



## **UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

### **DEVELOPMENT OF AUTOMATIC FIRE EXTINGUISHER SYSTEM**

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

By

**MUHAMMAD QAMARUL ARIFIN BIN ROSMAN**

**B071410177**

**930213-01-5769**

FACULTY OF ENGINEERING TECHNOLOGY

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## DECLARATION

I hereby, declared this report entitled Development of Automatic Fire Extinguisher System is the results of my own research except as cited in references.

Signature : .....

Author's Name : MUHAMMAD QAMARUL ARIFIN BIN ROSMAN

Date : .....

## **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 Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

.....  
(EN. MOHD YUNOS BIN ALI)

## ABSTRAK

Kebakaran merupakan satu kemalangan yang sering berlaku di mana-mana sahaja pada bila-bila masa, terutama di makmal kimia yang menjalankan penyelidikan berisiko tinggi. Masalah ini sukar dibendung walaupun pelbagai usaha dan peraturan-peraturan telah dilaksanakan. Menurut piawai teori lengkungan suhu, masa yang sesuai untuk memadamkan api adalah antara 1 hingga 4 minit. Walau bagaimanapun, tempoh masa yang kritikal adalah amat sukar bagi Jabatan Bomba dan Penyelamat untuk sampai ke tempat kebakaran. Oleh itu, penghuni makmal yang menjalankan eksperimen perlu memainkan peranan dalam memadamkan kebakaran. Tetapi ada satu persoalan di sini samaada pembantu makmal dan penyelidik di makmal mempunyai kemahiran untuk memadamkan api dengan adanya pelbagai bahan kimia yang disimpan padanya. Kajian ini dijalankan bertujuan untuk membantu memadamkan kebakaran yang mengandungi bahan kimia dan melindungi sesiapa yang bertanggungjawab untuk memadamnya sementara menunggu ketibaan pihak bomba dan penyelamat daripada api terus merebak ke bahagian makmal yang berdekatan. Malahan penyelidik juga ingin mengetahui sama ada sistem kebakaran yang dipasang di dalam makmal kimia yang sedia ada sudah mencukupi untuk melindungi kebakaran yang melibatkan bahan kimia atau tidak. Hasil daripada kajian yang dijalankan masih terdapat beberapa kebakaran makmal kimia yang hangus dijilat api akibat daripada kecuaiian dan sistem pelindung kebakaran yang kurang berkesan. Oleh itu, dengan wujudnya produk yang dihasilkan ini sememangnya memberi petanda positif bagi membantu untuk memadamkan kebakaran dengan jangka masa kurang daripada jangkaan pihak bomba dan memberi jaminan keselamatan kepada pengguna makmal untuk proses pemadaman yang dilakukan.

## **ABSTRACT**

Fire is a frequent accident in anywhere at any time, especially in a chemical lab conducting high-risk research. This problem still difficult to cater despite all the efforts and regulations been implemented. According to Standard Temperature Curve theory, time to extinguish the fire is between 1 to 4 minutes. However, a critical time period is very difficult for the Fire and Rescue Department to get to the fire. Therefore, residents who carry out laboratory experiments have played a role in firefighting. But there is a problem here either laboratory assistants or researchers across laboratories have the skills to put out the fire but there are various chemicals stored on it. This study aims to help extinguish the fire that contains chemicals and protect those who are responsible for removing them while awaiting the arrival of the fire and rescue team before the fire continued to spread to nearer laboratory. In fact, the researchers also wanted to know whether the fire system installed in the existing chemistry laboratory is sufficient to protect fires involving chemicals or not. The results of the study, there were some chemistry lab fire scorched by fire as a result of negligence and fire protection systems are less effective. Therefore, the existence of the resulting product is indeed a positive sign for help to extinguish the fire with a duration of less-than-expected third fire and assure safety to users of laboratory for the deletion process.

## **DEDICATION**

Dedicated to my beloved parents Mr. Rosman Bin M Amin and Mrs. Umi Kalsom Binti Abd Wahab for their support and pray. A full appreciation to my Supervisor Mr. Mohd Yunos Bin Ali helping me through this project, honourable lecturers, helpful friends, my beloved family, my love Siti Zahirah Binti Mohd Yusof and who has given me support throughout this final year. Thanks for the memories that we had in UTeM throughout these years.

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# TABLE OF CONTENT

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	viii
List of Figures	ix
List Abbreviations, Symbols and Nomenclatures	xi
<b>CHAPTER 1: INTRODUCTION</b>	<b>1</b>
1.0 Introduction	1
1.1 Project Background	1
1.2 Objective of Project	3
1.3 Problem Statement	3
1.4 Scope of Project	5
<b>CHAPTER 2: LITERATURE REVIEW</b>	<b>6</b>
2.0 Introduction	6
2.1 Approach Safety Laboratory in school	9
2.2 Fire Protection and Prevention	9
2.3 Fire Extinguisher	10
2.4 Fire Extinguisher Robot	12
2.4.1 The component that used at this project	13
2.5 Automatic Fire Detection using Adaptive Fusion Algorithm	13
2.6 Structure system for Automatic Fire Extinguisher	14
2.7 Working principle of Fire Extinguisher Robot	15
2.8 Fire protection alarm system	16
2.9 Automatic extinguisher structure for car fire of commercial vehicle	16



2.10	The group of chemicals	17
------	------------------------	----

### **CHAPTER 3: METHODOLOGY** **20**

3.0	Introduction	20
3.1	Flow chart project	21
3.2	Operation of project	22
3.3	Temperature sensor analysis	23
3.3.1	Contact temperature sensor	23
3.3.2	Temperature sensor circuit specification	23
3.3.3	Advantage of temperature sensor	24
3.3.4	Flowchart temperature sensor	24
3.4	Motor power window	25
3.4.1	Method	26
3.4.1.1	Test Rig for Low Voltage Power Window DC Motor	26
3.4.1.2	Secondary sources	26
3.5	Sealed Lead Acid Battery	27
3.6	MQ2 Sensor- Based Smoke Detector	28
3.7	LCD module	29
3.8	Microcontroller	31
3.8.1	PIC16F877A	31
3.9	Project design	32

### **CHAPTER 4: RESULTS AND DISCUSSION** **34**

4.0	Introduction	34
4.1	Results for heat sensor (LM35)	34
4.1.1	Simulation and experiment data for heat sensor (LM35)	34
4.2	Results for motor power window (Saga)	39
4.3	Results for smoke sensor (MQ-2)	41

**CHAPTER 5: CONCLUSION AND FUTURE WORK** 43

5.0 Introduction 43

5.1 Summary of research 43

5.2 Achievement of Research Objective 44

5.3 Significant of Research 44

5.4 Suggestion for Future Work 44

**REFERENCES** 46

**APPENDICES**

## LIST OF TABLES

2.1	Cause of fire accident in laboratory	8
2.2	Class of fire and firefighting	11
2.3	How to use a fire extinguisher	12
2.4	Potentially resulting in heat generation, a strong reaction	17
2.5	Potentially resulting in the release of toxic substances in case of fire or explosion	18
2.6	The potential to cause a fire or explosion, the generation of hydrogen gas Flammable	18
2.7	Potentially resulting in a fire, explosion or heat generation, generation flammable toxic gas	18
2.8	Potentially causing fires, explosions or strong reaction	19
2.9	Potentially resulting in the generation of hydrogen cyanide or hydrogen Sulphide toxic	19
2.10	Potentially causing fires, explosions or strong reaction	19
3.1	MQ series sensors and target gas of detection	28
3.2	The mechanical dimension 1602A LCD module	30
3.3	Advantage and disadvantage of microcontroller	31
3.4	Specification of PIC16F877A	32
4.1	Results of the simulation sensor (LM35)	35
4.2	Results of the experiment heat sensor (LM35)	36
4.3	Data of motor power window (saga)	40
4.4	Data of gas concentration of the time smoke sensor (MQ-2)	41

## LIST OF FIGURES

1.1	Newspapers wrote about the Fire and Rescue Malaysia being extinguish the fire at a chemical laboratory UiTM, Shah Alam	2
1.2	News about the fire at chemical laboratory	4
1.3	Shows the position of fire extinguisher	4
2.1	Operation Schematic diagram	7
2.2	Percentage of breakdown of root causes in chemical reaction fire casualties	8
2.3	Fire triangle reaction	10
2.4	The overview home security for firefighting robot	14
2.5	Structure of the system	15
2.6	Structure of Automatic Extinguishing System	17
3.1	Flow chart of the project	21
3.2	Flow chart operation of project	22
3.3	The flow chart of the temperature sensor circuit	24
3.4	The sensor temperature LM35	25
3.5	K-Chart for squeeze and sweep Application	25
3.6	Low voltage power window DC motor	26
3.7	Sealed Lead Acid Battery (12V 9AH)	27
3.8	Module sensor MQ2	29
3.9	LCD 1602A QAPASS module	30
3.10	PIC16F877A Microcontroller	32
3.11	3D dimension view	33
3.12	Side view of Automatic fire extinguisher	33

4.1	Equation voltage out of the heat sensor (LM35)	36
4.2	Simulation heat sensor (LM35) using Proteus software	37
4.3	Voltage for the temperature of heat sensor (LM35)	38
4.4	Time for the temperature of heat sensor (LM35)	39
4.5	The value of Voltage, Current, Power, Speed and time for motor power window (saga)	40
4.6	Concentration of smoke sensor (MQ-2) gas concentration vs. time	42
4.7	Simulation of heat detector (LM35) and smoke detector (MQ-2) at normal condition	42

## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

V	-	Voltage (volt)
S	-	Second (sec)
PPM	-	part- per million
LCD	-	liquid crystal display
PIC	-	peripheral interface controller
IC	-	Integrated circuit
OP-Amp	-	Operational amplifier
mm	-	Millimeter

# **CHAPTER 1**

## **INTRODUCTION**

### **1.0 Introduction**

In this chapter will explain the introduction of the project consist of project background, objective of project, problem statement and scope of project.

### **1.1 Project background**

According to fire statistics 2013 in Malaysia, released by the Fire and Rescue Department of Malaysia, displays that fire statistics by the laboratory of building in Malaysia for the year 2013 fifteen cases. According to newspaper reports the Utusan Malaysia newspaper reported a fire in a chemical laboratory Chemical Laboratory building Laboratory Research Management Institute (RMI) in Universiti Teknologi Mara (UiTM) Shah Alam, was declared a protected area for all individuals and unsafe to use due to the fire. The number of cases is a real concern because it involves the lives of individuals.

Today, safety in the laboratory is an issue that often appears about in the newspapers that involve the destruction of laboratory equipment that is equipped with a system of research technology with high-cost spending. This is particularly troubling when the safety of researchers during experiments involving several dangerous chemicals that may be life-threatening someone researcher and people who are around the laboratory building. This is because every conducted experiment has different risks. However, in the present level of safety in the experiment is a major addition to the importance of the successful results of an experiment.

## Makmal Fakulti Sains UiTM terbakar



Anggota bomba dan penyelamat bertungkus lumus memadamkan api yang memusnahkan makmal Fakulti Sains di UiTM kampus Shah Alam di Shah Alam, Selangor, semalam.

Figure 1.1: Newspapers wrote about the Fire and Rescue Malaysia being put out fire at a chemical laboratory UiTM, Shah Alam.

Figure 1.1 shows newspaper article by Utusan Malaysia (July 2013), Malaysian Fire and Rescue Department took about eleven minutes to arrive at the scene of the fire which occurred at 4.15 pm. When the fire started, there three students with a lecturer and an assistant lab is conducting experiments in one of the rooms in a laboratory. However, the victims managed to escape as soon as the fire spread realized in a laboratory in the middle of the building. Immediately the fire brigade arrived at the scene, black smoke billowed and the fires started burning down the laboratory. The results of the investigation of the Fire and Rescue Department of Malaysia believe the fire was caused by the reaction of chemicals found in the lab. As such, the firemen took about an hour to control the fire from the fire continued spreading to other areas with the assistance of the Hazardous Materials Unit (Hazmat) for fear that there are harmful chemicals in the laboratory. Further, the department is still investigating the amount of loss suffered and investigate the cause of the fire. In observation expounded



upon in this incident shows that the system of fire protection equipment that should be installed in the laboratory is feared may not function properly. Therefore, the authorities should have thought of a solution to increase the effectiveness of fire protection equipment in every laboratory chemicals.

## **1.2 Objective of Project**

There are three objectives of final year project that need to achieve:

- 1) To design a fire extinguisher system that involves a wide range of chemical in chemical laboratory.
- 2) To increase application fire extinguisher to be more effective.
- 3) To detect time reaction of gas concentration in ambient temperature, environment and area.

## **1.3 Problem Statement**

According to sources derived from facebook Malaysian Fire and Rescue Department dated December 15,2014 featuring news about the fire at the chemical laboratory of Sekolah Kebangsaan Dato' Penggawa Barat. The fire destroy the entire laboratory involved arising from chemicals reaction. The results of these investigation to priorities and important problem is no actions obtained by the relevant authorities about the fire was caused by a fire prevention system cannot function properly. Therefore, using of manually fire extinguisher are very difficult situation because the fire involving chemicals and dangerous of people who want to extinguish the fire.



Figure 1.2: News about the fire at chemical laboratory

Figure 1.3 shows an view of the state of fire extinguishers are placed on the walls give the impression that the use of the manual is not giving effect to the specific use in chemical laboratories as a result of several factors that can effect anyone who helped to extinguish the fire.



Figure 1.3: Shows the position of fire extinguisher

#### **1.4 Scope of Project**

The scope of this project is to develop an automatically system fire extinguishers to remove fire. The project is special in a table placed next to a laboratory where it was used to carry out the experiments research which would be likely to cause a fire. Therefore, applications that use the same as the use of fire extinguishers manually, where the hose is placed adjacent laboratory table act sweep the entire surface area of laboratory table. Next, the heat detector is acting source for this project to work with this heat detector acts to detect the presence of fire due to the heat detector position that is placed on the surface of the table with the appropriateness of a predetermined distance. After heat detector detects the presence of heat that has been set according to a predetermined range, emergency lights and siren function to let the people around that there was a fire or an accident is detected in the laboratory. The entire focus of this project to run automatically once the system detect the fire. Finally, by only using emergency stop button to extinguish the fire as safety precautions.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.0 Introduction**

The most effective way to prevent such damage by fire is preliminary extinguishing. Preliminary extinguishing is extinguishing a fire in 2 minutes from the time the fire has occurred. By extinguishing the fire before it spreads, damage is drastically reduced. In addition, the activity of fire engine is also reduced. Therefore, initial extinguishing is an efficient way of fire extinguish. There is a great difference in damage between the cases preliminary extinguishing is performed and the other cases. The systems for performing extinguishing already exists. For example, the home fire alarm is low in price and installable in any house.

However, it doesn't have an extinguishing function. Additionally, when it worked and the alarm was raised, fire may become so big that it is not at initially extinguish stage. For more examples, sprinkler has high fire extinguishing ability, but it sprinkles a large amount of water all over the area. Owing to its way to extinguish, the area is soaked with water even it succeeded in extinguishing the fire, hence electronic equipment like computers can break down. To take advantage of initial extinguish, we need a system that detects fire in the initial stage and extinguishes the detected fire properly.

There had built a system that performs initial extinguishing by remote control last time. However, the system is intended to detect fire by setting an IR camera near one of the fire sources. Therefore, it was a problem that appropriate detection for

multiple fire sources was difficult. Therefore, we improved the system so that it can detect fire properly for multiple fire sources.(Takahashi & Kitazono, n.d.)



Figure 2.1: Operation Schematic diagram

The operation schematic diagram of the system is shown in Figure 2.1. First, if a fire occurs, fire detection system detects the breaking out of the fire. Then, a notification is sent to the user, and the user accesses the website for fire fighting via device user owns such as smartphone, tablet or any device which has a web browser. If the user makes sure that fire has actually occurred and presses the extinguishing button on the website, the system makes the fire extinguisher work. The causes of laboratory accidents are usually very complex. Root cause analysis (RCA) provides a structural way, with regard to a particular event, to help investigators systematically identify root causes. However, they also need a way to estimate the impact of each cause and human corrective action for policy making. The analytic hierarchy process (AHP), proposed by Saat, is a well-recognized multi-criteria tool designed for dealing with complex decision-making problems.(Shih, Horng, & Lee, 2016)

Chemistry laboratories, by their nature, are of primary concern with regard to fire accidents; they may be highly destructive as leading to an explosion and serious threat to human life when they occurred. As shown in Table 2.1, the causes of lab fire accidents can be classified into five categories, that is, chemical reaction fires, static electricity fires, equipment failure fires, fire due to operational errors (man-made fire),

and fires caused by nature disaster. Chemical reaction fires are the most frequent type of fire, with 64 cases, and static electricity fires are the second, with 27 cases.

Table 2.1: Cause of fire accident in laboratory.

Laboratory	Chemical reaction	Static electricity	Equipment failure	Operational error	Nature disaster	Others	Total
Chemical	54	13	6	14	1	7	95
Physical	3	10	2	5	0	4	24
Biological	7	4	2	5	0	2	20

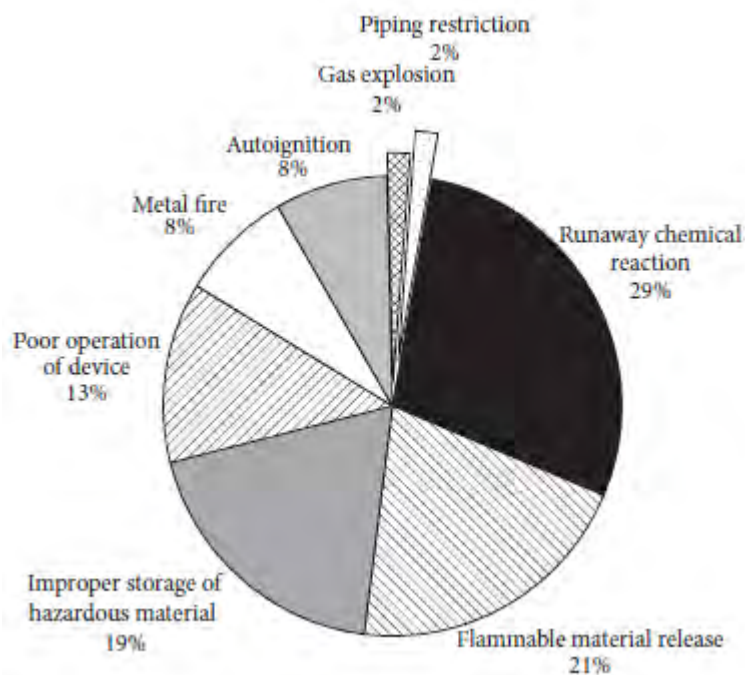


Figure 2.2: Percentage of breakdown of root causes in chemical reaction fire casualties.

Figure 2.2 shows details of the ignition factors causing chemical reaction fires, where runaway chemical reaction (29%) and the release of flammable materials (21%) are the most dangerous.

## **2.1 Approach Safety Laboratory in school**

Laboratory safety in schools should be emphasized as existing education system encourages students to conduct scientific experiments in school laboratories. The Ministry of Education (MOE) has published guidelines on the Management and Safety of School Laboratory (PKMSS) and incorporated elements of laboratory safety into science textbook and practical. Nonetheless, these documents did not offer a comprehensive approach that can be easily memorized by the students. Hence by analysing relevant documents, this study offers a systematic approach that encompasses important components of laboratory safety, in order to make it more comprehensive and easily memorized by the students. The basis to develop the approach is based on the 3R approach (reduce, reuse and recycle). The laboratory safety approach developed in this study is known as 5P (Procedures, Safety Equipment, Handling Experiment, Chemical Waste Management and Emergency Response Plan). Perhaps the 5P approach can be adopted by stakeholders in the future and then enhance school laboratory safety in Malaysia. (Nur Liyana Ali, Goh Choo Ta, Sharifah Zarina Syed Zakaria, Mazlin Mokhtar, 2014).

## **2.2 Fire Protection and Prevention**

Fire is a chemical reaction that requires three elements to be present for the reaction to take place and continue. Figure 2.3 shows the three elements typically are referred to as the “fire triangle.” Fire is the result of the reaction between the fuel and oxygen in the air. Scientists developed the concept of a fire triangle to aid in the understanding of the cause of fires and how they can be prevented and extinguished. Heat, fuel, and oxygen must combine in a precise way for a fire to start and continue to burn. If one element of the fire triangle is not present or removed, the fire will not start or, if already burning, will extinguish. (Protection, 2011)



Figure 2.3: Fire triangle reaction

### 2.3 Fire Extinguisher

1. Security measures to avoid accidents:
  - i. Systematic inspection of wiring in the lab routinely in laboratories as a precaution.
  - ii. Ensure systems, fire extinguishers and fire hydrants can always be used in good condition.
2. Prepare a safety plan or emergency exit during a fire at the Central Laboratory Complex.
3. Affix a poster on a fire extinguisher which contains how to use a fire extinguisher.
4. Fire extinguishers labelled by symbols or use a standard letter for each class of fire can be extinguished.

There are different types of fire extinguishers designed to put out the different classes of fire. Selecting the appropriate fire extinguisher is an important consideration for a roofing contractor. The wrong extinguisher actually may make a fire emergency worse. For example, failing to use a C-rated extinguisher on energized electrical components may endanger workers by causing the extinguishing material to be electrified by the energized components that are on fire. C-rated fire extinguishers put out the fire by using a chemical that does not conduct electricity. Table 2.3 illustrates