AMEIRCAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

FACULTY OF ENGINEERING

MICROPROCESSOR AND EMBEDDED SYSTEMS [L]

Spring 2021-2022

Project on

GSM based fire controlling system using Arduino uno board

Supervised by

Prof. Dr. Engr. Muhibul Haque Bhuyan

Professor

Department of Electrical and Electronic Engineering

Group - 03

Submitted by:

Serial	Name	ID	Department
1.	CHOWDHURY, ANKETA	19-39514-1	CSE
2.	SHAWON, EHSANUZZAMAN	19-39823-1	CSE
3.	SAHA, ARNAB	19-39836-1	CSE
4.	MARMA, WATHIN	19-40379-1	CSE
5.	AHMED, NAFIZ	19-41283-3	CSE
6.	SAHA, ANIK KUMAR	19-41289-3	CSE
7.	AHMED, RAIYAN	19-41322-3	CSE
8.	SIDDIQUE, RAIYAN KHADIZA	19-41456-3	CSE

Date of submission: 13 April, 2022

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Abstract:

Fire alarm system plays an important role in maintaining and monitoring the safe of all kind environments and situations. However, the usability of many existing fire Alarm system is well known but could be produce 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 systems the detection system the monitoring system and the appliance system. The detection system operates as the fire detector and smoke detector. This paper discusses the design and implementation of a fire alarm system using the ARDUINO UNO R3 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 GSM for sending SMS services, buzzer for alarming, servos for automatic lockdown of doors in emergency exits and motor pump fire extinguishing foam to stop the fire and GPS module to indicate the location where the fire is occurred for the fire extinguishing car. The entire system is controlled by microcontroller. The microcontroller is programmed in such way by using C-Programming with ARDUINO IDE. From the project done, the System can detect smoke, flame, heat etc. sensed by the detector, followed by the monitoring system which indicates smoke, light, flame, heat etc. at that particular level. Finally, when the sensors form each level triggered individually, the main Buzzer operates, send SMS. Then it shows in the control panel LCD display which area is affected and which is safe. Then it runs the emergency exit servo motor to escape and the water pump motor to the affected zone to stop the fire.

Introduction:

Background:

Nowadays, securing one's property and business against fire is becoming more and more important. Monitoring commercial and residential areas all-round is an effective method to reduce personal and property losses due to fire disaster. Home fire detection is a matter of great concern, and thus many efforts are devoted in most developed countries to the design of automatic detection systems. A fire alarm system should reliably and in a timely way notify building occupants about the presence of fire indicators, such as smoke or high temperatures. A fire detector is usually implemented as a smoke sensor due to its early fire detection capability, fast response time and relatively low cost. Other options for the fire detection are based on gas sensors or temperature sensors fire detectors that use a single sensor, generally a smoke sensor, and present high false-alarm rates due to temperature changes. In order to prevent fires from occurring or minimize their impact, accurate and early detection is essential, and automatic fire detection is becoming

very essential to reduce the fire in the building and industry. Automatic fire alarm system provides real-time surveillance and monitoring. 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. This is the role of fire detection and alarm 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.

Description of the project:

This system is a kind of stand-alone embedded system. It is a self-contained device. It takes either digital or Analog inputs from its input ports, calibrates, converts, and processes the data, and outputs the resulting data to its attached output device, which either displays data, or controls and drives the attached devices. These devices could be for example, Global System for Mobile Communication (GSM) and short message service (SMS) to carry out data from the building with sensors directly alert the owners FINAL THESIS PROJECT 2010 E.C Adigrat University GSM Based Fire and Smoke Detection and Prevention System Page 2 to their mobile phone. Therefore, this makes controlling damages caused by fire easier by directly sending alert notification messages to owners or fire department using GSM technology. So, we designed a smart fire alarm model. Parameters like, temperature and smoke level will be controlled by microcontroller. Each of these parameters is measured by a sensor that is set at a specific range, if this sensor signals any change in that range, the system will take the appropriate action required, and the system sends a daily report to the user by SMS.

Objective:

The main purpose of this project is to design and implement an automatic fire and smoke detection and prevention system that can be produced at a low cost with effective and competitive usage. This System is designed to be more users friendly and easy to operate at any level.

The project is also been designed to be further working vision using minimum hardware at the lower level of processing. These systems are directed at specific applications. Our objective is to design a fire and smoke detection and prevention system that would fulfill the following:

- To indicate the room in which fire erupted
- To indicate the location where the fire is occurred
- To prevent fire and smoke

- To sound the alarm if fire occurs
- To run the emergency EXIT servo motor and control the fire by supplying water to the remote area by motor pump
- To indicate the state of the room as ‘Safe’ in order to avoid any confusion under normal condition. So, the system should never be in any ambiguous state

Literature review:

From the beginning of recorded history people have learned that early response to fires had positive results in controlling those fires. When someone discovered a fire the fire brigades and fire departments were alerted by roving watchmen using hand bell-ringers or church sextons ringing church bells or factory steam whistles. Unfortunately, these systems did not provide very much detail and often directed the fire department to the wrong location. But with the advent of the telegraph, invented in the early 1840ís by Samuel F. B. Morse, firefighters were given a faster and more accurate fire reporting system. In 1847, New York became the first American city to begin construction of a municipal fire alarm system required by ordinance to construct a line of telegraph, by setting posts in the ground, for communicating alarms of fire from the City Hall to different fire stations, and to instruct the different bell-ringers in the use of said invention. The Automatic Fire Alarm Telegraph is operated by any dangerous Heat, and detects the presence of fire at its commencement. The apparatus, usually set at 125 Fahrenheit, is placed on the ceiling at regular intervals in every room, office, closet, and elevator in the building the alarm is given directly to the Insurance patrol and fire department. It tells the exact location of the fire to the companies before they leave their station, giving the particular building and floor. Each instrument performs the service of a constant, vigilant watchman, ready to act in time of danger in every part of the building. Fire and smoke spread within the building can be affected by various factors such as the geometry, dimension, layout and usage of the building. In order to provide fire protection in the building, it is very important to detect fire at its early stage. The most common fire and smoke detection methods include the use of point type detectors (i.e. ionization smoke detectors, photoelectric detectors, heat detectors), line type detectors etc. These detection methods based on the use of fire signatures such smoke and heat. Fire is a chemical reaction known as combustion. It is defined by the rapid oxidation of a combustible material accompanied by release of energy in the form of heat. In order for ignition to occur, the presence of both a fuel and a heat energy source is required. When the two come together, with the appropriate proportions, either by a lack of separation or by some type of active interaction, a fire occurs. FINAL THESIS PROJECT 2010 E.C Adigrat University GSM Based Fire and Smoke Detection and Prevention System Page 5 The creation of the faster evacuation technologies and safer living conditions at affordable cost for everyone. This paper discusses

the automatic fire detection system, the composition and working principle. The principle of the proposed circuit is derived from the physical principles of ionization. Fire detectors using two-wire method to reduce the wall alignment, improve reliability, and ease of construction and installation. This describes the overall structure of the fire detection system and control software in the design. Low-cost fire detection and control system based on smoke and heat detection is proposed. It is comprised of a combination of electrical/electronic devices/equipment's working together to detect the presence of fire and alert people through audio or visual medium after detection. These alarms may be activated from smoke detectors or heat detectors which, when detects fire. Then, it automatically operates a relay which can be used to send Short Message Service (SMS) to the registered mobile numbers and switch on a water sprayer or a Solenoid Pump to spray water or fire ceasing foam. A Short Message Service (SMS) was used as a method of wireless connection in the designed system. The adopted (T-BoxN12R device) which was programed in Java to Micro Edition language (J2ME) will keep scanning the received gas smoke data signal from the Gas Smoke Sensor output to pre monitor the ability of occurrence of a fire, once it detects that the collected data (Gas Level) exceed a predefined threshold it will enable the communication with GSM network and send the ALARM SMS message to the predefined phone number. Also, it will Turn Alarm Buzzer "ON", and Turn Water Pumping Motor "ON".

Theory and Methodology:

So, for this project, we mainly used the Arduino UNO board to connect all the necessary stuffs along with Arduino IDE to run the code. Based on that we developed a C++ code which executes according to our needs continuously until we stop the process. All the necessary components and their theory have been discussed below:

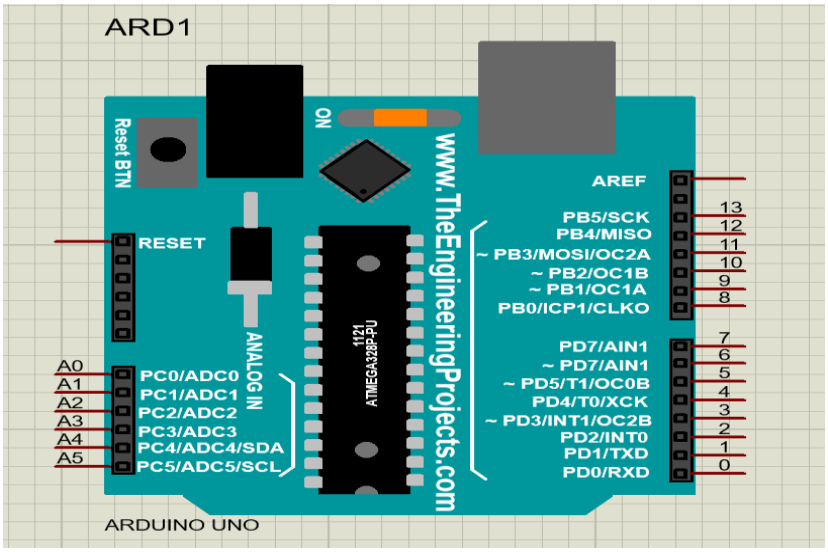

Figure 1: Arduino UNO Board

Figure 1 shows the first and most important component that we had to use for our experiment is the Arduino UNO board which is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

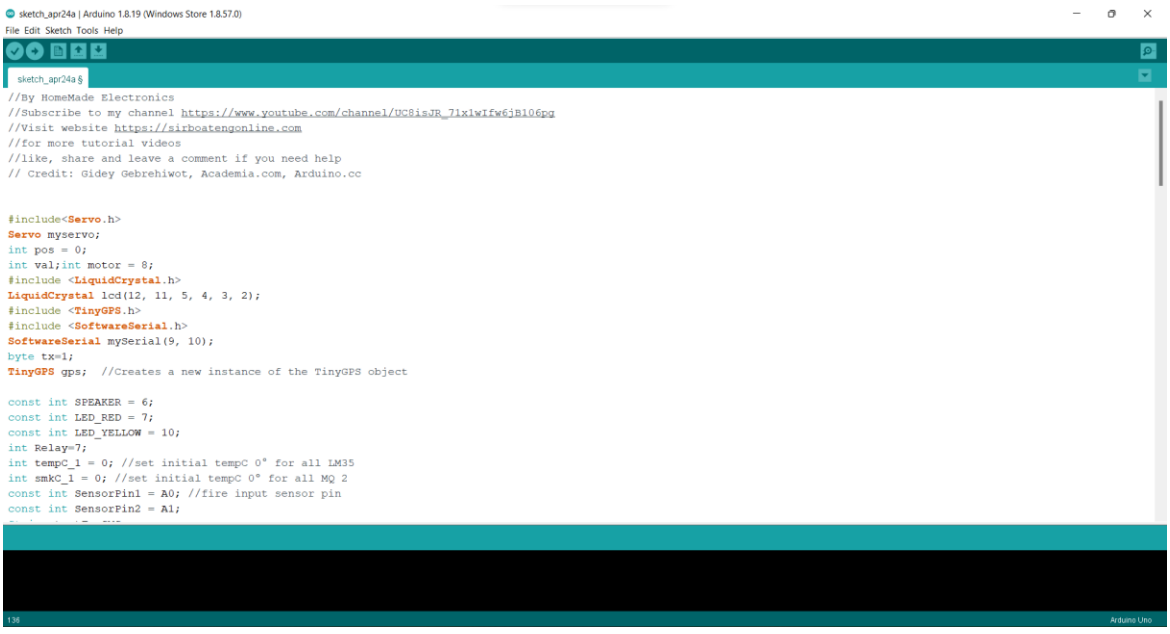

Figure 1: Arduino IDE

The next most important thing is the Arduino IDE (Shown in Figure 2) which is an open-source platform that may be used to make interactive electronics projects. Arduino is basically made up of a

programmable microcontroller and IDE (Integrated Development Environment) software that runs on your computer and is used to write and upload computer code to the microcontroller board. To load new code into the board, the Arduino Uno does not require a hardware circuit (programmer/burner). Using a USB cord and the Arduino IDE (which utilizes a simplified version of C++ to write code), we can quickly load a code into the board.

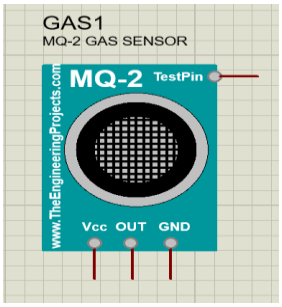

Figure 3: GAS Sensor

Gas sensors are devices that can detect the presence and concentration of various hazardous gases and vapors, such as toxic or explosive gases, volatile organic compounds (VOCs), humidity, and odors.

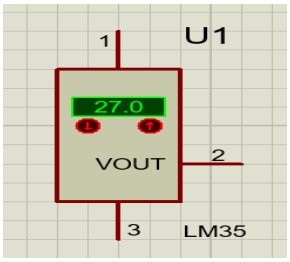

Figure 4: Temperature Sensor

A temperature sensor is a device that detects and measures hotness and coolness and converts it into an electrical signal.

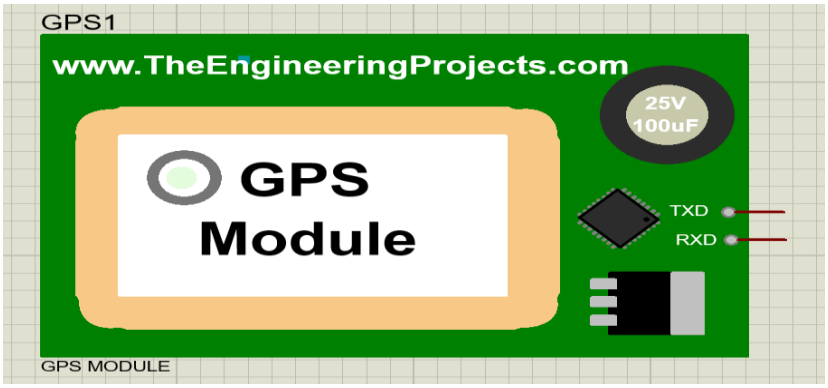

Figure 5: GPS Module

GPS modules contain tiny processors and antennas that directly receive data sent by satellites through dedicated RF frequencies. From there, it'll receive timestamp from each visible satellites, along with other pieces of data.

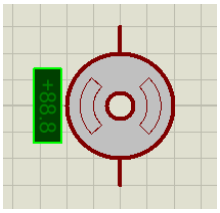

Figure 6: DC Motor

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation.

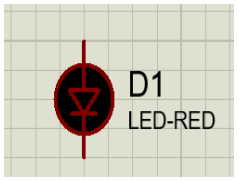

Figure 7: Red LED Light

LEDs are small, powerful lights that are used in many different applications. To start, we will work on blinking an LED, the Hello World of microcontrollers. It is as simple as turning a light on and off.

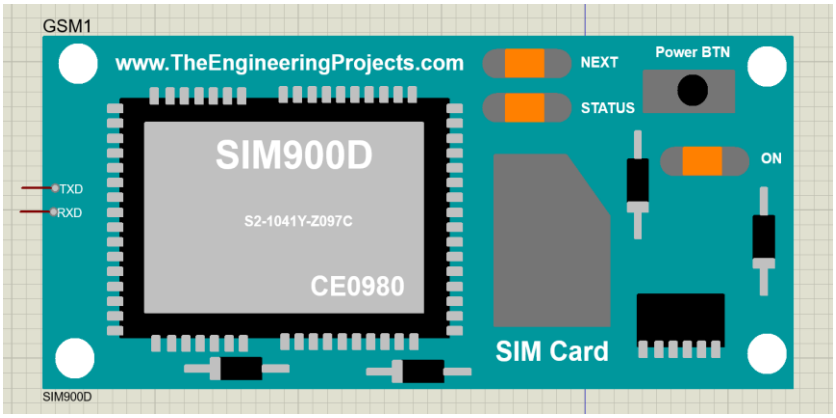

Figure 8: GSM Module

A GSM modem or GSM module is a device that uses GSM mobile telephone technology to provide a wireless data link to a network. GSM modems are used in mobile telephones and other equipment that communicates with mobile telephone networks. They use SIMs to identify their device to the network.

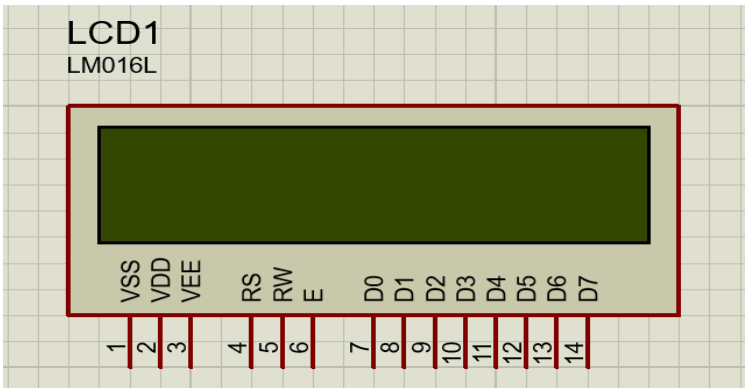

Figure 9: LCD Display

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

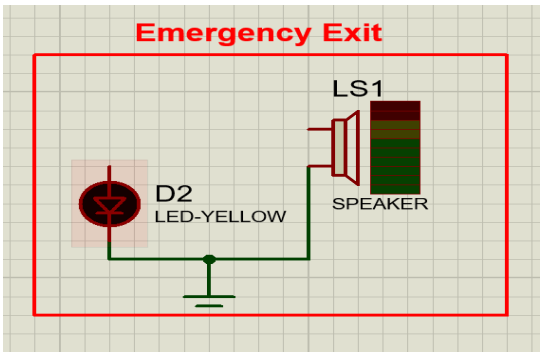

Figure 10: Emergency Exit

This emergency exit consists of one buzzer and one LED light. The buzzer makes sound along with the LED light goes on when there is fire or smoke.

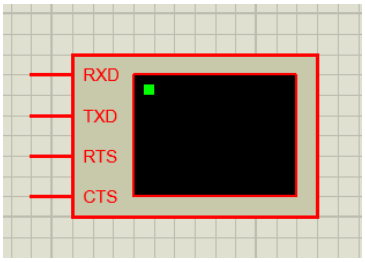

Figure 11: Virtual Terminal

Virtual Terminal is a tool in Proteus, which is used to view data coming from Serial Port (DB9) and also used to send the data to Serial Port.

Apparatus:

- Proteus Software
- Arduino UNO board
- GAS Sensor
- Temperature Sensor
- DC Motor
- GPS Module
- GSM Module
- LED Lights
- LCD Display
- Buzzer
- Ground
- Resistors
- Power Supply
- Connecting wires
- Virtual Terminal

Simulation Setup/Schematic Diagram:

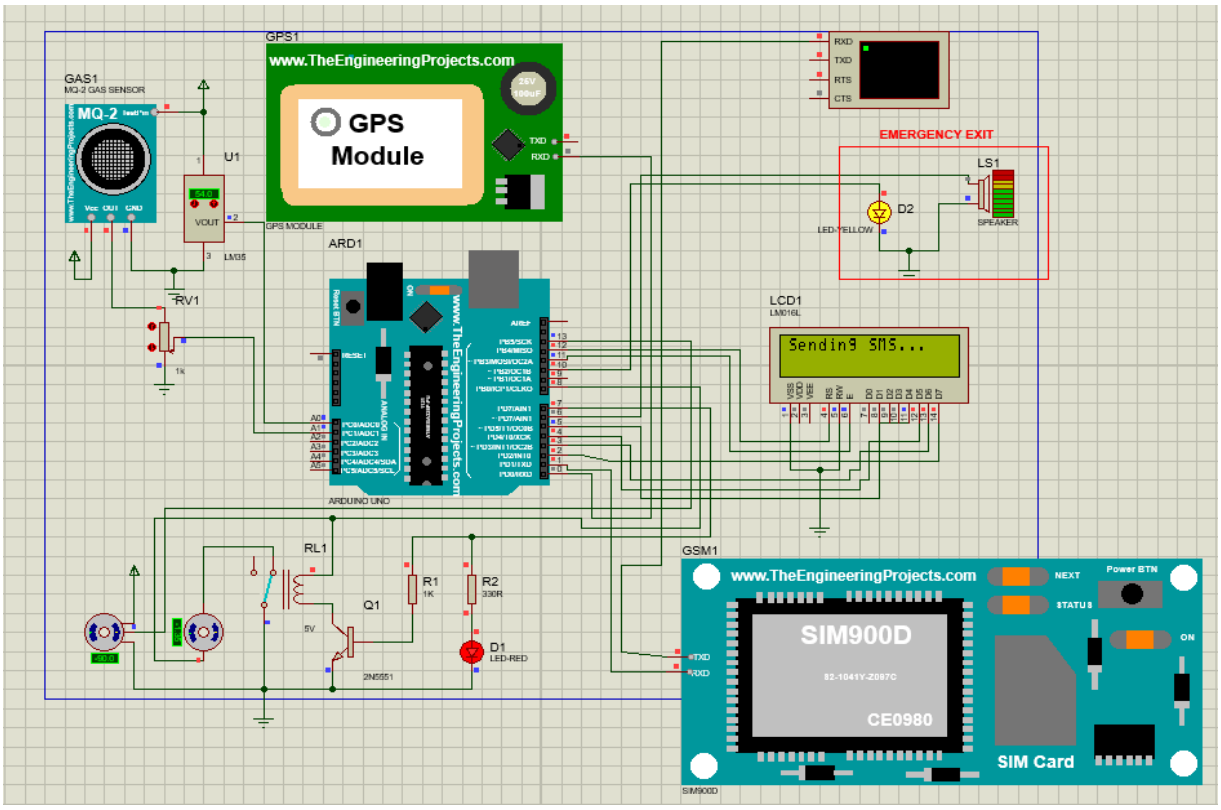

Figure 12: GSM based fire controlling system using Arduino uno board

Code:

```
   //By HomeMade Electronics

   //Subscribe to my channel
https://www.youtube.com/channel/UC8isJR_71x1wIfw6jB106pg

   //Visit website https://sirboatengonline.com

   //for more tutorial videos

   //like, share and leave a comment if you need help

   // Credit: Gidey Gebrehiwot, Academia.com, Arduino.cc
```

```
#include<Servo.h>
Servo myservo;
int pos = 0;
int val;int motor = 8;
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
#include <TinyGPS.h>
#include <SoftwareSerial.h>
SoftwareSerial mySerial(9, 10);
byte tx=1;
TinyGPS gps;  //Creates a new instance of the TinyGPS object

const int SPEAKER = 6;
const int LED_RED = 7;
const int LED_YELLOW = 10;
int Relay=7;
int tempC_1 = 0; //set initial tempC 0° for all LM35
int smkC_1 = 0; //set initial tempC 0º for all MQ 2
const int SensorPin1 = A0; //fire input sensor pin
const int SensorPin2 = A1;
String textForSMS;
void setup()
{
  pinMode(motor, OUTPUT);
  pinMode(tx, OUTPUT);
  pinMode(Relay, OUTPUT);
```

```
    myservo.attach(13);
    pinMode(SPEAKER, OUTPUT);
    lcd.begin(14, 2);
    delay(100);
    pinMode(SensorPin1, INPUT);
    pinMode(SensorPin2, INPUT);
    pinMode(SPEAKER, OUTPUT);

  pinMode(LED_RED, OUTPUT);
  pinMode(LED_YELLOW, OUTPUT); //Set control pins to be outputs
  digitalWrite(LED_RED, LOW);
  digitalWrite(LED_YELLOW, LOW);//set both motors off for start-up
  mySerial.begin(9600);
  Serial.begin(9600); //Start the serial connection with the computer
  }
  void loop()
  {
    int tempC_1 = analogRead(SensorPin1);
    int SmkC_1 = analogRead(SensorPin2);
    tempC_1 = analogRead(SensorPin1); //read the value from the LM35 sensor
    tempC_1 = (5.0 * tempC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
    smkC_1 = analogRead(SensorPin2); //read the value from the MQ 2 sensor
    smkC_1 = (5.0 * smkC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
    delay(50);
```

```
bool newData = false;
unsigned long chars;
unsigned short sentences, failed;
for (unsigned long start = millis(); millis() -start < 1000;)
{
  while (Serial.available())
  {
    char c = Serial.read();
    if (gps.encode(c))
    newData = true;
    }
  }

  if (tempC_1 >= 50 || smkC_1 >= 50)
  {
    digitalWrite(Relay,HIGH);
    val = analogRead(pos);
    val = map(val, 0, 1023, 0, 180);
    myservo.write(val);
    delay(50);
    digitalWrite(motor, HIGH);
    digitalWrite(LED_RED, HIGH);
    digitalWrite(LED_YELLOW, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
```

```
lcd.print("  THERE IS FIRE ");
lcd.setCursor(0, 1);
lcd.print(" NOT SAFE HERE ");
delay(100);
lcd.clear();
lcd.print("Sending SMS...");
delay(100);

tone(SPEAKER, 1047, 500);
delay(200);
tone(SPEAKER, 1109, 300);
delay(200);
tone(SPEAKER, 1175, 100);
delay(5);

float flat, flon;
unsigned long age;
gps.f_get_position(&flat, &flon, &age);
Serial.print("AT+CMGF=1\r");
delay(100);
Serial.print("AT+CMGS=\"+233266302607\"\r");
Serial.print("FIRE ALERT!\r");
delay(100);
Serial.print("AT+CMGS=\"+233266302607\"\r");
Serial.print("FIRE OCCURED!\r");
delay(100);
```

```
Serial.print("AT+CMGS=\"+233266302607\"\r");
Serial.print("FIRE OCCURED! in\r");
delay(200);
Serial.print("Latitude = ");
Serial.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
Serial.print(" Longitude = ");
Serial.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
delay(200);
Serial.println((char)26); // End AT command with a ^Z, ASCII code 26
delay(200);
Serial.println();
}
else
{
  digitalWrite(Relay,LOW);
  delay(50);
  digitalWrite(LED_RED, LOW);
  digitalWrite(LED_YELLOW, LOW);
  digitalWrite(motor, LOW);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("    NO FIRE    ");
  lcd.setCursor(0, 1);
  lcd.print("   ALL SAFE   ");
  }
}
```

Conclusion:

The design and construction of a GSM – based Fire and Smoke detection and prevention system was successfully carried out and tested effectively. The system did not pose extraordinary constraint and the components and materials used conform to engineering standard. A close look at the circuit diagram of the smoke detector reveals that all the components used were all locally sourced and available. Finally, project design was challenging because it gave an exposure into the practical application of theoretical knowledge in solving problems associated with design and construction most especially in developing countries but at the end we managed to finish the project anyways.

References:

[1] International Journal on Engineering Performance-Based Fire Codes, Number l, p.21-23, 2010

[2] Fire safety design guidelines for federal buildings by George V. Hadjisophocleous and Noureddine Benichou

[3] https://www.ijert.org/research/design-of-gsm-based-smoke-detection-and-temperature-monitoring-system-IJERTV2IS4152.pdf

THE END