VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI-590018 KARNATAKA

A PROJECT REPORT

ON

"AUTOMATIC FIRE EXTINGUISHER SYSTEM"

Submitted By

BASAVARAJESHWARI	2LG22CS006
REKHA	2LG22CS028
SHRIDEVI	2LG22CS044
SHRIDEVI AJJODI	2LG23CS409

Under the Guidance of

Prof. RAJESHWARI GUDLANUR M.Tech

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

GOVERNMENT ENGINEERING COLLEGE TALKAL,

KOPPAL-583238

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GOVERNMENT OF KARNATAKA
GOVERNMENT ENGINEERING COLLEGE,
TALAKAL, KOPPAL-583238

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Certificate

This is to Certified that the project work entitled **"AUTOMATIC FIRE EXTINGUISHER SYSTEM"** carried out by **BASAVARAJESHWARI USN: 2LG22CS006** a bonafied students of B.E 7th Semester in partial fulfilment for the award of Bachelor Degree in Computer Science and Engineering as prescribed by the Visvesvaraya Technological University, Belagavi during the year 2025-26. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

Signature of Guide
Prof. RAJESHWARI GUDLANUR

Signature of Guide
Prof. VEERESH

Signature of Principle
Dr. VIRUPAXI BAGODI

Name of the Examiners

1………………………

2………………………

Signature with the Date

1………………………

2………………………

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Cordially,

NAME	USN
BASAVARAJESHWARI	2LG22CS006

ABSTRACT

Fire hazards pose a serious threat to life and property, making early detection and immediate action essential. This project presents an Automatic Fire Extinguisher System using Arduino UNO that operates without human intervention. A flame sensor is used to continuously monitor the environment and detect the presence of fire. When fire is detected, the sensor sends a signal to the Arduino controller, which processes the data and activates a relay module. The relay switches ON a water pump to spray water for extinguishing the fire. At the same time, a servo motor is controlled by the Arduino to rotate and direct the water flow accurately toward the fire source. The complete system is assembled on a breadboard and powered using a battery supply, ensuring reliable operation even during power failure. This system provides a low-cost, efficient, and reliable solution for automatic fire detection and suppression. It minimizes human risk, reduces fire spread, and can be effectively used in homes, offices, laboratories, and small industrial applications to enhance safety.

LIST OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Fire accidents can cause severe damage to life, property, and the environment if not detected and controlled at the right time. Traditional fire safety systems often depend on human intervention, which can lead to delays in responding to emergencies. To overcome these limitations, modern safety systems are increasingly adopting automation and smart technologies. An Automatic Fire Extinguisher using IoT is an intelligent safety system designed to detect fire at an early stage and take immediate action to control it. The system uses sensors such as flame sensors, smoke sensors to continuously monitor the environment. When a fire is detected, the system automatically activates an extinguisher mechanism ensuring timely awareness even when no one is physically present. This project improves safety, reduces response time, and minimizes fire-related damages. By integrating automation with IoT, the system becomes more reliable, efficient, and suitable for homes, offices, industries, and remote areas.

1.1 Problem statement

- Fire accidents often remain undetected in their early stages, especially when no one is present, leading to delays in response and causing major property damage and risk to human life.
- Existing fire extinguishing methods are mostly manual and lack affordable automated systems that can instantly detect fire and activates the extinguisher mechanism ensures quick action.

1.2 Objectives

- To automatically detect the presence of fire using sensors such as flame or temperature sensors. The system continuously monitors the environment for any signs of fire. It ensures early detection without requiring human supervision.
- To activate the fire-extinguishing mechanism immediately after detecting fire. The system controls the fire by switching on the pump or spray system automatically. It provides a simple, reliable, and low-cost solution for small and as well as larger area fire safety.

CHAPTER 2

LITERATURE SURVEY

R. Kumar and S. Patel [2018], Developed an IoT-based automatic fire detection and extinguishing system using temperature and flame sensors. The system continuously monitors environmental conditions and communicates fire alerts using the MQTT protocol. When a fire is detected, a relay is automatically triggered to turn on a water pump, allowing immediate fire suppression without human intervention. This approach improves response time and reduces fire damage in enclosed spaces.

A. Gomez et al. [2019], Designed a smart fire extinguisher using smoke, carbon monoxide (CO), and flame sensors. To reduce false alarms caused by environmental disturbances such as dust or steam, sensor fusion techniques were implemented. Additionally, the system used GSM technology to send SMS alerts to remote users, enabling faster emergency response and remote monitoring.

H. Li and M. Zhang [2020], Proposed a CO_2-based automatic fire suppression system controlled by an Arduino Mega. The system safely releases CO_2 gas when fire conditions are detected, making it suitable for electrical rooms and data centers where water-based extinguishing is unsafe. All fire event data and sensor readings are transmitted to the cloud for storage and analysis, supporting future system improvements.

S. Ahmed and P. Rao [2021], Introduced a camera-based fire detection system using a Raspberry Pi and a lightweight Convolutional Neural Network (CNN). The use of machine learning enabled visual fire detection, which significantly reduced false activations compared to traditional sensor-only systems. This method also provided faster and more reliable detection in open or large areas.

Y. Singh and M. Banerjee [2024], Designed an advanced IoT-based fire extinguisher system for public spaces. Their system used multi-level confirmation involving environmental sensors, a live camera feed, and optional human verification through a mobile application. This approach significantly reduced accidental activations while maintaining rapid fire response and improved overall system reliability.

CHAPTER 3

SYSTEM MODEL

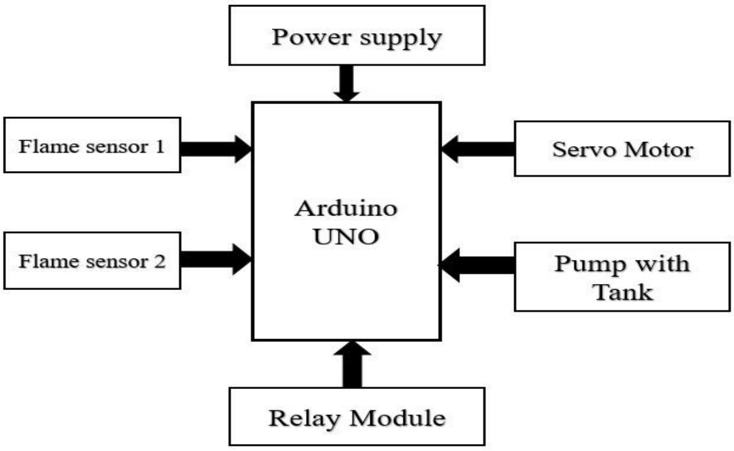

Fig 3.1 Flowchart

The automatic fire extinguisher system is designed to detect fire and extinguish it automatically using IoT technology. The system employs an Arduino UNO microcontroller as the central controller, which is connected to two flame sensors that continuously monitor the surrounding area for any presence of fire. When the sensors detect a flame, they send a signal to the Arduino UNO, which activates a relay module. This relay then switches on a pump connected to a tank containing the fire extinguishing agent. At the same time, a servo motor is controlled by the Arduino to rotate and direct the nozzle of the extinguisher towards the source of the fire. The pump sprays the extinguishing agent in the direction of the fire to control and put it out effectively. A power supply ensures all components function continuously and reliably. This automation reduces the need for manual intervention, allowing for quick and effective response to fire incidents. The system model, illustrated in the flowchart, clearly shows the interconnection among the power supply, Arduino UNO, flame sensors, relay module, servo motor, and pump with tank, demonstrating an integrated approach to fire detection and extinguishing.

CHAPTER 4

REQUIREMENT SPECIFICATIONS

4.1 SOFTWARE REQUIREMENTS

Software	:	Arduino Cloud
Programming language	:	Embedded Programming Language

4.1.1 Arduino cloud

Arduino Cloud is a versatile platform designed to simplify the process of creating and managing IoT (Internet of Things) projects. It enables users to connect, monitor, and control their Arduino devices from anywhere using a web-based dashboard or mobile app. With features like real-time data visualization, automated triggers, and seamless integration with other services such as Alexa, Arduino Cloud provides an intuitive environment for both beginners and advanced users. The platform supports various Arduino and third-party devices, and its code editor streamlines programming with pre-built libraries and templates.

4.1.2 Embedded programming language

An embedded programming language is a specialized type of programming language used to develop software for embedded systems. Embedded systems are computer systems integrated into hardware devices, designed to perform dedicated functions within a larger system. Languages like C and C++ are widely used for embedded programming due to their efficiency, low-level hardware access, and deterministic behavior. Other languages like Assembly are used for highly resource-constrained applications, while Python and Java are becoming more common in high-level embedded applications.

Embedded programming often involves direct interaction with hardware components, such as microcontrollers and sensors, and requires knowledge of real-time operating systems, memory management, and low-level debugging. The goal is to create software that is compact, efficient, and reliable for specific hardware tasks.

4.2 HARDWARE REQUIREMENTS

In an IoT-based automatic fire extinguisher system, hardware components play a crucial role because they form the physical foundation that allows the system to sense, process, and act in real time. Hardware enables the detection of environmental changes such as heat or flames, ensuring that the system can identify fire accurately and quickly. The hardware acts as the interface between the real world and the digital system by collecting data through sensors and executing commands from the controller. It ensures reliable operation by handling electrical power, providing stable communication, and supporting automation. Without proper hardware, the IoT system would not be able to measure conditions, respond to emergencies, or connect to the network for remote monitoring.

4.2.1 Arduino UNO

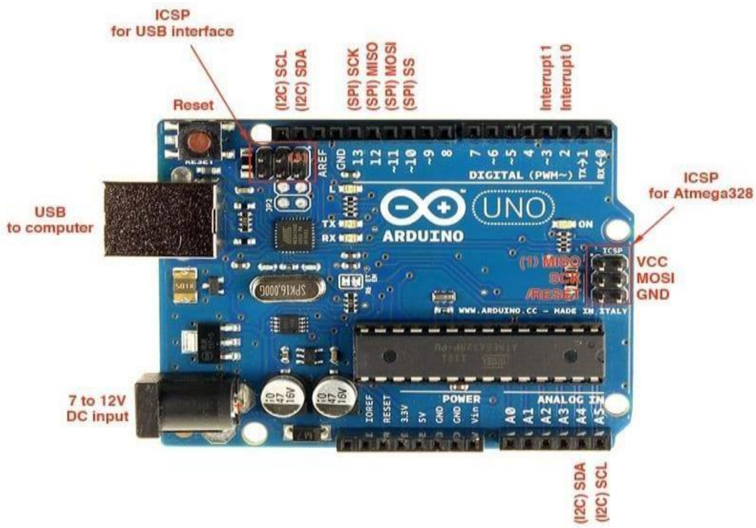

Fig 4.1 Arduino UNO

The above fig 4.2.1 is a Arduino UNO. It is a micro controller based on the AT mega 328. It has 14 digital input and output pins (of which 6 can provide PWM output), 6 analog inputs, USB connector, a power jack reset bottom. The operating voltage is 5 volts. Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, and can control relays, LCD, and motors as an output**.**

4.2.2 Flame Sensor

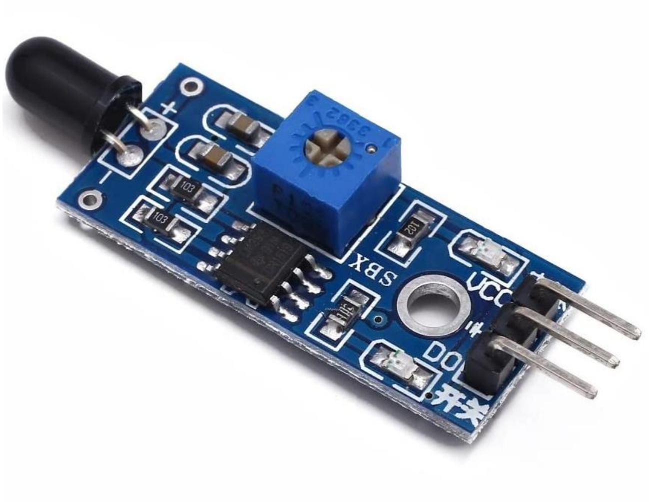

Fig 4.2 Flame Sensor

A flame sensor is an electronic device used to detect the presence of fire by sensing the infrared (IR) radiation emitted from flames. It is specially designed to respond to the specific wavelength of light produced during combustion, making it reliable in identifying real flame sources. The sensor can detect fire quickly within a short to medium range, depending on its sensitivity. It is commonly used in safety systems such as fire alarms, fire detection units, and automatic fire extinguisher projects. Flame sensors usually provide two types of outputs: a digital output that indicates whether fire is detected and an analog output that shows the intensity of the flame. These outputs make it easy to interface the sensor with microcontrollers like Arduino.

The module typically operates on 3.3V or 5V and has three pins—VCC, GND, and OUT. Because of its quick response time, it helps activate alarms, relays, pumps, or motors immediately when fire is detected. The sensor works normally under indoor lighting conditions and is not affected by regular bulbs or tube lights. However, direct sunlight or strong infrared sources may cause false readings. Proper calibration using the onboard sensitivity potentiometer improves accuracy. Flame sensors are compact, low-cost, and easy to integrate into IoT-based fire safety systems. They play a crucial role in preventing fire accidents by enabling early detection and fast action.

4.2.3 Relay Module

Fig 4.3 Relay Module

A relay module is an electrically operated switch used to control high-voltage or high-current devices using a low-power signal from a microcontroller. It acts as an interface between low-power circuits and heavy electrical loads. The relay contains an electromagnet that activates when a small current flows through its input coil. When the coil is energized, it creates a magnetic field that pulls an internal switch, closing or opening the circuit connected to the output terminals. This allows a small control signal to safely operate devices like motors, pumps, or alarms. The relay module usually includes components like a transistor, diode, and optocoupler to protect the microcontroller from voltage spikes. When the controller sends a HIGH or LOW signal, the relay either turns ON or OFF the connected device. The clicking sound heard during switching is the movement of the internal metal contacts.

A normally open (NO) terminal keeps the device off until activated, while a normally closed (NC) terminal keeps it on until switched. The relay also isolates the high-voltage side from the low-voltage control side for safety. LED indicators on the module help show when the relay is active. This makes the relay highly reliable for automation projects. In IoT-based fire extinguisher systems, it is used to turn on pumps or alarms. Overall, the relay module enables safe control of powerful electrical loads using simple digital signals.

4.2.4 Water Pump

Fig 4.4 Battery

A water pump is a device used to move water from one place to another by creating pressure and flow. It works by using an electric motor that rotates an internal mechanism such as an impeller or diaphragm. When the motor starts, the impeller spins rapidly and pushes water outward, creating a low-pressure area at the inlet. This low pressure pulls water into the pump through the suction pipe. As the impeller continues to rotate, it forces the water toward the outlet with high pressure. This creates a continuous flow of water through the system. The pump operates using electrical power, which drives the motor. Inside the pump housing, seals and valves ensure that water flows only in one direction. The speed of the motor affects how much water is pumped per minute. A pump must always be primed or filled with water to work properly, otherwise it may run dry and get damaged. The pump is designed to handle different pressures depending on its size and type.

In small projects, mini DC pumps are used to supply water for simple spraying or cooling systems. The pump's performance also depends on the voltage supplied to it. When connected to a relay or controller, the pump can be turned ON or OFF automatically. In an automatic fire extinguisher system, the pump helps spray water immediately when fire is detected. Overall, a water pump works by converting electrical energy into mechanical force to move water efficiently.

4.2.5 Servo Motor

Fig 4.5 Servo Motor

The servo motor is an important component used to control the movement of the extinguisher mechanism. A servo motor is a type of motor that provides precise control over angular position. In this system, it is mainly used to rotate the nozzle or control the valve that releases water to extinguish the fire. When a fire occurs, the flame sensor detects the presence of flame and sends a signal to the Arduino microcontroller. The Arduino processes this input and decides the required action. Based on the signal received, the Arduino sends Pulse Width Modulation (PWM) signals to the servo motor. These signals control the angle at which the servo motor rotates, usually between 0° and 180°.

The servo motor then rotates to a specific position to accurately aim the water spray towards the fire source. This precise movement helps in directing the extinguishing agent exactly where it is needed, reducing water wastage and increasing the efficiency of the fire extinguishing process. Once the fire is put out, the servo motor returns to its original position, ready for the next operation.

Thus, the servo motor enhances the automation and accuracy of the Arduino-based fire extinguisher system. By enabling controlled and targeted movement, it reduces the need for human intervention and improves safety, making the system reliable and effective in handling fire accidents.

4.2.6 Battery

Fig 4.6 Battery

A battery is a device that stores chemical energy and converts it into electrical energy. It is made of two electrodes: a positive terminal (cathode) and a negative terminal (anode). Between them is an electrolyte that allows ions to move. When a battery is connected to a device, a chemical reaction starts inside it. This reaction causes electrons to flow from the negative terminal to the positive terminal through the external circuit. The flow of electrons is what we call electric current. Inside the battery, ions move through the electrolyte to balance the charge. As long as the chemical reaction continues, the battery can supply power. The voltage of a battery depends on the materials used in its electrodes. Small batteries provide low voltage, while larger ones can deliver higher power. A battery gets weaker when its chemical energy runs out. Rechargeable batteries can restore this energy by reversing the chemical reaction using a charger.

Batteries must be used with the correct voltage to avoid damaging electronic devices. They come in different sizes such as AA, 9V, and lithium cells. In small electronics or IoT systems, batteries provide portable and reliable power. They help run sensors, motors, and controllers when no external power is available. Overall, a battery works by using chemical reactions to create a steady and controlled flow of electricity.

CHAPTER 5

SYSTEM DESIGN

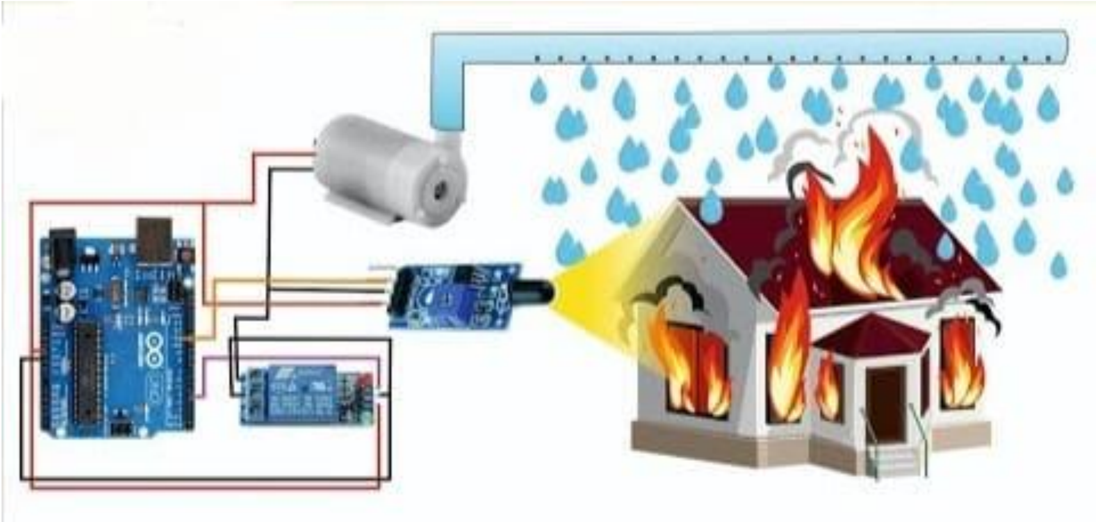

Fig 5.1 System Design

The above system design shows automatic fire extinguisher system operates by continuously monitoring the environment for the presence of fire using a flame sensor. When the system is powered on, the Arduino UNO initializes all the connected components and keeps reading the output from the flame sensor. Under normal conditions, when no fire is present, the flame sensor sends a normal signal to the Arduino, and the relay connected to the water pump remains in the OFF state.

When a fire occurs, the flame sensor detects the infrared radiation emitted by the flames and sends an alert signal to the Arduino. The Arduino immediately processes this signal and activates the relay module. The relay works as an electronic switch, allowing power to flow to the DC water pump. Once the relay is activated, the water pump turns ON and starts spraying water on the fire-affected area.

The flame sensor continues to monitor the presence of fire even during the extinguishing process. As soon as the fire is reduced or fully extinguished, the flame sensor output returns to its normal state. The Arduino detects this change and deactivates the relay module, which in turn switches OFF the water pump. The system then returns to its standby monitoring state, ready to detect any new fire incidents automatically. This ensures a continuous, automatic, and efficient fire-extinguishing operation without the need for human intervention.

CHAPTER 6

SYSTEM IMPLEMENTATION

6.1 PROGRAM MODULES AND FUNCTIONALITY

- **analogRead()**

  The analogRead() function reads analog values from the flame sensors in the range of 0 to 1023. Lower values indicate the presence of fire, which helps Arduino detect flames.

- **pinMode()**

  The pinMode() function configures Arduino pins as INPUT or OUTPUT. Flame sensor pins are set as INPUT, and the relay pin is set as OUTPUT for pump control.

- **Servo.attach()**

  The Servo.attach() function connects the servo motor to a PWM pin of the Arduino, allowing it to be controlled by the program.

- **Servo.write()**

  The Servo.write() function rotates the servo motor to a specified angle. It is used to move the nozzle towards left, center, or right positions.

- **delay()**

  The delay() function pauses the program execution for a fixed time. It is used to keep the pump ON for a required duration.

- **Serial.begin()**

  The Serial.begin() function starts serial communication between Arduino and the computer for monitoring and debugging.

- **Serial.print() and Serial.println()**

  These functions display sensor readings and system status on the Serial Monitor, helping in testing and troubleshooting.

6.2 PROGRAM

```
#include <Servo.h>

#define FLAME_LEFT A0
#define FLAME_RIGHT A1
#define RELAY_PIN 7
#define SERVO_PIN 9

#define THRESHOLD    300
#define PUMP_TIME    3000
Servo servo;
void setup() {
  Serial.begin(9600);

  pinMode(FLAME_LEFT, INPUT);
  pinMode(FLAME_RIGHT, INPUT);
  pinMode(RELAY_PIN, OUTPUT);

  servo.attach(SERVO_PIN);
  servo.write(90);                  // center position
  digitalWrite(RELAY_PIN, HIGH);   // pump OFF (active-low)
}
void loop() {
  int left  = analogRead(FLAME_LEFT);
  int right = analogRead(FLAME_RIGHT);

  bool fireLeft  = left  < THRESHOLD;
  bool fireRight = right < THRESHOLD;

  Serial.print("L:"); Serial.print(left);
```

```
  Serial.print(" R:"); Serial.println(right);

  if (fireLeft && !fireRight) {
    extinguish(0);       // left
  }
  else if (fireRight && !fireLeft) {
    extinguish(180);     // right
  }
  else if (fireLeft && fireRight) {
    extinguish(0);       // sweep left
    delay(1000);
    extinguish(180);     // sweep right
  }
  else {
    servo.write(90);
    digitalWrite(RELAY_PIN, HIGH);
  }

  delay(200);
}
void extinguish(int angle) {
  servo.write(angle);
  digitalWrite(RELAY_PIN, LOW);    // pump ON
  delay(PUMP_TIME);
  digitalWrite(RELAY_PIN, HIGH);   // pump OFF
}
```

CHAPTER 7

RESULT

7.1 OVERWIEW

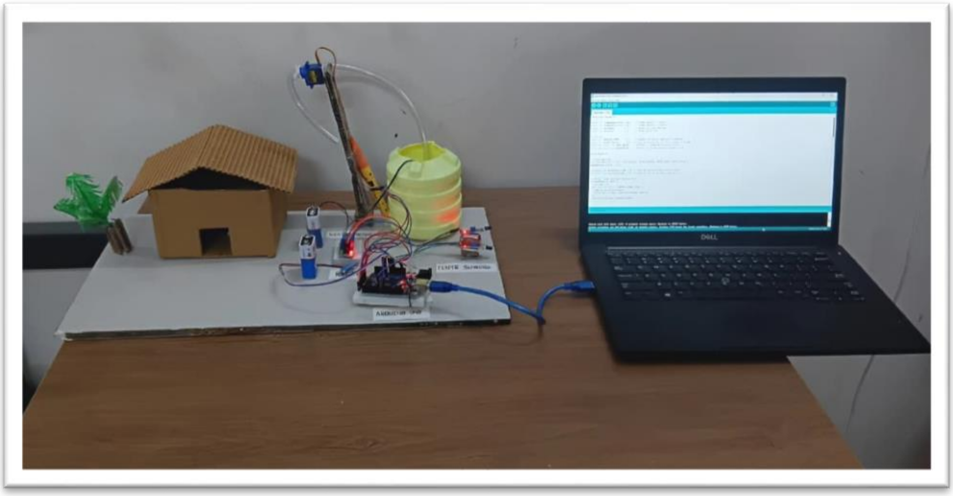

Fig 7.1 Overview of Proposed System

The Automatic Fire Extinguisher System was successfully implemented and tested using Arduino UNO, flame sensor, relay module, water pump, servo motor, jumper wires, breadboard, and battery. During testing, the flame sensor accurately detected the presence of fire within its sensing range and immediately sent signals to the Arduino controller. On receiving the signal, the Arduino activated the relay module, which switched ON the water pump, while the servo motor rotated to direct the water precisely toward the fire source.

The system responded quickly and extinguished small flames effectively without any human intervention. Battery operation ensured continuous functioning even during power failure, demonstrating reliable performance. The project successfully showed that the combination of sensors, microcontroller, and actuator mechanisms can provide an efficient, low-cost, and automated solution for fire detection and suppression in small-scale applications such as homes, laboratories, and offices.

7.2 SCOPE OF THE FURTHER WORK

- **Iot Integration**

IoT integration enhances the fire extinguisher system by enabling internet connectivity. It allows real-time fire alerts to be sent to mobile phones or monitoring dashboards. This helps users to get instant notifications during fire accidents. Remote monitoring of the system becomes possible from any location. It improves response time and reduces damage. Overall, IoT makes the system smarter and more reliable.

- **Additional Sensors**

The system can be improved by adding additional sensors such as smoke and temperature sensors. These sensors help in detecting fire at an early stage. Multiple sensor inputs increase detection accuracy. They also reduce the chances of false alarms. Early detection helps in faster activation of the extinguisher. This improves overall safety and efficiency.

- **Camera Integration**

Camera integration helps in identifying the exact location of the fire. It provides visual confirmation of the fire incident. This helps in targeting the fire more accurately. The camera data can be useful for monitoring and analysis. It also assists emergency responders in understanding the situation. This feature improves the effectiveness of fire control.

- **System Scalability**

The system can be scaled for use in large buildings and industrial areas. Multiple fire extinguisher units can be connected together. Centralized control of all units becomes possible. It helps in monitoring large areas efficiently. The system can be expanded without major changes. This makes it suitable for real-time large-scale applications.

CONCLUSION

The automatic fire extinguisher system is an efficient and reliable solution for detecting and controlling fire at an early stage without human involvement. By continuously monitoring the environment, the system quickly responds when fire or excessive heat is detected and activates the extinguishing mechanism automatically. This rapid response helps in reducing damage to property and minimizing the risk to human life. The project demonstrates the successful integration of sensors, control units, and actuators to achieve effective fire suppression. It is suitable for use in homes, offices, industries, and electrical panel areas where quick action is critical. The system is cost-effective, easy to install, and requires minimal maintenance. Overall, the automatic fire extinguisher enhances safety and proves to be a practical and essential solution for modern fire protection system

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