UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE AUTOMATED MONITORING ROBOT (MOBOT)

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Engineering Technology Electronic (Industrial Electronic) with Hons.

by

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DECLARATION

I hereby, declared this report entitled "The Automated Monitoring Robot System" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology Engineering Electronic (Industrial Electronic) with Hons. The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Gas adalah bahan utama dalam industri terutama dalam industri minyak dan gas dan bidang perlombongan. Terdapat pelbagai jenis gas dan masing-masing mempunyai ciri-ciri sendiri dan risiko kepada alam sekitar. Masalah utama yang dihadapi oleh industri ini adalah kemalangan kebocoran gas yang melibatkan gas yang mudah terbakar dan beracun. Dalam kebanyakan industri, terdapat beberapa peralatan yang digunakan gas rasa tetapi ia adalah lebih baik untuk menggunakan sistem automatik. Kertas kerja ini diperkenalkan Mobot, platform robot yang berfungsi untuk mengesan kebocoran gas. Proses pengesanan dicapai dengan mengesan kehadiran gas tersebar di udara, jika kebocoran gas dikesan ia harus mengeluarkan penggera dan mengesan sumbernya dalam lingkungan 5 kaki. Eksperimen ini dijalankan di dalam bangunan, analisis penggunaan data dan keputusan yang dilihat dalam graf dan jadual. Pengujian prototaip, dalam eksperimen perkakasan, menunjukkan 30% daripada proses pengesanan gas dan memenuhi matlamat projek dan adalah disyorkan untuk pelaksanaan.

ABSTRACT

Gas is the main material in industrial especially in oil and gas and mining field. There is variety type of gases and each has its own properties and risk to the environment. The main problems that faced by this industry is the gas leak accidents that involved the combustible and poisonous gas. In most industries, there are several equipments used sense gases but it is preferable to used automated system. This paper introduced Mobot, a robotic platform that function to detect a gas leak. The detection process was achieved by sensing the presence of gas spread in the air, if gas leak detected it should emit an alarm and detect of its source in the range of 5 feet. The experiment was conducted inside the building, use data analysis and the result viewed in graph and table. Testing of the prototype, in the hardware experiment, showed 30% of gas detection process and satisfied the project goals and is recommended for implementation.

DEDICATION

To my beloved family members, lecturers, friends and my supervisor

Mr. Tengku Faisal bin Tengku Wook

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Combustible	Able to catch on fire and burn
Concentration	The amount of specific substance mixed into given volume of air or liquid
Corrosive	A chemical that causes visible destruction or irreversible alterations in human skin tissue or other material at the place of contact.
Decomposition	Breakdown of a chemical into simpler parts, compounds or elements.
Explosive limits	The range of concentration (% by volume in air) of flammable gas or vapor that can result in an explosion from ignition.
UEL	Upper Explosive Limit
LEL	Lower Explosive Limits
Ppb	Part per billion, a measure of concentration, such as parts of a chemical per billion parts of air or water
Ppm	Part per million, a measure of concentration, such as parts of a chemical per billion parts of air.

CHAPTER 1
INTRODUCTION

Now we live in 21st century, the development of technology rapidly growth in line with the industries and human needs in this modernization era. Technology is the elements that use to make daily routine become easier and save energy source. There is variety type of technology in nowadays but the most technology that been highlight today is the robotic technologies. Generally, robotics is the combination of an actuator and program codes. The relation between the two elements is the robotic actuator will move and completed the task according to the instruction that set in the program. Robot is defined as humanoid because the structure of the robot is part of human body such as arm robot but today, these robots known as androids robot. In nowadays, our industries start to use the robotic technology in terms to increase the product quantity, upgrading the manufacturing process and completing the task that cannot be done by human. There is a lot of industrial filed such as electronic, agriculture, biotechnology, chemical, manufacturing, automotive and much more but the most critical is the oil and gas industries. Each industry use different analogy of the robotic technology. In oil and gas industry, robot is use to monitor the high risk area to detect any hazard such as gas leaks. Other than that, in mining industry also use robot to monitor the condition of the mine and detect any harm of gas leaks. The robot role is to replace the use of human or animals as an experiment object to detect a gas hazard.

1.1   Background study.

1.1.1   Robot.

Robot is define as programmable and multifunctional manipulator that design to move components, material and specialized devices through variable programmed movements to perform different tasks in various environments [1]. The first autonomous electronic robot were designed and created by William Grey Walter, England in 1948. At this time, the focus of the robot structure is to prove that a robot also can do the task as human by combining the small cells until it become complex. So, with this the robot will work by following an instruction and functions. In the past, the function of robots is more to replace human role in industrial manufacturing and called as industrial robots. This replacement is due to the increase the amount of production and time saving matter. In industrial robot is useful in wide variety of application such as material handling, welding inspection and assembly. For future, engineers has starts to create a 'smart' robot that can 'see', 'hear', 'touch' and make decisions [2]. Our technology has become more sophisticated and continuously being upgrade day by day and because of this the use of robots also has become much wider than before. Nowadays, robot is exposes to use in security, military and surveillance system. Robot can be use as the environmental monitor for surveillance system or to prevent unwanted accidents. Environmental monitoring can be described as the process of collecting the necessary data to characterize the quality of the environment. This notion can be applied to countless indoor and outdoor applications. The timely detection of environmental hazardous can prevent potential disaster and the consequent life losses and property damage [3]. As to realize the new application of robot for monitoring purposes, the process involves the combination of computer technology, actuators, sensors and programming techniques. The task program for robot is set by user and specifies the manipulator motion to complete a specific task and it will be generates either by leading the robot through the task by using programming languages [4].

1.1.2 Petroleum and Petrochemical Industries.

Petroleum and petrochemical industry is a place that built on the land that has high potential of natural gas also known as crude oil sources. It involves the process of drilling, refining process and transferring the oil or gases to consumer by using a pipeline. The oil is come from the mixture of thousand of molecules composed of different hydrogen and carbon atoms also called as hydrocarbons [5]. These hydrocarbons also contain different proportion of impurities such as oxygen, sulfur, nitrogen and heavy metal atoms [6]. Today, the terms of crude oil is no longer used. It is known as petroleum, where the name is the combination of rock and oleum which means oil [7]. This due to the modern research that shows the hydrocarbon is the family of gases instead of liquid. Table 1 shows the sample of gases produces in petroleum field :

Table 1.1 : Components of gases produces in petroleum (Devold 2013)

Component	Chemical Formula	Boiling Point at 101 kPa	Vapor pressure at 20 °C approx.
Methane	CH_4	-161,6 °C	$T_{cri t}$ -82.6 °C @ 4,6 MPa
Ethane	C_2H_6	-88.6 °C	4200 kPa
Propane	C_3H_8	-42.1 °C	890 kPa
Butane	$n\text{-}C_4H_{10}$	−0.5 °C	210 kPa
Higher order HC Alkenes Aromatics	C_nH_{2n} e.g. C_6H_6		
Acid gases Carbon dioxide Hydrogen sulfide Mercaptans ex. Methanethiol Ethanethiol	CO_2 H_2S CH_3SH C_2H_5SH	−78 °C -60.2 °C 5.95 °C 35 °C	5500 kPa

Raw natural gas consists of methane and many other smaller fractions of heavier hydrocarbons and others. This natural gas divided into several categories which is wet gas is a gas with methane content of less than 85%. Secondly, dry gas that contains less than 15 liters of condensate per 1,000 sm³. Thirdly, is sour gas with a content of more than 5.7 mg hydrogen sulfide (H_2S) per scm equal to 4 ppm. Fourthly, is acid gas with high content of acidic gases such as carbon dioxide (CO_2). Pipeline specification typically less than 2% $C0_2$. Acid gas consists of 90% CO_2 but the normal range for sour gas is 20% to 40%. The fifth

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is condensates gas, it is the mixture of hydrocarbons and other components as shown in Table 1. During the production process these condense will be produces in liquid [8].
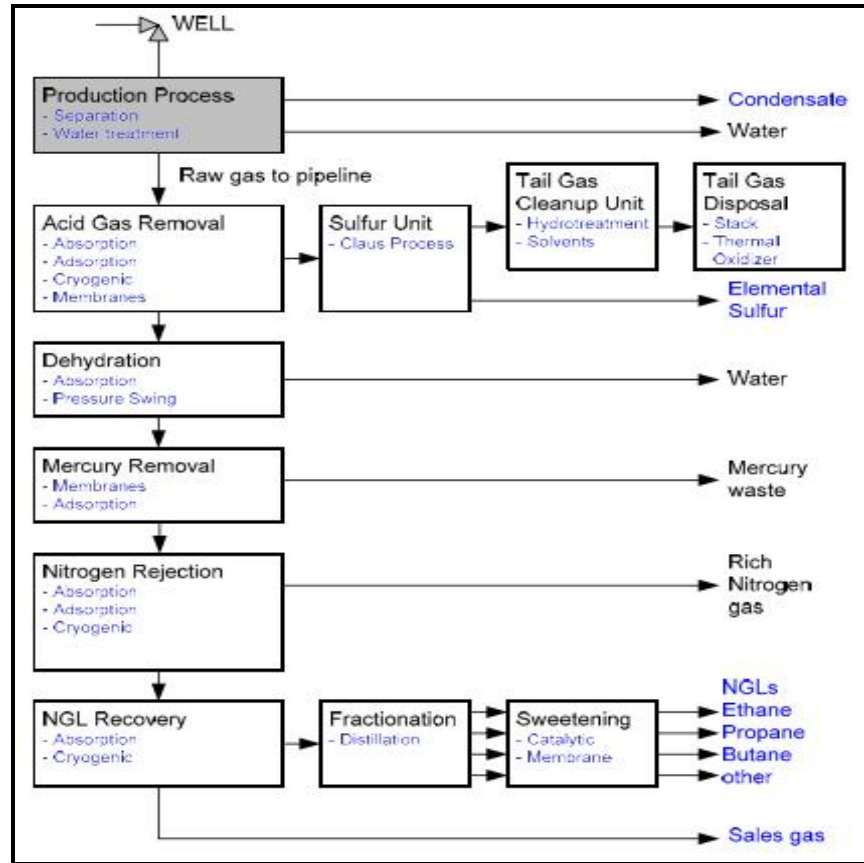
Figure 1.1 : Typical gas plant (Devold 2013).

Figure 1 shows the basic gas plant, from the process it shows that there is several high risk gas produced. The gas categorize as combustible gases (flammable) and poisonous gases (toxic). All these gases can affect our environment either can cause a crucial accidents such as an explosion or an acute hazard that can harm humans health. So, it is important to monitor the condition of the gases and control the amount of gas that spread in air.

1.1.3 Mining industry.

Mining industry was built to find an object based on minerals form from the earth underground as it product. The product of mining industry such as aluminum, copper, gold, zinc, uranium oxide, diamonds, iron core and much more [9]. All these materials will be use to produce a high quality of accessories, electric and electronic components, manufacturing product and much more. The process to get the minerals product is not easy because we need to drill the ground until it reaches the target. All the minerals is bury under the ground for thousand or even million years, so, the area must be too deep below the ground to reaches by human but with the help of new technology, the drilling process become easier. The scientific tool that used to detect hidden mineral deposit is geophysics, an anomalies using physical measurement of gravitational, seismic, magnetic, electromagnetic and radiometric variable of earth [10]. Generally known, in a mine there also has produce gases. This is because the air inside the ground is the mixture of the natural gas from the compose materials. The gases in the mining coal called as damps. For combustible gas known as firedamp consists of methane (CH_4) and is highly inflammable and explosive when present in the air in a proportion of 5 to 14 percent. For poisonous gas known as white damp, consists of carbon monoxide (CO) as little as 0.1 percent can cause death within a few minutes [11].

1.1.4 Definition of gas.

Air is a mixture of gases, each type of gases has a different composition and type. When the different elements of gas mix together it will produce a new composition of gas. Definition the word of 'gas' comes from the word chaos, which indicates the main feature of the simplest state of matter and the implication of the gas itself [12]. Naturally, a gas is a combination a group of small particles that move in our air randomly and chaotically, when it move from

one place to the other, immediately it will colliding with each other (particles) and fill the space of any container or area [13].

The gas able to fill any available volume in a container because the particles volume is in minutes that will be compare to the total space of the container and this process affected by the speed of the gas itself, where the molecules of the gases able to move in 100s of metres per second and will colliding each other in billion of times per second. The ranges of the molecules speed, the gas able to mix rapidly and exert the pressure around it in the air [14]. In order to identify the type of gases the element involves is the gas volume, temperature and pressure where the value same as the gas molecules. The measurements of the gas at higher levels are in percent of volume and at lower levels parts per million, ppm [15].

It is known that each type of gas has its own density where they are not totally separate into layers according to their density. For examples, a heavier gas tend to sink means move near to the ground and a lighter gases tend to rise means it move up in the air but in between their constant motion still can cause a continuous mixing between each molecules of gases [16]. Generally, a gas can cause an explosion, can harm human health and the environments. A gas that able to catch on fire and burn called as combustible gases. The other type of gases is poisonous gas, it is categorized as dangerous because they are invisible and some of them odorless means cannot be detect by human sense. The physical behavior of gases is unpredictable in terms of its ambient temperature, pressure and ventilation patterns influence the behavior of a gas leak [17]. Thus, this may result in early assumption the danger has cleared and over but the reality is the prolonged exposure to concentrations that we thought it has no affect to us even above 50ppm will result in paralysis and silent death [18].

1.2 Problem statement.

The current techniques to detect a gas leaks can be risky to human and animals which can cause a fatal and the limitation of the gas detector installed in industry cause an accidents either in explosion risk or harm our health [19]. Most of the accidents cause by the combustible and poisonous gas leakage. As a human, it is hard for us to detect the gas leakage because the limitation of our sense, some gas is colorless and odorless, furthermore, it can harm our health. Thus, they change the detection subject with an animal and observe their action but this techniques only works in small area. As the technology growth, a gas detector develops in many type and form. The techniques using gas detector, need the person to go near the pipeline as to install the probe into the pipeline inlet and measure the pressure. If the gas leak too far from the pipeline inlet, still it cannot detect the leaks. In long term, the gas finally cause an explosion and silent death (fatal). The other way is installing gas sensor at certain angle of the building but in long term the sensor become inaccurate and error calibration due to the expose to high temperature and lack of maintenance. The idea of this project is to act as the early detector of the gas leak indirectly can prevent the accidents especially in petroleum industry and mining as well. The best technique to detect a gas is by using an automatic robotic feature installed with a sensor that will be monitoring the identified high risk area.

1.3 Objectives.

The main three objectives that need to be achieve to complete this project are :

(i) To prevent an accident that cause by gases.

(ii) To design and construct an automated monitoring robot system to detect a gas leak.

(iii) To avoid the use of human and animal as the subject to detect directly a gas leak.

1.4   Scope of the study.

To achieve the most effective checking process, an automatic robot are able to detect and localize the gas leakage sources would be useful in various scenario, for instance to monitor and check high risk combustible and poisonous gas areas of leaks by using sensor. This project will entails the design, construction and function of The Automated Monitoring Robot (Mobot) system to able the robot to check and detect a gas leaks when the suspected location identified by using sensor and emit an alarm to warn the controller room. The scopes of this project are :

1.4.1   The automated monitoring robot system (Mobot) operation.

The function of this robot is to monitor the high risk area in industrial that involve the area that use to store the raw material of gases. Usually, to store a gas they will use a pipeline. The pipeline will connect and transfer the gases from the source to the required department. Each of the industrial production use different type of gases but not all the industrial process use a gas. The main gases that commonly use are combustible gas that consists of a butane and propane and also a poisonous gas which is the carbon monoxide. During the monitoring process, the robot will move independently and automatically on its own. The robot can avoid any obstacles around it by using the ultrasonic sensor. When the robot detects a gas leak, it will stop when the range is close enough. If the gas is combustible type, the led indicators yellow color will ON and if the gas is carbon monoxide the red led will ON. As a warning, the robot will emit an alarm sound as to alert anyone around the area.

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1.4.2 The components of the robot system.

There are several equipment and software needed as to support and complete the robot architecture. For the hardware the main components is the sensor, programmable integrated circuit (PIC) microcontroller and motor driver L298. There are five sensor will be install on the robot, it consists of two gas sensor and three ultrasonic sensor. The first type of gas sensor will be use is the MQ-9 semiconductor sensor for combustible gas. The sensor is able to detect combustible gas in the range of 100ppm-10000ppm. It works by method of cycling high and low temperature. When it is at high temperature (heated by 5.0 V) it detect butane, methane, propane and LPG [20]. The second type is the MQ-7 semiconductor sensor for poisonous gas. It is high sensitive to carbon monoxide gas. The detecting range of the sensor is 20ppm-2000ppm carbon dioxide [21]. The type of ultrasonic sensor is the HC-SR04, it use sonar to determine distance to an object. It is non-contact range detection and high accuracy. It is able to detect in the range of 2cm to 400cm or 1 inch to 13 feet [22] . The function of ultrasonic sensor for this project is to detect any obstacle around the robot and help it to avoid from crush to the wall. For the software, the circuit will be design by using the Proteus software because the simulation similar to the real equipment and it can connect with the MPLAB IDE software that will be use to create the program coding for the robot system. The hardware specification will be design by using the AutoCAD software.

1.4.3 Analysis on the gas composition.

Lower Explosive Limit (LEL) levels for gases defined in international standard. The LEL measurement standard points using a static concentration of gas because some gases is volatile in motion and become an explosive risk at lower concentration. For this project, two types of gases will be study which is the combustible and poisonous gases. The type of combustible gas that will