Sudan University of Science and Technology

COLLEGE OF POST GRADUATE STUDIES

DESIGN AND IMPLEMENTATION OF AUTOMATIC FIRE FIGHTING SYSTEM

تصميم و تنفيذ نظام لاطفاء الحريق التلقائي

Thesis submitted in partial fulfillment to the Requirements for
The award of the degree of Master in Electrical Engineering
(Microprocessor and Electronic Control)

Presented By:

AMANI OSMAN KHOJALI ELTAYEB

Supervised by:

Dr.ABD ALRASOUL ALZOUBIDI

December 2015

الآيـة

قال تعالى:

بسم الله الرحمن الرحيم

(اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِن شَجَرَةٍ مُّبَارَكَةٍ زَيْتُونِةٍ لَّا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُّورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَن يَشَاء وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ)

سورة النور (35)

DEDICATION

My thanks and deep appreciation to my great parents my source of inspiration and love who dedicated their live to empower me with carriage and support. Their praying strengthen my will to challenge all difficulties. My gratitude and special thank to my family and friend.

ACKNOWLEDEMENT

In the name of Allah, the Most Gracious and the Most Merciful Alhamdulillah, all praises to Allah for endowing us with health, patience, and knowledge to complete this work.

I would like to thank Dr. Abd Alrasoul Alzobidi for his invaluable assistance and insight leading to the writing of this research.

ABSTRACT

Nowadays, securing one’s property and business against fire is becoming more and more important. Monitoring commercial and residential areas all-round is an effective method to reduce personal and property losses due to fire disasters. Most of this building use modern and intelligent systems, and contain valuable equipments so it needs sophisticated firefighting system.

The main objective of this dissertation is to implement and design Automatic firefighting system based on a Microcontroller. The designed system describe building consist of three rooms each room contain three sensors (temperature, smoke, and flame). The system uses set of LEDs, buzzer to indicate the presence of smoke, over temperature or fire in any room, and a firefighting pump on standby to put out the flames when needed. The system simulated in proteus VSM, A microcontroller (ATmega16) is used to process the various sensor signals and control the system actuators accordingly.

A software code is developed to control the overall system functions. The code is written in BASIC language using Basic Compiler for AVR (BASCOM-AVR).

The system Supposed to give quick response to the sensors, give alarm, Extinguish, localize, or put out fires in a short time.

مستخلص

في هذا العصر أصبح تأمين الثروات و الأعمال ضد كوارث الحريق من الأولويات, و أهم الطرق الفعالة لذلك مراقبه المناطق التجارية و الصناعية و السكنية لتقليل فقد الأرواح و الممتلكات. لأن معظم تلك المباني تعمل بأنظمة حديثه و تحوي معدات و أجهزه قيمه فبالتالي تحتاج أنظمةمتطورة لمكافحه الحرائق .

ان الهدف الرئيسي من هذه الأطروحه هو تصميم نظام إطفاء حريق تلقائي باستخدام تقنيه المايكرونترولر. يصف النظام مبني مكون من ثلاث غرف كل غرفة تحتوي على ثلاثة أجهزة استشعار (محساس درجة الحرارة وكاشف الدخان و كاشف اللهب). و يستخدم النظام المصابيح و جرس الانذار للا شاره الي وجود (ارتفاع درجه الحراره, دخان, لهب), و توجد ايضا مضخه اطفاء في وضع الاستعداد لاخماد الحريق.

تم استخدام نظام المحاكاه proteus VSM, حيث يقوم المتحكم (ATmega16)) بمعالجة مختلف إشارات أجهزة الاستشعار والتحكم في النظام.

تم تطوير مدونة برنامج للتحكم في وظائف النظام العام. تم كتابة التعليمات البرمجية في اللغة الأساسية باستخدام AVR (AVR-BASCOM).

من المتوقع أن يستجيب النظام بسرعة للمتحسسات ليعطي إشارة الإنذار ويقوم بإطفاء الحريق في زمن وجيز.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

IMO	International Maritime Organization
ISO	International Standard Organization
NFPA	National Fire Protection Agency
IMO FSS	International Maritime Organization. Fire Safety System
BLEVES	Boiling Liquid Expending Vapor Explosions
UV	Ultraviolet Radiation
IR	infra-red
DSP	Digital Signal Processors
MCU	Microcontroller
ADC	Analog-to-Digital Converter
DAC	Digital-to-analog converter
I/O	Input /Output
UART	Universal Asynchronous Receiver/Transmitter
VLSI	Very Large Scale Integration
CU	Control unit
CPU	Central Processer Unit
PC	Personal Computer
NO	Normally Open
NC	Normally Close contact
AFFF	Aqueous film forming foams
AR-AFFF	Alcohol-resistant aqueous film-forming foams
EEPROM	Electrically Erasable Programmable Read Only Memory
AVR	Advanced Virtual RISC
AVRASM	AVR Assembler
PIC	Peripheral Interface Controller
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw

LED	Light Emitted Diode
LCD	Light Crystal display
IAR	Ingenjörsfirman Anders Rundgren
JTAG	Joint Test Action Group
SRAM	Static Random-Access Memory
ANSI	American National Standards Institute
APG	Automatic Program Generator
IDE	Integrated Development Environment
PCB	Printed Circuit Board
GND	Ground
VCC	Digital Supply Voltage
XTAL	Oscillator
VSM	Virtual System Modeling
GSM	Global System for Mobile
RF	Radio Frequency Module
GPRS	General packet radio service

CHAPTER ONE

INTRODUCTION

1.1 Back Ground

Nowadays, securing one's property and business against fire is becoming more and more important. Monitoring commercial and residential areas all-round isan effective method to reduce personal and property losses due to fire disasters.

Fire fighting System used to prevent, Extinguish, localize, or put out fires in enclosed spaces. The traditional fire protection units are widely deployed. But that are actuated manually by an operator, which may cost time and property. Automatic fire-fighting systems are installed in buildings and rooms where the fire hazard is relatively high.

An automatic fire-fighting system includes a sensor capable of detecting combustion, alarm signaling devices, fire-extinguishing equipment, starting and stopping devices, and feeders for the fire-extinguishing substance; in some cases, it includes control equipment for the production process being protected. Atomizers, foam generators, and pipe nozzles form and direct the stream of the fire-extinguishing substance, which may be a liquid, foam, powder, or gas. Fire-extinguishing substances are fed into the system from a centralized supply, such as a water supply, or from self-contained or combined feeders [1].

The most widely used systems employ water (sprinkler and drencher systems), carbon dioxide, aerosols, or powders. A sprinkler system consists of a grid of pipelines located on the ceiling of the room, with sprinkler heads attached to the pipes by threaded connections. The opening of a sprinkler is kept closed by a disk held in a closed position by a thermal lock. If the room temperature rises to a specified point, the lock is destroyed and the disk opens, admitting water to the room.

Drencher systems, which use nozzles without thermal locks, are actuated either by a sprinkler installed in a trigger air line or by a cable-type thermal lock. Automatic fire protection systems are classified according to the time elapsed between the start of the fire and the actuation of the system as ultrahigh-speed (to 0.1 second), high-speed (to 3 seconds), and standard (to 180 second). The fire-extinguishing substance can be applied for periods ranging from 30 second to 3600 second [1].

A simple automatic fire alarm system for buildings based on an ATmega16 microcontroller using sensors is designed and implemented in this project.

1.2 Problem Definition

Traditional fire fighting systems have an invaluable role in securing residential industrial buildings and facilities. Most of these systems are manually adjusted and incapable of providing an early detection mechanism.

1.3 Objectives

- To design and simulate firefighting system.
- To monitor and observe the current status of environment and send voice and visual alarm when fire occurs.

1.4 Methodology

In order to meet the above stated objectives, the system should be simulated in proteus VSM, A microcontroller (ATmega16) is used to process the various sensor signals and control the system actuators accordingly. A firefighting pump will be interfaced to the microcontroller through a relay.

A software code is developed to control the overall system functions. The code is written in BASIC language using Basic Compiler for AVR (BASCOM-AVR).

1.5 Layout of the Thesis

This thesis includes six chapters:

Chapter Two describes the literature overview of fire fighting system constituents, their classification of fires, portable fire extinguishers, fire extinguishing systems, and fire alarm systems.

Chapter Three includes description of wireless fire fighting system, basic design and requirements, input system, tips for input system, processing system, and output system.

Chapter Four explain programming of Microcontroller, and software description.

Chapter Five summarizes the implementations of the design, and the results detained.

Chapter six the conclusion and the recommendations proposed for the future work.

CHAPTER TOW

Overview of Fire Fighting System

2.1 Overview

Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products.

The flame is the visible portion of the fire. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity will be different.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems around the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, light, signaling, and propulsion purposes.[18]

The negative effects of fire include hazard to life and property, atmospheric pollution, and water contamination.

Firefighting is the act of extinguishing fires. A firefighter suppresses and extinguishes fires to protect lives and prevent the destruction of property and the environment. Firefighters may provide many other valuable services to their communities including emergency medical services. Firefighting requires professionals with a high technical skill who spend years training in both general firefighting techniques and specialized areas of expertise. Some of the specialized areas of fire and rescue operations include Aircraft/airport rescue; Wild land fire suppression; and Search and rescue.[18]

One of the major hazards associated with firefighting operations is the toxic environment created by combusting materials. The four major hazards associated with these situations are smoke, the oxygen deficient atmosphere, elevated temperatures, and toxic atmospheres. Additional risks of fire include falls and structural collapse. To combat some of these risks, firefighters carry self-contained breathing apparatuses.

The first step of a firefighting operation is a reconnaissance to search for the origin of the fire and identification of the specific risks and any possible casualties. A fire can be extinguished by water, fuel removal, or chemical flame inhibition. In the US, fires are sometimes categorized as "one alarm", "all hands", "two alarm", "three alarm" (or higher) fires. There is no standard definition for what this means quantifiable though it always refers to the level response by the local authorities. In some cities, the numeric rating refers to the number of fire stations that have been summoned to the fire. In others, the number counts the number of "dispatches" for additional personnel and equipment.[18]

This chapter discusses the phenomena and different mechanisms that work within a fire and is intended to provide a better understanding of the requirements in fire-fighting scenario.

2.2 History of Fires

The earliest known firefighters were in the city of Rome. In 6 A.D. , emperor Augustus made the Corps of Vigils to protect Rome after a disastrous fire. The Corps of Vigils consisted of 7000 people. They were equipped with buckets and axes, and they fought fires and served as police [17].

2.2.1Old Tactics and Tools

In 4th century B.C. , an Alexandrian Greek named Ctesibuis made a double force pump called a 'siphona'. As water rose in the chamber, it compressed the air inside which forced the water to eject in a steady stream through a pipe and nozzle.

In the 16th century, syringes were also used as firefighting tools. The larger ones were usually put on wheels.

Another tactic that was used was the bucket brigade. The villagers would form two lines between the water source and the fire. The men would pass along the full buckets of water to the fire. The women and children would pass back the empty buckets to be refilled.

In the 17th century, fire engines were being made and the best one was made in Amsterdam.In 1721, Richard Newsham made a fire engine that was very popular. It was basically a rectangular box on wheels. The bucket brigade would pour water into the machine and the men would supply the power to produce the water pressure.

The first American attempt at fire insurance failed after a large fire in Charlestown, Massachusetts in 1736. Later in 1740, Benjamin Franklin organized the Philadelphia Contribution ship to provide fire insurance, which was more successful. The Contribution ship adopted "fire marks" to easily identify insured buildings. Firefighting started to become formalized with rules to provide buckets, ladders, hooks, and the formation of volunteer companies.[clarification needed] The chain of command was also established[17].

2.3 Classification of Fires

Fires are classified by the types of fuel they burn. As follow

2.3.1 Class A

Ordinary, combustible materials i.e. wood, cloth, paper, some rubber and plastic materials.

2.3.2 Class B

Class B includes: - Flammable liquids, gases, greases, and some rubber and plastic materials [1].

2.3.3 Class C

Live electrical equipment, when equipment is reenergized, extinguishers for class A or B fires could be used safely; however, in fighting an electrical fire there are two important things to be taken into consideration: namely (a) damage to the equipment far beyond what the fire could do, and (b) danger to the individuals fighting the fire. To avoid these two possibilities, deenergize the circuit and use only the types of extinguishment recommended for class C fires.

2.3.4 Class D

Combustible metals such as magnesium, titanium, sodium, potassium, lithium, and zirconium.

The International Maritime Organization (IMO) mentions two standards in IMO Resolution A. 602(15) which define the various classes of fires. The first is the International Standards Organization (ISO) Standard 3941, and the second is the National Fire Protection Agency (NFPA) , Table 1 identifies these classes of fire as they are listed in IMO Resolution A. 602(15).IMO Resolution A. 602(15) is included in Annex of the International Code for Fire Safety System (IMO FSS Code)[1].

TABLE (2.1): Fire Classifications

ISO Standard 3941	NFPA 10
Class A: Fires involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers	**Class A**: Fires in ordinary combustible materials, such as wood, cloth, paper, rubber and many plastics.
Class B: Fires involving liquids or liquefiable solids.	**Class B**: Fires in flammable liquids, oils, greases, tars, oil-based paints, lacquers and flammable gases.
Class C: Fires involving gases.	**Class C**: Fires which involve energized electrical equipment where the electrical Non-conductivity of the extinguishing medium is of importance.
Class D: Fires involving metals.	**Class D**: Fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium and potassium.

2.4 Fire Extinguishing Systems

Fire extinguishing systems hare various types – by fire main, water, foams, sprays or water spray etc. Other uses gas inert. All systems conform to ISO.

2.4.1 Fire Main Systems

The fire main is a system consisting of sea inlet(s), suction piping, fire pumps and a distributed piping system supplying fire hydrants, hoses and nozzles located throughout the vessel. Its purpose is to provide a readily available source of water to any point throughout the vessel which can be used to combat a fire and is considered the backbone of the fire fighting systems onboard a vessel.

Through the fire main system, the firefighter is provided with a reliable and versatile system capable of providing a number of different methods with which to engage a fire. Water can be supplied as a straight stream for combating deep seated fires, as a spray for combating combustible liquid fires where cooling and minimum agitation is desired or as a means to protect personnel where cooling is the primary effect desired. [2]

2.4.2 Fixed Gas Fire Extinguishing Systems

Fixed gas fire-extinguishing systems typically suppress fires by reducing the available oxygen in the atmosphere to a point where combustion can no longer take place or by interrupting the chemical reaction necessary for the progression of the fire.

Advantages of fixed gas systems over water-based systems are that:

• Damage to sensitive equipment can be avoided, especially in the case of electronic equipment.

• Clean up time and equipment down time is substantially reduced.

Disadvantages are that:

• Some gaseous agents are hazardous to personnel.

• Cooling effect of gas systems is significantly less than water-based systems.

• Unlike the unlimited supply of water for fire-fighting systems, the quantity of gas available is limited to that carried in the cylinders protecting the space.

Due to the above disadvantages, it is essential that fixed gas fire-fighting systems be deployed as quickly as possible to minimize heat buildup. Also, care should be taken to avoid the possibility of a

fire being restarted due to dissipation of the fire-extinguishing gas and the introduction of fresh air from protected compartments being prematurely opened after a fire.[2]

In new installations, the most common fixed gas extinguishing systems encountered are either high/low pressure CO_2 systems or those utilizing Halon "alternatives".

2.4.3 Fixed Water Fire Extinguishing Systems

Water is an ideal extinguishing medium for many shipboard applications. It is readily available, has great heat absorbing capabilities and can be used on a variety of fires. There are several mechanisms involved in the extinguishment of a fire with water. First, there is the cooling of the flame temperature when water passes through the combustion zone and absorbs heat through evaporation.

Cooling of the flame temperature results in a reduction in the amount of radiant heat released by the fire, and therefore, a reduction in the amount of heat radiated back to the fuel surface. Secondly, there is the cooling effect of the fuel surface by the direct impingement of water droplets on the surface.

With a reduction of the radiant heat received at the fuel surface and the additional cooling of the fuel surface by direct contact with the water droplets, there is a reduction in the amount of combustible gases released. With sufficient cooling of the flame temperature and/or the fuel, the rate of pyrolysis or vaporization of combustible vapors will be reduced to a point which combustion will no longer be self-supporting. Water has the important additional effect of when it evaporates it turns into steam.[2]

The steam, which is in the immediate vicinity of the chemical reaction, displaces the air that supplies oxygen for the combustion process and results in a smothering of the fire.[2]

Fixed water extinguishing systems are normally considered to include water spray, water sprinkler and water mist systems. These systems utilize fixed piping systems with distributed arrays of nozzles located in the overhead, which are supplied from dedicated pump(s). However, the particular fire hazards and safety concerns vary depending on the particular type of space being protected. For example, in a machinery space, one would anticipate Class “B” combustibles to be involved, while in an accommodation space, one would anticipate the involvement of Class “A” combustibles. Even the degree of anticipated supervision has a role. There are many locations in the accommodation spaces and service spaces that are not continuously supervised (cabins, storage closets, etc.) and a small initial fire could easily go unnoticed by shipboard personnel. There are also certain differences in the extinguishing mechanisms at work for a water mist system as compared to those involved in water spray or water sprinkler system. Accordingly, the system designs, as well as the requirements, vary depending upon the space to be protected and the type of system to be installed.[2]

2.4.4 Foam Fire Extinguishing Systems

Foam is produced by the combination of three materials:

- Water
- Air
- Foam making agent.

Foam is formed by first mixing the foam-making agent (foam concentrate) with water to create a foam solution. The actual foam bubbles are created by introducing air into the foam solution through an appropriate aerating device. The correctly chosen foam concentrate, when properly proportioned with water and expanded with air through an application device, will form finished foam.

The foam concentrate is required to be thoroughly mixed with water at a particular concentration to produce the foam solution needed to create the desired foam. Two of the most common concentrations are 3% and 6% foams. These values are the percentages of the concentrate to be used in making the foam solution. Thus, if 3% concentrate is used, three parts of concentrate must be mixed with 97 parts of water to make 100 parts of foam solution. If 6%

concentrate is used, six parts of concentrate must be mixed with 94 parts of water. [2]

2.4.5 Gas Carrier Cargo Area Fire Extinguishing Systems

Gas carriers present a number of unique fire hazards. Therefore, the fire-fighting systems used must be carefully reviewed to ensure they are adequate for the dangers involved. The unique hazards associated with gas carriers include:

• Boiling Liquid Expanding Vapor Explosions (BLEVEs).

• Vapor release of cargo, leading to creation of gas clouds.

• Liquid pool fires, where discharge of water would only increase the evaporation rate and intensify the fire.

• Jet fires [2].

2.4.6 Water Spray Type Fixed Fire Fighting System

Water spray is defined as water in a specific form having a specific pattern, particle size, density and velocity which is discharged from specially designed nozzles or equivalent devices. Types of fire hazard are protected by water spray systems.

2.4.7 Foam Water Spray Fire Fighting Systems

Foam water systems generally work by allowing foam concentrate to mix with water flowing into the piping system. These systems are equipped with a bladder tank containing foam. When a fire is detected a signal is sent to the releasing panel to open the deluge valve allowing water to flow. At the same time, piping to the bladder tank flows and pressurizes the outer shell of the bladder tank which forces foam concentrate to travel into the system piping and then into the Foam Proportioner. The foam solution produced by water and foam concentrate flows into the system piping and is discharged through the open nozzles or sprinklers. [2]

2.5 Portable Fire Extinguishers

Portable fire extinguishers will work as intended to provide a first line of defense against fires of limited size.

A fire extinguisher is a storage container for an extinguishing agent such as water or chemicals. It is designed to put out a small fire not a big one. An extinguisher is labeled according to whether the fire on which it is to be used occurs in wood or cloth, flammable liquids, electrical, or metal sources. Using the wrong type of extinguisher on a fire can make the fire much worse.

2.6 Fire Alarm Systems

All Fire Alarm Systems essentially operate on the same principle. If a detector detects smoke or heat or someone operates a break glass unit (manual break point), then alarm sounders operate to warn others in the building that there may be a fire and to evacuate. It may also incorporate remote signaling equipment which would alert the fire brigade via a central station[3].

Fire Alarm Systems can be broken down into four categories:

- Conventional
- Analogue Addressable
- Addressable
- Wireless systems

2.6.1Conventional Fire Alarm System

In a Conventional Fire Alarm System, a number of call points and detectors are wired to the Fire Alarm Control Panel in Zones. A Zone is a circuit and typically one would wire a circuit per floor or fire compartment. The Fire Alarm Control Panel has a number of Zone Lamps. The reason for having Zones is to give a rough idea as to where a fire has occurred. This is important for the fire brigade and of course for the building management. The accuracy of knowing where a fire has started is controlled by the number of Zones a Control Panel has and the number of circuits that have been wired within the building. The Control Panel is wired to a minimum of two sounder circuits which could contain bells, electronic sounders or other audible devices. Each circuit has an end of line device which is used for monitoring purposes [3].

2.6.2Addressable Systems

The detection principle of an Addressable System is similar to a Conventional System except that the Control Panel can determine exactly which detector or call point has initiated the alarm. The detection circuit is wired as a loop and up to 99 devices may be connected to each loop. The detectors are essentially Conventional Detectors, with an address built in. The address in each detector is set by dil switches and the Control Panel is programmed to display the information required when that particular detector is operated. Additional Field Devices are available which may be wired to the loop for detection only i.e. it is possible to detect a normally open contact closing such as sprinkler flow switch, or a normally closed contact opening. Sounders are wired in a minimum of two sounder circuits exactly as a Conventional System. Loop Isolation Modules are available for fitting on to the detection loop/loops such that the loop is sectioned in order to ensure that a short circuit or one fault will only cause the loss of a minimal part of the system [3].

2.6.3Analogue Addressable Fire Alarm Systems

Analogue Addressable Fire Alarm Systems are often known as Intelligent Fire Alarm Systems. There are several different types of Analogue Systems available which are determined by the type of protocol which they use. The bulk of standard Analogue Detectors available are fairly stupid as the Detectors can only give output signals representing the value of detected phenomena. It is left up to the Control Unit to decide whether there is a fire, fault, pre-alarm or other. With a true Intelligent Analogue System each detector effectively incorporates its own computer which evaluates the environment around it, and communicates to the Control Panel whether there is a fire, fault or the detector head needs cleaning.

Essentially Analogue Systems are far more complex and incorporate far more facilities than Conventional or Addressable Systems. Their primary purpose is to help prevent the occurrence of false alarms. With the Analogue Addressable System, up to 127 input devices i.e.: Smoke Detectors, Call Points, Heat Detectors, Contact Monitors and other interface devices may be wired to each detection loop. In addition to the 127 Input Devices, up to 32 Output Devices such as Loop Sounders, Relay Modules and Sounder Modules may be connected. Analogue Systems are available in 2, 4 and 8 loop versions which means large premises can be monitored from one single panel. Isolator units should be connected between sections of detectors as described for Addressable Systems [3].

2.6.4Wireless Fire Alarm System

Wireless fire alarm systems are an effective alternative to traditional wired fire alarm systems for all applications. They utilize secure, license-free radio communications to interconnect the sensors and devices (smoke detectors, call-points, etc.) with the controllers. It is a simple concept, which provides many unique benefits and is a full analogue addressable fire detection system without the need for cable[3].

2.6.5 Key Components of a Fire Alarm System

The key components of the fire alarm system are the control panel, detector, and the alerting devices [4].

1. Control (Alarm) Panel

The control panel is the brain of the fire alarm system. The control panel constantly monitors the detectors installed throughout the protected facility for signs of fire. When a fire condition is detected the control panel can carry out a range of activities including:

- Sound the evacuation alarms for the facility.
- Notify the Fire Service.

- Notify the building management.
- Close fire and smoke doors.
- Start up smoke handling and ventilation systems.
- Initiate operation or shutdown of other building services.

2.Detectors

The Fire Protection is able to offer a full range of detectors to suit a range of different environments and hazards including:

- Heat detectors
- Linear heat detectors
- Fiber optic linear heat detectors
- Ionization smoke detectors
- Optical smoke detectors
- Intelligent multi-criteria detectors
- Aspirating smoke detector
- Beam detectors
- Flame detectors

3. Types of Fire Alarm System

The types of classifications fire alarm systems as follows:

TABLE (2.2): Types of Fire Alarm System

Type 2	A manual fire alarm system only, activated by manual call points.
Type 3	An automatic fire alarm system activated by heat detectors and manual call points.
Type 4	An automatic fire alarm system activated by smoke detectors and manual call points.
Type 5	Variation to a Type 4 that allows smoke detectors in some fire cells to sound a local alarm only, provided that heat detectors are also installed in those fire cells.
Type 6	An automatic fire sprinkler system and Type 2 manual fire alarm system.
Type 7	An automatic fire sprinkler system and Type 4 automatic fire alarm system.

CHAPTER THREE

Description of Components System

3.1 System Layout

The block diagram of the hardware implementation of the entire system is as shown in Figure (3.1).

The aim of the project is to illustrate the usage of the fire fighter and its applications and the minimum equipment required to construct the fire fighting system is a microcontroller, pump water, smoke sensor, temperature sensor, flame sensor, led's, and buzzer.

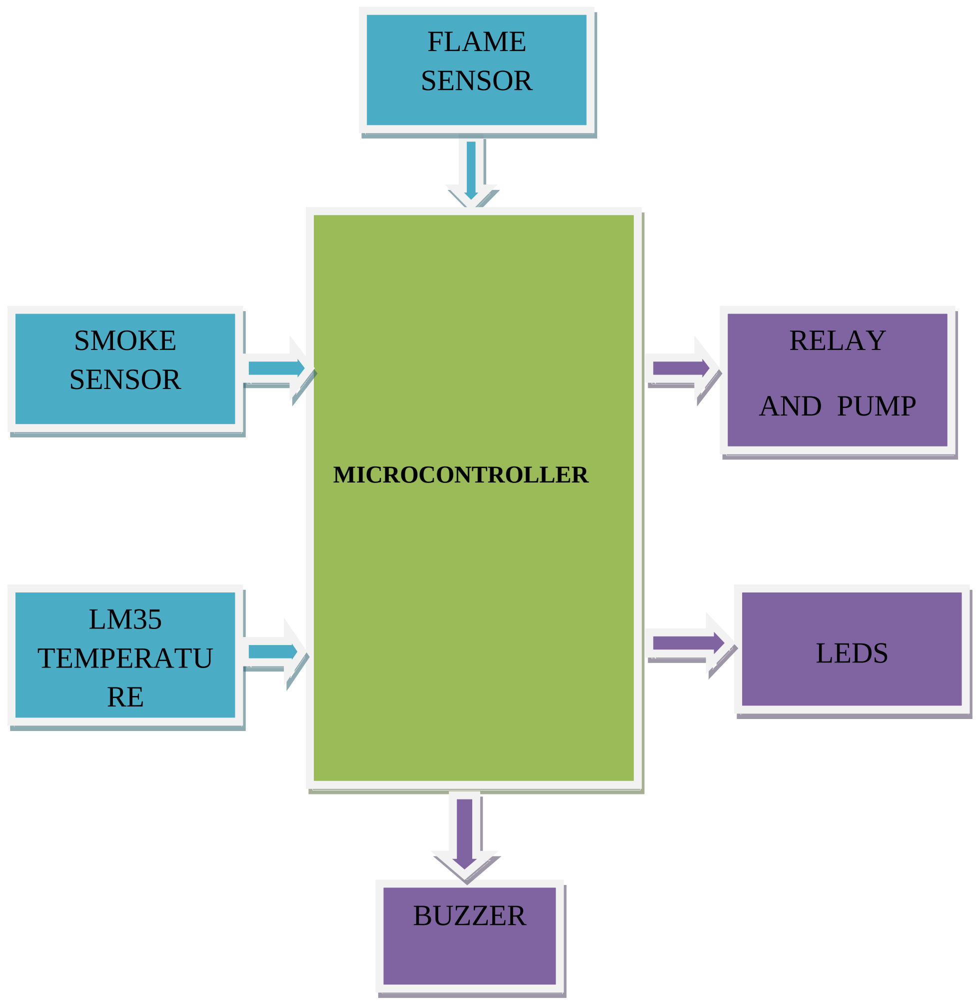


Figure 3.1 Hardware Implementation of Automatic fire fighting system

3.2 Input Unit

Input system consists of three sensors. The mechanism of the input system is described as follow.

3.2.1 LM35 Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in oC),

- It has an output voltage that is proportional to the Celsius temperature.
- The scale factor is .01V/oC
- The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 oC at room temperature and +/- 0.8 oC over a range of 0 oC to +100 oC.
- Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 oC temperature rise in still air.

The LM35 comes in many different packages:

TO-92 plastic transistor-like package,

T0-46 metal can transistor-like package

8-lead surface mount SO-8 small outline package

TO-202package[5].

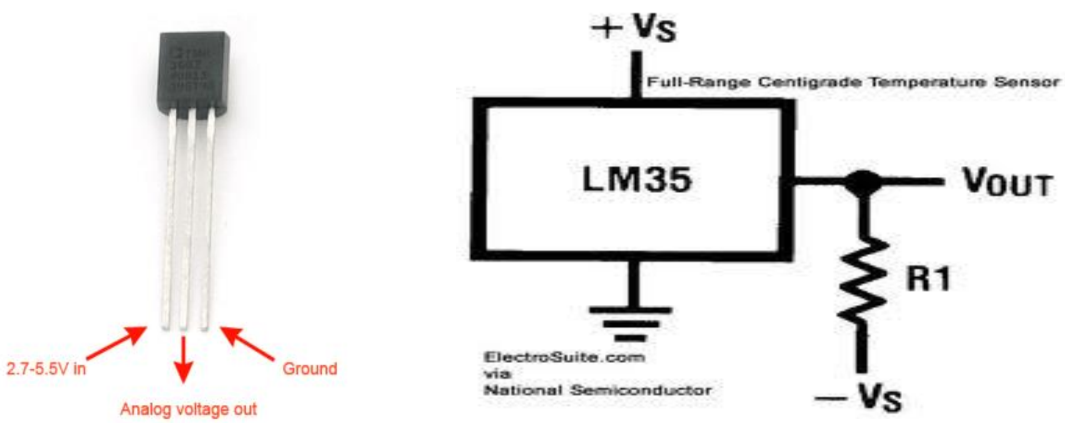


Figure 3.2: LM35 Temperature Sensor

3.2.2 Smoke Sensor

A smoke detector is a device that detects smoke, typically as an indicator of fire. Commercial, industrial, and mass residential devices issue a signal to a fire alarm system, while household detectors, known as smoke alarms, generally issue a local audible or visual alarm from the detector itself. Smoke detectors are typically housed in a disk-shaped plastic enclosure about 150 millimeters (6 in) in diameter and 25 millimeters (1 in) thick, but the shape can vary by manufacturer or product line. Most smoke detectors work either by optical detection (photoelectric) or by physical process (ionization), while others use both detection methods to increase sensitivity to smoke. Sensitive alarms can be used to detect, and thus deter, smoking in areas where it is banned such as toilets and schools. Smoke detectors in large commercial, industrial, and residential buildings are usually powered by a central fire alarm system, which is powered by the building power with a battery backup. However, in many single family detached and smaller multiple family housings, a smoke alarm is often powered only by a single disposable battery [6].

Figure 3.3: Smoke Sensor

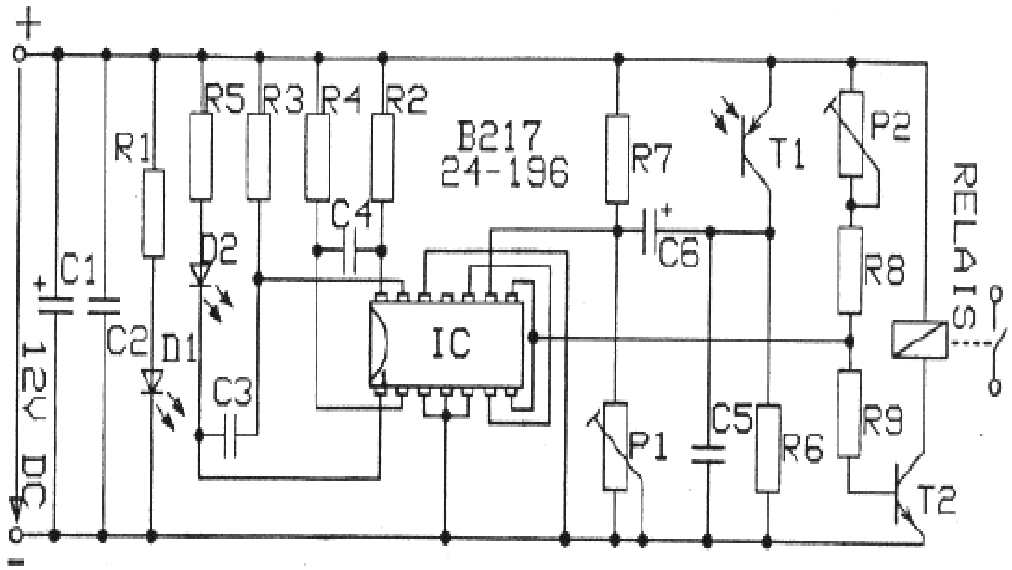


Figure 3.4: A Smoke sensor circuit

3.2.3 Flame Sensor

Flame type detectors are sophisticated equipment to detect the flame phenomena of a fire. These detectors have various types depending on the light wavelength they use. Such as, ultraviolet, near infrared, infrared, and combination of UV/IR type detectors.

UV detectors generally work with wavelengths shorter than 300 nm. This type of detectors can detect fires and explosions situations within 3 - 4 milliseconds from the UV radiation emitted from the incident. However, to reduce false alarm triggered by UV sources such as lightning, arc welding etc. a time delay is often included in the UV flame detector. The near Infrared sensor or visual flame detectors work with wavelengths between 0.7to 1.1 μm. One of the most reliable technologies available for fire detection, namely multiple channel or pixel array sensors, monitors flames in the near IR band. The Infrared (IR) flame detectors work within the infrared spectral band (700 nm - 1 mm). Usual response time of these detectors is 3 - 5 seconds. Also, there is UV and IR combined flame detectors, which compare the threshold signal in two ranges to detect fire and minimize false alarms.

Flame detectors are expensive and complex, though they provide very reliable and accurate response. They can operate in highly sensitive environment where other detectors can't be used. Aircraft maintenance facilities, fuel loading platforms, mines, refineries, high-tech industries etc. use these flame detectors for safety [6].

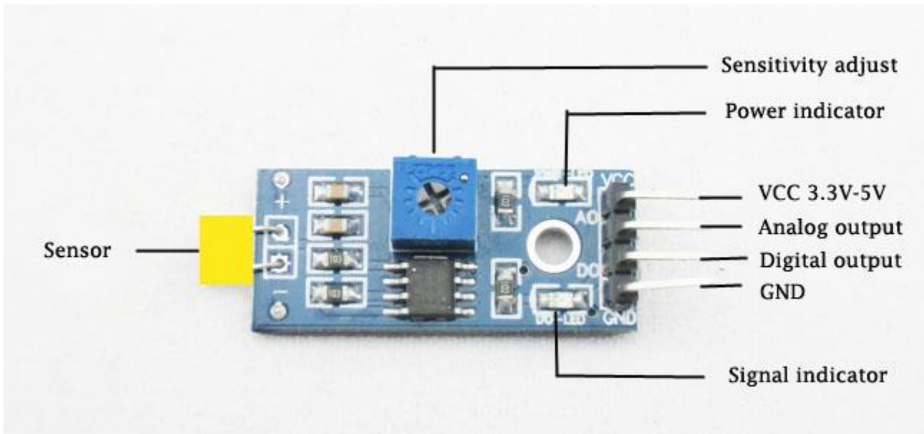


Figure 3.5: Flame sensor

3.3 System Processor

Processing system acts as the brain of robot, which generates desired output for corresponding inputs. For that purpose, microcontrollers are used. In present days, there are several companies that manufacture microcontrollers, for example ATMEL, Microchip, Intel, Motorola etc. ATmega16 microcontroller is used in this robot. It is an ATMEL product. It is also called AVR.

3.3.1 Microcontroller

A microcontroller MCU is a single chip computer. Micro suggests that the device is small and controller suggests that it is used in control applications. Another term for microcontroller is embedded controller since most of the microcontrollers are built into or embedded in the devices they control. Microcontroller is a very powerful tool that allows a designer to create sophisticated input-output data manipulation under program control. Microcontrollers are classified by the number of bits they process. Microcontrollers with 8 bits are the most popular and are used in most microcontroller-based applications.

MCU contains some of the following peripheral components

Memory ,Timers, counters, input capture, output compare, real time interrupt, and watchdog timer, Pulse Width Modulation PWM ,Analog-to-Digital Converter ADC ,Digital-to-Analog Converter DAC, Parallel I/O Input /Output interface ,Asynchronous serial communication interface Universal Asynchronous Receiver/Transmitter UART ,memory interface, software debug support hardware. Microcontroller is fabricating using Very Large Scale Integration VLSI such as microprocessor .In this type of fabrication there at least thousand of gates in a single chip.

A generic view of a microcontroller is shown in Figure 2.1 it contains a simple microprocessor core along with all necessary data and program memory[7].

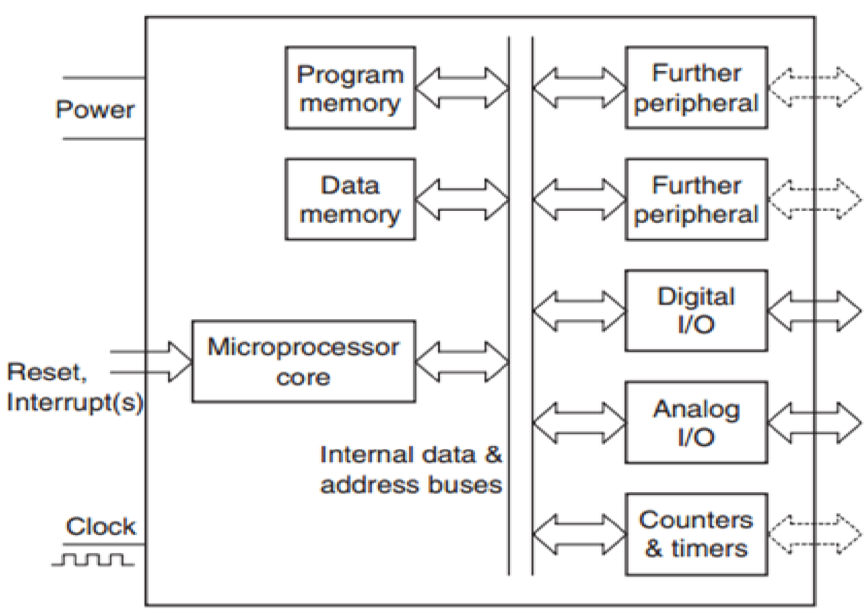


Figure 3.6: Generic Microcontroller

3.3.2MicrocontrollerHardware Details

TheATmega16is a low power Complementary Metal Oxide Semiconductor CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture by executing powerful instructions in a single clock cycle.

The Atmega16 provides the following features: 16K bytes of in system programmable, flash program memory with read write capabilities, 1024bytes EEPROM, 2K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a Joint Test Action Group JTAG interface for boundary scan on chip debugging support and programming, three flexible timer/counters with compare modes, internal external interrupts, a serial programmable universal Synchronous/Asynchronous Receiver/Transmitter USART, a byte oriented two wire serial interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain , programmable watchdog timer with internal oscillator, Serial Peripheral Interface SPI serial port, and six software selectable power saving modes the power down mode saves the register contents but freezes the oscillator[8].

Input and Output Ports used in the system the pins of Port A (PA0 to PA7) was used as input ports to use temperature and smoke sensors because this port consists of ADC feature. and pins of Port B (PB0 to PB2) are used as input port to use flame sensors, (PB3 to PB6) are used as output to control panel led's and buzzer, and output pins of port c (PC0 to PC1) IS output of led's for Auto and Manual modes , (PC3 to PC4)to output relay and pump water.

3.4 Output Unit

An output device is any piece of hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a microcontroller) which converts the electronically generated information into sensors.

3.4.1 Transistor - NPN (BC337)

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.

This is the BC337, NPN silicon BJT (Bipolar Junction Transistor). This little transistor can help drive large loads or amplifying or switching applications. The BC337 is specifically rated at 50V and 800mA max [9].

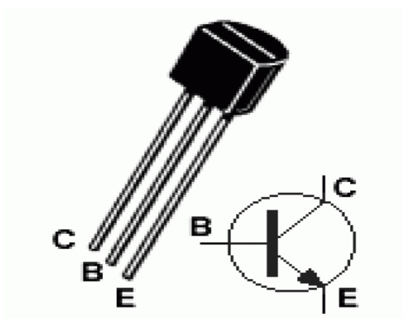


Figure 3.7:BC337 Transistor

3.4.2 Relay

Relays are operated switches many relays use an electromagnet to operate a switching mechanism mechanically but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low power signal with complete electrical isolation between control and controlled circuits or where several circuits must be controlled by one signal. Relays and switches come in different configurations. The most common are Single Pole Single Throw SPST is the simplest with only two contacts. Single Pole Double Throw

SPDT has three contacts. The contacts are usually labeled Common COM, Normally Open NO and Normally Closed NC. The Normally Closed contact will be connected to the Common contact when no power is applied to the coil. The Normally Open contact will be open i.e. not connected when no power is applied to the coil. When the coil is energized the Common is connected to the Normally Open contact and the Normally Closed contact is left floating. The Double Pole versions are the same as the Single Pole version except there are two switches that open and close together. Figure 3.6 illustrates the relay. [10]

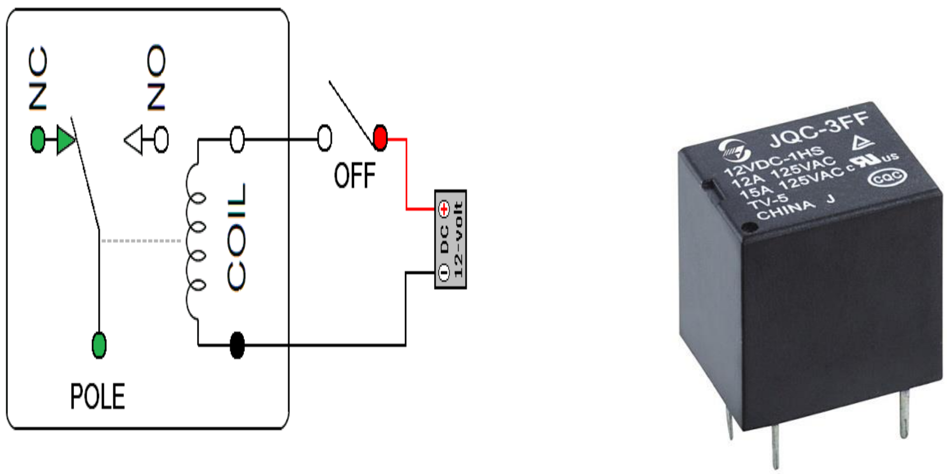


Figure 3.8: Relays

3.4.3 Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.[1]

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. [11]

Figure 3.9: Pump

3.4.4 Light Emitting Diode (LED)

light-emitting diode (LED) is a two-lead semiconductor light source that resembles a basic pn-junction diode, except that an LED also emits light. When an LED's anode lead has a voltage that is more positive than its cathode lead by at least the LED's forward voltage drop, current flows. Electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor, as shown below in the Figure (3.8).

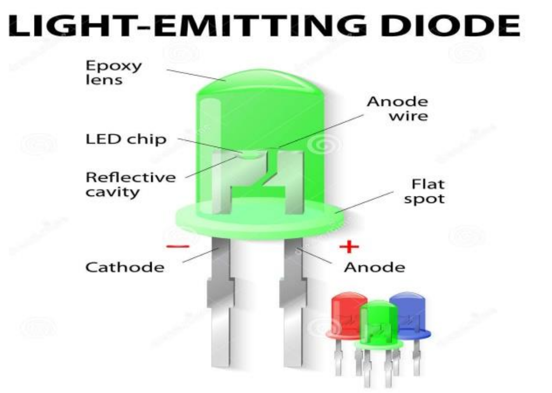


Figure 3.10: Light Emitting Diode (LED)

3.4.5 Buzzer

A buzzer or beeper is an audio signaling device,[1] which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

Figure 3.11: Buzzer

3.5 Firefighting foam

A fire fighting foam is simply a stable mass of small air-filled bubbles, which have a lower density than oil, gasoline or water. Foam is made up of three ingredients - water, foam concentrate and air. When mixed in the correct proportions, these three ingredients form a homogeneous foam blanket.[12]

- Low-expansion foams have an expansion rate less than 20 times. Low-expansion foams such as AFFF are low-viscosity, mobile, and able to quickly cover large areas.
- Medium-expansion foams have an expansion ratio of 20–100.
- High-expansion foams have an expansion ratio over 200–1000. They are suitable for enclosed spaces such as hangars, where quick filling is needed.
- Alcohol-resistant foams contain a polymer that forms a protective layer between the burning surface and the foam, preventing foam breakdown by alcohols in the burning fuel. Alcohol-resistant foams should be used in fighting fires of fuels containing oxygenates, e.g. MTBE, or fires of liquids based on or containing polar solvents.

3.5.1 Classes of foams

There are two types of foams:

3.5.1.1 Class A foams

Class A foams were developed in mid-1980s for fighting wildfires. Class A foams lower the surface tension of the water, which assists in the wetting and saturation of Class A fuels with water. This aids fire suppression and can prevent resignations. Favorable experiences led to its acceptance for fighting other types of class A fires, including structure fires.

3.5.1.2 Class B foams

Class B foams are designed for class B fires — flammable liquids. The use of class A foam on a class B fire may yield unexpected results, as class A foams are not designed to contain the explosive vapors produced by flammable liquids. Class B foams have two major subtypes.

I. Synthetic foams

- Synthetic foams are based on synthetic surfactants. Synthetic foams provide better flow and faster knockdown of flames, but limited post-fire security.
- Aqueous film forming foams (AFFF) are water-based and frequently contain hydrocarbon-based surfactant such as sodium alkyl sulfate. They have the ability to spread over the surface of hydrocarbon-based liquids.
- Alcohol-resistant aqueous film-forming foams (AR-AFFF) are foams resistant to the action of alcohols, able to form a protective film when they are present.

II. Protein foams

Protein foams contain natural proteins as the foaming agents. Unlike synthetic foams, protein foams are bio-degradable. They flow and spread slower, but provide a foam blanket that is more heat-resistant and more durable.

Protein foam from non-animal sources is preferred because of the possible threats of biological contaminants like prions.[12]

CHAPTER FOUR

SIMULATION OF THE SYSTEM

4.1 Programming Microcontroller

Programs are known as software. A program is a set of instructions that the microprocessor can execute. The program is stored in the microcontroller's memory in the form of binary numbers called machine instructions. All microcontrollers operate on a set of instructions stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations. Microcontrollers have traditionally been programmed using the assembly language of the target device. And when you write a source code with the C language the compiler of the C language is necessary [13].

4.2 Machine Code

A machine instruction is a combination of 0s and 1s that informs the CPU to perform certain operation. The most fundamental program form is machine code is the binary instructions that cause the CPU to perform the desired operations. Machine code or machine language is a system of instructions and data executed directly by CPU.

Machine code may be regarded as a primitive programming language or as the lowest level representation of a compiled assembled computer program. Programs in interpreted languages are no represented by machine code however their interpreter which may be seen as a processor executing the higher level program. Machine code is sometimes called native code when referring to platform dependent parts of language features or libraries. Machine code should not be confused with byte code, which is executed by an interpreter.

Every processor or processor family has its own machine code instruction set. Instructions are patterns of bits that by physical design correspond to different commands to the machine. The instruction set is thus specific to a class of processors using the same architecture[14].

4.3 Assembly Language

One step removed from machine code is assembly language where abbreviations called mnemonics memory aids substitute for the machine codes. The mnemonics are easier to remember than the machine codes they stand for. Since machine code is ultimately the only language that a CPU understands, you need some way of translating assembly language programs into machine code for very short programs you can hand assemble or translate the mnemonics yourself by looking up the machine codes for each abbreviation. Another option is to use an assembler which is software that runs on the desktop computer and translates the mnemonics into machine code. Most assemblers provide other features such as formatting the program code and creating a listing that shows both the machine code and assembly language versions of a program side by side. There are a few drawbacks for assembly language programming

-The programmer must be familiar with the hardware architecture on which the program is to be executed.

-Programming productivity is not satisfactory for large programming projects because the programmer needs to work on the program logic at a very low level [15].

4.4 High Level Language

High level languages such as C, C++, and Java were invented to avoid the Problems of assembly language programming. High level languages are close to plain English and hence a program written in a high level language becomes easier to understand. Statements in high level language often needs to be implemented by tensor even hundreds of assembly instructions. The programmer can now work on the program logic at a much higher level which makes the programming job much easier. A program written in a high level language is also called a source code and it requires a software program called a compiler to translate it into machine instructions. A compiler compiles a program into object code. Just as there are cross assemblers there are cross compilers that run on one machine but translate programs into machine instructions to be executed on a computer with a different instruction set.

Some high level languages are interpreted that is they use an interpreter to scan the user's source code and perform the operations specified interpreters do not generate object code. Programming languages that use this approach include Basic, Lisp, and Prolog. The Java language is partially compiled and partially interpreted program written in Java language is first compiled into byte code and then interpreted. The design purpose of this language is compiled once run everywhere.

High level languages are not perfect one of the major problems with high level languages is that the machine code compiled from a program written in a high level language is much longer and cannot run as fast as its equivalent in the assembly language. For this reason, many time critical programs are still written in assembly language [15].

4.4.1The C programming language

The C programming language allows applications to be written using syntax whose meaning is a little easier to understand than assembly code. Programs in C are converted into assembly language by a compiler and assembled into machine code in a two stage process.

C is the high level language of choice for microcontrollers. A range of different development systems and compilers are available but most use the same basic syntax defined as American National Standards Institute ANSI C. Assembly language is syntax which is unique to each type of processor while C provides a common language for all MCU types[16].

4.4.2 Bascom AVR

Bascom AVR is a compiler that uses a version of Basic very similar to QBASIC to produce programs for the AVR. Bascom AVR uses Integrated Development

Environment IDE which allows writing and editing programs, compiling them, testing them with a simulator and finally writing the program to the microcontroller for use in a circuit all from one program.

Microcontrollers such as the AVR are controlled by software and they do nothing until they have a program inside them. The AVR programs are written on PC using the Bascom AVR. This software is a type of computer program called compiler [14].

4.5 Code Assembler

Each memory location in the program memory map of the AVR controller is a 16-bit word. This 16-bit word constitutes the op-code and the operand. The controller reads the program memory and interprets the binary word. For human convenience rather than handle the op-codes you can use the mnemonic representation of the op-codes. However the controller understands the op-code and not the mnemonic and so you need a translation program that takes the mnemonic codes and translates these codes into op-codes. The program that does this job is called an assembler.

An assembler takes text file called the source file with the mnemonic representation of the program simply called the source code and converts it into another file with the machine op-codes simply called the machine code or object code [14].

4.5.1 AVR Family assembler

One of the assemblers available for AVR controllers is from Atmel. It is called AVRASM. It covers the entire range of AVR controllers .The assembler takes an assembler source code file and translates it into an object code file. The object code can be used as an input to a simulator or an emulator. The assembler also generates a file containing the code that can be programmed into the chip by a suitable programmer. The AVRASM is a very simple assembler and takes only a single input assembler code file. It is not possible to link other object code files using the AVRASM .The AVRASM can also generate an EEPROM file if EEPROM data has been allocated in the assembler source file[14].

4.5.2 IAR assembler

IAR assembler is a shareware product from Ingenjörsfirman Anders Rundgren IAR .This is a very high quality assembler with sophisticated features. IAR assembler allows assembling of multiple files as well as linking object code. The IAR assembler is fast and has a C preprocessor[14].

4.5.3 The mikroC

The micro C PRO for PIC is a powerful feature rich development tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution to developing applications for embedded systems without compromising performance or control.PIC and C fit together well PIC is the most popular 8-bit chip used in a wide variety of applications and C prized for its efficiency is the natural choice for developing embedded systems. MikroC provides a successful match featuring highly advancedIDE, ANSI compliant compiler, broad set of hardware libraries and comprehensive documentation plenty of ready to run examples[16].

4.5.4 Code vision AVR

Code Vision AVR is a C cross compiler IDE and Automatic Program Generator APG designed for the Atmel AVR family of microcontrollers. The C cross compiler implements all the elements of the ANSI C language as allowed by the AVR architecture with some features added to take advantage of specificity of the AVR architecture and the embedded system needs. Code Vision AVR also contains the Code wizard AVR and APG that allows you to write in a matter of minutes all the code needed for implementing the following functions. External memory access setup, Chip reset source identification, I/O port initialization, External Interrupts initialization, Timers/Counters initialization and Watchdog Timer initialization [14].

4.6 Code Simulator

Now once you have the object file you can transfer the op-codes into the AVR controller and if you have written a program exactly according to the system design it may work correctly. However there are good chances that your program does not work as expected. In such a case you will need to find out where the errors are and make suitable changes or additions to the source file assemble the source file again and load the machine code into the controller. This may be a time consuming iterative process rather than transferring the op-codes into the controller and debugging the code it is possible to simulate the working of the AVR controller on the development PC itself without downloading the machine code into the controller. A program that simulates or mimics the AVR controller is called a simulator. A simulator can execute the program code one code at a time displaying the result on the screen contents of registers, ports, status, etc and this can help ensure that the program works as expected[14].

4.6.1AVR simulator

The AVR simulator executes object code files generated for the AVR microcontrollers. It also supports simulation of various I/O functions. The simulator can be controlled through a command line as well as through menus. The AVR Simulator is very easy to use[14].

4.6.2 AVR studio

The AVR Studio is a development tool for AVR controllers. It allows control of execution of programs in circuit emulator or on the built in AVR instruction set simulator .The AVR Studio supports source level execution or AVR assembler programs as well as C programs compiled with IAR .At the time of starting the AVR Studio if the AVR in circuit emulator is connected and powered on the AVR Studio detects it and enables execution of programs on the emulator.

Otherwise it invokes the built in AVR instruction set simulator for source level simulation [14].

4.6.3 Proteus VSM

It allow to draw a complete circuit for a microcontroller based system and then test it interactively, all from within the same piece of software. Meanwhile ISIS retains a host of features aimed at the *Printed Circuit Board*PCB designer, so that the same design can be exported for production with ARES or other PCB layout software. Major features of PROTEUS VSM include:

-Support for both interactive and graph based simulation.

-CPU models available for popular microcontrollers such as the PIC and 8051 series.

-Interactive peripheral models include Light Emitted diode LED and liquid crystal display LCD and a whole library of switches, pots, lamps, etc.

-Virtual instruments include voltmeters, ammeters, a dual beam oscilloscope and a 24 channel logic analyzer [14].

4.7 Download a Program into Microcontroller

After compiling a microcontroller program in bascom will be able to generate hex files from the program codes.hex file is a machine code that corresponds to our language codes. Only microcontroller and microprocessor can interpret it. After building a hex file write it to the memory of microcontroller. This process is called burning of microcontroller.

Now open proteus and make the design which will include the required microcontroller and the double click on the microcontroller and then include that hex file which was created. This way you can simulate your design.

4.8 Software Description

The software was written in ATMEL AVR Basic Compiler (BASCOM-AVR). BASCOM-AVR is an Integrated Development Environment (IDE) that includes a BASIC Compiler for the Atmel AVR microcontroller family, Editor, AVR Simulator and In-System Programming support for a range of 3rd party hardware. It is designed to run on W95/W98/NT/W2000/XP and Vista [14]. See

Appendix A for the software code.

4.9 Flow Chart

Figures (4.1) and (4.2) explain the flow chart of implemented automatic firefighting system.

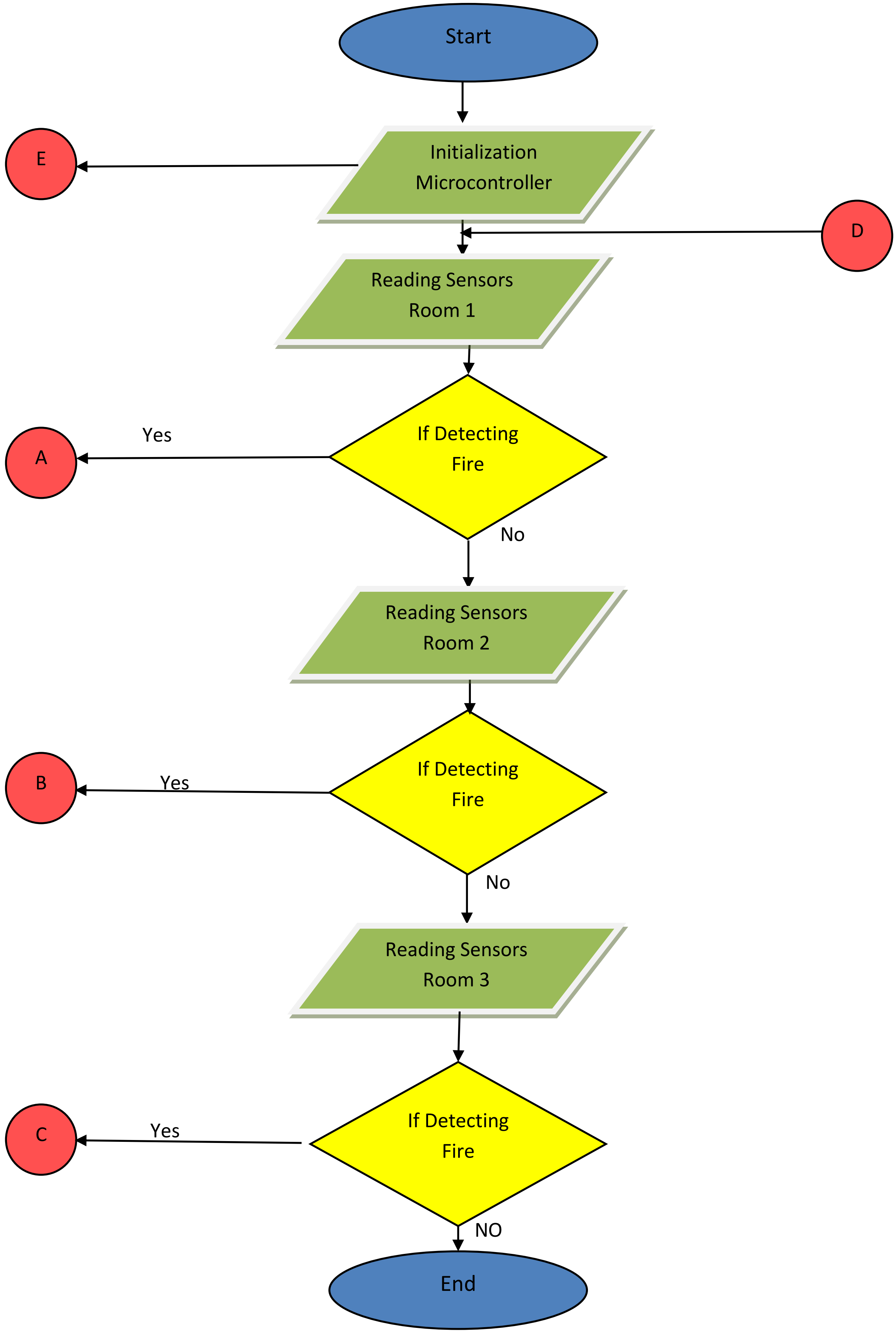


Figure 4.1: flow chart1

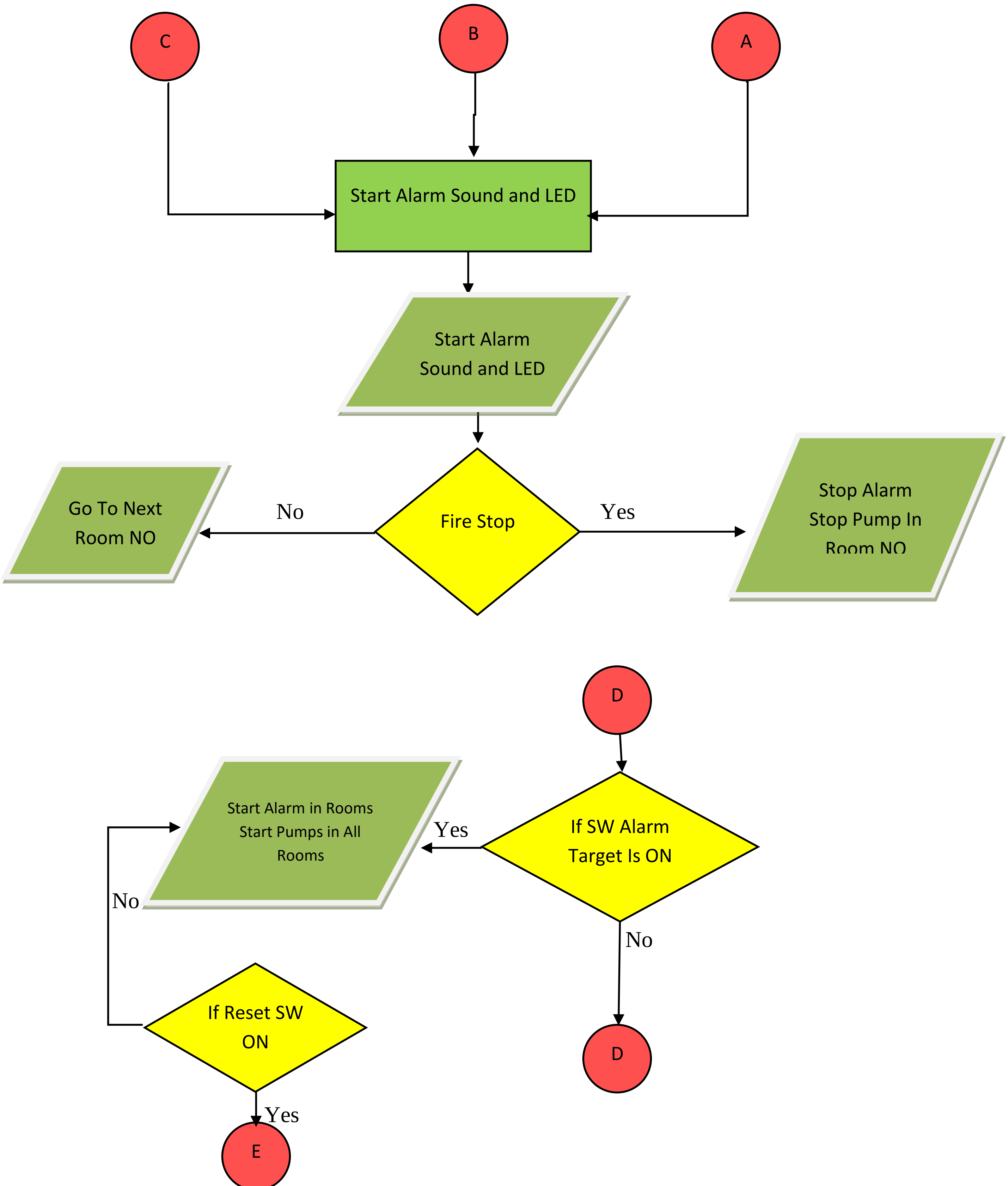


Figure 4.2: flow chart 2

CHAPTER FIVE

Implementations and Results

5.1 Overview

The automatic firefighting designed system is controlled by a microcontroller unit describe building consist of three rooms each room contain three sensors (temperature, smoke, and flame). The system uses set of LEDs, buzzer to indicate the presence of smoke, over temperature or fire in any room, and a firefighting pump on standby to put out the flames when needed. The figures (5.1) illustrate the hardware design of implemented automatic firefighting system.

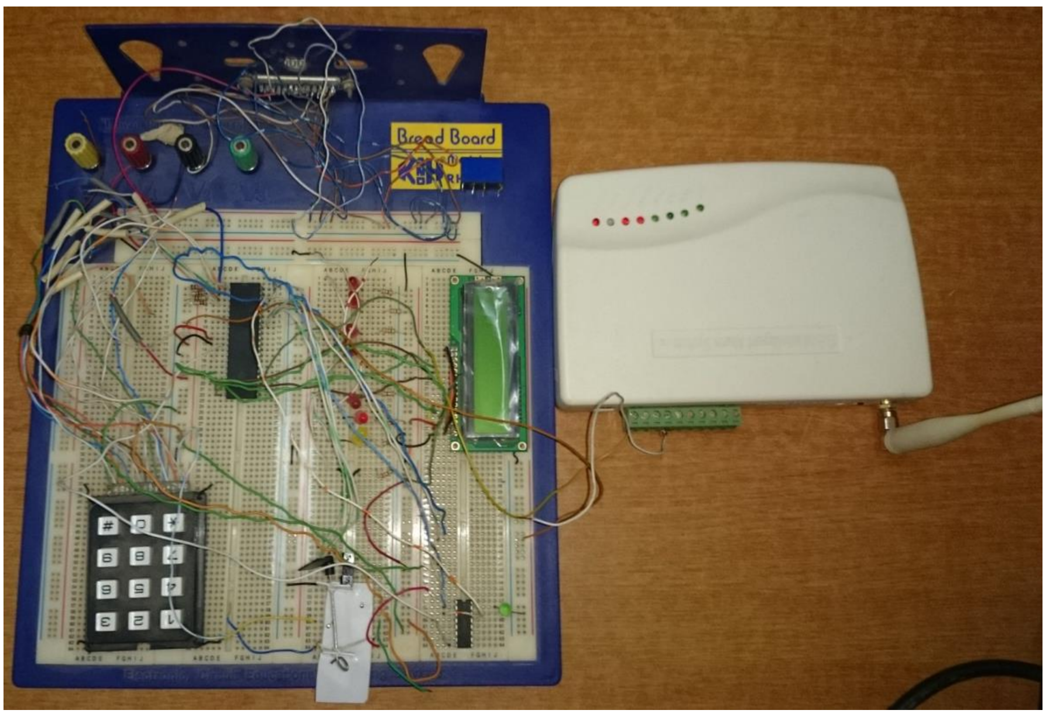


Figure 5.1 hardware design of automatic firefighting system

5.2 System Operation

When the system is powered up and switched on, the system will run in auto mode, The microcontroller then proceeds examining the nine sensors allocated in each room following a predefined routine which goes on as follows; first the microcontroller calibrates the overall temperature starting with first room, followed by the second and finally the third and incase it detects that the temperature of any of these rooms has gone outside its normal parameters, which is above 50º Celsius corresponding alarm led's will light up, then the microcontroller is proceeds with examining the smoke sensors in the same manner, and if smoke is detected in any room, the microcontroller will light up its corresponding indicator hazard led’s, also microcontroller will switch on the firefighting pump. The same procedure is followed with the flaming sensor, if flames are detected the microcontroller will light up its corresponding indicator hazard led’s, and also will switch on the firefighting pump. The firefighting pump is meant to operate in a single room rather than the three of them.

The manual mode designed to run at emergency case , it work by pressing the fire alarm target switch , in this mode led’s, buzzer, and firefighting pump in three room will switch on, and continuous running until it rested.

5.3 Simulation design

-When the system operate at auto mode:

1-smoke or temperature sensor has gone outside its normal parameters, alarm led light up as shown in figure 5.2.

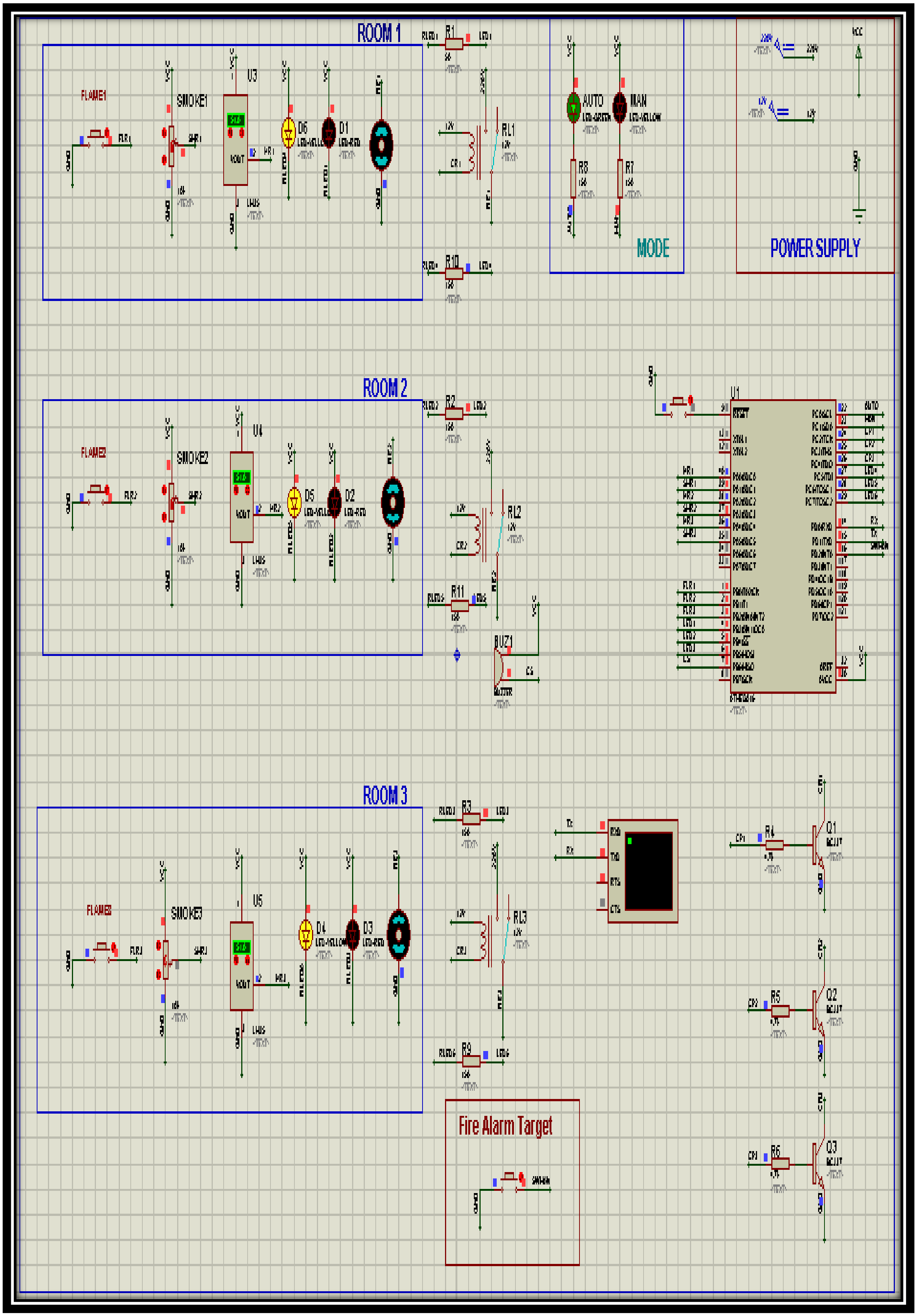


Figure 5.2:case one (Auto mode1)

2-smoke and temperature sensor has gone outside its normal parameters together, hazard led light up, pump and buzzer on as shown in figure 5.3.

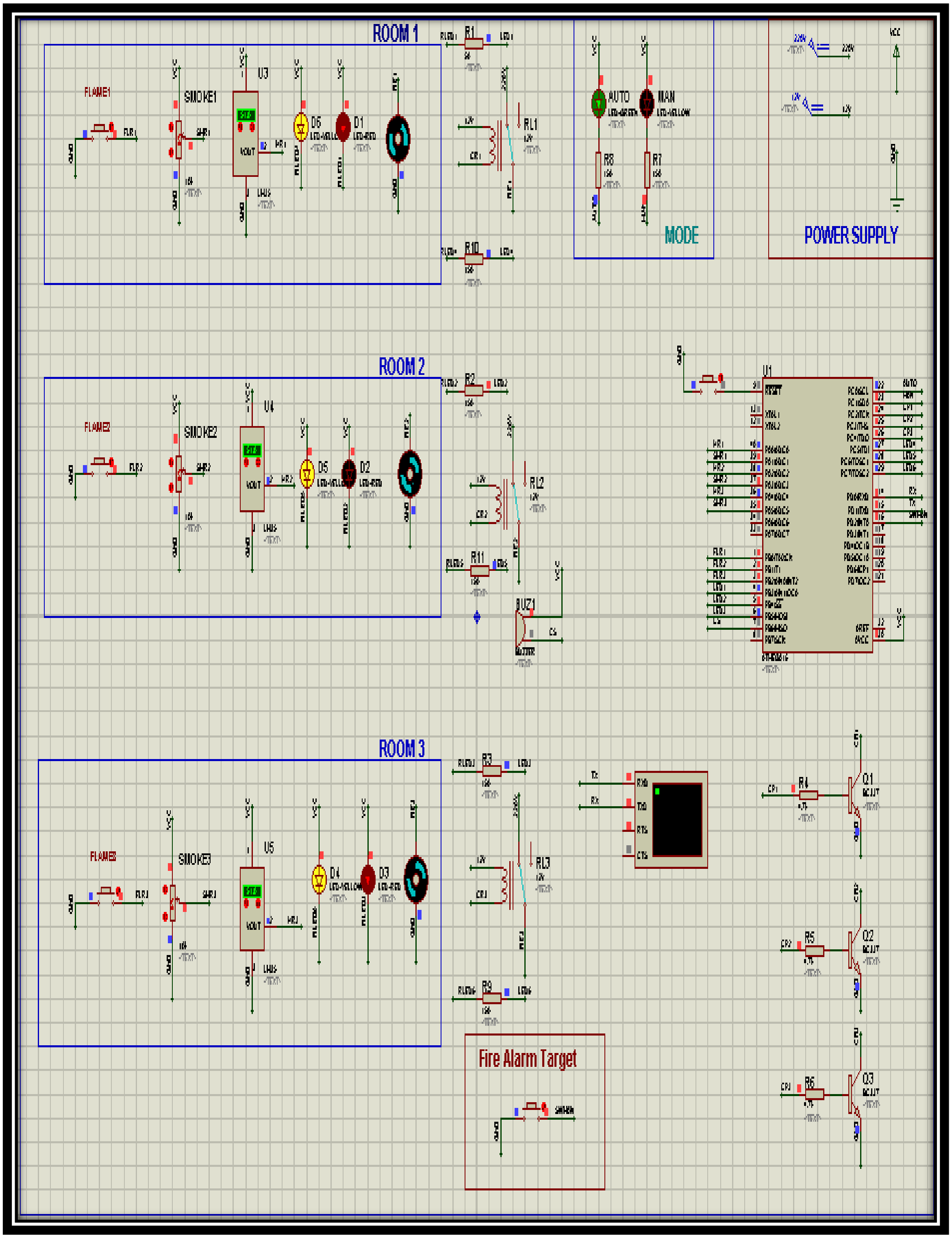


Figure 5.3: case two (Auto mode2)

3-When flame sensor detected flame; hazard led light up, pump and buzzer on as shown in figure 5.4.

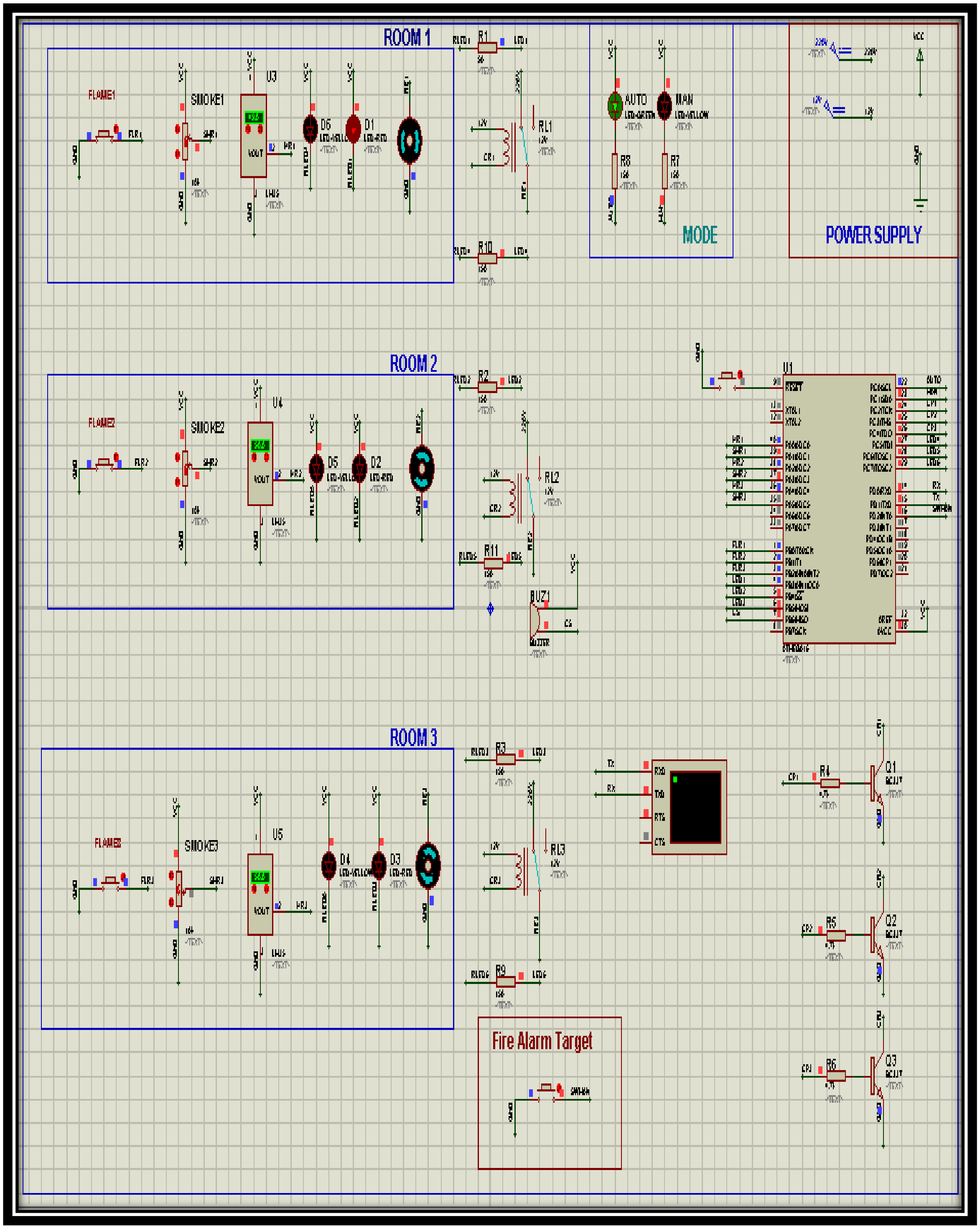


Figure 5.4 case three (Auto mode3)

4-At manual mode, when fire alarm target switched on, hazard red led light up, pump and buzzer switch on in three rooms, and continuous running until it rested as shown in figure 5.5.

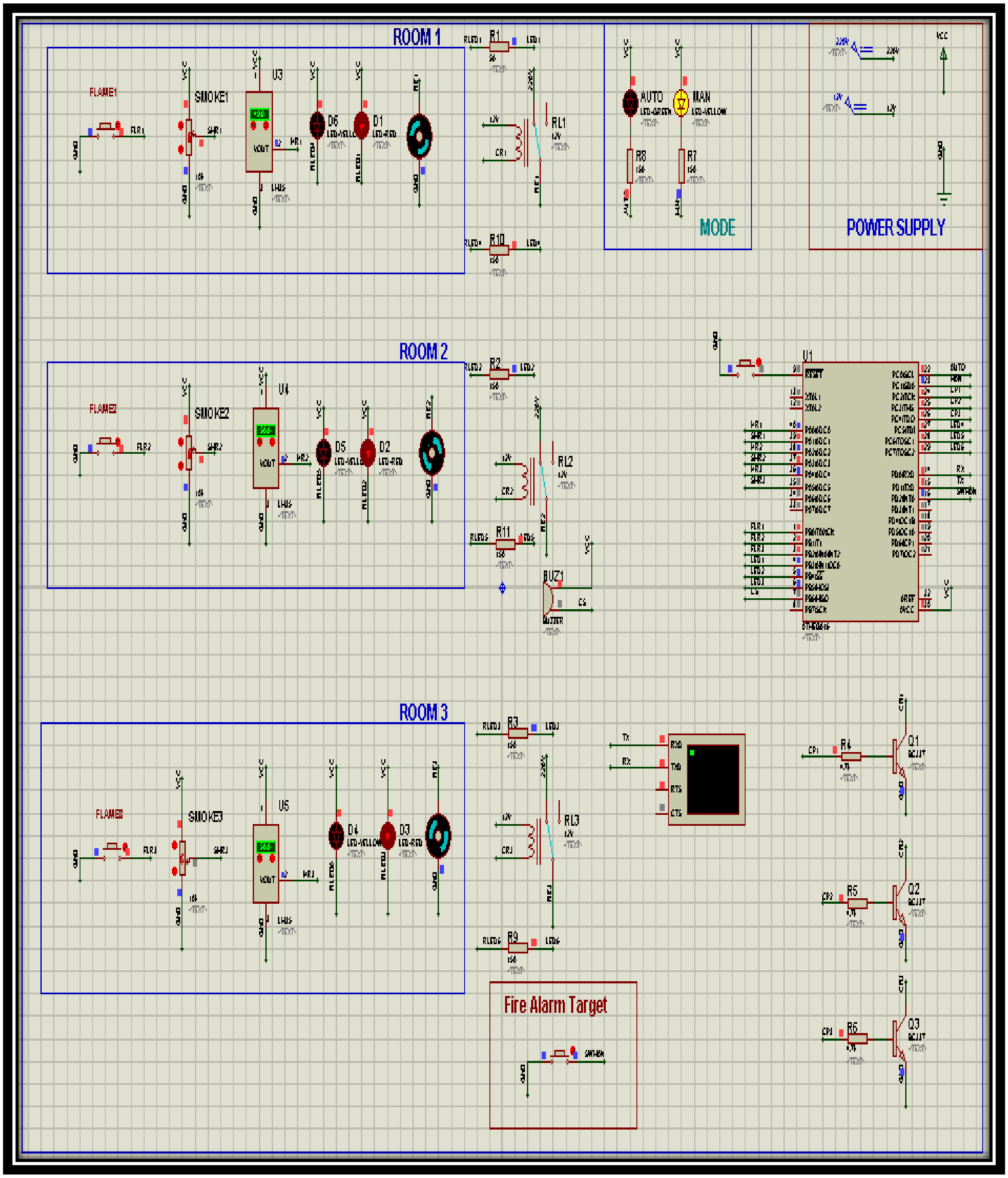


Figure 5.5: manual mode

5.4 Results

The system performs automatic fire fighting task when the system assures the fire occurrence .Table (5.1) below shows the results when operating the system.The table indicates the action taken for each happening.

Table 5.1: The results when operating the system

Temp. sensor	Flame sensor	Smoke sensor	Hazard LED's and buzzer	ACTION
0	0	0	Off	No action
0	0	1	Off	Alarm led on
0	1	0	On	Pump on
0	1	1	On	Pump on
1	0	0	Off	Alarm led on
1	0	1	On	Pump on
1	1	0	On	Pump on
1	1	1	On	Pump on

NOTE: Logic 1 = sensor is activated, Logic 0 = sensor is idle (not activated).

5.5 Discussion

As shown in table (5.1), the alarm led switch on when smoke sensor or temperature sensor activated. While pump, hazard led, and buzzer are switch on when flame sensor activated, or both smoke sensor and temperature sensor activated, or all the sensors activated.

CHAPTER SIX

Conclusion and Recommendations

6.1 Conclusion

The designed firefighting system is able to detect and deal with over-temperature, smoke and flame. After develop and testing the software the automatic firefighting system has successfully completed the tasks as expected and as outlined in the report. The system is capable of indicating its status on an LED, buzzer, and detecting and putting out fire. The ATmega16 microcontroller is used to process the sensor circuitry input and control the indicator panel, and also used to control a firefighting pump to put out flames when detected. A simulation of the system is created and it gave a good performance.

6.2 Recommendations

This project leads to several recommendations concerning the Wireless Firefighting System problems in the evaluation of both source code and simulation. The following points summarize some recommendations for the future work and further improvements:

1- To use wireless GSM/GPRS module, or RF modules that enables the system to wirelessly alert certain someone (e.g. the owner) by texting their predefined numbers and inform them with the current status of their controlled environment.

2- Adding a solar cell to the system as a power backup.

3- To use video cameras that is to be switched on whenever an event occurs in specific sector, and provide live video feed of whatever is happening in that sector.

References

[1] www.iosrjen.org IOSR Journal of Engineering (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719, Vol. 04, Issue 12 (December 2014), ||V4|| PP 64-68

[2]ABS GUIDANCE NOTES ON FIRE-FIGHTING SYSTEMS, American Bureau of Shipping Incorporated by Act of Legislature of the State of New York 1862, Copyright 2005.

[3] www.firesafe.org.uk, 2/6/2015 , 11:25 AM.

[4] www.argusfire.co.nz,11/10/2015, 9:20 PM.

[5]http://www.facstaff.bucknell.edu/mastascu/elessonsHTML/Sensors/TempLM35.html5/7/2015,10:45PM

[6] Int. J. Communications, Network and System Sciences, 2014, 7, 386-395, Published Online September 2014 in SciRes. http://www.scirp.org/journal/ijcns.

[7] TimWilmshurst, “Designing Embedded systems with PIC microcontrollers principles and application”, newness, London, 2007.

[8]http://pdf1.alldatasheet.com/datasheetpdf/view/78532/ATMEL/ATMEGA16.html, 20/8/2015,8:40 PM.

[9]http://alltransistors.com/5/10/2015, 2,45 PM

[10]http://www.ia.omron.com/data_pdf/data_sheet/my_dsheet_gwj111-e1-03.pdf,20/8/2015,9:36 PM.

[11]https://en.wikipedia.org/wiki/Pump,1/9/2015, 12:31 PM

[12] https://en.wikipedia.org/wiki/Firefighting_foam 10/9/2015,1:10 PM

[13]Ahmed Z.Kulab,FadyR.Alokka and others “Educatinol Material for PICmicrocotroller”, Islamic University of Gazza.

[14]DhananjayV.Gader “Programming and Customizing the Avr Microcontroller”, McGraw –hill, 2001.

[15]Han-Way Hung “PIC microcontroller An Introduction to software and Hardware Interfacing”,Thomson Delmar lerning,2005.

[16] Martin Bates, “Interfacing PIC Microcontrollers Embedded Design by

Interactive Simulation", newness,Jordan Hill,2006.

[17] https://en.wikipedia.org/wiki/Firefighting_history, 16/11/2015 , 2:20 PM

[18] https://en.wikipedia.org/wiki/fire , 15/11/2015 , 12.02 am

APPENDIX

Appendices

AppendixA

ATmega 16-Data sheet

Features

• High-performance, Low-power Atmel® AVR® 8-bit Microcontroller

• Advanced RISC Architecture

– 131 Powerful Instructions – Most Single-clock Cycle Execution

– 32 × 8 General Purpose Working Registers

– Fully Static Operation

– Up to 16 MIPS Throughput at 16 MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory segments

– 16 Kbytes of In-System Self-programmable Flash program memory

– 512 Bytes EEPROM

– 1 Kbyte Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

– Data retention: 20 years at 85°C/100 years at 25°C(1)

– Optional Boot Code Section with Independent Lock BitsIn-System Programming by On-chip Boot ProgramTrue Read-While-Write Operation

– Programming Lock for Software Security

• JTAG (IEEE std. 1149.1 Compliant) Interface

– Boundary-scan Capabilities According to the JTAG Standard

– Extensive On-chip Debug Support

– Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

• Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes

– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and CaptureMode

– Real Time Counter with Separate Oscillator

– Four PWM Channels

– 8-channel, 10-bit ADC

8 Single-ended Channels

7 Differential Channels in TQFP Package Only

2 Differential Channels with Programmable Gain at 1x, 10x, or 200x

– Byte-oriented Two-wire Serial Interface

– Programmable Serial USART

– Master/Slave SPI Serial Interface

– Programmable Watchdog Timer with Separate On-chip Oscillator

– On-chip Analog Comparator

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection

– Internal Calibrated RC Oscillator

– External and Internal Interrupt Sources

– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standbyand Extended Standby.

• I/O and Packages

– 32 Programmable I/O Lines

– 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF

• Operating Voltages

– 2.7V - 5.5V for ATmega16L

– 4.5V - 5.5V for ATmega16

• Speed Grades

– 0 - 8 MHz for ATmega16L

– 0 - 16 MHz for ATmega16

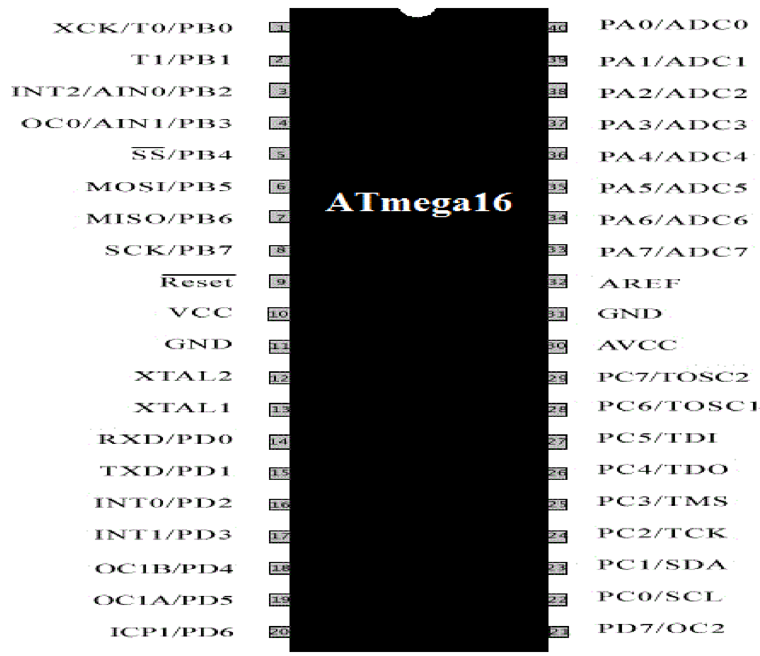
• Power Consumption @ 1 MHz, 3V, and 25°C for ATmega16L

– Active: 1.1 mA

– Idle Mode: 0.35 mA

– Power-down Mode: < 1 μA

PinConfigurations



Pin Descriptions

VCCDigital supply voltage.

GNDGround.

Port A (PA7..PA0) Port A serves as the analog inputs to the A/D Converter.

Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pinscan provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetricaldrive characteristics with both high sink and source capability. When pins PA0 to PA7are used as inputs and are externally pulled low, they will source current if the internal pull-upresistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). ThePort B output buffers have symmetrical drive characteristics with both high sink and sourcecapability. As inputs, Port B pins that are externally pulled low will source current if the pull-upresistors are activated. The Port B pins are tri-stated when a reset condition becomes active,
even if the clock is not running.

Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). ThePort C output buffers have symmetrical drive characteristics with both high sink and sourcecapability. As inputs, Port C pins that are externally pulled low will source current if the pull-upresistors are activated. The Port C pins are tri-stated when a reset condition becomes active,
even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pinsPC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). ThePort D output buffers have symmetrical drive characteristics with both high sink and sourcecapability. As inputs, Port D pins that are externally pulled low will source current if the pull-upresistors are activated. The Port D pins are tri-stated when a reset condition becomes active,even if the clock is not running.

RESET Reset Input. A low level on this pin for longer than the minimum pulse length will generate areset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

XTAL1 Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2 Output from the inverting Oscillator amplifier.

AVCC AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connectedto VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCCthrough a low-pass filter.

AREF AREF is the analog reference pin for the A/D Converter.

AppendixB

```
$regfile = "m16def.dat"

$crystal = 1000000

$baud = 2400

================================='

Dim R1h As Integer

Dim R2h As Integer

Dim R3h As Integer

Dim R1sm As Integer

Dim R2sm As Integer

Dim R3sm As Integer

Dim R1fl As Bit

Dim R2fl As Bit

Dim R3fl As Bit

================================'

Dim Ha As Long

Dim HbAs Integer

Dim HcAs Integer

Dim Sa As Integer

Dim SbAs Integer

Dim ScAs Integer

Dim Count As Integer

Dim Count1 As Integer

Dim Count2 As Integer

Dim Count3 As Integer

Dim Count4 As Long
```

```
Dim Count5 As Byte

Dim Count6 As Byte

Dim Count7 As Byte

Dim K As Byte

///////////////////////////'

Dim A As Byte

Dim B As Byte

Dim C As Byte

Dim D As Byte

Dim E As Byte

Dim F As Byte

Dim G As Byte

Dim H As Byte

Dim I As Byte

Dim KaAs Byte

Dim Kb As Byte

Dim KcAs Byte

Dim L As Byte

Dim M As Byte

Dim N As Byte

Dim O As Byte

Dim P As Byte

Dim R As Byte

Dim S As Byte

Dim T As Byte

*****************************'
```

```
Config Portb.0 = Input : Portb.0 = 1
Config Portb.1 = Input : Portb.1 = 1
Config Portb.2 = Input : Portb.2 = 1
Config Portb.3 = Output : Portb.3 = 1
Config Portb.4 = Output : Portb.4 = 1
Config Portb.5 = Output : Portb.5 = 1
Config Portb.6 = Output : Portb.6 = 1
ConfigPortc = Output : Portc.1 = 1
Config Portc.5 = Output : Portc.5 = 1
Config Portc.6 = Output : Portc.6 = 1
Config Portc.7 = Output : Portc.7 = 1
Portd.2 = 1
Config Int0 = Low Level
On Int0 Int0_alarm
Enable Int0
ConfigAdc = Single ,Prescaler = Auto , Reference = Avc
Config Timer0 = Timer ,Prescale = 1024 , Clear Timer = 1
Ocr0 = 244
Start Timer0
Start Adc
Portb = 255'
Enable Interrupts
K = 0
Do
Gosub Room1
Gosub Room2
```

```
Gosub Room3
Loop
End
===============================================================' 
Room1:
'Start Timer0
A = 0
B = 0
R1h = Getadc(0(
(R1sm = Getadc(1
Sa = R1sm * 5
Sa = Sa / 1024
'Print Sa
Ha = R1h / 2.048
If Pinb.0 = 0 Then
Gosub Alarm
Portc.2 = 1
Incr Count5
If Count5 = 3 Then
Toggle Portb.3
End If
Incr Count1
If Count1 = 1 Then
Print "BUILDING NO: 10; "
"Print "  ROOM1 : FIER ALARM
End If
```

```
G = 1
End If
If Ha > 51 Then
A = 1
' Portb.3 = 0
End If
If Sa> 2 Then
B = 1
' Portb.3 = 0
End If
C = A And B
R = A Or B
If R = 1 Then
Portc.5 = 0
End If
If R = 0 Then
Portc.5 = 1
End If
If C = 1 Then
Gosub Alarm
Portc.2 = 1
Incr Count5
If Count5 = 3 Then
Toggle Portb.3
End If
Incr Count1
```

```
If Count1 = 1 Then
Print "BUILDING NO: 10; "
Print "  ROOM1 : FIER ALARM"
End If
End If

If C = 0 Then
If Pinb.0 = 1 Then
Portc.2 = 0
Portb.3 = 1
End If
End If
I = H Or C
P = O Or I
If P = 0 Then
If Pinb.0 = 1 Then
If Pinb.1 = 1 Then
If Pinb.2 = 1 Then
GosubAlarm_stop
End If
End If
End If
End If
If Count1 = 2000 Then
Count1 = 0
End If
```

```
Return

=========================================================='
:Room2
D = 0
E = 0
'H = 0
R2h = Getadc(2(
(R2sm = Getadc(3
Hb = R2h / 2.048
Sb = R2sm * 5
Sb = Sb / 1024
If Pinb.1 = 0 Then
Gosub Alarm
Portc.3 = 1
Incr Count2
If Count2 = 1 Then
Print "BUILDING NO: 10; "
Print "  ROOM2 : FIER ALARM"
End If
End If
If Hb> 51 Then
D = 1
End If
If Sb> 2 Then
E = 1
```

```
End If
H = E And D
S = E Or D
If S = 1 Then
Portc.6 = 0
End If
If S = 0 Then
Portc.6 = 1
End If
If H = 1 Then
Gosub Alarm
Portc.3 = 1
Incr Count6
If Count6 = 3 Then
Toggle Portb.4
End If
Incr Count2
If Count2 = 1 Then
Print "BUILDING NO: 10; "
"Print "  ROOM2 : FIER ALARM
 'End If
End If
End If
If H = 0 Then
If Pinb.1 = 1 Then
Portc.3 = 0
```

```
End If
End If
I = H Or C
P = O Or I
If P = 0 Then
If Pinb.1 = 1 Then
If Pinb.0 = 1 Then
If Pinb.2 = 1 Then
GosubAlarm_stop
Portc.3 = 0
End If
End If
End If
End If
If Count2 = 2000 Then
Count2 = 0
End If
Return
=======================================================================' 
Room3:
M = 0
N = 0
R3h = Getadc(4(
(R3sm = Getadc(5
Hc = R3h / 2.048
Sc = R3sm * 5
```

```
Sc = Sc / 1024
If Pinb.2 = 0 Then
Gosub Alarm
Portc.4 = 1
Incr Count3
If Count3 = 1 Then
Print "BUILDING NO: 10; "
Print "  ROOM3 : FIER ALARM"
 'End If
End If
End If
If Hc> 51 Then
M = 1
End If
If Sc> 2 Then
N = 1
End If
O = M And N
T = M Or N
If T = 1 Then
Portc.7 = 0
End If
If T = 0 Then
Portc.7 = 1
End If
If O = 1 Then
```

```
Gosub Alarm
Portc.4 = 1
Incr Count7
If Count7 = 3 Then
Toggle Portb.5
End If
Incr Count3
If Count3 = 1 Then
Print "BUILDING NO: 10; "
Print "  ROOM3 : FIER ALARM"

 'End If
End If
End If
If O = 0 Then
If Pinb.2 = 1 Then
Portc.4 = 0
End If
End If
P = O Or I
If P = 0 Then
If Pinb.2 = 1 Then
If Pinb.1 = 1 Then
If Pinb.0 = 1 Then
GosubAlarm_stop
Portc.4 = 0
```

```
End If
End If
End If
End If
If Count3 = 2000 Then
Count3 = 0
End If
Return
=========================================================='
Int0_alarm:
Portb.6 = 0
Portb.3 = 0
Portb.4 = 0
Portb.5 = 0
Portc.0 = 1
Portc.1 = 0
Print "ALARM"
Do
Incr Count4
If Tifr.1 = 1 Then
Tifr.1 = 1
'   Timer0 = 0
Incr Count
End If
If Count = 4 Then
Toggle Portb.6
```

```
Toggle Portb.3
Toggle Portb.4
Toggle Portb.5
 '      Print "portb.6=" ; Portb.6
Count = 0
Timer0 = 0
End If
Portc.2 = 1
Portc.3 = 1
Portc.4 = 1
If Count4 = 1 Then
Print "BUILDING NO: 10; "
Print "   FIER ALARM"
End If
If Count4 = 60000 Then
Count4 = 0
End If
Loop
Return
======================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================'
:Alarm
If Tifr.1 = 1 Then
Tifr.1 = 1
Incr Count
End If
If Count = 4 Then
```

```
Toggle Portb.6
'     Toggle Portb.3
'     Print "portb.6=" ; Portb.6
 '    Print "c1=" ; Count
Count = 0
Timer0 = 0
End If
Return
========================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================================'
:Alarm_stop
Portb.6 = 1
'    Portb.3 = 1
Portc.2 = 0
Portc.3 = 0
Portc.4 = 0
 A = 0 : B = 0 : C = 0 : D = 0 : E = 0 : H = 0 : I = 0 : O = 0 : M = 0 : N = 0 : P = 0
Return
```