DEVELOPMENT OFA LOW COST EMBEDDED SYSTEM FOR FIRE DETECTION IN A RESIDENTIAL HOUSE

By

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The project titled "**DEVELOPMENT OF A LOW-COST EMBEDDED SYSTEM FOR FIRE DETECTION IN A RESIDENTIAL HOUSE**" Submitted by MD. TURAB HOSSAIN, Roll No.: 0419311018, Session: April, 2019 has been accepted as satisfactory of the requirement for the degree of Postgraduate Diploma in Institute of Information and Communication Technology on 30 November 2022.

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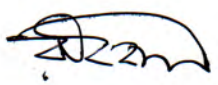

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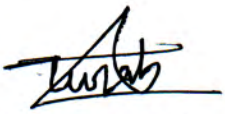
It is hereby declared that this project or any part of it has not been submitted elsewhere for the award of any degree or diploma.



MD. TURAB HOSSAIN

Dedicated

To

My Parent

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ACRONYMS

AC	Alternative Current
A/D	Analog to Digital convertor
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
BLEVE	Boiling Liquid Expanding Vapor Explosion
DC	Direct Current
EEPROM	Electrical Erasable program Read Only Memory
GND	Ground
GSM	Global System Mobile
IDE	Integrating Development Environment
IR	Infrared
LCD	Liquid Crystal Display
LED	Light Emitting Diode

OFD	Optical Flame Detector
PCB	Printed Circuit Board
PIC	Peripheral Interfacing Circuit
RAM	Random Access Memory
RF	Radio frequency
ROM	Read Only Memory
RTD	Resistance Temperature Detector
USART	Universal Synchronous Asynchronous Receiver Transmitter
VFD	Visual Flame Detector

Acknowledgement

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Abstract

This project describes Development of a Low-Cost Embedded System for Fire Detection in a Residential House that can monitor an industry, building, and home. Plays an important role in maintaining and monitoring the safe of all kind environments and everything that damaged by fire. However, the many existing fire detecting (fire extinguisher) systems are not modernized or automatic and also with high cost. Subsequently, it is not affordable for the low-income users. The main objective of this project is to make a fire control system with low cost. The project has three main system the first is the detection system, the second is the monitoring system and the third is the appliance system. The detection system operates as the Smoke detector. The detector will sense smoke caused by fire accident. This detection system has components like flame detector, smoke detector, temperature detector etc. This discussion is about the design and implementation of a fire detecting and controlling system using the microcontroller which operates the entire system. The detectors are placed in parallel in different levels. Any signal from each detector at any level is monitored using monitoring system. The appliance system has components like buzzer, LED for alarming, LCD for displaying temperature. The system which is proposed in this paper uses the modern technology to detect the fire accidents and also to inform the respective authorities with minimum delay. Three types of sensors flame, smoke and temperature sensors are used to detect the fire accidents. The signals from these sensors will activate the Arduino which intern activates the alarm system. The proposed system is designed by using Arduino ATMega328 along with sensors. The entire system is controlled by a microcontroller. We have tested the fire detection system in the laboratory. The System is capable of detecting fire in residential house.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The motivation towards working on this project and development program was originated from the view of massive fire occurrence in “Armanitola, Dhaka” and it is increasing rapidly year by year (day by day). The existing fire extinguishing system is working according to our needs but we wanted to establish an innovative idea and make more feasible and reliable system. Thus, we can reduce losses than before and protect human life and property [1]. The number of fires has increased more than threefold across Bangladesh since 1997; with the year 2022 seeing a daily average of 53. On the night of 4 June 2022, a fire and subsequent explosions at a container depot in Sitakunda Upazila, Chittagong District, Bangladesh killed at least 47 people and injured around 450 others. The incident occurred at BM Container Depot in the Kadamrasul area of Sitakunda Upazila. After a fire started in the loading area at around 21:00 BST, a massive explosion occurred at around 23:45 BST, triggering more explosions that spread across the depot caused by ignition of chemicals stored in the containers [2]. The force of the explosions affected buildings several kilometers away, and one witness stated that the explosions caused a rain of fireballs. On Abroad, the single worst industrial accident in history occurred on December 3, 1984, when some 45 tons of the dangerous gas methyl isocyanate escaped from the Union Carbide plant in Bhopal, India [3].

1.2 Motivation

Fire hazards are one of the most critical problems around the globe [1]. The aftermath of fire incident leads to huge damage of properties and loss of valuable lives. According to fire departments in Bangladesh, there occurred around 2,50,000 fire incidents in the country between January 1, 1997 and December 31, 2018 where an estimated financial loss of around Tk 6,400 crore taka and loss of more than 2000 lives to the nation were reported [2-3]. Even in United States 1,345,500 fire incidents were reported which caused 3,280 civilian deaths, 15,700 civilian injuries, and $14.3 billion in property damage. So, it is very important to devise a system for early detection of fire occurrences. There are a number of fire detection system in the market as a proprietary item where technical know-how is little known. Moreover, in the literature a number of research and development work on fire detection system have been reported [4-7] where Arduino development board has been used to interface with temperature and gas sensor. Although Arduino development board is easy to learn

for microcontroller programming and there are many third-party libraries available however it has a number of limitations [8-9]. So, there are scope of research in this area.

1.3 Objectives

General objective & Specific objectives

The objective of the project is to develop a low-cost microcontroller-based fire detection system. To realize the objective the project has the following aims:

i. To design hardware and firmware of fire detection system using Arduino system.

ii. To optimize the fire detection system and compare with existing research.

iii. To test the system in the laboratory.

1.4 Scope

In a way to achieved above objectives, this project needs to be implemented as below:

- This fire alarm system can also incorporate the smoke, heat and flame detector that are connected in parallel.
- The microcontroller is used as the heart of this fire alarm system that controls the entire operations involved.
- The fire alarm system is capable to locate and identified the place that is in fire whereby it is monitored using the monitoring system.
- Capable to display the output from each sensor in the monitoring system.

1.5 Organization of the Report

This report is explained about Development of a Low-Cost Embedded System for Fire Detection in A Residential House. This project report consists of five chapters. The first chapter deals with background, significance of the project, statement of the problem, scope, objectives of project, limitation of project and outline of the project. Chapter two is about the literature reviews. The third chapter deals about methodology, Feasibility analysis and system block diagram. The fourth Chapter is about system design and implementation, requirements of proposed system, hardware

requirement, software requirement, and flow chart of the system. Finally, the fifth chapter is about conclusion and recommendation of this project, respectively.

1.6 Significance of the Study

The result of this study will be significant to the following:

1. **To the Beneficiary:** The result of this study will help the institution's facilities management in designing the embedded system based automatic fire detection system in BUET. This will help them provide the fire detector in every Buildings and other facilities for the institution.
2. **To the Society:** The result of this study will benefit the institution by means of having automatic fire detection system facilities to provide during the state of fire emergency.
3. **To the Department:** This study will benefit the School of Electrical and computer engineering by means of acquiring authority on the publication of the document for the future developments of the department.
4. **To the Future Researchers:** The study that was conducted can assist future researchers on the design of Fire Sprinkler System through the application of Plumbing. This document can serve as a reference and a guide for the researchers who would design Fire Sprinkler for a building.

1.7 Safety

The firefighting system is automated. So, it can work automatically, no one has to operate the system or use it at risky position when fire hazard occurs. So, it is too much safe in compare with other fire extinguisher. We know that firefighting is a very risky occupation. Many people are becoming injured by using fire extinguisher, but automated firefighting system can ensure us a safe environment without destroying anyone's life.

1.8 Limitation of the Project

Detects the fire from one location at a time, if there is fire in more than desired locations, the system will not be able to detect and No record keeping is being done in the system and the project has been limited to a desired area of condition.

CHAPTER TWO

Preliminaries and Fundamentals of Fire Detection System

2.1 Introduction

We reviewed similar projects, journals, articles, and books for our project. The evaluated materials improved our project design. Our assessed projects are discussed here. Fire mains Sea inlets, suction piping, fire pumps, and a distributed piping system supply fire hydrants, hoses, and nozzles throughout the vessel. The ship's firefighting system supplies water to all areas. Firefighters use a reliable and adaptable system. Water can cool personnel, deep-seated fires, and combustible liquid fires [2]. Fixed-Gas Extinguishers Fixed gas fire extinguishers lower atmospheric oxygen or stop the chemical process that fuels fires.

Gas transporters pose fire risks. Thus, firefighting systems must be thoroughly assessed to ensure they meet risks. Gas carriers face BLEVEs, cargo vapor leaks, and liquid pool fires. Extinguishers fight small fires. Fire extinguishers contain water or chemicals. It extinguishes small fires. Wood, textile, flammable liquid, electrical, and metal extinguishers are labeled. Unsuitable extinguishers can worsen fires. Fire alarms sound when a detector detects smoke or heat or someone activates a break glass unit (manual break point). A central station can notify the fire brigade of remote signaling.

2.2 LITERATURE REVIEW

Throughout the development of our project, we were able to review some projects, Journals, Articles and books which are related to the title of our project.

We believe that all the reviewed materials have been a good asset for the overall design and development of the project we have chosen. In this section some of the related projects we have reviewed are discussed.

2.3 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 firefighting 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 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.

2.5 Gas Carrier Cargo Area Fire Extinguishing Systems

Gas carriers present a number of unique fire hazards. Therefore, the firefighting 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.

2.6 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.

2.7 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

Chapter Three

Design and Development of Fire Detection System

3.1 Introduction

Our project development process, from title selection to submission, is shown below. System hardware and software are designed separately. Separate software and hardware designs are combined later. Design flowchart The supervisor discusses many topics in Figure 7. To understand the project's goals, more discussions followed topic selection. Then, journals, articles, reference books, lecture notes, and data sheets were used to review the project's background. Integration follows software and hardware design. Experimentally test the system. Redesign and troubleshooting will reveal problems and improvements. Redesign and troubleshooting will occur if the output is incorrect. This approach will continue until project goals are met. Panel verification would follow project completion. To build the wheelchair controller and home automation, we interviewed professors, especially those with Android application development and embedded system design experience. Interviews provide system design and execution specifications. Android app development and embedded system design are discussed.

3.2 System Specification/Features of the Proposed Fire Detection System

This section describes the main requirements of the proposed system that are very necessary for system design and implementation which are hardware requirements, and software requirements.

Hardware Requirement

- Power Supply
- Arduino
- Temperature sensor
- Buzzer
- Smoke sensor
- Flame Sensor

3.3 System Block Diagram of the Fire Detection System with description of each module

3.3.1 Input Unit

Input system consists of three sensors. These sensors are Heat sensor, Smoke sensor, and Flame sensor. The mechanism of these input system is described as follow.

3.3.2 Smoke Detectors

Figure 3.1 shows smoke detectors operate on the principle of buoyancy or forced air flow. The important feature of a fire detecting system is the smoke sensor. By detecting smoke, the fire accident can be escaped.

Smoke is produced in the early stages of fire development, often long before the initiation of rapid flame spread. Smoke detector is a device that detects visible or invisible particles of combustion. Smoke detection is often considered a reliable option for early warning fire detection. Smoke is released from the source of ignition and can travel through heat induced detecting the presence of a certain level of smoke particles within the area being monitored. Once the threshold level of smoke particles in the area has been exceeded, the smoke detector indicates the alarm condition. Such smoke detectors may operate on photoelectric light scattering principle. The detector will sense smoke caused by fire accident and switch on the water sprinkler to prevent major damage [21].

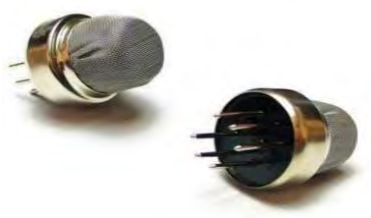

Figure 3.1: Smoke Sensor

A number of smokes detecting devices are available in the market. These devices include:-

- Photo electric spot type detector
- Spot type smoke detector
- Ionization spot type smoke detector
- Beam type smoke detector
- Photoelectric beam type smoke detector
- Air sampling smoke detector

Note-We select photo electric beam type smoke detector for its efficiency at high ceilings and its usage in sensor number reduction due to its wide area coverage which in turn minimizes the cost.

3.3.3 Operation of photoelectric beam type smoke detector

The detector works on the principle of light obscuration. The photosensitive element sees light produced by the transceiver unit in a normal condition. The transceiver unit is calibrated to a preset sensitivity level based on a percentage of total obscuration. This sensitivity level is determined by the manufacturer based on the length of the beam, the distance between the transceiver unit and reflector as shown in Figure 3.2.

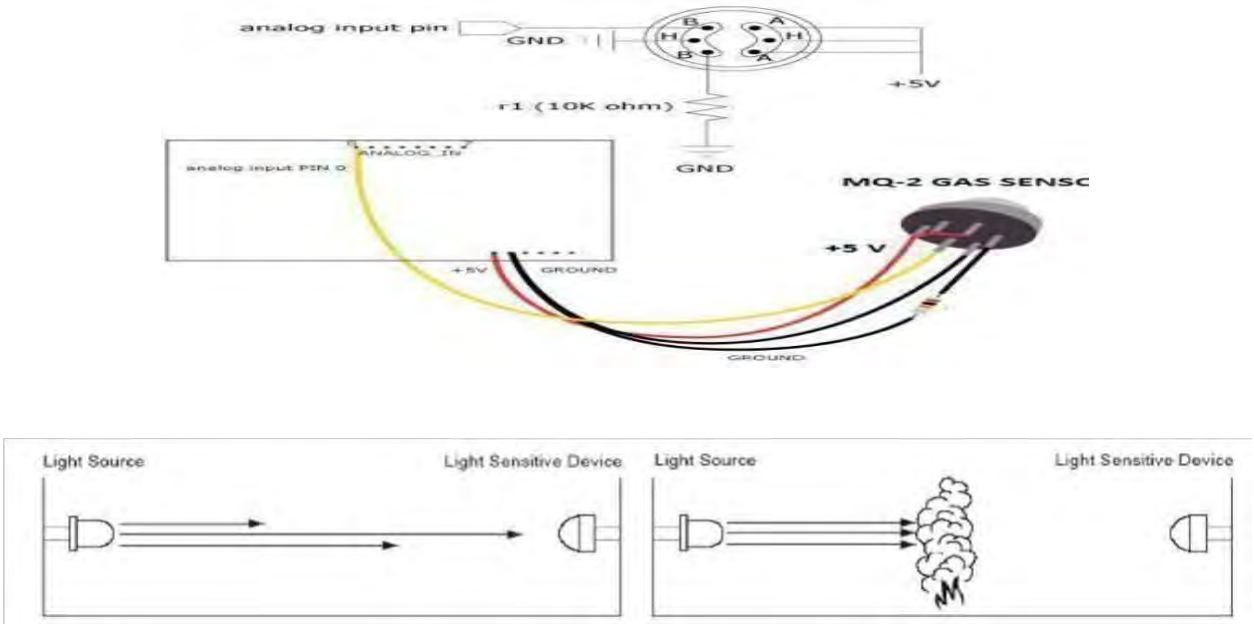

Figure 3.2: Beam type smoke detector

3.3.4 Heat Detector

A number of heats detecting devices are available in the market. These devices include [18]:

- Thermistors
- Thermocouple
- Resistance temperature device (RTD)
- Diode based temperature sensor

3.3.5 LM35 Temperature Sensor

Figure 3.3 shows the LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature in:

- It has an output voltage that is proportional to the Celsius temperature.
- The scale factor is .01V/o C.
- The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 o C at room temperature and +/- 0.8 to Cover a range of 0 o C to +100 o C.
- 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 o C temperature rise in still air.

The LM35 comes in many different packages:

- T0-92 plastic transistor like package.
- T0-46 metal can transistor like package.
- 8-lead surface mount S0-8 small outline package.

Figure 3.3: Temperature sensor

3.3.6 Flame Detectors

Figure 3.4 shows flame detection can be performed through optical visualization of protected spaces by measuring emitted thermal radiation or through resolved imaging technologies. Flame detectors may comprise an optical sensor for detecting electromagnetic radiation. For example, visible, infrared or ultraviolet, which is indicative of the presence of a flame? A flame detector may detect and measure infrared (IR) radiation, for example in the optical spectrum at around 4.3 microns, a wavelength that is characteristic of the spectral emission peak of carbon dioxide. An optical sensor may also detect radiation in an ultraviolet range at about 200-260 nanometers.

This is a region where flames have strong radiation, but where ultra-violet energy of the sun is sufficiently filtered by the atmosphere so as not to prohibit the construction of a practical field instrument [17].

Figure 3.4: Flame Sensor

Types of flame detectors

1. Optical flame detectors (OFD)
2. Visual flame detection (VID)

Note- even though there are some types of flame detectors, we have used the IR optical flame detector because of its simplicity and cost efficiency.

- Infrared optical flame detector

Infra-Red flame detectors detect electromagnetic radiation which travels from a flame at the speed of light. They respond only to the short wavelengths of very high temperatures such as that present in flames. The radiation from flames is characterized by a flicker at a frequency in the range of 5 to 30 cycles per second. Infrared (IR) flame detectors work within the infrared spectral band. Hot gases emit a specific spectral pattern in the infrared region, which can be sensed with a type of thermos graphic camera called a thermal imaging camera. A typical response time for infrared fire detectors is between 3 and 5 seconds as shown in Table 3.1.

Table 3.1: Summary for Sensors

Sensor	Type	Operating Voltage & Current(dc)	Response Time (in seconds)	Mounting Height	Area coverage	Spacing b/n Detectors
Smoke	Photoelectric/ Optical beam type(wall mounted)	5v	3	4.80	15*100	15
Heat	Rate of rise spot type (ceiling mounted)	5v	20	5	7.5*7.5	7.5
Flame	Infrared (ceiling mounted)	5v	10	2.5 -5	30*27	30

3.3.7 Arduino ATMega328

A microcontroller is a chip that acts as an electronic circuit controller and can generally store programs, and consists of CPU (Central Processing Unit), memory, individual I/O and support units such as Analog-to-Digital Converter (ADC). Figure 3.5 shows Arduino Uno is a microcontroller board based on ATmega328 (datasheet). It has 14 input pins from digital output where six pin input can be used as PWM output and six input analog pin, 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. To support the microcontroller to use, connect only the Arduino Uno Board to the computer using a USB or power cord with AC-to-DC adapter or battery to run it. The Arduino Demilune ATmega328P scheme based on the diagram blog of ATmega328P. Memory management in the microcontroller is essential because memory owned by the microcontroller is very limited. At Atmega328P there are three types of memory, namely data memory, memory program, and EEPROM. The third bus memory is separate so that it can access all three kinds of mind at the same time. ATmega328P uses Flash Memory for memory program. Flash Memory divided into two parts, namely Boot Loader and Application Program. This division aimed at software security. Flash Memory has to write endurance or delete 10,000 times.

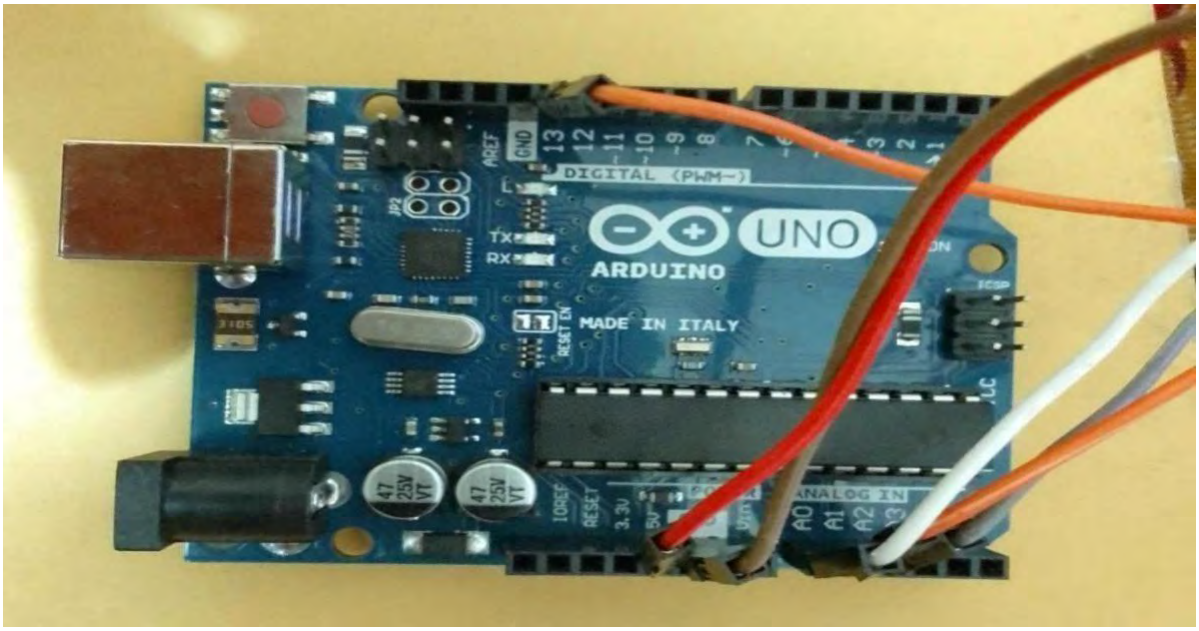

Figure 3.5: Arduino AT Mega 328

3.3.8 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.

3.3.8 Buzzer

For alarm purposes a lot of electric bells, alarms and buzzers are available in the market that has got different prices and uses. Figure 3.6 shows the buzzer being used in this project is a 5-12 V buzzer and has got enough alarm sound to be used in a fire alarm system.

Figure 3.6: Buzzer

3.4 Operational Flowchart

In Configuration, Connect Power and system start. Sensors (Smoke, Flame, Temperature) will be start reading. Then Check tig value if sensor value less then tig value this is false. Then it starts again. If sensor value grater then tig value this is true. Then we will get buzzer and then it starts again. As long as sensor value more then tig value we will get buzzer as shown in Figure 3.7.

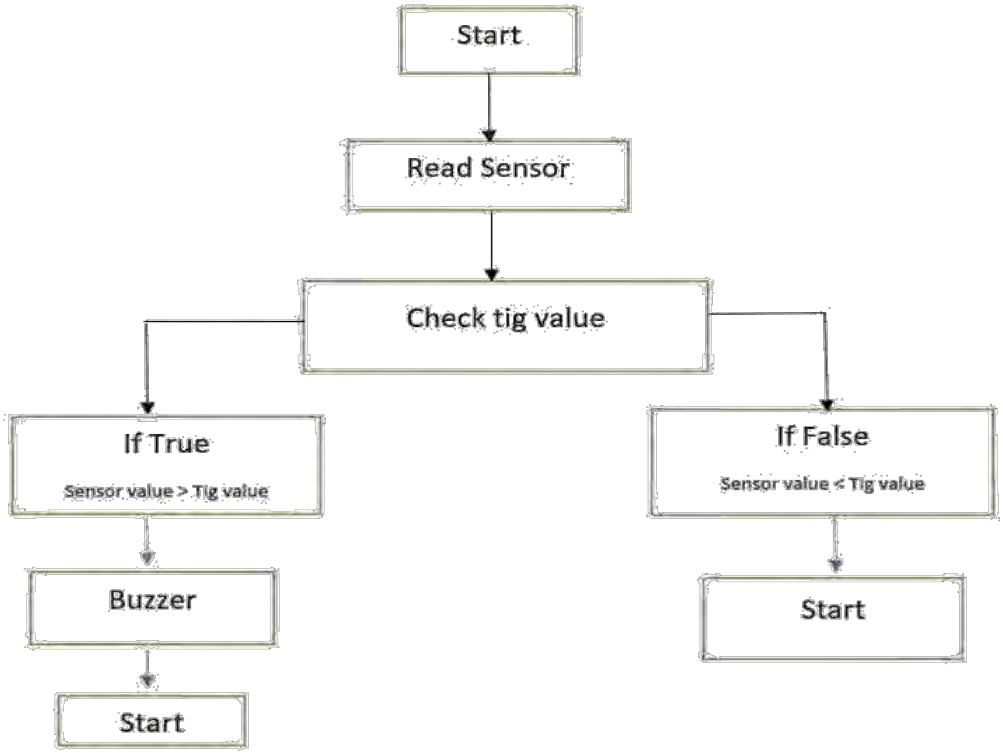

Figure 3.7: Flow chart

3.5 Software requirements & Description

- Proteus 8
- Arduino Code

3.5.1 Arduino Programming

Once the Arduino IDE tool is installed in the PC, attach the Arduino board to the computer with the help of USB cable. Open the Arduino IDE & select the right board by choosing Tools–>Board.>Arduino Uno, and select the right Port by choosing Tools–>Port. This board can be programmed with the help of an Arduino programming language depends on Wiring.

To activate the Arduino board & flash the LED on the board, dump the program code with the selection of Files–> Examples.>Basics.>Flash. When the programming codes are dumped into the IDE, and then click the button 'upload' on the top bar. Once this process is completed, check the LED flash on the board.

3.5.2 Proteus 8

It allows 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 8 include:

- Support for both interactive and graph-based simulation.
- CPU models available for popular Arduino such as the ATMega328.
- Interactive peripheral models include Light Emitted diode LED and liquid crystal display LCD and a whole library of switches, pots, lamps, etc.

3.6 Methodology and System block diagram

3.6.1 Methodology

The methodology we have followed during the development of this project which starts from the project title selection up to the complete project submission is presented in the following section diagrammatically. As the system contains both hardware and software designs, these designs are developed separately. Both the software and hardware designs are developed separately and will be integrated at last. The design methodology is explained in figure 1.1 with a general flow chart. As it can be seen in the flowchart from figure 1.1 the project starts by discussing several possible topics with the supervisor. After a topic has been selected, additional discussions were done in order to understand the concept and objectives of the project. Then, literature review was done and the background of the project was studied in detail by referring to various sources such as journals, articles, reference books, and lecture notes and data sheets. Once the software and hardware designs are completed individually they will be integrated. Then the system will be ready for experimental testing. In the redesign and troubleshooting part, any problem faced defects or inadequacies and improvements required will be fed back to the previous stages. Redesign and troubleshooting processes will be carried out in case the output obtained is not as expected. This process will keep repeating until a result that meets the objectives of the project is found. Finally, the project would be realized and ready for presentation to panel for verification.

3.6.2 Process Model

The methodology that we have used in our project design is RAD (Rapid Application Development) model as shown in Figure 3.8.

Because of the following best advantages:

- Reduced development time.
- More accurate requirements.
- The ability to track changing requirements.
- Frequent customer feedback and involvement.
- Encourages code reuse.
- Constant testing promotes high quality code and eases integration issues. chance of success. [10]

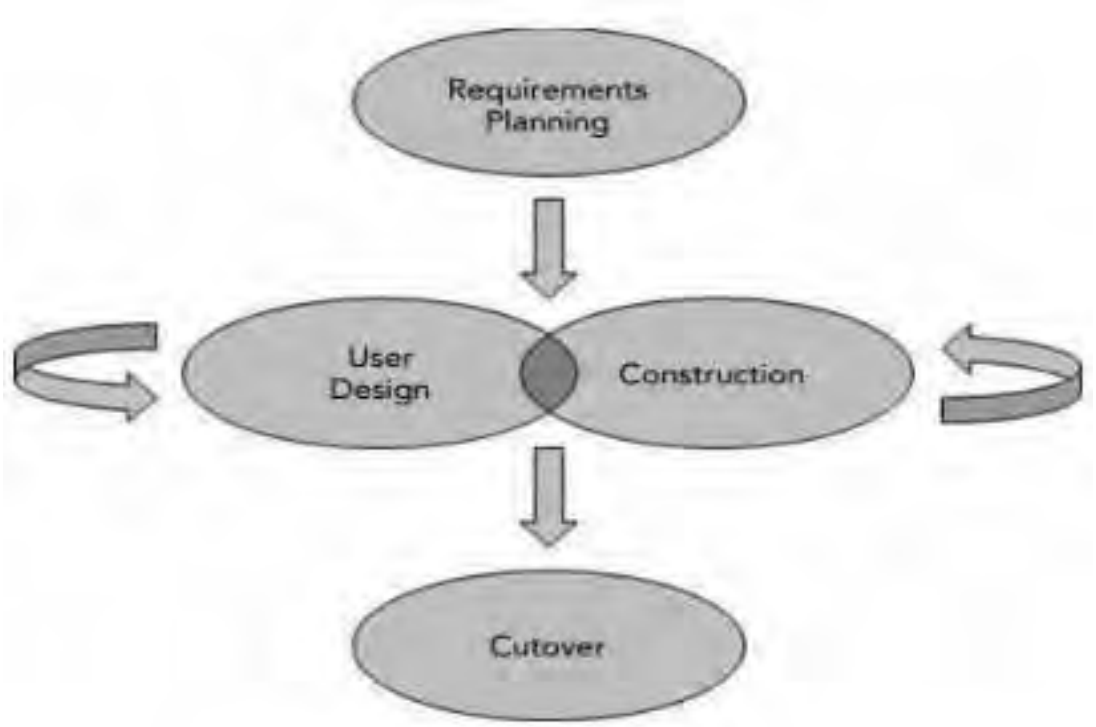

Figure 3.8: Phases of RAD model

I. **Requirement planning:** during this phase all the group members, advisor and the computer engineering stream chairman agree on the project's general goals and requirements. More illustration project goal is on the objective part of this paper and the hardware& software requirements are on chapter four.

II. **User design:** this phase is used to convert the requirements into a workable design. In user design phase based on the requirements defined in the above phase we design the user interface of the Embedded system based automatic fire detection system and the hard ware with a block diagram and flow chart which is shown in this chapter and chapter four respectively.

III. **Construction:** the developers go to work building the application. The advisor continues to review our design as we build them to make corrections and suggestions for improvements using micro C. In addition to this using the designed block diagram we construct the circuit diagram and we write the embedded c code on Micro software. Based on the constructed circuit diagram and the c code that we have written, by loading on the

microcontroller and it provides the desired outputs which is more elaborated on chapter four.

IV. Cutover: The developers deliver the finished application to the users. The proponents is not capable of implementing this phase for the system is implemented just for beta testing.

3.6 Sources of data

In order to gather more information to do our project, we have used the following sources of data.

- Observation
- Internet and library

3.6.3 Observation

We have also done some inspections by ourselves how the existing manual system works to gather ideas on how our proposed system should be designed and implemented. During our observation we try to identify the following problems.

- The wheelchair is accessed manually, meaning it requires a hand power for the mobility, this results tedious work.
- Its speed is slow.
- More time consuming, they cannot arrive as their need at a particular time.

3.6.3 Internet and library

In order to gather more information, we have also used internet research how such kind of system are designed by research studies related to our study. We also used library materials that are more related to our work. In general, from the internet and library we have read more knowledgeable web links as well books.

3.6.4 Feasibility analysis

Feasibility is the measure of how beneficial or practical the development of an information system will be to an organization. Feasibility study is critical since it provides the initial proposed system concepts, objectives and requirement needed during the design and implementation of the proposed system.

3.6.5 Operational feasibility

Operational feasibility is a measure of how well a specific solution will work in the organization. It is also a measure of how people feel about the system/project. This feasibility study measures how well a proposed system solves the problems, and takes advantage of the opportunities identified during scope definition and how it can organize the identified components in the requirements analysis phase of system development.

3.6.6 Technical feasibility

Technical feasibility a measure of the practicality of a specific technical solution and the availability of technical resources and expertise.

- Is the proposed technology or solution practical, Is the technology mature?
- Do we currently possess the necessary technology?
- Do we possess the necessary technical expertise, and is the schedule reasonable?

To answer the above questions the proposed system by using the recent necessary technologies like the android application that is work on the android operating system, can be implemented and deployed. It can be practically done.

Finally, in order to test the technical feasibility of the system we have stated and discussed the hardware and software requirements with simulation result for the system which is more illustrated on chapter four of this document.

3.6.7 Economic feasibility

Economic feasibility is a measure of the cost-effectiveness of a project or solution. This is often called a cost-benefit analysis.

In order to implement this system small number of devices with low cost due to the specification of those devices, are required. Since those devices are low cost the proposed system is economical or cost effective to the end users.

3.7 System Block Diagram

Figure 3.9 shows the system block diagram for fire detection system. The structure of this fire detection system is composed of five components, which are Arduino ATMega328, smoke sensor, flame sensor, temperature sensor, buzzer. Selected due to its good technical specifications, high performance for data processing and is cheaper than other single components available in the market.

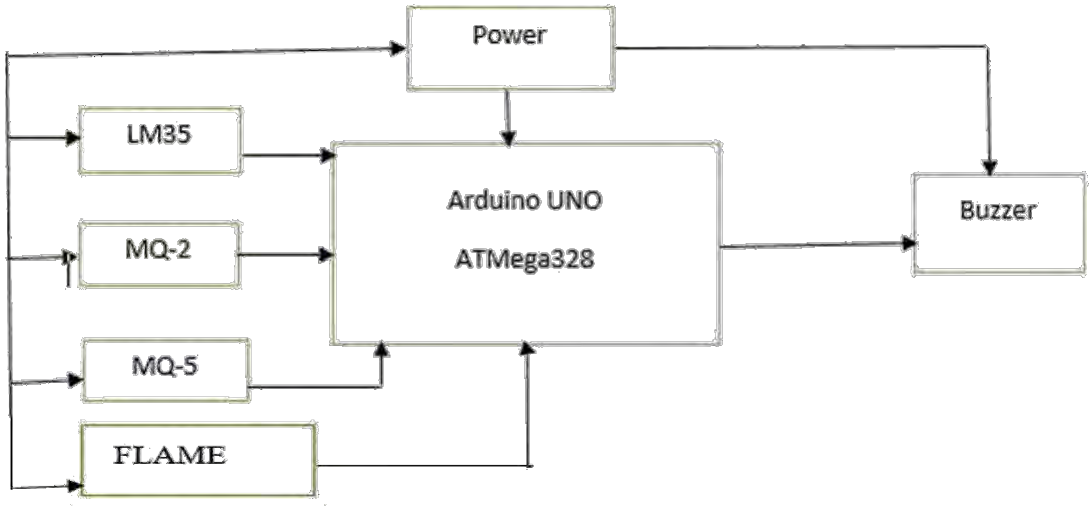

Figure 3.9: Block diagram for Development of a Low-Cost Embedded System for Fire Detection in a Residential House.

Chapter Four

Results and Discussions

4.1 Introduction

When a fire is detected, the system will automatically begin taking action to put it out. The outcomes of running the system are displayed below. Depending on the outcome of each event, the table shows the appropriate response. In the event that either the smoke detector or the thermometer is triggered, the alert LED will light up as given in the table. When the flame sensor, smoke sensor, temperature sensor, or all three are triggered, the solenoid valve opens and the hazard lights and alarm sound.

4.2 Laboratory Test Setup

Figure 4.1 shows laboratory test setup. In this setup Arduino board pin A0 connect with smoke sensor MQ2 and pin A1 connect with smoke sensor MQ5. Flame sensor connect with Arduino board pin ground and pin 8 and temperature sensor connect pin A2. Buzzer connect with Pin 13 and ground.

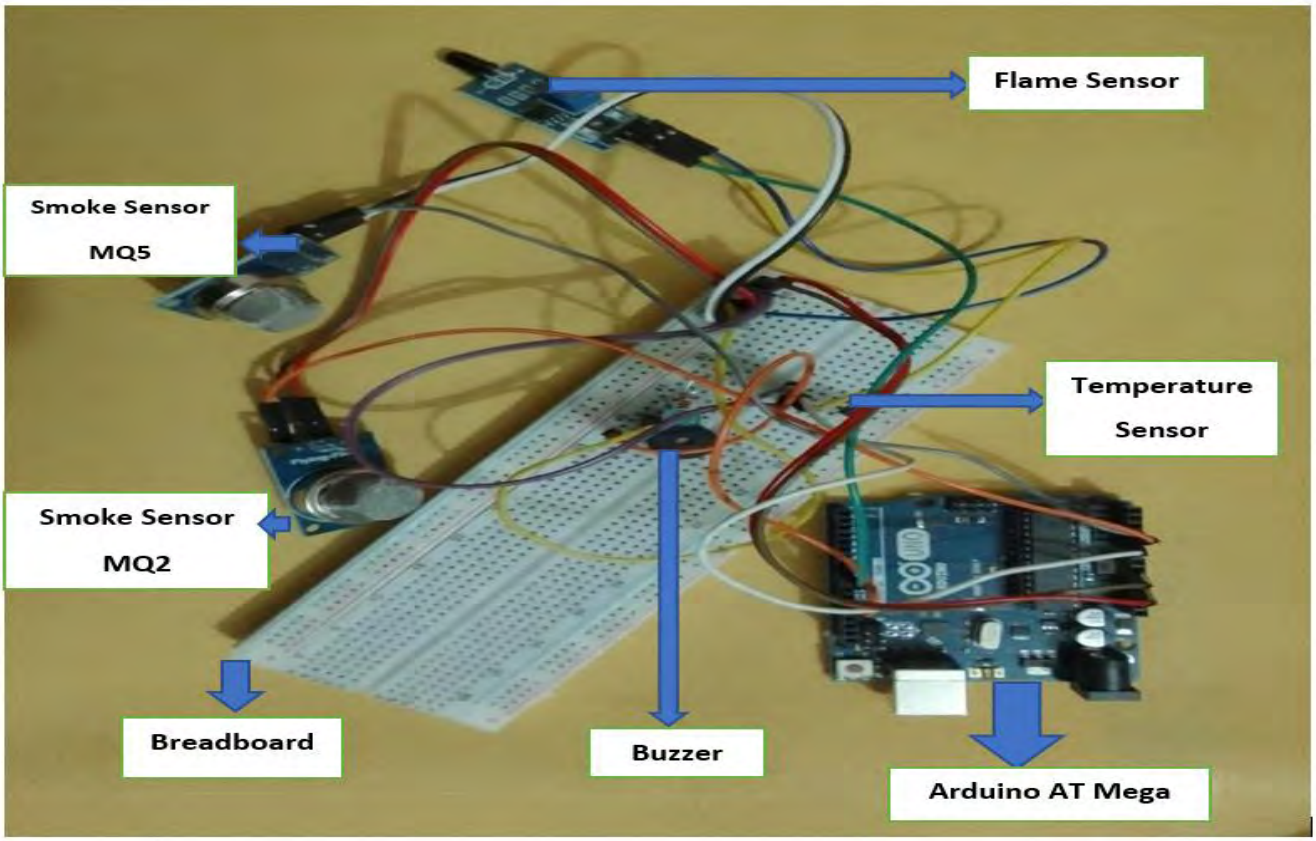

Figure 4.1: Full Setup

4.3 Simulation Results

4.3.1 Circuit design on proteus

Figure 4.2 shows circuit design on proteus. In this circuit smoke sensor VCC connect with Arduino pin A0 and A1. Flame sensor connect with pin 8 and temperature connect pin A2 and output buzzer connect with Arduino pin 13 and ground.

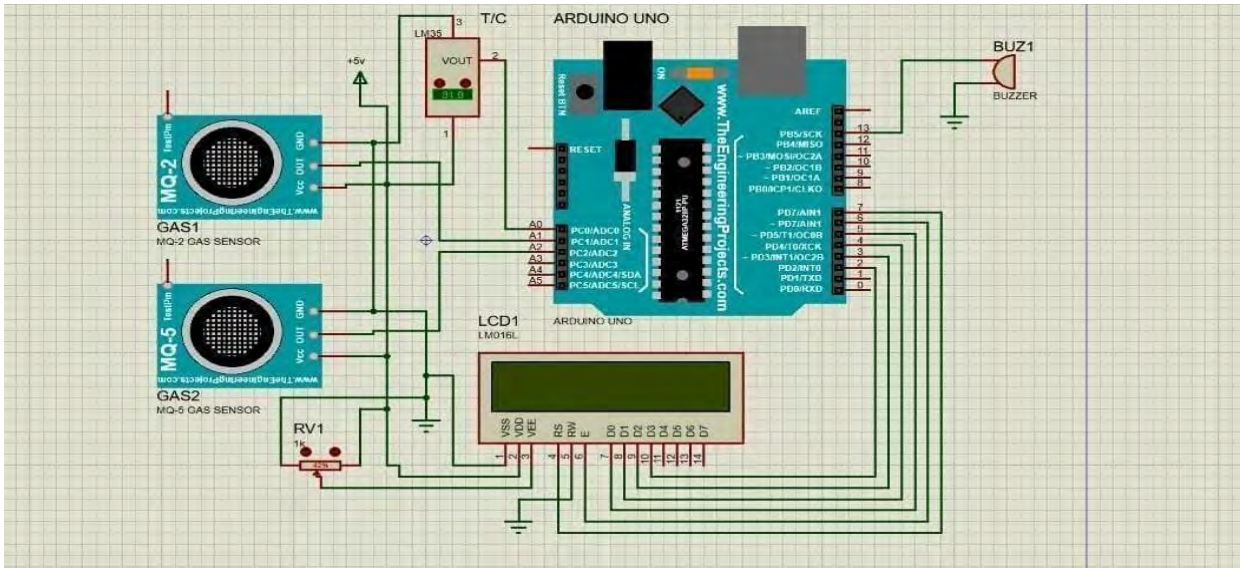

Figure 4.2: Circuit design on proteus

4.3.2 Simulation Design

Figure 4.3 shows circuit design on proteus Results. If sensor value greater tig value this is true and we will get buzzer. If sensor value less then tig value this is false, that means not detected.

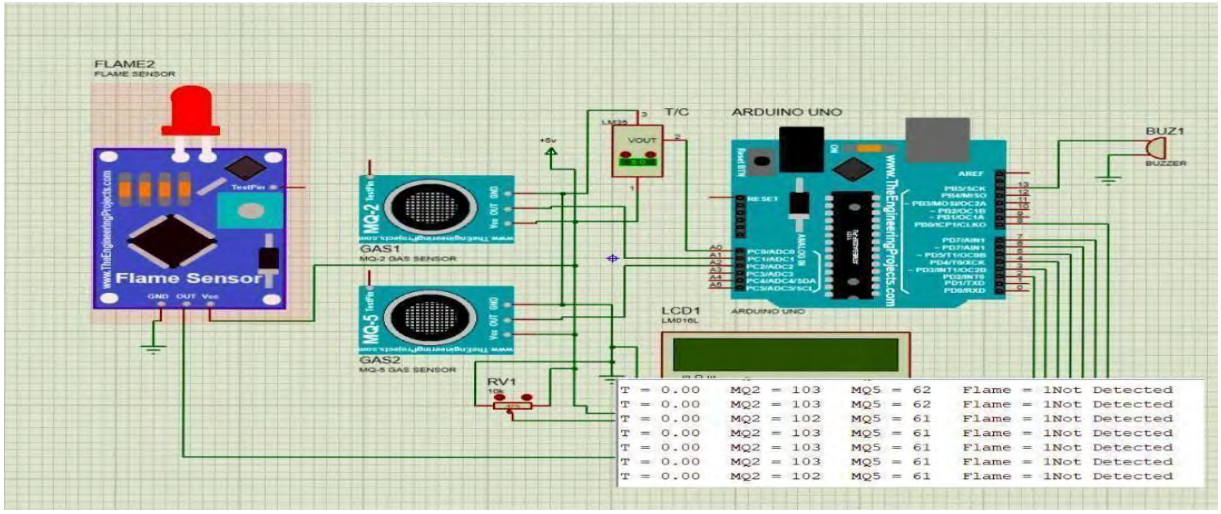

Figure 4.3: Circuit design on proteus Results

4.4 Results

The system performs automatic fire fighting task when the system assures the fire occurrence. below show the results when operating the system. The table indicates the action taken for each happening as shown in Table 4.1 & Table 4.2.

Table 4.1: The results for system operating

Test	Temp. Sensor	Flame Sensor	Smoke Sensor	Hazard LED's & Buzzer
Test 1	0	0	0	Off
Test 2	0	0	1	On
Test 3	0	1	0	On
Test 4	0	1	1	On
Test 5	1	0	0	On
Test 6	1	1	0	On
Test7	1	1	1	On

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

Table 4.2: Comparison of others requirements

Number	Detectors	Price in Bangladesh		Others Detectors	Price in Bangladesh
1	**MQ2 & MQ5 Smoke Detectors**	600 tk & 600 tk		**Others Smoke Detectors**	4900 tk
2	**Flame Detectors LM393**	700 tk		**Others Flame Detectors**	6500 tk
3	**LM35 Temperature Detectors**	500 tk		**Others Temperature Detectors**	3100 tk
Total		2400 tk			14500 tk

4.5 Discussions

As shown in table the alarm led switch on when smoke sensor or temperature sensor activated. While solenoid valve, 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 FIVE

CONCLUSION

5.1 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 Arduino AT mega 328 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.

5.2 Recommendation for Future Work

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 mobile SIM board for fire detection.
2. To use data base or website to text the temperature.
3. Adding a solar cell to the system as a power backup.
4. 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.

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Appendix A Source Code

```
int mq2_tig = 500;
int mq5_tig = 500;
int temp_tig = 100;

int valA0, valA1, valA2, value_flame;

void setup ()
{
  Serial.begin(9600);
  Serial.println("Starting");
  pinMode(A0, INPUT);
  pinMode(A1, INPUT);
  pinMode(A2, INPUT);
  pinMode(13, OUTPUT);
  pinMode(8, INPUT);
}

void loop()
{
  valA0 = analogRead(A0);
  float mv = ( valA0 / 1024.0) * 5000;
  //float cel = mv/10;
  float cel = 0;
  valA1 = analogRead(A1);
  valA2 = analogRead(A2);
  value_flame = digitalRead(8);

  Serial.print("T = "); Serial.print(cel);
```

```
  Serial.print(" MQ2 = ");
  Serial.print(valA1);

  Serial.print(" MQ5 = ");
  Serial.print(valA2);

  Serial.print(" Flame =");
  Serial.print(value_flame);



  if ((cel > temp_tig) || (valA1 > mq2_tig) || (valA2 > mq5_tig) || (value_flame
  == 0)) {
    digitalWrite(13, HIGH);
    Serial.println("Detected");
  }
  else
  {
    digitalWrite(13, LOW);
    Serial.println("Not Detected");
  }

  delay(500);
}
```