1. INTRODUCTION

Fire Alarm Systems are very common in commercial building and factories, these devices usual contain a cluster of sensors that constantly monitors for any flame, gas or fire in the building and triggers an alarm if it detects any of these. One of the simplest way to detect fire is by using an IR Flame sensor, these sensors have an IR photodiode which is sensitive to IR light. Now, in the event of a fire, the fire will not only produce heat but will also emit IR rays, yes every burning flame will emit some level of IR light, this light is not visible to human eyes but our flame sensor can detect it and alert a microcontroller like Arduino that a fire has been detected.

In this article we interface Flame Sensor with Arduino and learn all the steps to build Fire Alarm System by using Arduino and flame sensor. Flame sensor module has a photodiode to detect the light and an op-amp to control the sensitivity. It is used to detect fire and provide a HIGH signal upon the detection. Arduino reads the signal and provides alert by turning on the buzzer and LED. The flame sensor used here is an IR based flame sensor. We have also used the same concept to detect fire in our Fire Fighting Robot, you can also check that our if you are interested.

The design of a flame detection system is an interesting system. This system helps you to detect fire in advance without any loss of life and property. In this project, we use Arduino, flame sensor, buzzer and jumper wires. Flame detectors represent a type of automatic detection method and imitate human sense of sight.Common uses include locomotive and aircraft maintenance facilities, refineries and fuel loading platforms and mines. The flame sensor detects the presence of fire or flame based on the infrared (IR) emitted by the flame. Arduino reads the signal and provides alert by turning on buzzer and LED.

Flame detectors utilize optical technologies to detect flames. Flames are known to emit electromagnetic radiation in the infrared (IR), visible light, and ultraviolet (UV) wavelengths depending on the fuel source. The operation of a metal detector is based on the principle of electromagnetic induction. Metal detectors contain one or more inductor coils. When metal is placed in a close proximity to a varying magnetic field (generated by the coil or coils), currents are induced in the metallic part.FIRE is a small world but causes many disasters every year in many parts of the world. Like forest fires in amazon are very common we couldn't stop them completely but take some preventive measures to control them so today we are going to make a fire alarm that will detect even small fires within an acceptable range of sensors. for that, we are making a flame detector using Arduino.

Fire detectors are designed to detect one or more of the three characteristics of fire-smoke, heat and flame. Besides it every fire detection system must include manual call points (break glass),so that in the event of fire can be of immediate help. During a fire importance of activation of the occupants through alarm or bell is of at most vital and this can performed through alarm system.

2.LITERATURE SURVEY

To detect fire, numerous techniques are available. In forthcoming sections, reviewed some fire detection techniques. A. Fire Detection Using Smoke and Gas Sensors The smoke detector alone based fire detection have high false alarming rate. Alarm having no verified smoke is known as false alarming rate. To overcome this problem fire detection based on smoke detector and gas sensors is developed. The fire detection system consists of smoke detector, CO sensor, CO2 sensor, data processing module, fire alarm algorithm and fire status report module. This fire detection system detect fire by detecting levels of CO, CO2 and smoke by using gas sensors and smoke detector. Generate alarm if rates of increase of these levels exceeds their predefined threshold rate. This system is used in closed areas such as buildings, ship compartments, aircraft cargo compartments. It detect fire like smoldering to combustion.

Smoke concentration is detected by using light scattering method. A photoelectric smoke detector is used here. The light radiated from the LED is passed to the place being detected and received to the photodiode. The obtained light intensity is decreased due to scattering from smoke particles. Generate alarm if the light intensity is below a specified threshold rate. CO and CO2 sensors based on the method of diode laser absorption spectroscopy is utilized for detecting concentrations of CO and CO2. To measure the concentration of gases diode laser absorption spectroscopy is one of the best technique. The wavelength of diode laser is tuned over the absorption line of gases. This causes a reduction of light intensity due to absorption. The light intensity is measured by using photodiode and it then used to detect gas concentration. Wavelength of diode laser is tuned by adjusting its temperature and injection current. Diode laser used here is a distributed feedback (DFB) diode laser. After detecting the levels of CO, CO2 and smoke its output is fed to data processing module.

APPLICATIONS OF FIRE DETECTION SYSTEM:

- High ceiling
- Partially open building
- Production hall-warehouses
- Fully open building
- car parks
- Petro-chemical production
- Warehouses
- Petro-chemical plants
- Paint production,
- Chemical Mixing area
- Chemical Storage Area
- Air Craft Hanger
- High Roof Cargo Ware House
- Automatic Painting Booth

3. HARDWARE AND SOFTWARE REQUIREMENTS

3.1 Hardware Components:

(a) Arduino Uno

Fig 3.1

Microchip ATmega328P microcontroller and developed by Arduino.CC and initially released in 2010. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The board has 14 digital I/O pins six capable of PWM output, 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

(b) Flame sensor

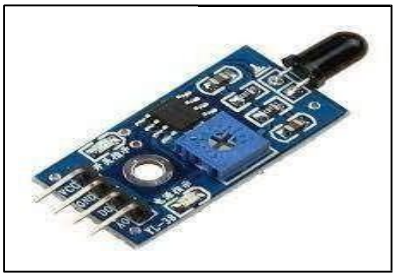


Fig 3.2

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source. This sensor can be easily damaged to high temperature. So this sensor can be placed at a certain distance from the flame. The flame detection can be done from a 100cm distance and the detection angle will be 600. The output of this sensor is an analog signal or digital signal. These sensors are used in fire fighting robots like as a flame alarm.

(c) 5V Relay Module

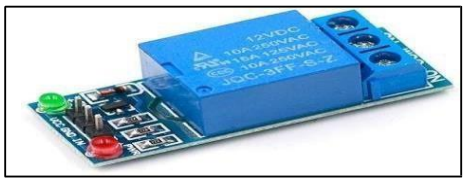


Fig 3.3

The 5V relay module can be used to control a load such as a lighting system, motor, or solenoid. It can also be used to switch AC or DC voltages. The maximum voltage and current that the 5V relay module can control is dependent on the specifications of the relay.The relay is activated by a low-level trigger signal applied to its IN1 or IN2 pin. When the trigger signal is applied, the transistor turns ON and amplifies the signal.This triggers the relay to turn ON and connect the load to either the NO or NC pin. The LED will light up to indicate that the relay is ON.When the trigger signal is removed, the transistor turns OFF and the relay turns OFF. The load is then disconnected from the NO or NC pin. The LED will turn OFF to indicate that the relay is OFF.

(d) 5V DC Pump

Fig 3.4

DC powered pumps use direct current from motor, battery, or solar power to move fluid in a variety of ways. Motorized pumps typically operate on 6, 12, 24, or 32 volts of DC power. Solarpowered DC pumps use photovoltaic (PV) panels with solar cells that produce direct current when exposed to sunlight. This DC 3-6 V Mini Micro Submersible Water Pump is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.

(e) 5V Electromagnetic Buzzer

Fig 3.5

The pin configuration of the buzzer is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the"_"symbol or short terminal and it is connected to the GND terminal.

(f) 5V AC-DC Adapter

Fig 3.6

A 5V output is most commonly used when the end application needs powering via a USB connector, for example a mini/micro B or Type-C plug. Or, if space is at a premium, the DC cable and USB plug can be removed altogether and replaced with a female socket on the case like on phone chargers.

A 5V power supplies (or 5VDC power supplies) are one of the most common power supplies in use today. In general, a 5VDC output is obtained from a 50VAC or 240VAC input using a combination of transformers, diodes and transistors.

(g) 9V DC Battery

Fig 3.7

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 volts. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very common size is known as PP3, introduced for early transistor radios.

(h) Bread Board

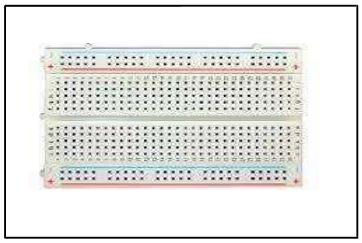


Fig 3.8

A breadboard, solderless breadboard, or protoboard is a construction base used to build semipermanent prototypes of electronic circuits. Unlike a perf board or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable.

A breadboard (sometimes called a plugblock) is used for building temporary circuits. It is useful to designers because it allows components to be removed and replaced easily.

(i) Jumper wires

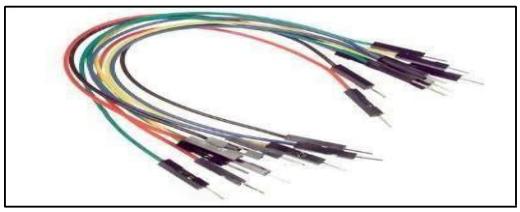
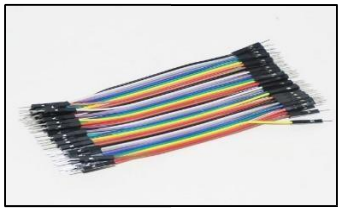


Fig 3.9

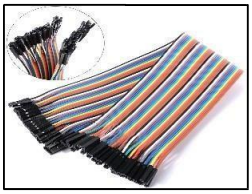
Jumper wires are used for making connections between items on your breadboard and your Arduino's header pins. Use them to wire up all your circuits! Jumper wires are of 3 types:

i. Male-Male Jumper
ii. Male-Female Jumper
iii. Female-Female Jumper



i.

ii.



iii.

3.2 Software Components Arduino IDE Software

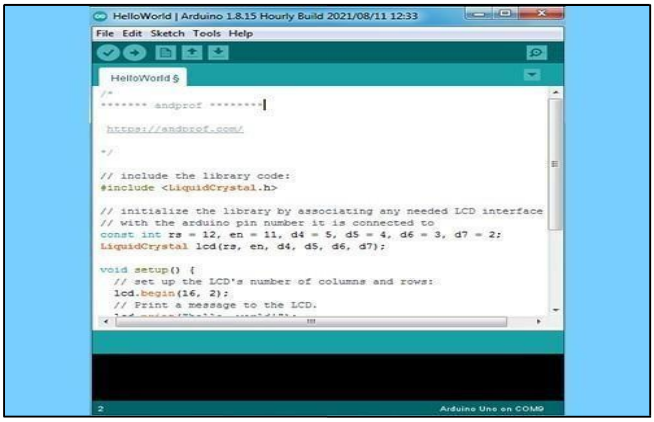


Fig 3.10

The arduino software (IDE) is an open source software, which is used to programme the Arduino boards, and is an integrated development environment, devloped by arduino.cc. Allow to write and upload code to arduino boards. And it consiste of many libraries and a set of examples of mini projects.Arduino software (IDE) is compatible with different operating systems (Windows, Linux, Mac OS X), and supports the programming languages (C/C++).

4. BLOCK DIAGRAM AND CIRCUIT DIAGRAM

BLOCK DIAGRAM:

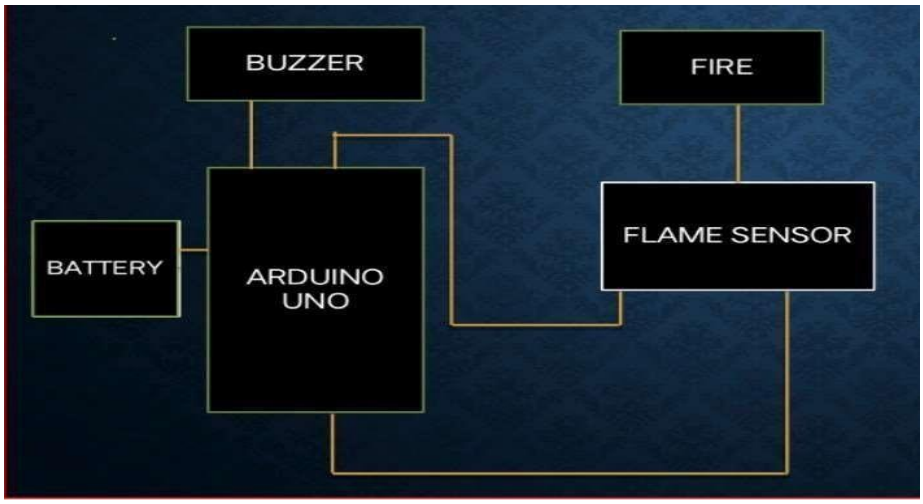


Fig 4.1

CIRCUIT DIAGRAM:

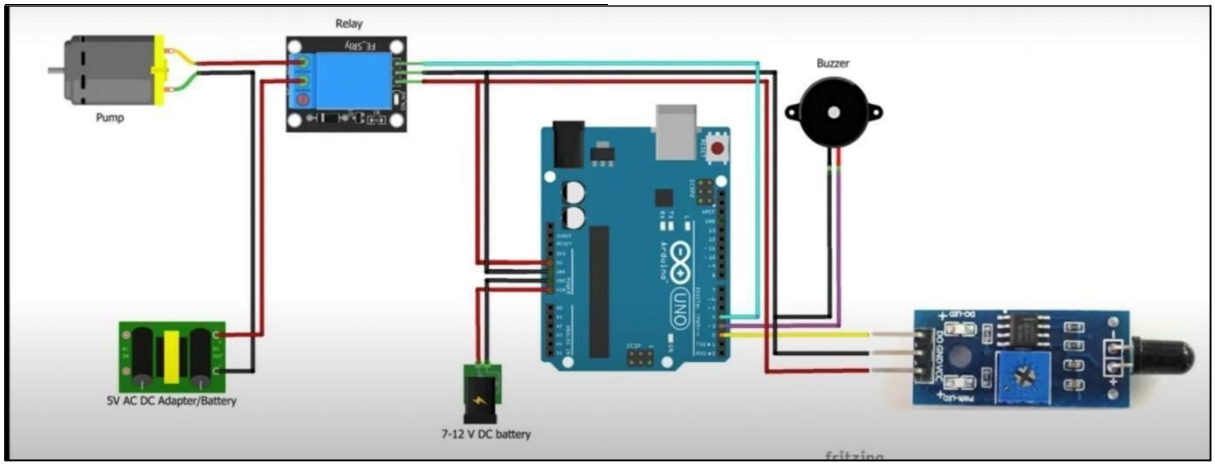


Fig 4.2

The components are connected as shown above the circuit diagram.

- Connect 5V and GND of Arduino uno to GND of Bread board.
- Connect VCC of Flame sensor to +5V of Bread Board.
- Connect GND of Flame sensor to GND of Bread Board.
- Connect D0 of Flame sensor to D2 of Arduino uno.

- Connect '+' of Buzzer to D3 of Arduino uno.
- Connect '-' of Buzzer to GND of GND.
- Connect Input wire of Relay to D4 of Arduino uno.
- Connect 5v and GND of Relay to GND of BreadBoard.
- Connect 'COM' pin of Relay to '+' pin of Connector.
- Connect '+' pin of Battery to 'NO' pin of Relay.
- Connect '-' pin of Battery to '-'pin of Adapter.
- Connect '+'9volts Battery to Vin of Arduino uno.
- Connect '-'9volts Battery to GND of Arduino uno.

The above figure is the circuit diagram of Flame Detection system using Arduino uno, Flame sensor,5V relay,9V battery,AC/DC adapter,Buzzer.

A flame detector is a type of sensor that can detect and respond to the presence of a flame. These detectors have the ability to identify smokeless liquid and smoke that can create open fire. For example, in boiler furnaces flame detectors are widely used, as a flame detector can detect heat, smoke, and fire. These devices can also detect fire according to the air temperature and air movement. The flame detectors use Ultraviolet (UV) or Infra-Red (IR) technology to identify flames meaning they can alert to flames in less than a second. The flame detector would respond to the detection of a flame according to its installation, it could for example sound an alarm, deactivate the fuel line, or even activate a fire suppression system.

5. ARDUINO PROGRAM

The code for the project Flame Detection System using Arduino is given below.

```
#define SENSOR_PIN 2
#define BUZZER_PIN 3
#define RELAY_PIN 4
#define SPRINKLER_START_DELAY 5000  //5 seconds
#define SPRINKLER_ON_TIME 3000      //3 seconds Sprinkler on time

unsigned long previousTime = millis();

void setup()
{
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(SENSOR_PIN, INPUT);
}

void loop()
{
  //If there is fire then the sensor value will be LOW else the value will be HIGH
  int sensorValue = digitalRead(SENSOR_PIN);

  //There is fire
  if (sensorValue == LOW)
  {
    analogWrite(BUZZER_PIN, 50);                    //Turn on buzzer

    if (millis() - previousTime > SPRINKLER_START_DELAY)
//We will wait for few seconds before sprinkler can be started once fire is detected.
    {
```

```
      digitalWrite(RELAY_PIN, LOW);
//Relay is low level triggered relay so we need to write LOW to switch on the
light
      delay(SPRINKLER_ON_TIME);
//Keep sprinkler on for sometime.
    }
  }
  else
  {
    analogWrite(BUZZER_PIN, 0);
    digitalWrite(RELAY_PIN, HIGH);
    previousTime = millis();
  }
}
```

6. SNAPSHOT OF THE PROJECT

Most fire detection technology focuses on detecting heat, smoke (particle matter) or flame (light) the three major characteristics of fire. All of these characteristics also have benign sources other than fire, such as heat from steam pipes, particle matter from aerosols, and light from the sun. Other factors further confound the process of fire detection by masking the characteristic of interest, such as air temperature, and air movement.

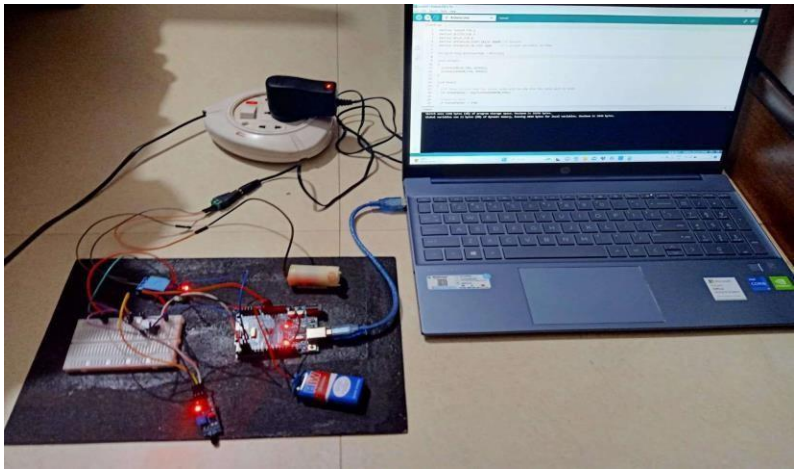


Fig 6.1

In addition, smoke and heat from fires can dissipate too rapidly or accumulate too slowly for effective detection. In contrast, because flame detectors are optical devices, they can respond to flames in less than a second. This optical quality also limits the flame detector as not all fires have a flame. As with any type of detection method its use must match the environment and the risk within the environment.

Applications for flame detectors are;

- High ceiling
- Partially open building
- Production hall-warehouses
- Fully open building
- car parks
- Petro-chemical production

Examples of actual installations are;

Gasoline transport loading terminals
Pipeline pumping stations
Refineries
Aircraft hangers
Automotive paint spray booths

7. CONCLUSION

In this work, an attempt has been done to design a Fire Detection system using Flame sensor and Micro controller for efficient use of electricity. This project will help to reduce huge hazards and also save human lives easily. It will also help to reduce the wastage of electricity, save lives, reduce percentage of accident and reduce waste of electric appliance. The results obtained from the measurement have shown that the system perform well under all the conditions. The main objective of this project has been to design a circuit that detects Fire and consequently triggers an alarm, starts sprinkle the water to extinguish the fire. These objectives were met since the systems works effectively.

REFERRENCES

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