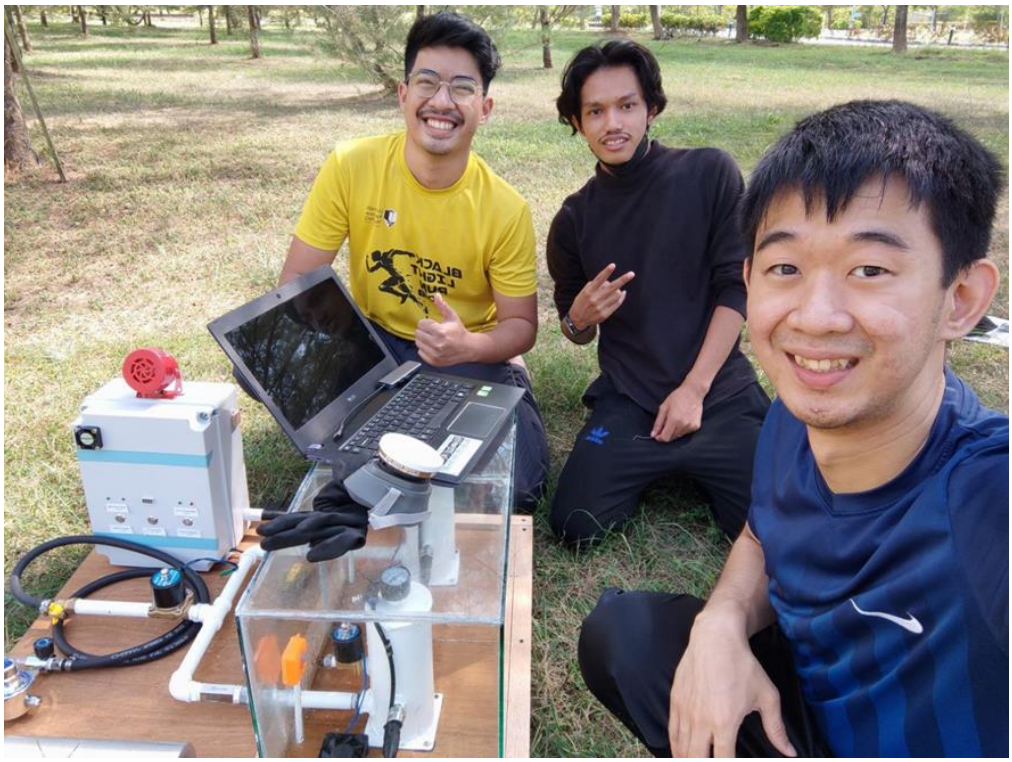
Appendix A: Final Prototype of fabrication ammonia plant system







Appendix B: Project Group Members



Appendix C: Gantt Chart project planning of SDP 2

TASK/WEEK	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
SDP 2 Briefing													
Project meeting													
Specify requirement													
Develop prototype													
Construct the Circuit and monitoring system													
Thesis first draft													
Draft correction													
Thesis second draft													
Finalize porotype and monitoring system													
Presentation SDP 2													