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DOMESTIC LPG LEAKAGE DETECTION SYSTEM USING MICROCONTROLLER AND GSM NETWORK

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

by

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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 Electrical Engineering Technology (Industrial Automation and Robotics) (Hons.). The member of the supervisory is as follow:

………………………………….
(Project Supervisor)

ABSTRACT

LPG is an abbreviation from Liquefied Petroleum Gases that consist of substances such as propane and butane. It is highly flammable and can easily burn even at some distance from the source of leakage. LPG leakage is a major problem in residential area and may cause fatal inferno if the leakage is not prevented. One of the preventive measures to avoid the danger associated with gas leakage is to install a LPG leakage detector at vulnerable places. This project focuses on issues such as for the people who have a low sense of smell that may not be able to recognize upon this inherent safety mechanism and to alert people on the danger of gas leakage in their home and premises. The aim of this project is to design and build a system of a microcontroller-based prototype of domestic LPG leakage detection and to develop an automatic alert system by using GSM network with LPG supply cut-off valve with the aid of servo motor. The cutting-off of the LPG valve is to stop the gas from continuously flowing to surrounding. Besides, this system prototype is developed as a mechanism to provide community service in the form of educational kit for academic institutions, especially for schools and pre-university students to promote safety awareness and knowledge in engineering technology. When the system detects the LPG concentration in the air has reach certain levels of pre-determined settings, then it will immediately alerts users by sending signals to GSM network using SMS. As results, a servo motor is activated to safely cut-off the gas regulator knob or disable the LPG supply. This system is capable to minimize injuries or property loss associated by explosion due to gas leakage while using domestic cooking gas.

ABSTRAK

LPG ialah satu singkatan dari Liquefied Petroleum Gases yang terdiri daripada bahan seperti propana dan butana. Ia sangat mudah terbakar dan boleh dengan mudah membakar walaupun di beberapa jarak dari sumber kebocoran. Kebocoran LPG ialah satu masalah utama di kawasan kediaman dan boleh menyebabkan kebakaran membawa maut jika kebocoran tidak dicegah. Salah satu langkah pencegahan untuk mengelak bahaya berkaitan dengan kebocoran gas adalah dengan memasang alat pengesan bocor LPG di tempat-tempat mudah terjejas. Penekanan utama dalam projek ini ialah untuk membantu mereka yang mempunyai deria hidu rendah yang mungkin tidak dapat mengecam mekanisme keselamatan sedia ada ini dan untuk mendedahkan kepada umum akan bahayanya kebocoran LPG di premis mereka. Tujuan projek ini adalah untuk mereka dan membina satu sistem prototaip berasaskan mikropengawal pengesanan kebocoran LPG tempatan dan membangunkan satu sistem amaran automatik dengan menggunakan rangkaian GSM dengan injap penyekat bekalan LPG dengan bantuan motor pelangkah. Injap LPG disekat adalah untuk menghentikan aliran gas ke sekeliling. Selain itu, sistem ini direka untuk memberi perkhidmatan kepada komuniti berbentuk kelengkapan pendidikan kepada pelajar di seluruh institusi. Apabila sistem ini mengesan tahap kelikatan LPG di udara melebihi tahap tertentu maka mikropengawal akan menghantar isyarat kepada GSM untuk menghantar khidmat pesanan ringkas (SMS) kepada pengguna. Kemudian, motor pelangkah diaktifkan untuk menyekat LPG dengan selamat. Sistem ini dapat menghindarkan sebarang kecederaan atau kehilangan harta benda disebabkan oleh letupan kebocoran gas dan meningkatkan keselamatan diri semasa menggunakan gas memasak di rumah atau premis-premis kecil.

DEDICATIONS

To my beloved parents

To my supervisor, Mr. Maslan Bin Zainon

To my lecturers

And not forgetting to all dear friends

Especially Nurul Atikah Azis

For their love, support, sacrifice, encouragement and motivation.

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LIST OF SYMBOLS AND ABBREVIATIONS

LPG	=	Liquefied Petroleum Gases
GSM	=	Global System for Mobile Communication
PIC	=	Programmable Integrated Circuit
PC	=	Personal Computer
AT	=	ATTENTION command
CMOS	=	Complementary Metal-Oxide Semiconductor
RISC	=	Reduced Instruction Set Computer
EEPROM	=	Electrically Erasable Programmable Read-Only Memory
PWM	=	Pulse Width Modulation
UART	=	Universal Asynchronous Receiver/Transmitter
ADC	=	Analog-Digital Converter
PCMCIA	=	Personal Computer Memory Card International Association
USB	=	Universal Serial Bus
GPRS	=	General Packet Radio Service
DCS	=	Distributed Control System
TCP/IP	=	Transmission Control Protocol/Internet Protocol
SMS	=	Short Message Service
TPDU	=	Transport Protocol Data Unit
MMS	=	Multimedia Messaging Service
DC	=	Direct Current
GPS	=	Global Positioning System

CHAPTER 1
INTRODUCTION

1.0   Introduction

This chapter explain the background of this project, problem statements, objectives and conclusion for this chapter as well as the limitations in completing this research. The structure of the report of the project is briefly explained to ensure a better visualization of the sequence of the entire project.

1.1   Background

LPG or LP Gas is the truncation of Liquefied Petroleum Gas. This gathering of items incorporates saturated hydrocarbons – propane (C_3H_8) and butane (C_4H_{10}), which can be put away and transported independently or as a mixture. They exist as gasses at typical room temperature and air weight. LPG was initially delivered by Dr. Walter Snelling in 1910. Those hydrocarbons are profoundly combustible and hazardous. If the liquefied petroleum gas leak is a gas leak it may not be seen because LPG is colourless, except where the leak is of sufficient size to be seen shimmering in the air.

At the point when a fluid LPG break happens, the gas discharge will be as a patch of ice around the zone of the release, or as a plane of white fluid. This white appearance is because of the cooling impact made by the quick development the LPG fluid into a gas. The gathering air dampness makes them noticeable. In gathered sums and in uncontrolled conditions, LPG can possibly make a flame or a blast. LPG leakage is a major concern with private and business premises in view of its alluring properties which incorporate high calorific quality, which create the less smoke, creates less residue, and does not bring about much damage to nature. LPG is additionally utilized as other fuel as a part of vehicles because of taking off in the costs of petrol and diesel. The gasses being heavier than air do not scatter effectively

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and may prompt suffocation when breathed in. The spilled gasses when lighted may lead to explosion.

1.2   Problem Statement

LPG consists of mixture of propane and butane which is highly flammable chemical. Since the LPG as such does not have any odour, gas companies or refineries add an odorant such as Ethanethoil, Thiophene or a Mercaptan so that leaks can be detected easily by most people. However, some people who have a low sense of smell may or may not be able to rely upon this inherent safety mechanism. In such cases, a gas leakage detector becomes vital and helps to protect people from the dangers of gas leakage. When the leakage is exposed to atmospheric air with high level concentration of LPG, it may cause explosion. Due to this explosion, there will be a number of death. In order to avoid explosion, gas leakage detector become an essential and help to protect from gas leakage accidents. This project will focused on LPG leakage detector by using PIC16F877A microcontroller and SIMCOM900A GSM network also the using servo motor to cut off the gas supply for safety prevention.

1.3   Objectives

The main objectives of this project are:

(a)   to design and build a microcontroller-based prototype of domestic LPG leakage detection system,

(b)   to develop an automatic alert system with LPG supply cut-off using GSM network and servo motor, and

(c)   to develop the prototype as an educational training tool to promote knowledge in engineering technology to community.

1.4   Scope of Project

In order to obtain a clearer visualization and achieve the objectives of this project, the scope of the project has been performed. In general, the goal of this project is to design a prototype on LPG leakage detection controlled by PIC16F877A using MQ-6 gas sensor. Then, SIM900A GSM module will be used as fast-response notification that will alert the users about the leakage. In order to prevent the explosion, servo motor drive will be activated to cut off the gas valve at the regulator gas knob. All these hardware are selected based on their characterization and the ability to give fast response to users when LPG leakage occur. At the same time, any fatal incident will be avoided.

The project's prototype will be implemented in residential area such as home and small premises like food stall or food court. Besides that, this prototype can also provide service to community in form of educational training tool for students in all over institution to expose them about the important usage of LPG leakage detector and the security alerts as well to make them understand the danger of gas leakage.

1.5   Conclusion

This chapter describes the project background, goals, problem statement, purposes and limitation of the dissertation of this project. In addition, it shows details about problems or aims to be solved and how the project will be conducted. In the next chapter will provide an overview or related work that relates with this project in details.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provide a review of LPG leakage detector by using microcontroller and GSM network also the uses of servo motor drive to. In this chapter also provide the information about hardware used in this project. The main sources of information are taken from journals, articles, case report and websites. Each review sources are selected according to the similarity of projects' scope.

2.1 PIC16F877A as A Controller

Regarding this project, Figure 2.1 shows the microcontroller that will be used as the project controller. The function of microcontroller are to set the level of concentration of the LPG leakage for gas sensor to detect leakage, send signal to GSM network for notification alert and activate the auto cut off gas system.
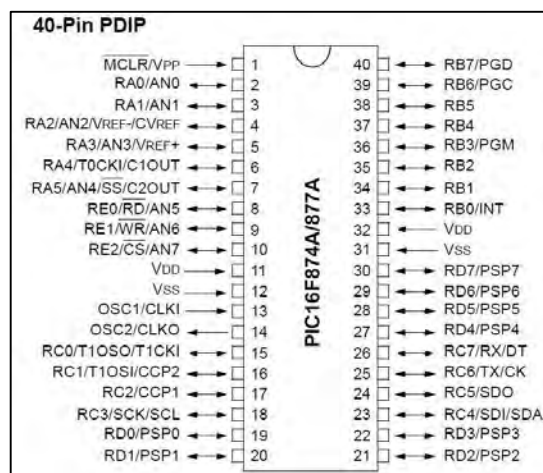

Figure 2.1: PIC 16F877A pins

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2.1.1 Introduction

PIC16F877A established by Microchip is a CMOS-FLASH based elite 8-bit RISC microcontroller. It consummately fits numerous uses from auto businesses and controlling home machines to modern instruments, remote sensors, electrical entryway locks and security gadgets. It is likewise perfect for savvy cards and in addition for battery supplied gadgets on account of its low utilization. EEPROM memory makes it less demanding to apply microcontrollers to gadgets where perpetual capacity of different parameters is required (codes for transmitters, engine speed, collector frequency, and so on.). Minimal effort, low utilization, simple taking care of and adaptability make PIC16F877A pertinent even in regions where microcontrollers had not already been considered for instance; clock capacities, interface substitution in bigger frameworks, coprocessor applications, and so forth.

In system programmability of this chip (alongside utilizing just two pins as a part of information exchange) makes conceivable the adaptability of an item, subsequent to amassing and testing have been finished. This capacity can be utilized to make mechanical production system generation, to store alignment information accessible strictly when last testing, or it can be utilized to enhance programs on completed items. This powerful 200 nanosecond instruction execution yet easy-to-program which only 35 single word instructions that microcontroller packs Microchip's powerful PIC® architecture into a 40 pin package. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART)(www.microchip.com).

2.1.2 Previous Research

Microcontroller can be employed to replace a lot of external components while adding extra functionalities at a cost comparable as a simple integrated comparator Rawat et al. (2014).

Gas sensor detects the gas leakage and gives the signal to the microcontroller with the help of ADC. After that in second step the microcontroller receive the signal, send by gas sensor. It sends activation signal to other external devices attached with it Shrivastava et al. (2013).

An efficient and smooth working controller is needed to continuously sense both leakage and level of the gas and also fast response is require when leakage found .Along with this the monitoring system must provide additional leakage information which can be used in further processing. The detection system includes Arduino Duemilanove microcontroller board as shown in Figure 2.2, which is Arduino compatible with microcontroller chip ATmega328p. The Duemilanove is a microcontroller breakout board featuring ATmega328 based on the popular Arduino Footprint T.Soundarya et al. (2014).
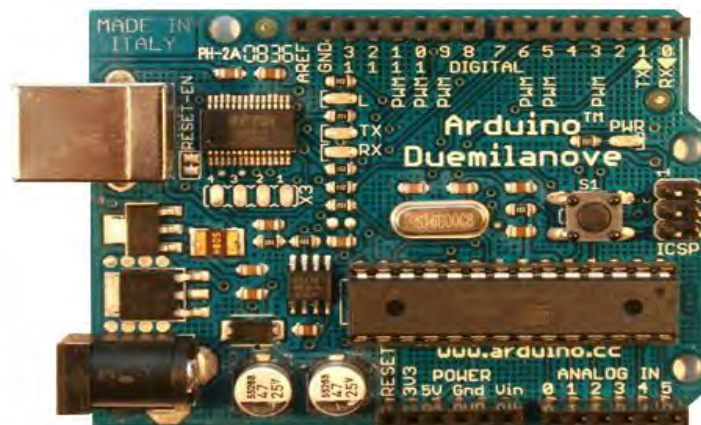

Figure 2.2: Arduino Duemilanove with ATmega328p microcontroller
(T.Soundarya et al. 2014)

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The PIC18F1320 microcontroller has been chosen to perform the desired task of gas leakage detection and activate the alarms when the exposure limit exceeds the acceptable values as per UK safety standards. At the point when the sensor detects no gas noticeable all around, it delivers a voltage beneath 1.2V on the yield pins which are associated with port RA0 of the microcontroller. At the point when the sensor detects the vicinity of gas noticeable all around because of a release, the voltage transcends 1.2V. The voltage differs somewhere around 1.2V and 5V relying upon the level of gas fixation distinguished Mahalingam et al. (n.d.).

2.2   GSM Modem Network

To fulfil the function of the project, GSM modem network will be used as notification alert to user. It will be activated when the modem receives signal from microcontroller and will send out notification to the users during LPG leakage.

2.2.1   Introduction

A GSM Modem stands for Global System for Mobile Communications is a telecommunication device, a wireless modem that uses GSM wireless network. GSM Modem comes in various interfaces, such as PCMCIA Type II, USB and Serial. It is a wireless modem just like dial-up modem works with GSM wireless network. The difference between dial-up modem and wireless modem is wireless modem sends and receives data through radio waves whereas dial-up modem send and receive data through a fixed telephone line.

This project uses SIM900A which is one of the model of GSM network modem. SIM900A basically is a tri-band GSM or GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900MHz. SIM900A provides GPRS multi-slot class 10 capability and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The SIM900A is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode. SIM900A also integrated with the TCP/IP protocol, Extended TCP/IP AT commands are

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developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

2.2.2 Previous Research

According to Rajitha and Swapna, (2012) if these gases exceed the normal level then an alarm is generated immediately and also an alert message (SMS) is sent to the authorized person through the GSM. The advantage of using this method instead of the manual method is that it offers quick response time and accurate detection of an emergency and in turn leading faster diffusion of the critical situation.

GSM modem is highly flexible plug and play modem based on tri-band SIMCOM300. SIMCOM300 can fit almost all the space requirements in much real-time application. This global system for mobile communication technology making it very easy to send and receive the messages support the AT commands. These commands can be implemented by interfacing to the receiver and transmitter pins of microcontroller. MQ6 gas sensor detects the leakage of gas, weight sensor provides the level in cylinder, and microcontroller will take the protective and necessary action. All these notable information or status happening has to be conveyed to the user. The SIMCOM300 shown in Figure 2.3 stores the mobile number of users and distributors T.Soundarya et al. (2014).

Figure 2.3: SIMCOM300 GSM Modem, T.Soundarya et al. (2014)