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Detection of Fire and its Control using Arduino and Proteus

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Abstract

Fire detection systems have been typically developed to detect fire and alert people to vacate that particular location. However, this research involves the design and development of a system for the detection and control of fire. To detect fire, temperature and smoke sensors are used. This proposed work is executed using Arduino and Proteus software. To control the working of sensors at the transmitter part, Arduino Uno is used. DC motor which is used as the controller, rotates upon the detection of over temperature and excess smoke, and then the alert signal is produced. In future, this DC motor can be replaced with a pump which would aid in controlling the fire.

Keywords: Temperature Sensor, Gas Sensor, Arduino, Proteus

1. Introduction

For the detection of fire and its control, fire detection and control systems are very important. For a long period, there was no fire detection system. People had to face many consequences. Now almost in all places like buildings, apartments, colleges, schools, and hotels, such systems are being used. In conventional methods, there are sensors connected together to form circuits [1]. The resistance of the circuit decreases when the environmental condition exceeds the set threshold. In a building, the floor map of that particular building is placed near the entrance where the fire control system is placed [2].

One advantage of this proposed work is that it is cost effective for small applications. Software called Proteus Design Suite was created by Lab Center Electronics for electrical and electronic automation design [3]. "From concept to completion" is the tagline. In order to manufacture printed circuit boards, this software is mostly needed to create electronics prints

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and schematics. Proteus ARES is used to create PCB layouts for electronic circuits [4]. For creating schematics and simulations of various electronic circuits, Proteus ISIS is employed [5].

The gas sensor is an electronic sensor that detects the presence of gases such as alcohol, smoke, carbon monoxide, methane, and hydrogen in the air. A sensor component whose resistance changes when it contacts petrol is known as a chermiresistor [7]. The MQ2 type gas sensor is made with a tin oxide semiconductor as the gas sensing component. The tin oxide absorbs oxygen from the air between 200 and 300 degrees Celsius, which causes the density of electrons on the semiconductor to decrease and resistance to rise [6].

An analogue signal proportional to temperature is produced by the LM35 temperature sensor [8]. It runs between -550C and 1500C. The temperature can be read in Celsius by interpreting the output voltage. It has many advantages over a thermostat because no external calibration is required. This temperature sensor's readings can be transmitted via electrical signals [9]. It has three pins: the 4-20V Vin, the output, and the ground. It takes up about 60 micro amps. In LM35 temperature sensor there is +10milliVolt per degree Centigrade i.e.,

Centigrade Temperature = Voltage read by ADC / 10m V (millis Volt)

Arduino Uno is an open source microcontroller board based on ATmega328P. It has pre-programmed boot loader through which new code can be uploaded without external hardware programmer. Arduino Uno has a flash memory of 32kB, RAM of 2kB and Electrically Erasable Programmable Read Only Memory of 1kB [9]. Arduino Uno has totally 28 pins and a crystal oscillator of 16MHz [10].

Wireless fire alarms are used to lower the cost of traditional wired fire alarm systems. The main benefit is that it is portable, it can be set up anywhere and can be easily changed if the design of the building changes. It may be simply moved to get the greatest protection. The range problems with wireless fire alarms exist. Information transmission to the main control panel is problematic [1]. Using a Wireless Sensor Network (WSN), a wireless fire detection node may measure the temperature, humidity, and smoke concentration. A shortest path routing algorithm based on the CSMA/CA principle is proposed for multi-hop transmission [2].

2. Proposed Work

LM 35 temperature sensor, MQ2 gas sensor and Arduino Uno board are used in this proposed work. According to Figure 1, the temperature sensor and smoke sensor are connected to the Arduino Uno board and the minimum value is set around 570 Celsius. If it exceeds that minimum value and if any kind of smoke is detected, then red LED blinks indicating the presence of fire; it buzzers and the motor connected to it rotates. In the future, this motor can be replaced with a pump. In the Proteus software, temperature sensor and MQ2 gas sensor are connected to Arduino. Whenever the logic toggle connected to MQ2 gas sensor is high, it indicates fire, and if the temperature is greater than 570C, then the red LED blinks and the buzzer turns on indicating the presence of fire.

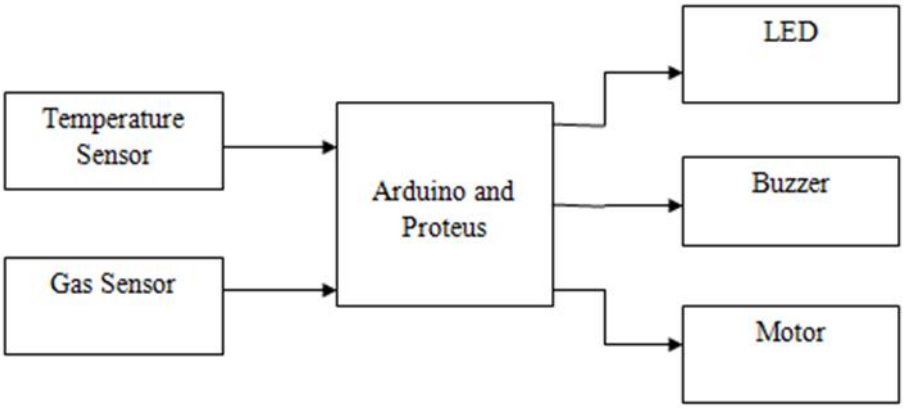

Figure 1. Block Diagram of the proposed system

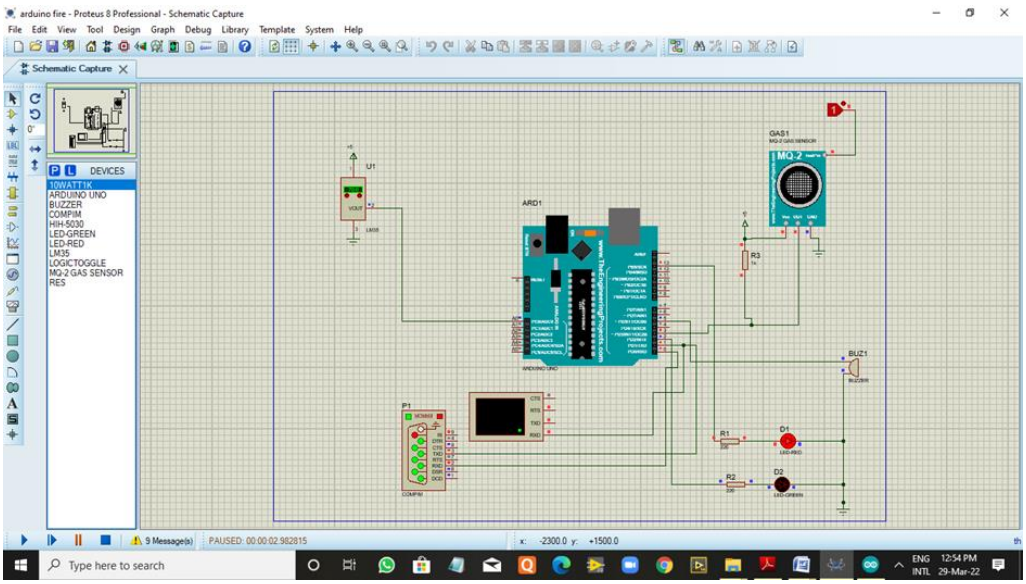

Figure 2. Block Diagram of the proposed system in Proteus

According to figure 2, in the Proteus software, pin A0 of Arduino Uno is connected to Lm 35 temperature sensor, and MQ2 gas sensor is connected to pin number 3. Two LEDs, green and red LED are connected to pin number 2 and pin number 13 respectively. One pin of buzzer is connected to pin number 5 and another pin of buzzer is grounded.

3. Results and Discussion

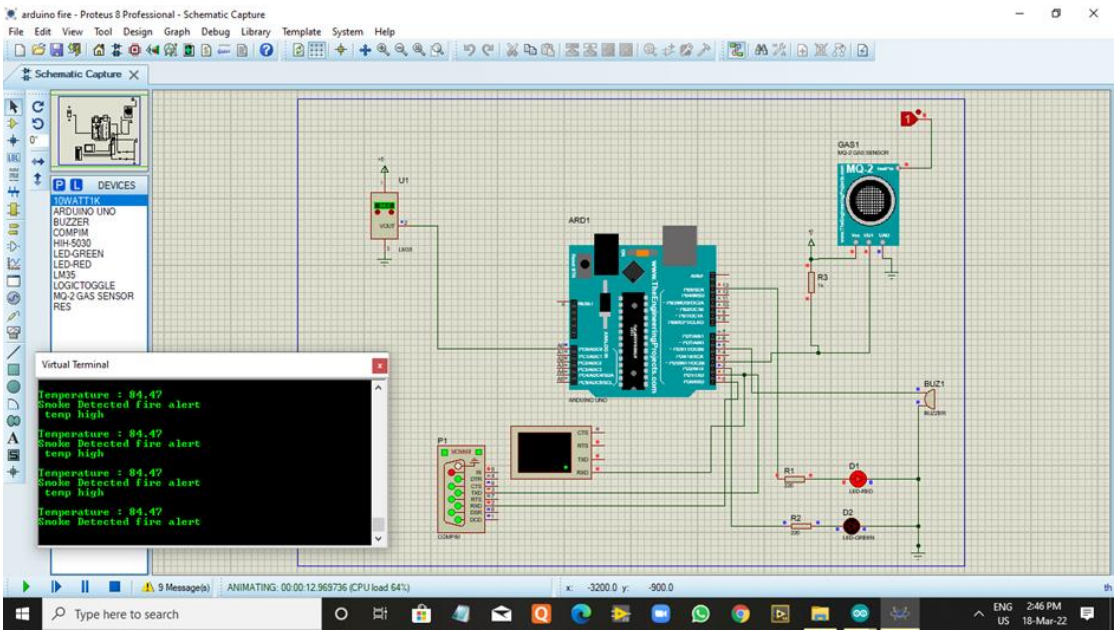

Figure 3. Output shown in Proteus software

According to figure 3, virtual terminal window shows the temperature and smoke content. From the virtual terminal, it is noted that the temperature value is shown as 840C, and if it is high than the required value it indicates temperature high, and if smoke is detected then it produces alert as fire is detected. There is a logic toggle connected to MQ2 gas sensor. If logic toggle is high, then it indicates the smoke content and it is displayed in the virtual terminal. Suppose the logic toggle is low, then there is no smoke content and it is displayed in the virtual terminal.

For LM35 temperature sensor, there is + and – knob. If the knob is increased, then it means the temperature value is increased and it is displayed in virtual terminal with the temperature value. Suppose it is decreased, then the temperature value is also decreased and the decreased temperature value is shown in the virtual terminal. If the temperature value is increased and the logic toggle is high, then there is red LED connected to pin number 13 which turns red indicating the presence of fire, and if the temperature value is normal and the logic

toggle is low, then the green colour LED blinks indicating the absence of fire. When the red LED glows, the motor rotates as the control action

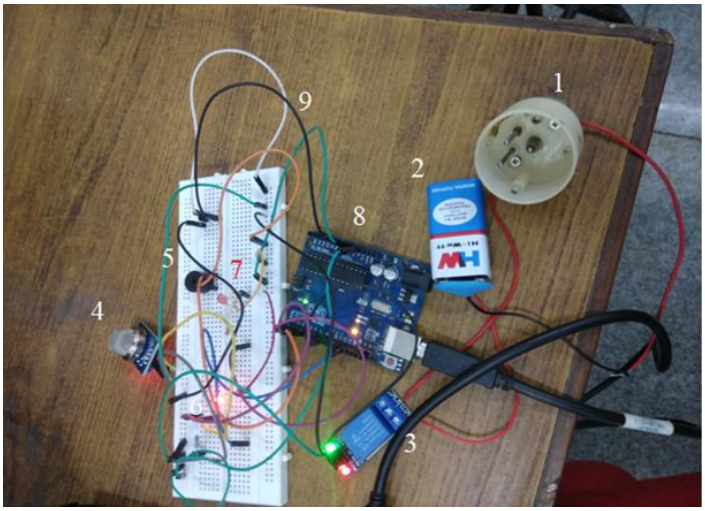

Figure 4. Hardware Setup

Figure 4 indicates the hardware setup of the proposed system, where 1 indicates DC motor, 2 indicates the battery, 3 indicates the relay module, 4 indicates the MQ2 gas sensor, 5 indicates the buzzer, 6 indicates the LM 35 temperature sensor, 7 indicates the LED, 8 indicates the Arduino Uno, and 9 indicates the jumper wire.

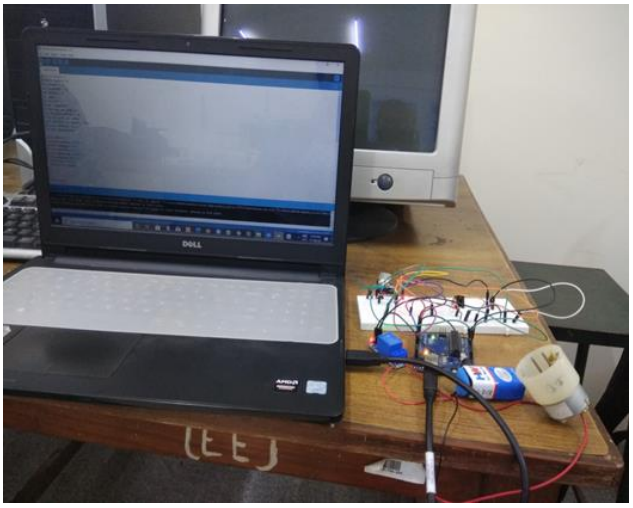

Figure 5. Hardware setup along with Arduino code

Figure 5 shows the hardware setup of the model along with Arduino code written in Arduino IDE software along with Proteus software. Arduino code written in Arduino IDE is shown in Figure 6.

```
#define gaspin 3
#define temppin A0
int redLED = 13;
int greenLED = 2;
int buzzer = 5;
int gas;
float  tempread;
String gas_str,temp_str;
int calibrationTime = 30;
long unsigned int lowIn;
long unsigned int pause = 5000;
boolean lockLow = true;
boolean takeLowTime;

void setup() {
  // put your setup code here, to run once:
pinMode(gaspin,INPUT);
pinMode(temppin,INPUT);
pinMode(redLED,OUTPUT);
pinMode(greenLED,OUTPUT);
pinMode(buzzer,OUTPUT);
Serial.begin(9600);

}


void loop() {
  // put your main code here, to run repeatedly:
 delay(200);
 gas = digitalRead(gaspin);
 tempread = analogRead(temppin);
 float val = (tempread/1024.0)*5000;
 float tempdata=val/10;
 if(gas==HIGH){
   gas_str="Smoke Detected fire alert";
   digitalWrite(redLED,HIGH);
   delay(50);
   digitalWrite(greenLED,LOW);
   delay(50);
   tone(buzzer,1000,500);
   delay(50);
   noTone(buzzer);
 }
 else{
   gas_str="NO smoke";
   digitalWrite(greenLED,HIGH);
   delay(50);
   digitalWrite(redLED,LOW);
   delay(50);
 }


 if(tempdata>=57){
   temp_str=" temp high";
   Serial.println(temp_str);
 }
 Serial.println();
 Serial.println("Temperature : "+String(tempdata));
  Serial.println(gas_str);
 }
```

Figure 6a, 6b, and 6c. Arduino Code

According to figure 6, the Arduino code first defines the gas pin, temperature pin, LED and buzzer, where gas pin and temperature pin are input, and the buzzer and LED are output. If smoke is detected, then it produces an alert saying “Smoke detected fire alert” and red LED is turned on and it buzzers. If there is no smoke, then green LED turns on indicating there is no fire. If the temperature is above 570C, then it displays temperature is high. If the temperature is high and smoke is detected, the motor turns on.

Table 1. Comparison Table

Data	Simulation Results	Experimental Results
Accuracy	Less accurate	More accurate
Delay	Less than 60 seconds	60 seconds
Efficient	Less efficient	More efficient

From Table 1, it can be noted that the experimental results are more accurate compared to the simulation results. The efficiency of experiments conducted in real time is more efficient when compared with simulation results. The delay of experimental results is around 60 seconds.

Table 2. Output Table

Temperature	Smoke	LED	Buzzer	Motor
>57	Detected	Red	On	On
<57	Not Detected	Green	Off	Off
>57	Not Detected	Green	Off	Off
<57	Detected	Green	Off	Off

From Table 2, it is noticed that if temperature is above 570C and smoke is detected, then red LED blinks, the buzzer is turned on and the DC motor rotates. If temperature is below 570C and smoke is not detected, then green LED blinks, the buzzer is off and the DC motor does not rotate. If red LED blinks that means there is fire, and if green LED blinks that means

there is no fire. Buzzer is on only if there is fire. Fire is detected only when the temperature is above 570C and smoke is detected. In case either of them is negative, then it means there is no fire.

4. Conclusion

The fire detection and control system has been designed in this proposed research work. From the experiment, it is noticed that when the temperature value exceeds the minimum value and when smoke is detected, then the LED glows, the buzzer beeps and the DC motor rotates automatically. From the results obtained, it is concluded that fire detection and control system which has been designed experimentally is more accurate and more efficient than the results obtained using Proteus software. In the future, the DC motor can be replaced with DC pump, or sprinkler to put out the fire.

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