



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**IOT-BASED SMART GAS LEAKAGE DETECTOR AND
FIRE PREVENTION SYSTEM WITH GSM MODULE**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

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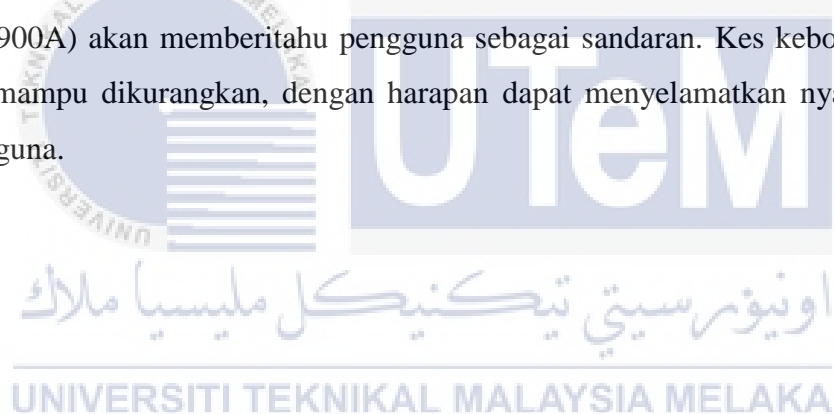
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ABSTRAK

Pada masa kini, teknologi IOT telah membawa keupayaan teknologi radikal untuk pelbagai pasaran pengguna, komersil dan kejuruteraan. Trend terkini ialah pembangunan rumah pintar di seluruh dunia dengan hanya menggunakan telefon pintar atau peranti lain yang boleh mengakses dengan Wi-Fi. Projek ini adalah bertujuan untuk menyelesaikan masalah dan meningkatkan keselamatan pengguna dengan menggunakan kewujudan modul IoT dan GSM untuk pemantauan dan mengambil tindakan apabila kebocoran gas dan kebakaran berlaku. Kebocoran gas boleh menyebabkan kebakaran rumah atau letupan dan ia juga beracun dimana boleh mengakibatkan kehilangan nyawa dan memusnahkan harta benda. Dengan penggunaan ESP32 sebagai modul Wi-Fi, pengguna boleh memantau dan mengambil tindakan apabila terdapat kebocoran gas dan kebakaran walaupun pengguna jauh dari rumah. Sekiranya terdapat masalah yang boleh mengganggu sambungan Wi-Fi, modul GSM (SIM900A) akan memberitahu pengguna sebagai sandaran. Kes kebocoran gas dan kebakaran mampu dikurangkan, dengan harapan dapat menyelamatkan nyawa dan harta benda pengguna.



ABSTRACT

Nowadays, IoT technologies have brought radical technological capabilities to multiple consumer, commercial and engineering markets. The recent trend is the development of smart homes all around the world just use a smartphone or other Wi-Fi access device. This project aims to improve the security of users by using the IoT and GSM module to monitor and respond on gas leakage and fire. Gas leakage can cause fire or explosion at home and also dangerous, leading to the loss of life and destruction of property. By using ESP32 as a Wi-Fi module, the user can monitor and respond when there has a gas leakage and fire event although the user is far away from home. If there has a problem that can disturb a Wi-Fi connection, the GSM module (SIM900A) will also notify the user as a backup. In the case of gas leakage and fire, the event can be reduced, it is expected to save the lives and properties of each user.



DEDICATION

To my beloved parents Mr. Mohd Sahib Bin Rahmat and Mrs. Ruzaida Binti Saal@Tahir for their support and prayers. A full appreciation to my supervisor Mr. Maslan Bin Zainon for advising and helping me through this project.



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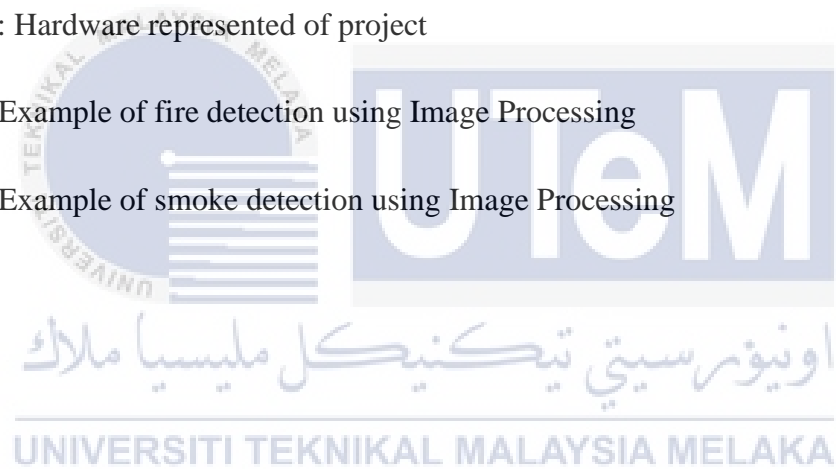
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LIST OF ABBREVIATIONS AND SYMBOLS

LPG	Liquefied Petroleum Gas
AC	Alternating Current
DC	Direct Current
GSM	Global Service For Mobile Communication
GPRS	General Packet Radio Service
V	Voltage
PPM	Parts Per Million
SMS	Short Service Message
SRAM	Static Random Access Memory
EEPROM	Electrical Erasable Programming Read-Only Memory
PWM	Pulse Width Modulation
USB	Universal Serial Bus
GND	Ground
SPI	Serial Peripheral Interface
AREF	Analog Reference
AT	Attention Command
ATH	All Time High
ADC	Analog to Digital Conversion

CHAPTER 1

INTRODUCTION

1.1 Introduction

The background project, objective and problem statements, as well as the conclusions, will be explained in general to give an idea about this project in this chapter. Besides that, the limitations and structure of this project also been described to give an early idea about this project.

1.2 Project Background

Gas leakage can cause a disaster when the gasses meet a source of ignition that will cause a fire event. It will get worse when we are far away from home to prevent it. So, this project is to propose an automatic gas leakage detection and fire prevention system by using IoT-based and GSM modules. By implementing this project, users will be notified by GSM module and by using IoT-based, the users also will be notified and can take an action to prevent their belonging from fire damage and can save a life. For this project, Arduino kits will be used as the main hardware of this project. The sensors used in this project will send data to the Arduino and will be linked to the Wi-Fi module (ESP32) as an IoT-based for more to notify and action purpose. The function of the GSM module just for notifies purpose. If there have a gas leakage and fire event, the users will get notifications from IoT-based and GSM module but for an action purpose, the users will use IoT-based to take control of the event.

1.3 Problem Statement

Time is of the essence when it comes to fires at home. In just two short minutes, a fire can become life-threatening. In five minutes, an entire home can be engulfed in flames. It will get worse if we are far away from home to take action to save our properties. Liquefied Petroleum Gas (LPG) is highly flammable and if gasses meet a source of ignition, there

definitely will generate a fire. "Gas leakage leads to various accidents resulting into both financial losses as well as human injuries. In human's daily life, the environment gives the most significant impact on their health issues. The risk of firing, explosion, suffocation all is based on their physical properties such as flammability, toxicity, etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years". (Soundarya, T., S. S. K. et al.,2014). Because of this, it is relevant that this gas leakage detector and fire prevention that can control far away from home by using IoT-based and GSM modules become important to save our property from damage and the most important to save and decrease life losses in fire events. This project will be targeted on LPG leakage detector and fire prevention that can notify a users and take an action directly using a mobile phone or any devices with the aid of the Wi-Fi module (ESP32) as an IoT-based that will communicate with Arduino and the users also will be notified by Global System for Mobile Communication (GSM) module. For the security mechanism, servo motor additionally being used to cut-off the LPG supply from continuously leaking and water pump that will be simulated as a water sprinkler for fire prevention system mechanism. A solar panel will be used as a backup supply when it collects energy from solar to keep the system continuously running.

1.4 Objectives

The objectives of this project are:

- a) To develop a microcontroller-based prototype alert and action system for detecting domestic LPG leakage and fire preventing via IoT-based and GSM module network.
- b) To further improve an automatic mechanism that can be activated by a user using an IoT-based to cut-off LPG supply and fire prevention system which is water sprinkler.
- c) To analyze the time required for the system prototype to react to LPG concentration and the existence of smoke during gas leakage and fire event.

1.5 Scope project

The aim of this project is to create an automatic system alert and fire prevention by using IoT-based and GSM modules. This project is able to solve a problem when a user is far away from home and not able to take action when there were a gas leakage and fire event.

By using a Wi-Fi module and GSM module, the user will be notified and can take an action if needed to save their properties from fire damage. The task of the MQ-6 gas sensor in this project is to detect the presence of gas leakage that senses the concentrations of LPG. Meanwhile, to detect smoke when a fire event, the MQ-2 smoke sensor is used. This project is focused on the cooking area using LPG gas for cooking.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An overview of the gas detector of LPG and fire preventer that supported by the IoT-based and GSM module with the aid of the usage of Arduino by using servo motor and water sprinkler as well solar as a backup supply to the battery is provided in this chapter. This chapter additionally grants the data about the component that been used for this project. Sources of data are taken from articles, journals, case reports, and websites. Every source is chosen based on the analogy of the project's scope.

2.2 Arduino Mega 2560

Figure 2.1 shows the most important component that will be used to control the whole project system which is Arduino MEGA 2560. This component will be performed as a brain in the system that set the degree of alertness of the LPG leakage and fire prevention for the sensor to become aware of the gasoline leakage and existence of the fire then transfer the sign to GSM module and Wi-Fi module (ESP32) that will communicate with a portable device. This purpose to notify the user then activates the security mechanism to cut off the gasoline system and trigger the water sprinkler that used as fire prevention. This component also will be acted as a brain to trigger the sensor to do their task when there have any faulty such as loss of connection of Wi-Fi that will be used as to communication between Wi-Fi module (ESP32) and the portable device.



Figure 2.1: Arduino MEGA 2560

2.2.1 Introduction

“Arduino is an open-source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is a source computing platform used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronic devices.” (Leo Louis et al., 2016)

2.2.2 Previous Research

According to (Prof. K.R.Katole et al., 2016) the Arduino improvement environment and program of the microcontroller are used by the Arduino programming language. In this case, gas sensor and fire detection which is temperature sensor sends a piece of information sensed by the Arduino. An Arduino board contains an ATmega microcontroller which is of 8-bits ahead with complimentary for the purpose to do programming and incorporation with other project circuits. In order to preprogram an Arduino microcontroller, a boot loader is used to get the programs to be uploaded on the on-chip flash memory is simplified to another level compared with an external programmer used by other devices.

The sensor is connected to an analog port of the Arduino Nano board (sensor nodes) in this wireless gas leak detection and fire prevention system which measure different gas concentration at ppm level and different temperature and sends the information to the Arduino UNO board (Gateway Node). The condition of sensor nodes where the leakage exists is shown in the serial monitor window in the gateway node (Mujawar et al., 2015).

The main platform to build the project is Arduino Mega 2560 which supplies the flexibility to program the code effectively inappropriate way and it provides features like inexpensive, cross-platform, simpler and clear programming environment, open source and extensible software and easy for beginners. It consists all needed to support the microcontroller and to get started, just connect it to a computer through USB cable or power it with AC to DC adapter or battery (Nail, R.N. et al.,2016).

2.3 GSM Module Network

As an alert system, a GSM module is used. To get consumer an alert system which is a notification is the function of this modem. When there has a gas leakage occurs, the system will be triggered when the GSM receive a signal from the microcontroller and will send a notification to the users. Figure 2.2 below shows the SIM 900A GSM GPRS Module used in this project.



Figure 2.2: SIM 900A GSM GPRS Module

2.3.1 Introduction

“The SIM900A is a complete Quad-band GSM/GPRS Module which delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS and Data with low power consumption. This GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with it is like a mobile phone with its own unique phone number.”(Altmash, S et al., 2018)

”SIM900A is a dual GPRS / GSM full-band SMT client applications, which allows you to take advantage of small size and cost-effective solutions. With the SIM900A interface provides industry standard GSM / GPRS 900 / 1800MHZ for voice, SMS, data and fax in the form of a small factor and with low power consumption. With a simple configuration of 24mm x 24mm x 3mm, SIM900A can be used in almost all space requirements in their application, especially for the application of slim design and small size.”(Prabhu Deva Kumar, S. V. S. V., & Akashe, S. et al., 2017)

GSM system was technologically advanced as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and

reduces the data, then transmits it down through a channel with two different streams of client data, each in its own time slot. The digital system has the capability to carry 64 kbps to 120 Mbps of data rates.

2.3.2 Previous Research

For the remote alarming function, the Arduino based GSM module (SIM mini 900) is combined with the Arduino circuit. Its ability to receive notification alert remotely via text message to deal with the hazard immediately. Moreover, for sending an alert via the GSM module at a dangerous condition, a message will be sent to the assigned number which added to the module (Moorat, S. et al., 2018).

Through AT command, the controllers can communicate with SIM900UAD BAND GSM/GPRS Module. Then, after the controller selects the right signal, SMS will send through the GSM modem to the service station or user after it completes the process. When it detects the signal, processes the signal and alert the security alarm which ATmega 328 microcontroller then send SMS alert to the user through SIM900 GSM modem. The system will remain alarming and monitoring until a user action is taken (Shiyana, A. and Deepa, R., 2017).

In many real-time applications, SIMCOM300 can adapt to almost all dimensions and space requirements. Based on tri-band SIM300, the GSM modem is pliable plug-in and play. Then, AT command make it accessible to transmit and receive a message in this mobile communication global structure. By connecting to microcontroller pins which is Arduino at the transmitter and receiver pin, all of the commands can be tested. The microcontroller will take the securing and all necessary action while the weight sensor provides the level in cylinder and gas sensor sensed the gas leakage. All the status happening, and important information must be sent to the user. (Soundarya, T. et al., 2014)

2.4 ESP32 Wi-Fi Module

The ESP32 is an important component that will be used as IoT based on this project. This component will communicate with an Arduino and sensor that link with Wi-Fi to do a task such as gas leakage detector and cut off mechanism and fire prevention mechanism that will use in this project. Figure 2.3 shows the ESP32 that will be used for project purposes.