# THE DESIGN AND IMPLEMENTATION OF A FIRE STATUS MONITOR BY

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A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN ELECTRICAL/ELECTRONICS ENGINEERING.

TO

DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING

FACULTY OF ENGINNERING

FEDERAL UNIVERSITY, OYE EKITI



February, 2019

## DEDICATION

This project is dedicated to the Almighty God, giver of life, the master of the universe, whom out of His abundant mercy has given me the rare privilege to reach this level of my academic pursuit.

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It is entirely my own work and has not been submitted to any other university or higher education institution, or for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledged and fully referenced.

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## ABSTRACT

A fire outbreak is a major tragedy that must be avoided by every possible means due to the potential loss of lives and property that accompanies it. Fire when not controlled can grow large and may require days to bring under control. Hence this project report presents the design and implementation of a fire status monitoring device which must be applied to minimize or even eliminate this great hazard. In this work, the development of a low cost, portable, and reliable microcontroller based fire status monitoring system for remotely alerting any fire incidents in household or industrial premises has been carried out.

The system is designed to alert the distant property-owner efficiently and quickly by sending short message (SMS) via GSM network, sounding a loud buzzer and also disconnect the electricity supply of the building on detecting any element of fire such as heat or smoke. It also provides means of displaying temperature readings in degree Celsius and the smoke level within the installed area via a 16 x 2 liquid Crystal Display (LCD). A microcontroller (AtMega8A) has been used, which serves as the brain of the project along with a linear integrated temperature sensor which reads the temperature to the microcontroller so that it performs a specified function over a preset value. Whereas semiconductor type sensor detects presence of smoke or gas emanating from the compartment.

The sensor units are connected via common data line to ATMega8A AVR microcontroller. A SIM800l GSM based network module, capable of operating in standard GSM bands, has been used to send alert messages. The system is implemented on printed circuit board (PCB) and tested under different experimental conditions to evaluate its performances.

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# CHAPTER 1

## 1.0 Introduction:

Amongst all the disasters that have occurred in residential areas, fire outbreak has been known to be a dangerous tragedy that could cause destruction of property and loss of life. In many disasters, fires have become recurrent, destructive and most influential disasters if compared to others hazards. With the rapid development of urban construction, the frequency of fire disaster increased year by year. Fires in the early detection and early warning are two important ways to extinguish the fire promptly and avoid great casualties and property loss. Therefore, the requirement of placing intelligent fire status monitoring system is important within buildings especially in the buildings which contain many people inside or valuable belongings.

With the advancement of human civilization, fire-safety has been a prime concern. Fire hazards can be fatal and denigrating for industrial and household security, also threatening to human life. The best way to reduce these losses is to respond to the emergency situation as quick as possible. So, there comes the necessity of a standalone autonomous fire detection systems. These systems render the works of quick detection, alarm notification, sending short message (SMS) to some designated phone numbers and initiation of some control actions such as disconnecting electricity supply of the building area. The system is equipped with smoke and temperature sensors which can detect unfavorable accidental situations, as it happens, and with the help of a processing unit it can alert instantly for undertaking cautious measures. In these fatal situations, early detection and faster alert will yield lesser losses of property and life.

Studies have shown that the major causes of fire outbreak results from transportations, electrical appliances and gas leakage. Fires in the households are often triggered by many common factors investigated which are from cooking equipment, smoking in the house, electrical appliances, candles, faulty wiring and many more (N. N. Mahzan et al, 2018). If the fire occurs when the residents are in the house, the possibility to extinguish the fire is a bit high. It is because the residents themselves can take immediate precaution to prevent the spread all over by using fire extinguisher or call the fire service instantly.

The main concern of this project is when the residents are not at home or are not aware of the existence of the fire in the house. Having said that, the home fire alert is purposely designed to alert the house residents whenever any possibilities for having fire disaster prompted in their house. For this project, the development of a home fire status monitor is built around the popular atmega8A microcontroller serving as the main controller device that interacts with GSM module which works in the communication part. The interaction is for the user to know the current situation in the house. This system incorporates a GSM module to perform wireless network communication which provides a means of sending an SMS alert to the user or users. It uses a GSM SIM card for communication purposes. It is basically just a modem which uses serial communication to interface using compatible AT commands for communicating with the microcontroller. The alert message and the phone number of the recipient are given by the user through the project codes. As soon as fire is detected an SMS will be sent to the recipient's phone number from the SIM card inserted into the module for giving information to the user upon fire detection in the house and also the microcontroller triggers off the electricity supply of the building thereby providing an initial solution.

## 1.1 **Background of the Project**

The development of this fire status monitoring device brings with it, new technologies, new materials, power sources and telecommunication equipment which decreases the chances of fire outbreak. The sensor-based systems can be very useful to detect a fire and to take decisions to control it. A sensor is able to transform physical or chemical readings gathered from the environment into signals that can be measured by a system. The reports of most of the panel of enquiries on fire accidents in Nigeria, confirmed the fact that electrical fault is a major source of fire accident (Oke A. O., 2015). Hence, realization that a fire protection system capable of automatically switching off electrical power supply to the affected area in addition to the traditional role of raising an alarm and triggering a sprinkler or other automatic fire fighting system is going to be more efficient than the existing systems which leaves those important role unaddressed.

Due to the fast development in telecommunication technologies, it is believed that wireless communication is a good practice for remote sensing and automation in industrial and residential locations. Nigeria, like any developing country, is witnessing an era of rapid economic and social development. Modern industries are springing up housing volatile materials and highly sophisticated equipment that increase the menace of fire. The concern for safety of lives and properties calls for an efficient and dependable fire protection system. This has enhanced the application of new technologies in the fire field. Sensors are able to consider certain dynamic and static variables such as humidity, the type of fuel, slope of the land, the direction and the speed of the wind, smoke , to mention a few. Nowadays automatic fire detection and control is becoming very essential to reduce the fire in the building and industry. Fire status monitoring system provides real-time surveillance, monitoring and automatic alarm. A key aspect of fire protection is to identify a developing fire emergency in a timely manner, and to alert the building's occupants and fire emergency organizations and also to disconnect electricity supply instantly. This is the role of fire detection and control systems. Generally fire detectors are designed to respond at an early stage to one more of the four major characteristics of combustion, heat, smoke, flame or gas. No single type of detector is suitable for all types of premises or fires. Heat detectors respond to the temperature rise associated with a fire and smoke detector respond to the smoke or gas generated due to fire. This paper describes the design and implementation of a fire status monitoring system with SMS notification. This idea is economically efficient as well because the system proposed is intelligent and reduces human intervention and labour extensively and execution can be gotten at a very low cost providing extensive environmental, property and life safety.

## 1.2 **Statement of the Problem**

Due to the alarming rate of fire hazard that has been claiming lives and properties in our country. This project work intends to mitigate the rate of fire hazard in our environment especially those that results from electrical faults in a building.

## 1.3 **Motivation**

Due to the outbreak of fire that damage properties and life, there is need to locally design and construct a fire detector and control system using a microcontroller with GSM module, which can be used conveniently in buildings, offices, homes also in industries which will be able to send text messages to the owner of the building when fire is detected in the premises. Furthermore there is need to contribute to the economic growth of the nation and reduce the fire outbreak, thus decreasing loss of life and properties.

## 1.4 **Significance of the study**

The fire status monitoring system is intended to reduce the risk of fire hazard in homes, offices, shops, schools and industries etc. in a cost efficient and highly functional design, by quickly responding to intending fire hazard on detection, thus saving life and properties. If the system becomes commercialized, it will help reduce uncontrolled fires because it warns of dangerous conditions before a fire outbreak so that appropriate action can be quickly carried out to put out the fire.

## 1.5 **Project aim and objectives**

### 1.5.1 **Aim**

The aim of this project is to design and implement a fire status monitoring system using a microcontroller.

### 1.4.2 **Design Objectives**

The following objectives shall be achieved in the design of the device.

1. The GSM module (SIM800L) must be able to send SMS (Short Message Services) over Network communication.
2. The Smoke sensor (MQ-2) must be able to detect the presence of smoke.
3. The Atmega8A microcontroller must be capable of receiving information, process it and give an output.
4. The temperature sensor (LM35) must be capable of reading the temperature of the environment continuously.

### 1.6 Scope of the project

The scope of this project is to design and construct a fire status monitoring system interfaced with a microcontroller unit, powerful Relay switch and GSM module with the wireless communication features over SMS. Within the scope of this project, the prototype model is equipped with a dedicated SIM (Subscriber Identification Module). Minimal power consumption can be achieved for the operations.

The fire status monitoring device detects the presence of smoke in a room compartment and it also monitor the temperature level in the room over a set point. When an abnormal condition is sensed, such as the detection of smoke or elevated temperature in the compartment, some controlled actions are performed such as shutting down of the power system of the building immediately, sounding a loud buzzer and sending an SMS (Short Message Services) to the phone of the occupant of the building thus informing them about the situation where ever they are. The occupant can then take proper action to restore order in the compartment.

## Chapter Two

### 2.0 Literature Review

### 2.1 Introduction to fire and fire alarm systems

Fire is a self-sustaining, chemical chain reaction with varying degrees of light and heat. Temperature and smoke sensing alert system is motivated to sense the temperature and smoke and send the alert in an intelligent fashion in case of emergency situation due to fire blow. In every country in the world the fire alarming system is considered to be essential for lots of physical structures including industries, shopping malls and private houses.

Anthony j. shalna, (2009) expressed that Fire is made up of four components which are; Fuel, Oxygen, Heat, Chemical Chain Reaction and by removing one of these four components the fire will go out. Fire extinguishers are designed to do just that.

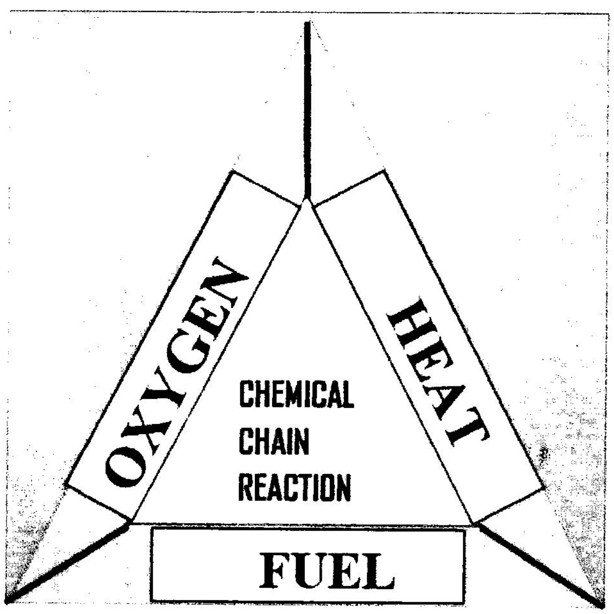



Fig. 1: Fire tetrahedron

A fire alarm system is used primarily to alert people for possible evacuation in the event of occurrence of a fire condition and then secondarily to report the fire to the proper authorities. The fire alarm system recognizes four different states or conditions: normal, alarm, trouble and supervisory. Simplistically speaking, a basic system consists of a fire alarm control panel (FACP) to which are connected initiating (input) devices, notification (output) appliances, and a source of operating power, and a source of standby power in the event the operating power should fail. As seen in Figure 2 below. The function of a fire alarm control panel is basically three fold (Anthony j. shalna, 2009)

1) Accept an alarm or supervisory input from an initiating device.

2) Provide an alarm output to the notification appliance(s).

3) Monitor the integrity of the panel itself and also the wiring to the above devices.

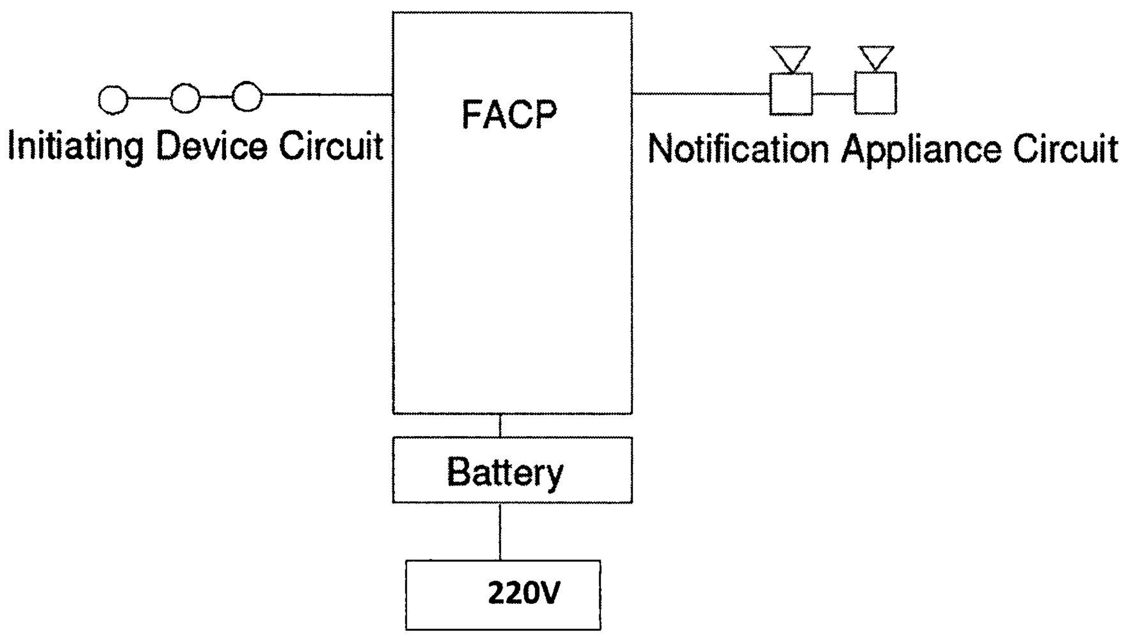



Fig. 2: Basic conventional fire alarm system

It was presented that fire alarm systems have changed dramatically over the past few years, primarily due to the advent of the low priced microprocessor. Basically there are two different approaches used for the fire alarm control panel, conventional and addressable ("Fire Alarm System", 2013)

The minimum basic components of a conventional system are:

1. Fire alarm control panel: This component, the hub of the system, monitors inputs and system integrity, controls outputs and relays information.
2. A primary operating power supply (220 VAC).
3. A secondary or standby power supply. This is most often a rechargeable storage battery, although generators are permitted subject to certain conditions.
4. Initiating devices: These components act as inputs to the fire alarm control unit and are either manually or automatically activated. Examples would be devices such as pull stations, heat detectors, and smoke detectors. Heat and smoke detectors have different categories of both kinds. Some categories are beam, photoelectric, ionization, aspiration, and duct.
5. Fire alarm notification device: This component informs the proximate persons of the need to take action, usually to evacuate. This is done by means of a pulsing incandescent light, flashing strobe light, electromechanical horn, electronic horn, speaker, or a combination of these devices. Strobes are either made of a xenon tube (most common) or recently LEDs.
6. Building safety interfaces: This interface allows the fire alarm system to control aspects of the built environment and to prepare the building for fire, and to control the spread of smoke fumes and fire by influencing air movement, lighting, process control, human transport and exit.

## 2.2 **Classes of fire**

There is a universal system to describe different types of fires. This system incorporates the use of letters, colors and symbols to help users select an extinguisher suitable for the type of material involved in the fire ("Fire Service Feature". 2015).

Class A: Ordinary combustibles, such as wood, cloth, paper, rubber, many plastics, and other common materials that burn easily. Dry chemical can be used to extinguish this type of fire.

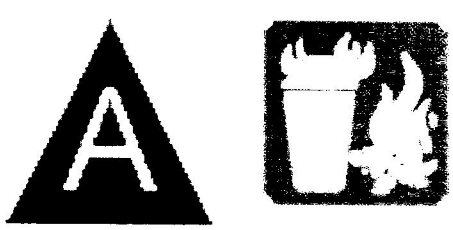



Fig. 3 class A fire

Class B: Flammable liquids. Includes gasoline, oil, grease, tar, oil-based paint, lacquer, and flammable gas. Dry chemical is used to extinguish this type of fire.

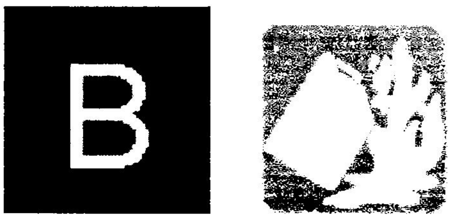



Fig. 4 class B fire

Class C: Electrical equipment, such as wiring, fuse boxes, circuit breakers, machinery and appliances. Dry chemical is used to extinguish this type of fire.

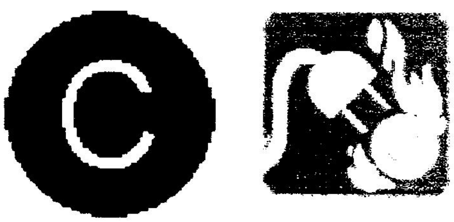



Fig. 5 class C fire

Class D: Combustible metals. Includes magnesium, aluminium, lithium, and other combustible metals or metal dust. Dry powder is used to extinguish this type of fire.


Fig. 6 class D fire

## 2.3 Fire Detector Review

Omar Asif et al, (2014) researched on different types of fire detectors with various specific features depending upon different scenarios and demands. More or less these detectors can be categorized as heat or thermal detectors, smoke or gas detectors, semiconductor gas detectors, and flame detectors.

### 2.3.1. Heat or Thermal Type Detectors

Heat or thermal type detectors are the most primitive types of autonomous fire detectors, dating back to mid-1800's ("introduction to fire Detection", 2015). Most of these detectors are fixed temperature ones, which activates upon reaching a predefined temperature. Others include types, which activate whenever there is an abnormal rise in temperature in the premises.

Thermal detectors are reliable, inexpensive, easy to maintain, and have lower false alarm rate. But these detectors are slow, and by the time they reach predefined detection point, damage could already been underway. Therefore these detectors are of limited use.

### 2.3.2. Smoke or Gas Detectors

Smoke or gas detectors, a relatively newer invention, became widespread during 1970's and 1980's.These detectors usually detect fire in early flaming or smoldering stages. These detectors can be of different types having different operation principles, namely—optical or photoelectric detectors, ionization detectors, air sampling detectors etc. (safelines-Fire safety Products). Each of these types has specific applications in specific circumstances.

Photoelectric or optical smoke detectors include various components, mainly, a light source (usually an infrared LED), and a lens to converge light rays into a beam, and a photodiode (cote, A, 1988). In normal condition, the light beam passes straight. But whenever smoke interrupts the path of light, scatters fraction of light into the photodiode, the smoke detector is activated. This method of detection can detect fires that begin with long duration of smoldering aptly (National Fire protection association). Ionization smoke detectors are based on ionization from radioactive elements like americium-241. This radioactive isotope emits alpha particles into an ionization chamber, which comprises of electrodes.

The alpha particles ionize the air inside the chamber, resulting current flow between the electrodes. Now, whenever smoke particles from a nearby fire passes through the chamber, the ions get attached to smoke particles, and thereby interrupts the current flow between the electrodes, and activates the detector (Omar Asif, 2014). This type of detectors is more suited to rapid flaming fire outbursts, unlike the photoelectric detectors, which responds better to smoldering stages (safeline-Fire Safety Products). Ionization detectors might perform better where there is risk of fast flaming fire, whereas photoelectric detectors react better to cases of slow smoldering, like electrical or furnishing fire. Ionization devices are weaker in scenarios where air-flow is high. Although ionization type detectors are cheaper than photoelectric ones, they have more chance of false alarm than the photoelectric detectors (Bukowski, R. W. et al., 2007). However, ionization based detectors have safety issues and possess threats to environment, because of americium-241. Therefore, on the basis of performance and safety concern some countries have banned ionization based alarms, and different fire authorities and associations have reports not recommending use of these detectors (Omar Asif et al, 2014). Air sampling detectors have applications in very sensitive areas, as they can detect very fine smoke particles. These detectors are mostly air aspirating type systems. Generally they comprise a control unit, and a network of sampling tubes or pipes. The control unit consists of detection chamber, an aspiration fan, and necessary operation circuitry.

Since this type of detectors are very sensitive and fast responding, they have applications in high-value and critical areas, such as, aesthetic galleries, archives, vaults, server rooms, high-tech organizations etc. However, these detection systems are complex and expensive. Moreover, some combination smoke alarms include both ionization and photoelectric technologies in a single device. Some smoke alarms use a carbon dioxide sensor or carbon monoxide sensor for detection as well (Cote, A. et al, 1988)

### 2.3.3 Flame Type Detectors

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 0.7 to 1.1μm. 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 detector, 2013).

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 (Introduction to fire detection alarm).

### 2.3.4. Semiconductor Gas or Smoke Detectors

These work by the principle of chemical reaction taking place between gas from fire incident and semiconductor material present inside the sensor. The semiconductor material used in these sensors is metal oxides, generally Tin dioxide (SnO2), Tungsten oxide (WO3), etc. Under normal circumstances, the surface potential acts as a potential barrier to restrict electron flow within the sensor circuitry. However, the deoxidizing gases from fire incidents diminish the oxygen surface density, and thereby reduce barrier potential to permit electron flow. The associated electrical circuitry detects the rise in conductivity due to electron flow, and activates alarm to undertake necessary measures (Flame detection, 2013).

These semiconductor sensors have wide range of applications for their advantageous features. They are small, compact, inexpensive, easy to install and maintain. These metal oxide type detectors are aptly used to detect fire incidents involving combustible gas, LP gas, methane, propane, alcohol, carbon monoxide etc. for their reliability.

These features make this detector best suited for our purpose and hence we opted for it in our system.

## 2.4 Review of related works

A lot of work has been done on this project choice, some of which are be reviewed below.

The paper presented in [15] proposes the development of a GSM -based fire detector system. A cost effective system that detects fire or smoke and sends alert information to a mobile phone for quick and immediate action thereby, avoiding unnecessary and costly industrial and domestic breakdown. The fire alert design was built around techniques for digitalizing analogue signals obtained from transducers used to monitor temperature of the room and the light intensity of the room. The room temperature to be monitored, being analogue, is measured through the use of a thermistor, while the light intensity of the room is detected using Light Dependent Resistor (LDR). The LDR's resistance increases with reduced light intensity causing the voltage input into the inverting input of the comparator used to be higher than the reference voltage set at the non-inverting input of the comparator which makes the comparator to output a LOW. The thermistor resistance decrease with increase in temperature and this would cause a decrease in the voltage input to the non-inverting input of the comparator thereby causing the voltage reference set at the inverting input to be greater. In this state the comparator outputs a LOW, to indicate high temperature (i.e. fire). The two LOW outputs were ORed and coupled to the astable stage of the circuitry. However the system presented here has no LCD (liquid crystal display) and did not disconnect electricity.

Oke A.O. (2015) developed a system that was based on the fundamental ideas of safety, security and control. Once this system is installed to operation specifying temperature and smoke threshold, in case of any emergency situation due to increasing temperature and/or smoke at place surpassing the threshold, the system immediately sends automatic alert-notifications to the users, concerned with the situations. The user gets total control over the system through mobile SMS, even from the distant location, that to change the threshold, turn on/off the feature of sending 'alert notification' and also to reset the system after the emergency situation is overcome. Before executing any command (through SMS) from the user, the system asks for the preset password to verify an authorized user. The security issues have been considered with utter attention in this system to ensure its applicability in industries and business organizations, where security is an important concern. Hence, the fundamental ideas of safety, security and control have been entirely ensured through the system, which have definitely worked as the gear moving factor to look for a new dimension of an 'Intelligent Fire Alert System'. Multiple temperature and smoke sensors are incorporated in the system to cover a wide range of area, which are connected to Atmega32 microcontroller interfaced with a GSM module. The alert notification can be sent to multiple users and the corresponding mobile numbers can be set/reset by the user in the server mobile through the user interface of the program, running on the computer. However the system did not disconnect electricity when fire has been detected.

Daniel D. et al (2015) presented a design which consisted of five major circuits to compensate the system operation. It includes Detection and Initiating Devices (DEADS), Notification Devices (NODES), Central Station Monitor (CSM), Annunciation Devices (ANODES) and the Suppression Circuitry. The DEADS is composed of a smoke detector and smoke ionization sensors which transmit initiated signal to CSM. The NODES are active devices like smoke alarms, and speakers attached to every room designed to give alarms to the room occupants. The Central Station Monitor designed with Arduino Uno as the Microcontroller served as the brain of the system interfaced with PHP & MySQL. The ANODES works once fire cannot be suppressed by the system itself, thereby when the fire department and other incident team needs to be contacted. The suppressor composed of robotic-arm connected to the water supply, fire hydrants, and sprinkler heads. The methodologies described in this paper heavily rely on integration of web science to an embedded system. Compared with traditional or conventional fire alarm system, this design reduces energy consumption, reduction of maintenance and service operation costs, improved security services, and increase the satisfaction of building occupants. However the design is complex and did not disconnect electricity supply of the building.

Babatunde B. (2013) Designed and constructed a smoke detector alarm using photo-resistor, capacitor, diode, op-amp, relay and integrated circuit. But the whole circuit was based on an analog system which has no microcontroller, no LCD, no GSM modem and cannot disconnect the electricity supply.

Chew A. (2011) proposed an alarm system that is specially designed for industrial use. The basic operation of the alarm system consist of heat detector, smoke detector and Burglar detector, when the heat or smoke is detected, it will communicate with the PIC microcontroller and The PIC will trigger an alarm. This system has no GSM modem and no LCD display and cannot trigger electricity supply.

Kooi, (2011) constructed an alarm system designed using two types of sensors. The photo-electronic and the inductive proximity sensor switches the photo-electronic sensor is activated when the receiver cannot receive the light from the transmitter. This system is unreliable, it has no LCD, no GSM modem.

Nur, (2012) constructed a fire alarm that consisted of three sensor infrared smoke sensor, thermostat heat sensor and infrared sensor. The infrared smoke sensor is designed to identify a fire while in it smoldering or early flame stage, replicating the human sense of smell. However the system couldn't alert occupant when far away, it also lacked an LCD (Liquid Crystal Display) and has no other control action.

George, (2014) constructed SMS base fire alarm detection system Using smoke and temperature sensor. This project was designed to detect fire. The fire system sends an SMS to the user when the detection crosses the threshold value. This device is dependent on electricity, it has no LCD display and cannot trigger electricity supply.

## 2.5 Introduction to GSM network

GSM (Global System for Mobile Communication) has been the backbone of the phenomenal success of mobile communication in the previous decade. Now at the dawn of true broadband services, GSM continues to evolve to meet new demands. GSM is an open, non-proprietary system with international roaming capability. GSM was originally known as Group Special Mobile but nowadays it is commonly referred as Global System for Mobile Communication. It is a set of standards developed by the European Telecommunications Standards Institute (ETSI) to describe technologies used for second generation digital communications, commonly referred as 2G technologies. It was developed as a replacement to the first generation analog communications. It originally described a digital circuit switched network optimized for full duplex voice communications (GSM modems)

2.5.1 Messaging Over GSM Network

GSM is the world's most popular standard for mobile telephony systems. GSM is used by over 3 billion people all over the world. GSM also pioneered the low cost implementation of the Short Message Service (SMS) which allows parties to exchange delay tolerant short text messages. The popularity and coverage of cellular networks allows the use of SMS service.

According to the analysis of real data taken from a real GSM network in India, SMS delivery success rate is found to be 94.3%. Of these successfully delivered messages, 73.3 arrived to their destination within 10 seconds. About 5% of them required more than 1 hour to reach the destination. Using SMS for AMR will certainly increase the flow of messages tremendously. GSM uses several cryptographic algorithms for security. The development of UMTS introduces an optional Universal Subscriber Identity Module (USIM), which uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user (GSM modems)

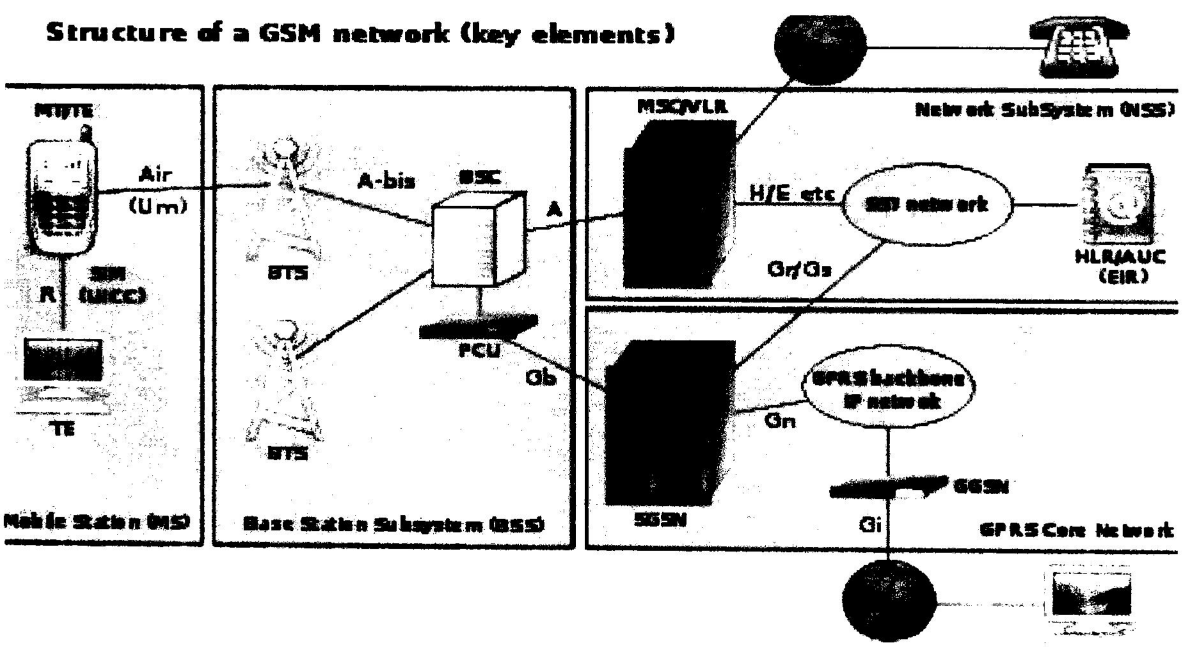



Fig. 7. GSM network structure

## Chapter Three

### 3.0 Design Methodology

Fire has been known to generate heat, light and gas (smoke) thus this fire status monitoring system uses temperature sensor and smoke sensor to read the status of fire in a room compartment. The data collected by these sensors are sent to the microcontroller for further processing. The microcontroller then compares the processed results with some reference values and the result of the comparison will be used by the microcontroller to make the decisions of performing some control actions

The method used in the execution of this project comprises the combination of serial communication protocols, signal processing, programming logics with embedded system. In other to establish the aim of the project these methods were combined from the design stage to the construction and performance results of the system. Using carefully selected materials and software implementation to drive the complete system as seen in the final construction. This chapter entails the design procedure of the system detailing the theoretical analysis, choice of components and values and construction and packaging materials. Indicating calculations, schematics and drawings

### 3.1 Requirements and Specification

In the research performed to carry out this project, special attention was put on the critical condition that makes the component and the module operate efficiently. All the required functions of the design will be discussed in this section. The major problem accosted in engineering design is to fully and correctly specify the requirements of the design. The 'Fire Status Monitoring" system design specification involves the following:

1. Capable of measuring temperature variation over a wide range and displaying the value on a display screen. Also it must be able to detect temperature over a preset limit and perform specified actions when this limit is crossed.
2. Capable of detecting smoke in a room compartment and performing a specified action.

3. Operated via a rechargeable battery for standby operation.
4. Capable of disconnecting electricity supply as soon as smoke or temperature level crosses a preset limit.
5. Capable of sending an SMS alert to designated numbers as soon as smoke or temperature level crosses a preset limit.
6. Capable sounding an alarm as soon as smoke or temperature level crosses a preset limit.

## 3.2 **Design**

Basically, the design and development of this project is divided into two main parts which are hardware architecture and software details. In the hardware architecture, the design of the circuit was constructed and the prototype of the project was built. The hardware of the system mainly comprises sensor section, control unit, network module, display, and power supply. While in the software development, the whole complete prototype was operated via programming codes

### 3.2.1 **Hardware architecture**

#### 3.2.1.1 **Control unit (**Atmega8A microcontroller)

The criterion for choosing this microcontroller are as follow:

Meets the computation needs of task at hand efficiently and cost effectively.

Availability of software development tools such as compiler, assemblers and debuggers

High speed up to 16 MHz, ADC (analog to digital converter) capability, Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART) capability.

Low power consumption: – Active: 3.6 mA – Idle Mode: 1.0 mA– Power-down Mode: 0.5μA

For these reason the Atmega8A microcontroller is chosen. It is further discussed below

The Atmega8A in figure 8 is the main microcontroller device, which controls all the operation of the system and manages the circuit accordingly. It is a low power Atmel 8-bit AVR RISC-based general purpose computer. Optimized power consumptions, good processing speed, small physical dimensions, and lower costs which make this microcontroller a perfect fit for this purpose. Only two of the analog input pins has been used to acquire the status of the sensor units via common data line. A Liquid Crystal Display (LCD) has been interfaced to the controller to show the status of the system. The controller also triggers the12 V relay to disconnect electricity supply when fire is detected and sound the buzzer. Serial communication protocol has been used to control the GSM module using AT commands.

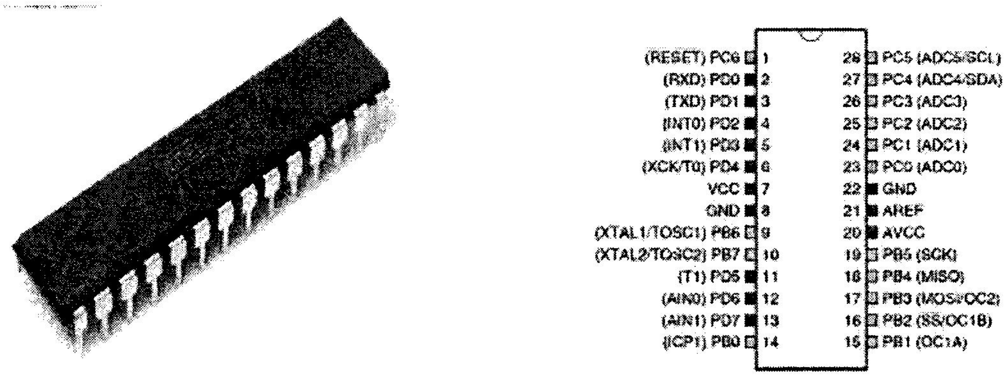



Fig. 8 The ATmega8a microcontroller

3.2.1.2 **Network module**

GSM Module (SIM800L)

For GSM module, GSM SIM800L type is selected to carry the task in communication part, which is to send an SMS alert to a designated number when fire has been detected. It can operate on Dual-Band 900-1800 MHz and designed solely for outside Europe and USA usage. It has an established performance, industrial grade interface standard plus embedded TCP/IP protocol which makes it to be presentable and suitable for the electronics project. Since it consumes small of power in its operation, thus it is said able to communicate with any low power consumption microcontroller (SIM800l Datasheet). It can be interfaced by using many interfaces which some are I2C, SPI interface, PWM, antenna pad, two serial interface and so forth.

GSM modem interfacing with microcontroller for SMS control of several applications. The SIM800L GSM module is a special type of modem which accepts a SIM card and operates like a mobile phone subscribed to a cell phone operator text message may be sent through the modem by interfacing only three signals of the serial interface of modem with microcontroller i.e., TxD, RxD and GND pins.

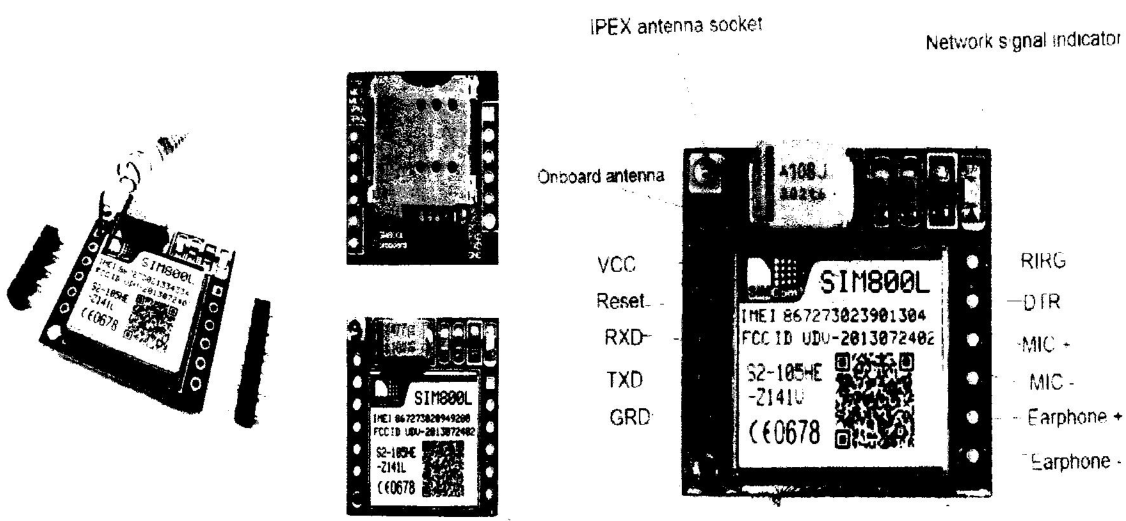
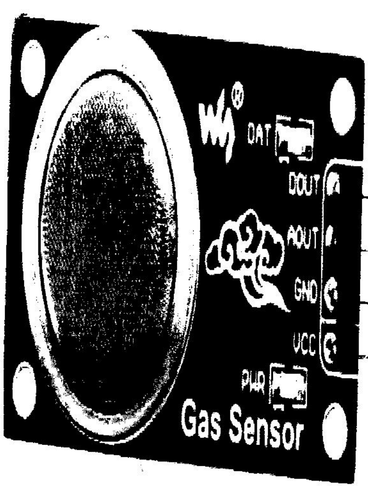



Fig. 9. SIM800L module

3.2.1.3 **Sensor module**

1. Smoke sensor (MQ2 sensor)

It comprises of a smoke/gas, comparator and variable resistors. MQ2 is a semiconductor Type sensor, which can aptly sense presence of smoke, LPG, methane, butane, propane and other hydrocarbon combustible gases. The sensitive material in this sensor is Tin dioxide ($SnO_2$). When comes in contact with the gas to be monitored, the electrical resistance of the sensor decreases, enabling the microcontroller to respond to the situation. The analog voltage from the sensor is applied to the input of the comparator IC LT1013 while its reference input voltage comes from a variable resistor to adjust the sensing intensity. The output of comparator has been connected to the MCU via single data line. In case of detection of smoke or gas, the output will be high, and the indicator LED will glow. Figure 5 below shows the configuration of the sensor. Figure 5 shows the typical sensitivity characteristics of the MQ-2 for several gases in their: Temp: 20°C, Humidity: 65%, O2 concentration 21% RL=5kΩ Ro: sensor resistance at 1000ppm of H2 in the clean air. Rs: sensor resistance at various concentrations of gases (MQ_2 datasheet).



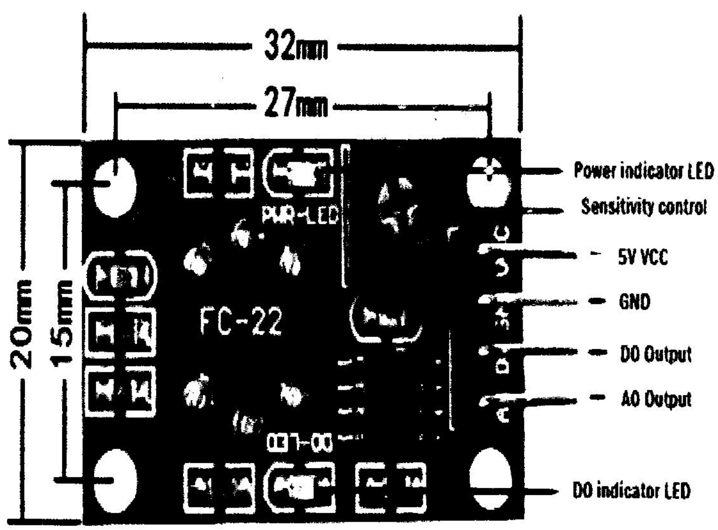




Fig. 10. MQ-2 smoke sensor

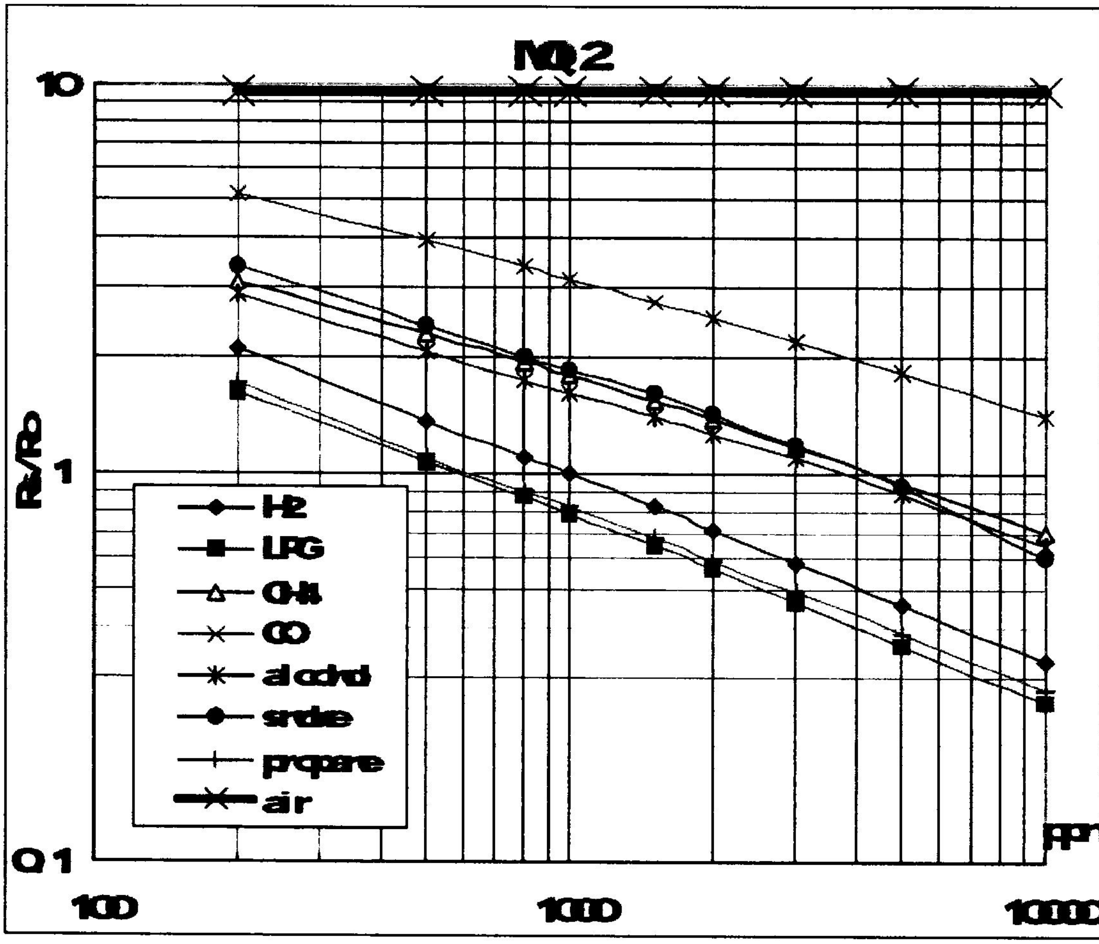



Fig. 11. Typical sensitivity characteristics of the MQ-2

2. Temperature sensor (LM35)

The LM35 temperature sensor is an integrated circuit sensor. Here the output voltage is linearly proportional to temperature in centigrade, making the sensor perfectly suitable for our purpose. The sensor is precise up to ±1/4°C at room temperature with operation range from −55°C to 150°C, and is very low self-heating as it draws very small amount of current. The output of LM35 module is also an analog voltage. The circuit operation of this module is similar to the smoke detection process described above. The reference voltage of the comparator is adjusted to 500 mV using a variable resistor same as the one used in smoke sensor circuitry. The LM35 increases its output by 10 mV/°C at the non-inverting pin of the op-amp. So when the temperature is greater than the pre-set temperature (45°C), the module will make its output high, which is connected to a single I/O digital pin of the control unit via a single data line. Any MQ2 and/or LM35 sensor unit will trigger the data bus to logic high state (5 V) if any smoke or gas is present in the location, or if room temperature surpasses the preset value due to fire or any other accidental situation.

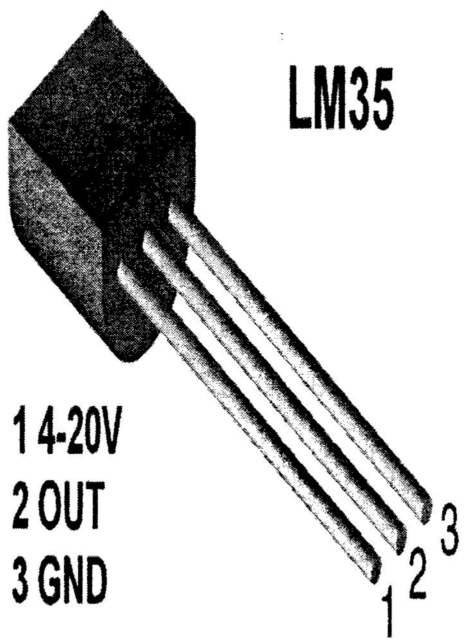



Fig. 12. Lm35 temperature sensor graph

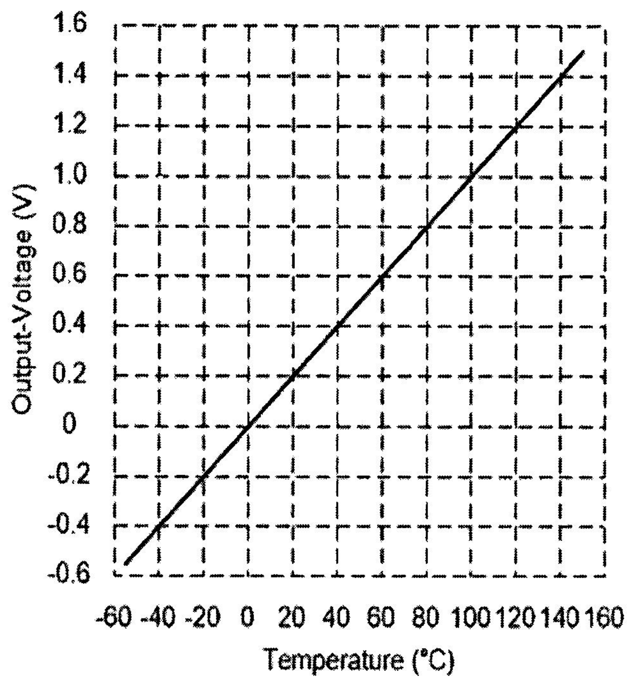



Fig. 13. Lm35 sensitivity

3.2.1.4 **Display**

Liquid Crystal Display (LCD)

(Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD

Fig. 14. 16x2 LCD (Liquid Crystal Display)

### 3.2.1.5 **Power supply**

Power supply unit:

The need for power supply stage is to provide the voltage and current requirements for the circuit since all the electronic components used in this project works with DC voltages. The required dc voltage and current of the power supply for the project is dependent on the component specifications and the nature of circuits to be powered. The power supply employed consist of a linear regulated power supply and a switching regulated supply to meet up with the power requirement of the project design.

Power supply requirement:

The power rating of all components used aided me in selecting a suitable power source for the device.

Table 1: Power distribution table

| S/N | Component | Voltage(V) | Current (mA) | Power(V*I) (mWatt) |
|---|---|---|---|---|
| 1 | Atmega8A | 5 | 5 | 25 |
| 2 | Sim800L | 3.7 | 50 | 185 |
| 3 | MQ-2 Sensor | 5 | 100 | 500 |
| 4 | Temperature sensor | 5 | 2 | 10 |
| 5 | 16*2 LCD display | 5 | 10 | 50 |
| 6 | Relay | 12 | 70 | 840 |
| 7 | Buzzer | 5 | 20 | 100 |
| 8 | LED | 3.4 | 5 | 17 |
| | | | Total | 1727 |

The device is powered by a 3.7v 3000mah lithium ion rechargeable battery which is recharged by a solar panel during the day. Different voltages are requires for different modules, the microcontroller uses 5v, the GSM module uses 3.7v to 4.2v and the relay uses 12v. Therefore two converters are used to provide necessary voltage to the devices. The GSM module is connected to the battery directly, a boost converter is used to boost 3.7v to 12v to drive the relay and also serves as input to the regulator IC (7805) which regulates the 12v input to give 5v output which is connected to the microcontroller.

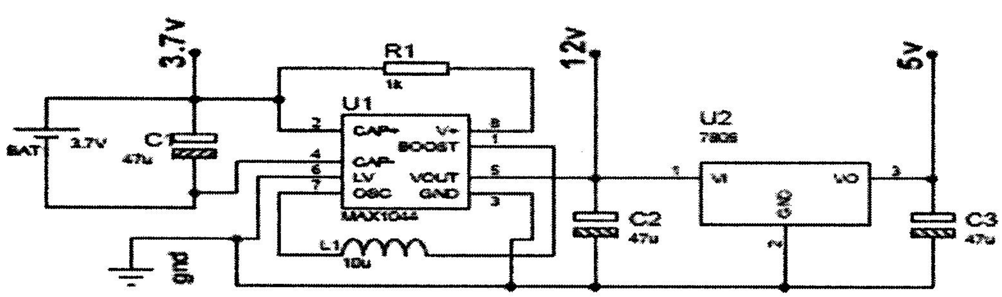



Fig. 15. Power supply circuit diagram

**Design calculation**

Selecting switch transistor for relay and buzzer

Relay parameters: Voltage = 12v, coil resistance = 175Ω

From ohms law $V = I * R,\ therefore\ I = \frac{V}{R}$

$V$ is the Voltage, $I$ is the Current ( A) and R is Resistance, hFE is current Amplification

Therefore the current (I) required to drive the relay is $I = \frac{12}{175} = 0.068A$ = 68mA

bc547 was chosen to drive the relay

$where\ I_C = hFE * I_b$ [25]

$I_b = I_c/hFE$

$I_b = \frac{68mA}{120} = 566.6uA$

From Ohms law $R = \frac{V}{I}$

$R_b = \frac{V_s - V_b}{I_b} = \frac{5-0.7}{566.6*10^{-6}} = 7589.12\Omega$

$R_b = 7.5k\Omega$ Which bias the base of both transistors correctly

LED series Resistance ($R_s$) calculations

LED specification: forward voltage($V_f$) 3.4v, current $I_f$ 20mA.

$R_s = \frac{V_s - V_f}{I_f}$, Where $V_s$ is the supply voltage

$R_s = \frac{5-3.4}{20*10^{-6}} = 80\Omega$

*Therefore 80Ω biases the LED correctly*

### *3.2* Software development

The software of the project is based on the flow chart in figure below. When the system begins, LM35 will always sense the surrounding temperature, and the smoke sensor (MQ-2 sensor) also monitors the presence of smoke. Whenever a fire is broken out, even a small little fire, a temperature rise is occurred accompanied with some level of smoke. When that happens, LM35 can detect the temperature value instantly. At the time when the temperature reaches 40°C or when smoke is detected, the microcontroller will notify GSM module to send an alert message to the user. Value of temperature limit that can be triggered by LM35 can be changed in the code upon request by the user. The limit is not constrained to any value since the LM35 sensitively senses any surrounding heat with regards to the temperature range it can count (-55oC to +150oC). During hot weather, the temperature can reach up to almost 36°C in Nigeria. Thus, the limit temperature to be detected.

Figure below illustrate the flow chart of the home fire status

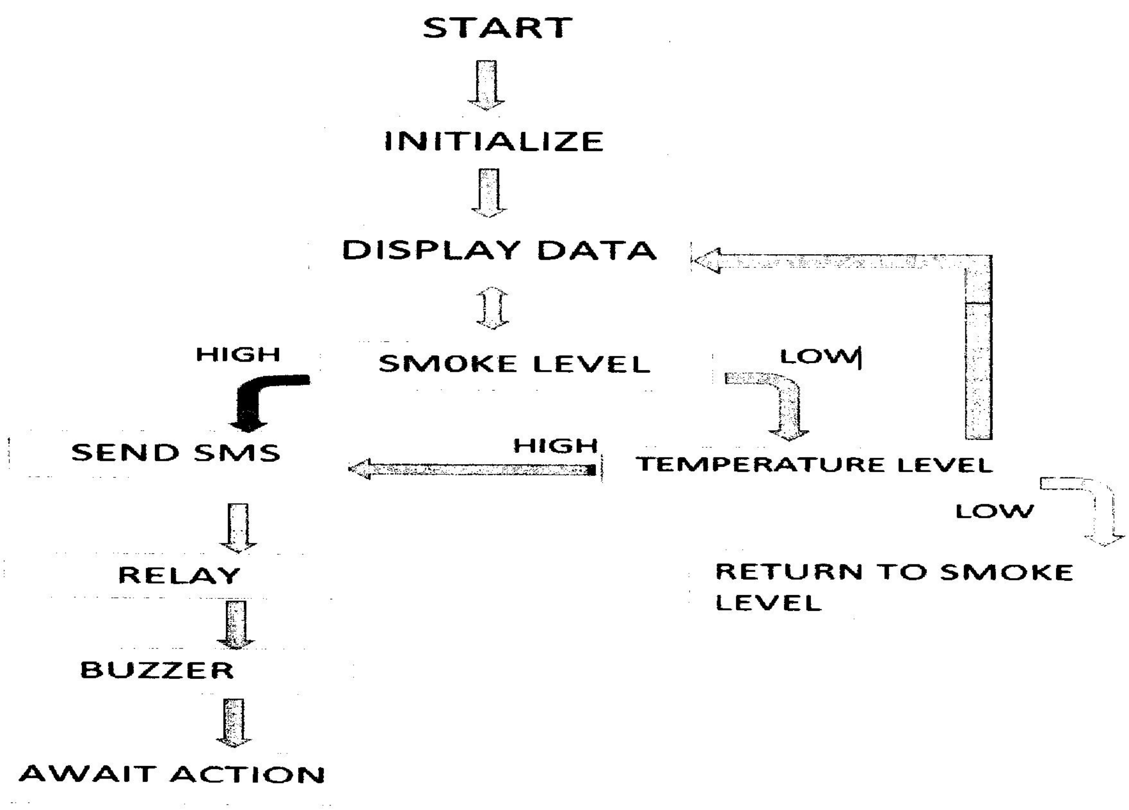



Fig. 16. Program algorithm

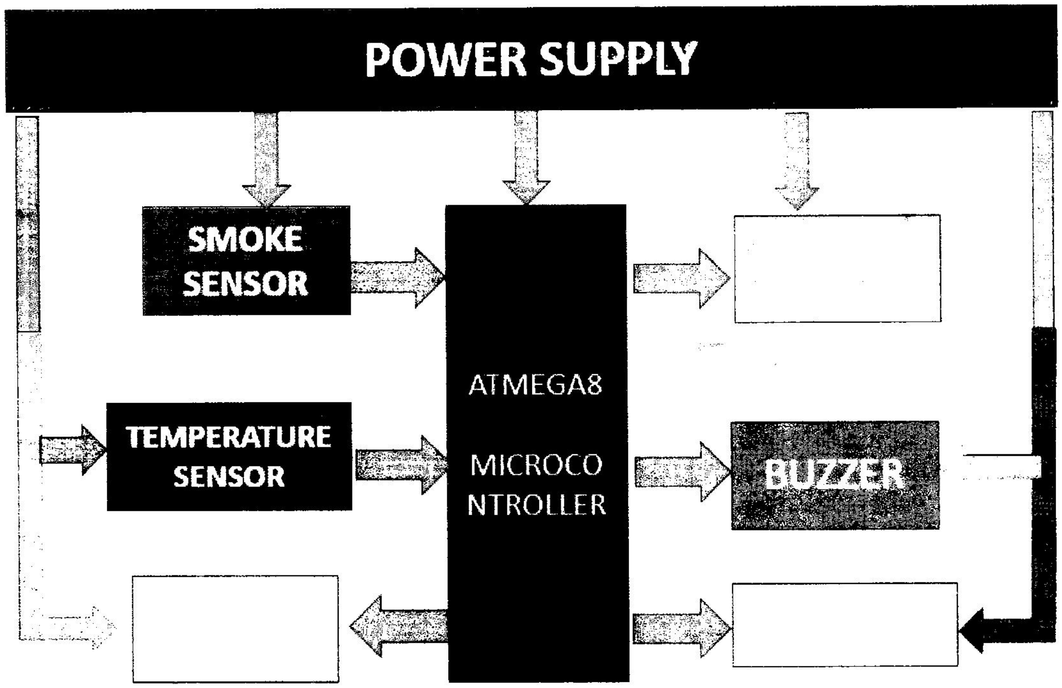



Fig. 17. Block diagram of the fire status monitor design

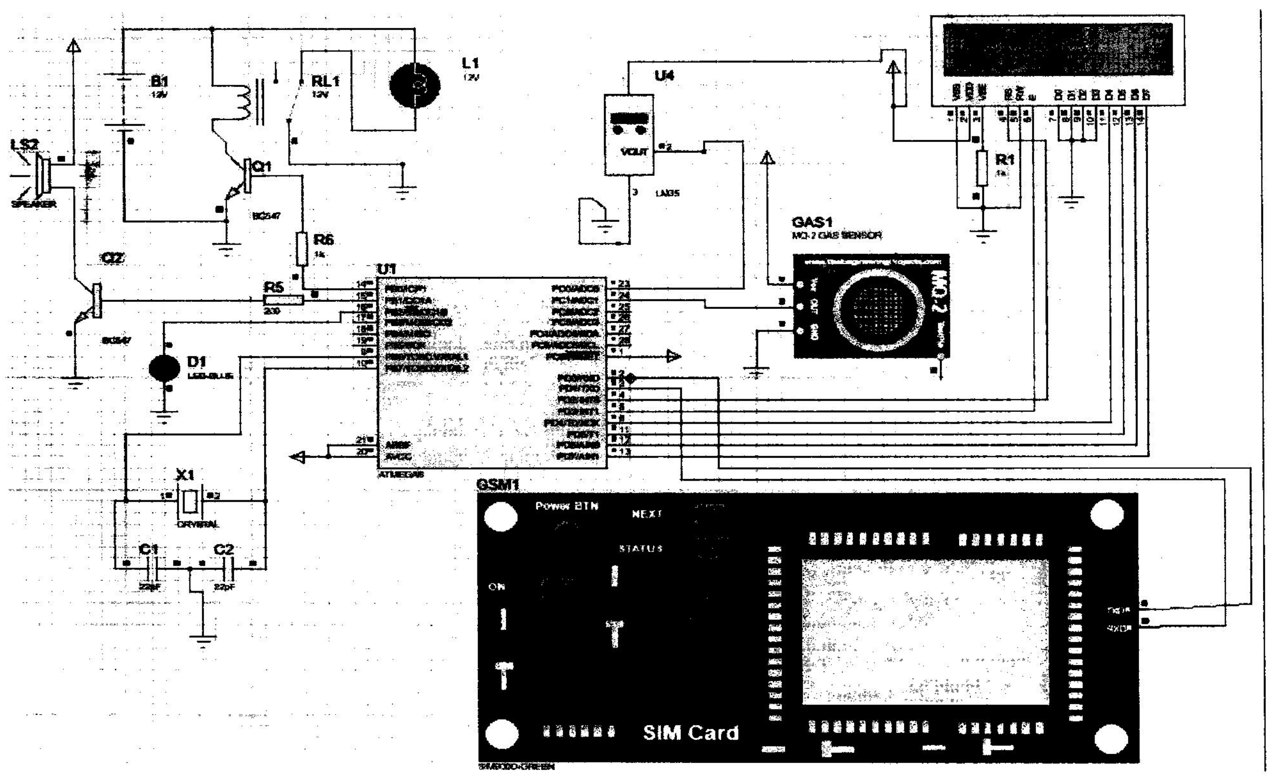



Fig. 18. Circuit simulation on proteus

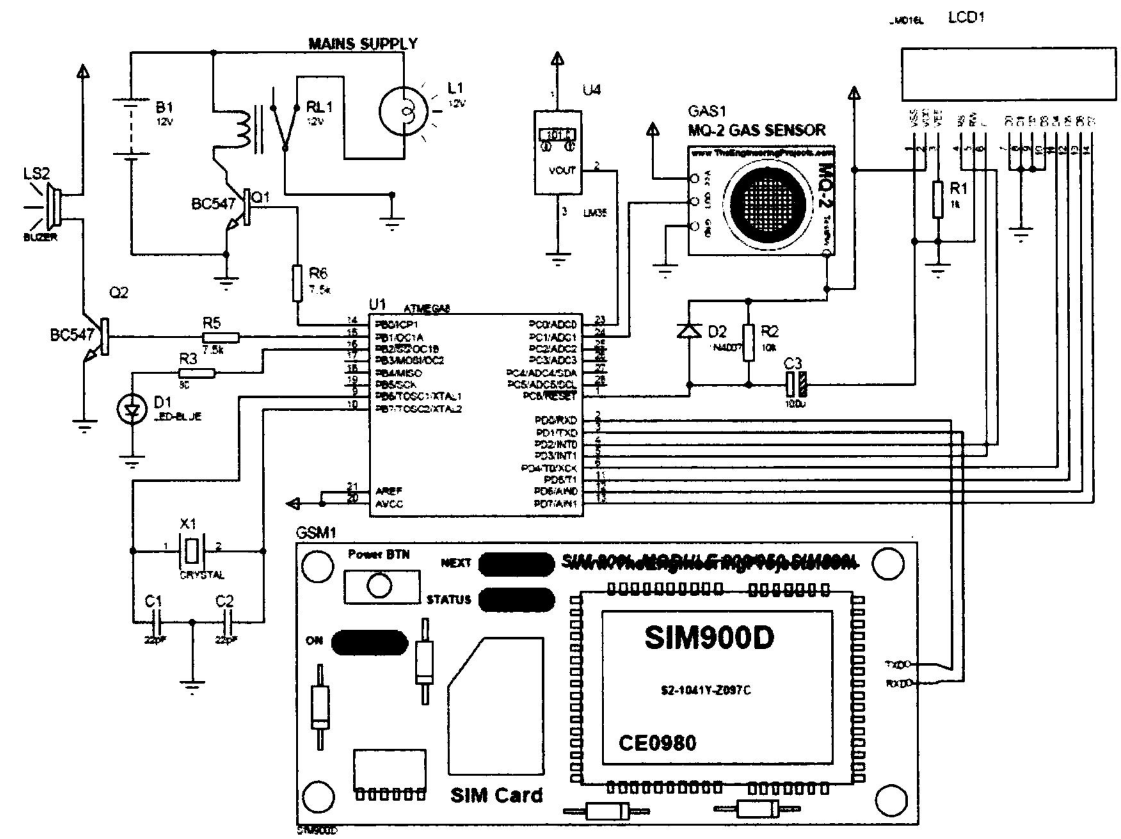



Fig. 19. Complete circuit diagram for the fire status monitor

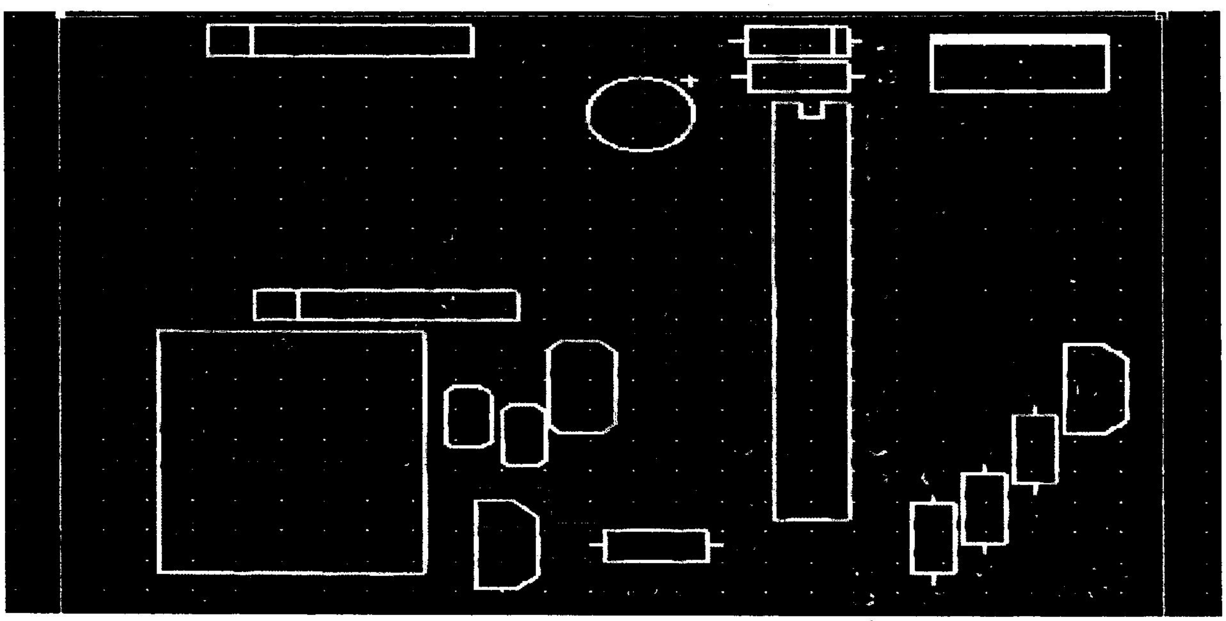


Fig. 20. Printed circuit board (PCB) layout of the design

# CHAPTER FOUR

## 4.0 Testing, Analysis of Results and Discussion

The design was implemented on a (PCB) printed circuit board to improve reliability. After simulation work was completed, I sourced for all components and materials needed. Afterwards I designed a PCB (printed circuit board) based on my simulation details. When the PCB was ready, I collected components and modules and tested them to confirm their working state and thereafter proceeded to connecting all components following the PCB design layout. Soldered all components on the PCB and fixing ICs (integrated circuits) in their respective sockets a basic board test was done using a digital multi-meter to make sure that there is no jamming of circuit tracks and that continuity is available where necessary. Also voltage source test was also done to make sure that correct voltage level gets to the different devices, modules and sensor. After circuit board test was done I proceeded to test the operation of the system to see if it conform to the design specification. Listed below are the Platforms, Tools and program used

### 4.0.1 Proteus professional circuit simulator

The design was started by first designing a model on a computer software which is Proteus professional circuit simulator. This software was used to observe the operation of the intended design and to make necessary calculations, adjustments and modification thus making it to conform to design specification before implementing. Figure 18 above shows the interface of the program during simulation.

As at the time of submission of this paper work the project was completed and fully functional.

### 4.0.2 Express PCB

This is a computer program which was used to design the printed circuit board for this project after simulations have been perfected. Figure 20 above shows the interface of the program during the design.

4.0.3 Atmel studio

Atmel Studio 7 is an integrated development platform (IDP) for developing and debugging all AVR® and SAM microcontroller applications. I used this program to write and compile my codes written in assembly language

4.0.4 Avrdudesss

This program was helpful in uploading the compiled codes to the Atmega8A microcontroller

4.0.5 Other tools used were:

1. Bench Power supply
2. Digital multi-meter
3. Component tester
4. Soldering iron
5. Hand tools such as; pliers, cutter, screwdriver etc.

## 4.1 **Testing**

Before the device was powered a thorough check was conducted on the circuit board using multimeter to make sure that all connections are done correctly to avoid any form of casualty due to wrong connection. When the switch was toggled, The LED indicator for power ON was lit indicating system power up, then the LCD came up, displaying the name of the project and other information and thereafter it displays the parameters being measured. The MODEM connected to Network in five seconds on powering ON. The temperature and smoke level of the environment were displayed on the display (LCD).

To test the functionality of the system, fire was set up beneath the device, the increment of the smoke level was seen on the display. As soon as the smoke level gets to the set threshold, the system immediately sounded the buzzer, disconnected the electricity and it sends SMS to my phone via the phone number provided in the code which says "FIRE DETECTED". The message was delivered within a minute, this time is early enough for a response and action to be taken before the spread of the fire and damage to lives and properties.

The temperature test was also conducted by placing a heat source towards the sensor, the increment of the level of heat was observed on the display which after the temperature has risen beyond the $40^0C$ preset level, it sends an SMS to my phone which says "HIGH TEMPERATRUE", disconnected the electricity supply and sounded the buzzer. These test results simply have shown a successful implementation of the work following the design specification and requirements.

## 4.2 **Analysis**

To observe the performance and response of the system to adverse fire situations, 10 individual simulation tests were performed with varying smoke, gas, and temperature conditions. The result of the tests suggests the system renders desired alert responses under different test conditions reliably. The experimental set-up of the tests is shown in **Figure 21b**. During the tests, the time taken from fire detection to alert message (SMS) delivery via GSM network by the system has been noted down as well. These time responses have been plotted in **Figure 21a**. The maximum time taken by the system to deliver alert SMS was 40 seconds (test no. 6), and the minimum time was 28 seconds (test no. 2) approximately. As it is seen, on an average, the developed system takes about 28 – 40 seconds to deliver alert SMS to the concerned authority, which is quick enough to undertake necessary measures to avert the fire hazard.

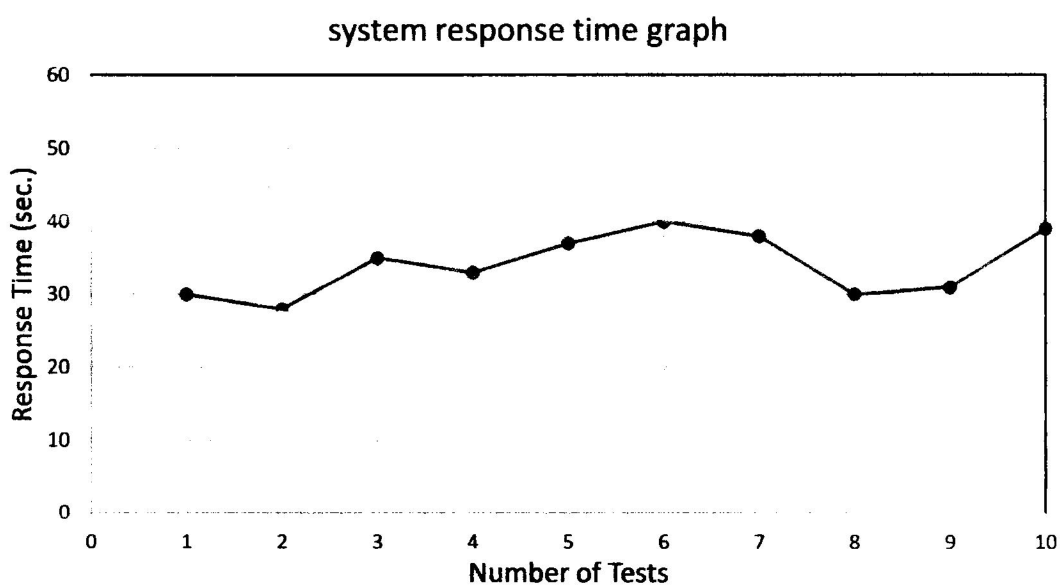



Fig. 21b system response time graph

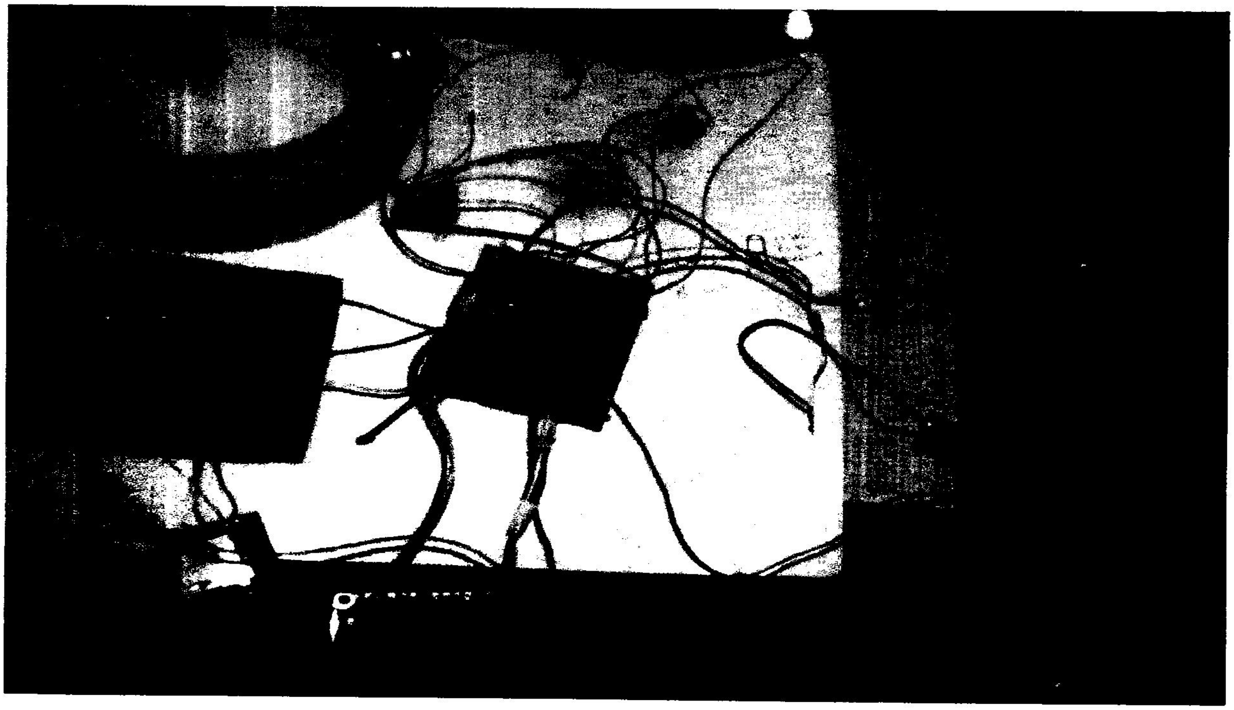


Fig. 21a. Project under test


Fig. 22. View of project starting up

### 4.3 **Project management**

The project was started progressively based on time management and work schedule following the Gantt chart provided in section 4.3.1 below.

### 4.3.1 Project schedule

Gantt Chart : FIRE STATUS MONITOR

Start Date: 7/2/2018 (Mon)

| WBS | Tasks | Task Lead | Start | End | Duration (Days) | % Complete | Working Days | Days Complete | Days Remaining |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Circuit Design Simulation | | 7/02/18 | 7/31/18 | [illegible] | 100% | 25 | 30 | 0 |
| 1.1 | circuit design diagram | | 7/02/18 | 7/09/18 | [illegible] | [illegible] | 6 | 7 | 0 |
| 1.2 | Modelling of circuit on proteus | | 7/10/18 | 7/12/18 | [illegible] | [illegible] | 3 | 2 | 0 |
| 1.3 | Writing the program code | | 7/13/18 | 7/18/18 | [illegible] | [illegible] | 4 | 5 | 0 |
| 1.4 | Simulation | | 7/19/18 | 7/26/18 | [illegible] | [illegible] | 6 | 7 | 0 |
| 1.5 | PCB Design | | 7/27/18 | 7/31/18 | [illegible] | [illegible] | 3 | 5 | 0 |
| 2 | Component and Material sourcing | | 8/01/18 | 8/30/18 | [illegible] | [illegible] | 22 | 30 | 0 |
| 2.1 | Purchasing components | | 8/01/18 | 8/15/18 | [illegible] | [illegible] | 11 | 14 | 0 |
| 2.2 | PCB fabrication | | 8/16/18 | 8/20/18 | [illegible] | [illegible] | 3 | 4 | 0 |
| 3 | Hardware Implementation | | 8/21/18 | 8/30/18 | [illegible] | [illegible] | 8 | 9 | 0 |
| 3 | Testing Components | | 9/01/18 | 9/27/18 | [illegible] | 100% | 19 | 26 | 0 |
| 3.1 | mounting and soldering | | 9/01/18 | 9/10/18 | [illegible] | [illegible] | 6 | 9 | 0 |
| 3.2 | Testing Circuit | | 9/11/18 | 9/20/18 | [illegible] | [illegible] | 8 | 8 | 0 |
| 3.3 | Programing | | 9/21/18 | 9/27/18 | [illegible] | 100% | 5 | 6 | 0 |
| 3.4 | Casing | | 9/28/18 | 9/30/18 | [illegible] | 100% | 1 | 2 | 0 |

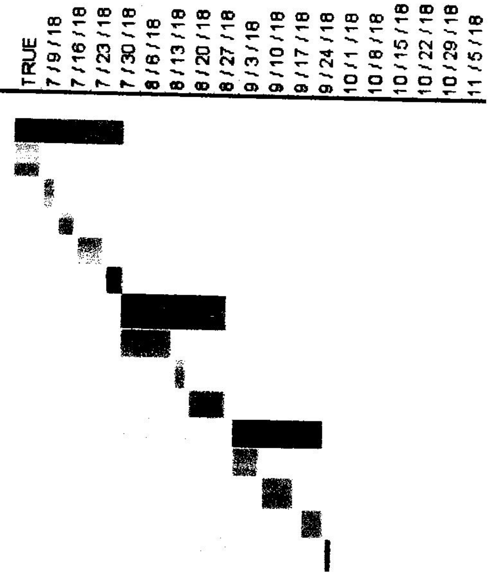



Fig. 24 Gantt chart for the project

### 4.3.2 Risk Management

The risks that are associated with this work are attributed to component sourcing and the decision to make the work myself.

To mitigate the risk, I made sure that I got all my components at once with extra copies and also with my little knowledge in electronics and some consultations, I was able to implement the work successfully. Thus all risks were well managed.

### 4.3.3 Social, Legal, Ethical and Professional Considerations

All social, legal, ethical and professional considerations have been duly observed in the implementation of this project work and it has been made to comply with all codes of conduct.

# CHAPTER FIVE

## 5.0 Conclusion and Recommendations

In this paper as proposed a fire status monitoring system with SMS notification has been designed and implemented, it can be deduced from the design and test results that the project has met its objectives. This project has therefore as proposed provided a novel solution to the inadequacies of traditional fire alarm systems. The device is simple but it has wide area of application in household and industrial safety, especially in developing countries. Using this system, quick and reliable alert response is possible to initiate preventive measures to avert danger of fire hazards and minimize losses of life and property. This is a cost effective fire alarm system which performs reliably to ensure safety from fire, and can be installed in houses, industries, offices, ware-houses etc. very easily. It can also be used to detect burnable gas like methane, LPG etc. as well. The designed systems have coverage up to 100 square meter area by using a category-6 cable as data line. Large industrial or residential area can be monitored through the proposed system by installing multiple modules, each for one floor or unit. The system can be further developed with added features like web server interconnect, fire area tracking and fire extinguisher interfacing etc.

The system is designed to run on a round the clock basis as it is presented with dual power backup system which include a 3000mah lithium ion battery pack and a solar panel. The drawback of the system from test implies the dependence of the system on the GSM network for SMS communication, for areas or times with no network coverage the system may not be able to communicate and these areas for future development.

## 5.1 Contribution to Knowledge

The design of this work has improved on the previous designs of fire alarm in the area of control actions triggered when fire has been detected. Thus this fire status monitoring device is capable of disconnecting mains electricity supply of the building against an intending fire outbreak. This is the first action to be taken to put out an intending fire outbreak resulting from electrical faults.

## 5.2 Limitations

I was faced with different problems, like every research and practical engineering work, diverse kinds of problems are often encountered. The major problems encountered in this project are listed below.

1. Some components got damaged due to insufficient details of using such components

2. Bridge in the circuit due to wrong connections and troubleshooting of faults

3. Faced with great challenge in selecting the best power supply option available.

4. Sourcing of Components

## 5.3 Future Works

As the system takes care of few of the drawbacks of the existing system, there is scope for further improvement and expansion of this work. The system can be expanded with further security measures, the system can be developed to have wireless sensors that can be placed strategically at different locations in a building.

After learning a lot from this project, there are few other things that could be done to the final design to improve its performance.

1. Increasing the overall speed of the microcontroller
2. Instead of sending an SMS it could have been designed to dial user phone number
3. The power consumption could have been lower
4. Reduction in overall size
5. Incorporating wireless sensor will expand detection area.
6. Fire proofing the system would be recommended in order to prevent damages to hardware components.

## 5.4Critical Appraisal

The system has been confirmed to be capable of reducing fire hazard, but it might not be the best solution to avert fire disaster. Multiple system might be used for better performance in fire hazard reduction.

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# APPENDIX 1

The Program code written in assembly language is given below

```
START:
        LDI     R17,0X5F                    ;STACK POINTER LOW
        OUT     SPL,R17
        LDI     R17,0X04                    ';STACK POINTER HIGH
        OUT     SPH,R17                             ;stack pointer 16 bit
        LDI     R17,0X00              ;CLEAR PORTD leaving pin 0,1 at high
        OUT     PORTD,R17
        LDI     R17,0XFC                    ;LOAD 11111100 IN R16
        OUT     DDRD,R17              ;SET PORTD AS OUTPUT PORT expt tx rx
        LDI     R17,0X00
        OUT     PORTB,R17                           ;CLEAR PORTB
        LDI     R17,0XFF                ;LOAD 11111111 INTO R17
        OUT     DDRB,R17                            ;SET PORTB AS OUTPUT
        LDI     R17,0X00
        OUT     PORTC,R17                           ;CLEAR PORTC
        LDI     R17,0X00                    ;LOAD 00000000 INTO R17
        OUT     DDRC,R17                            ;SET PORTC AS INPUT
        LDI     R17,0X00                    ;BECOS OF ADC
        OUT     ADMUX,R17
        LDI     R17,0X86                    ;ADC CONFIG
        OUT     ADCSRA,R17
        LDI     R17,0X00
        OUT     UBRRH,R17
        LDI     R17,0X19
        OUT     UBRRL,R17
        LDI     R17,0X18
        OUT     UCSRB,R17
        LDI     R17,0X86
        OUT     UCSRC,R17
        LDI     R17,0X00                    ;CLEARING REGISTERS
        STS     TEMP3,R17
        STS     TEMP2,R17
        STS     TEMP1,R17
        STS     SMOKE3,R17
        STS     SMOKE2,R17
        STS     SMOKE1,R17

        SBI  PORTB, 3
        RCALL    INTLCD                ;INITIALIZES LCD
        RCALL    DSP                                 ;CALLS DSP
        RCALL DELAY1SEC                         ;CALL DELAYS
        RCALL CLRSCR               ;CALL CLR SCREEN
        RCALL    DSPO                     ;CALLS DSPO
        RCALL DELAY1SEC                         ;CALL DELAYS
        RCALL CLRSCR
        RCALL  DSP2
        RCALL  DELAY1SEC
        RCALL CLRSCR               ;CALL CLR S
MAIN:
        RCALL    MEASURETEMPVOLTAGE
        SBI  PORTB, 2
        RCALL    MEASURESMOKEVOLTAGE
        CBI  PORTB, 2
        RCALL    DSP1
```

```
        RCALL   DELAY10US
        RCALL   DELAY10US
        CBI       PORTB, 3
        RJMP    MAIN
MEASURETEMPVOLTAGE:
        LDI     R18,0X40
        RCALL   CONVERT
        LDS     R17,ADRES3    ;CONVERTED ANA TO DIGITAL RESULT FROM ADCL
        STS     RESULT2,R17
        LDS     R17,ADRES2    ;CONVERTED ANA TO DIG RESULT FROM ADCH
        STS     RESULT1,R17
        RCALL   PRESULT1  ;
        LDS     R17,DRESULT2
        STS     TEMP3,R17
        LDS     R17, TEMP3
        CPI                 R17,0X05
        BRLO      CONT
        RCALL   TEMPERATURE
CONT:
        LDS     R17,DRESULT1
        STS     TEMP2,R17
        LDS     R17,RESULT1
        STS     TEMP1,R17
        RET
MEASURESMOKEVOLTAGE:
        LDI     R18,0X41
        RCALL   CONVERT
        LDS     R17,ADRES3
        STS     RESULT2,R17
        LDS     R17, ADRES2
        STS     RESULT1, R17
        RCALL   PRESULT1
        LDS     R17, DRESULT2
        STS     SMOKE3, R17
                ;RCALL    SMOKE
        LDS     R17,DRESULT1
        STS     SMOKE2,R17
        LDS     R17,RESULT1
        STS     SMOKE1,R17
        LDS                 R17, SMOKE1
        CPI                 R17, 0X09
        BRLO    CONT2
        RCALL  SMOKE
CONT2:
        RET
INTLCD:
        RCALL   DELAYM4
        LDI     R16,0X20
        RCALL   RSLOW2
        RCALL   DELAYM4
        LDI     R18,0XC2
        LDI     R16,0X2C
        RCALL   RSLOW
        RCALL   DELAYM3
        LDI     R18,0XC0
        LDI     R16,0X0C
        RCALL   RSLOW
        LDI     R18,0X10
```

```
        LDI     R16,0X01
        RCALL   RSLOW
        RCALL   DELAYM3
        LDI     R18,0X60
        LDI     R16,0X06
        RCALL   RSLOW
        RET
RSLOW2:
        CBR     R16,0X0C
        ORI     R16,0X01
        OUT     PORTD,R16
        RCALL   DELAYM
        SBR     R16,0X08
        ORI     R16,0X01
        OUT     PORTD,R16
        RCALL   DELAYM
        CBR     R16,0X08
        ORI     R16,0X01
        OUT     PORTD,R16
        RCALL   DELAYM
        RET
RSLOW:
        CBR     R16,0X0C
        ORI     R16,0X01
        OUT     PORTD,R16
        RCALL   DELAYMX
        SBR     R16,0X08
        ORI     R16,0X01
        OUT     PORTD,R16
        RCALL   DELAYMX
        CBR     R16, 0X08
        ORI     R16, 0X01
        OUT     PORTD, R16
        RET
RSHIGH:
        SBR     R16, 0X04
        CBR     R16, 0X08
        ORI     R16, 0X01
        OUT     PORTD, R16
        RCALL   DELAYMX
        SBR     R16, 0X08
        ORI     R16, 0X01
        OUT     PORTD, R16
        RCALL   DELAYMX
        CBR     R16, 0X08
        ORI     R16, 0X01
        OUT     PORTD, R16
        RCALL   DELAYM3X

        RET
CLRSCR:
        RCALL   DELAYM3
        ; TO CLEAR THE SCREEN
        LDI     R18,0X10
        LDI     R16,0X01
        RCALL   RSLOW
        ;WAIT FOR THE SCREEN TO BE CLEARED
        RCALL   DELAYM3
```

```
        RCALL   DELAYM3
        RET
 AUTOBAUD:                      ;SMS
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RCALL   AUTOBAUDG
        RET
AUTOBAUDG:
        LDI     R17, 0X41
        RCALL   SERIAL2
        LDI     R17, 0X54
        RCALL   SERIAL2
        LDI     R17, 0X0D
        RCALL   SERIAL2
        RCALL   DELAY1SEC
        RCALL   DELAY1SEC
        RCALL   DELAY1SEC
        RET
SERIAL2:
        SBIS UCSRA,5
        RJMP SERIAL2
        OUT     UDR,R17
        RCALL DELAYM
        RET
SERIALSM:
        LDI     R17,0X41
        RCALL   SERIAL2
        LDI     R17,0X54
        RCALL   SERIAL2
        LDI     R17,0X2B
        RCALL   SERIAL2
        LDI     R17,0X43
        RCALL   SERIAL2
        LDI     R17,0X4D
        RCALL   SERIAL2
        LDI     R17,0X47
        RCALL   SERIAL2
        LDI     R17,0X53
        RCALL   SERIAL2
        LDI     R17,0X3D
        RCALL   SERIAL2
        LDI     R17,0X32
        RCALL   SERIAL2
        LDI     R17,0X39
        RCALL   SERIAL2
        LDI     R17,0X0D
        RCALL   SERIAL2
        RET
SERIAL4GEN0:
        LDI     R17,0X30
        RJMP    SERIAL2
SERIAL4GEN1:
        LDI     R17,0X31
```

```
        RJMP    SERIAL2
SERIAL4GEN2:
        LDI     R17,0X32
        RJMP    SERIAL2
SERIAL4GEN3:
        LDI     R17,0X33
        RJMP    SERIAL2
SERIAL4GEN4:
        LDI     R17,0X34
        RJMP    SERIAL2
SERIAL4GEN5:
        LDI     R17,0X35
        RJMP    SERIAL2
SERIAL4GEN6:
        LDI     R17,0X36
        RJMP    SERIAL2
SERIAL4GEN7:
        LDI     R17,0X37
        RJMP    SERIAL2
SERIAL4GEN8:
        LDI     R17,0X38
        RJMP    SERIAL2
SERIAL4GEN9:
        LDI     R17,0X39
        RJMP    SERIAL2
SERIAL4GENA:
        LDI     R17,0X41
        RJMP    SERIAL2
SERIAL4GENB:
        LDI     R17,0X42
        RJMP    SERIAL2
SERIAL4GENC:
        LDI     R17,0X43
        RJMP    SERIAL2
SERIAL4GEND:
        LDI     R17,0X44
        RJMP    SERIAL2
SERIAL4GENE:
        LDI     R17,0X45
        RJMP    SERIAL2
SERIAL4GENF:
        LDI     R17,0X46
        RJMP    SERIAL2
SERIAL4:
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEND
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN3
        RJMP    SERIAL4GEN2

SERIAL5BUTTON1:
```

```
                                    ; PHONE NO I.E 08109655526
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GENF
        RJMP    SERIAL4GEN6
SERIAL6:
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN1
        RET
MESSAGE1:                   ;HIGH TEMPERATURE  IN PDU FORMAT
        RCALL   SERIAL4GENC
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GENE
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GENB
        RCALL   SERIAL4GEND
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN3
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEND
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GENB
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN0
        RET
MESSAGE2:  ;FIRE DETECTED
        RCALL   SERIAL4GENC
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN4
```

```
        RCALL   SERIAL4GENB
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GENC
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN0
        RET
SERIAL7:
        LDI     R17,0X1A
        RCALL   SERIAL2
        RET
TEMPERATURE:
        LDI     R17,0X03            ;RELAY AND BUZZER
        OUT     PORTB,R17
        RCALL   DELAY1SEC
        RCALL   AUTOBAUD
        RCALL   SERIALSM
        RCALL   DELAY1SEC
        RCALL   SERIAL4
        RCALL   SERIAL5BUTTON1 ; PHONE NO
        RCALL   SERIAL6
        RCALL   MESSAGE1  ;FIRE DETECTED
        RCALL   SERIAL7
        RCALL   DELAY20SEC
        CBI             PORTB,2
INFINITELOOP:
  CBI  PINB, 1
  RCALL DELAY1SEC
  SBI  PINB, 1
  RCALL DELAY1SEC
        RJMP    INFINITELOOP
        RET
SMOKE:
        CLR  R17
    LDI     R17,0X03            ;RELAY AND BUZZER
        OUT     PORTB,R17
        RCALL   AUTOBAUD
        RCALL   SERIALSM
        RCALL   DELAY1SEC
        RCALL   SERIAL4
        RCALL   SERIAL5BUTTON1 ; PHONE NO
        RCALL   SERIAL6
        RCALL   MESSAGE2  ;SMOKE
        RCALL   SERIAL7
        RCALL   DELAY20SEC
```

```
        CBI     PORTB,2
        RJMP    INFINITELOOP
        RET
CONVERT:
        RCALL   ADCCONVERT
REDOLOOP:
        RCALL   READVOLTAGE
        LDS             R17,ADCCOUNT2
        CPI             R17,0X01
        BRNE    REDOLOOP
        RET
READVOLTAGE:
        OUT             ADMUX, R17
        RCALL   DELAYMX
        RCALL   ADCCONVERTB
        RET
ADCCONVERT:
        CLR     R17
        STS     ADRES1,R17
        STS     ADRES2,R17
        STS     ADRES3,R17
        STS     ADCCOUNT,R17
        STS     ADCCOUNT2,R17
        STS     ADRES1B,R17
        STS     ADRES2B,R17
        STS     ADRES3B,R17
        RET
ADCCONVERTB:
LDI     R17,0XC7
        OUT     ADCSRA,R17                      ;C7 -1100 0111
        SBI             ADCSRA, 6
ADCCONVERTC:
        SBIC    ADCSRA, 6       ;HERE WE WANT TO KNOW IF CONVERSION HAS FINISH
        RJMP    ADCCONVERTC
        IN              R17,ADCL
                ; OUT           PORTB, R17  ;TO CONFIRM CONVERTION
        LDS             R16,ADRES1
        ADD             R16,R17
        STS             ADRES1,R16
        IN      R17,ADCH
        LDS     R16,ADRES2
        ADC     R16,R17
        STS     ADRES2,R16
        BRCC    ADCCONVERTD
        LDS     R17,ADRES3
        INC     R17
        STS     ADRES3,R17
ADCCONVERTD:
        LDS     R17,ADCCOUNT
        INC     R17
        STS     ADCCOUNT,R17
        CPI     R17,0X00    ; TAKE 256 SAMPLES FOR AVERAGE
        BRNE    ADCCONVERTBB
        LDS     R17,ADCCOUNT2
        INC     R17
        STS     ADCCOUNT2,R17
ADCCONVERTBB:
        RET
```

**Appendix ii**

Component list

| s/n | Name | Value | Quantity |
|---|---|---|---|
| **1** | Microcontroller | Atmega8A | 1 |
| **2** | Display screen | 16x2 LCD | 1 |
| **3** | GSM module | SIM800l | 1 |
| **4** | Smoke sensor | MQ_2 | 1 |
| **5** | Temperature sensor | LM35 | 1 |
| **6** | Relay | 12v dc | 1 |
| **7** | transistor | Bc547 npn | 2 |
| **8** | Buzzer | 5v | 1 |
| **9** | Resistor | 10k,1k | 6 |
| **10** | Capacitor | 100uf | 2 |
| **11** | Diode | 1N4007 | 1 |