

AUTOMATIC FIRE EXTINGUISHER SYSTEM

Aayisha Begam¹, M. Manojkumar², J. Harris³, K. Hemanathan⁴, M. Harikrishnan⁵

¹Professor, Department of Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India. Email: aayishabegam@gmail.com (Corresponding Author)

²Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India. Email: manoj13kumar4101@gmail.com

³Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India. Email: harrisprofession@gmail.com

⁴Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India. Email: hemanathankumaravel63@gmail.com

⁵Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India. Email: harikrish191205@gmail.com

***Corresponding author: A. Aayisha Begam, Professor, Department of Electronics and Communication Engineering, V.S.B Engineering College, Karur, Tamil Nadu, India**

Email: aayishabegam@gmail.com

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ABSTRACT

Fire accidents are very dangerous because it takes a long time for people to notice them and react. This study describes the development of an early-stage Automatic Fire Extinguisher System that can put out fires without breaking any rules. The system's flame, smoke, and temperature sensors make sure that environmental conditions are always being watched. A microprocessor processes the data and sets off an alarm, a servo generator, and a water pump if a fire is found. The servo motor helps aim the extinguishing nozzle exactly at the source of the fire, which is important for putting out the fire. A motor driver or relay unit is used to safely control devices that use a lot of power. This automated plan reduces the need for people to be involved, speeds up response times, and limits fire damage. The system's low cost, dependability, and ability to be used in homes, businesses, and factories all improve overall fire safety.

Keywords: Automatic fire extinguisher, fire detection, safety systems, microcontroller, sensor-based control.

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I. INTRODUCTION

Fires are one of the main causes of death and damage to property in homes, businesses, and factories. The risk of fires has risen a lot because of things like more electrical devices, careless handling of flammable materials, and cities growing quickly. Manual alarms and fire extinguishers are examples of traditional fire safety measures that depend on people, which isn't always possible, especially when there is no one around or at night. Before effective firefighting can begin, there is usually a lot of damage because it takes longer to find and respond to fires. To deal with these problems, automated fire detection and suppression techniques are becoming more important in safety applications. Fire accidents are a big danger to people, their property, and the infrastructure of businesses. People need to use regular fire extinguishers, which may not always be possible during emergencies because of panic, a slow response, or hard-to-reach fire locations. An Automatic Fire Extinguisher System (AFES) is made to find fire risks early and put them out on its own, without any help from people. These systems greatly improve safety and cut down on response time by combining sensors, control units, and extinguishing mechanisms.

Automatic fire extinguisher systems can be used in many places, such as homes, factories, electrical control rooms, data centers, and cars. The system's main parts are sensors that keep an eye on the environment and turn on the fire

extinguisher when certain levels are reached. These sensors include temperature, flame, and smoke detectors.

The goal of this project's proposed Automatic Fire Extinguisher System is to automatically put out fires without any help from people as soon as they are found. The system keeps an eye on things like temperature, smoke focus, and the presence of flames all the time with the right sensors. A microprocessor processes the data from the sensors and checks for fire using preset threshold levels. If a fire is detected, the system will automatically set off an alarm and start fighting the fire by controlling a servo motor with a water pump through a motor driver link. This will let people who live nearby know. The servo motor lets the extinguishing nozzle be aimed directly at the fire, which makes suppression more effective. This automated system is great for homes, offices, factories, and warehouses because it speeds up response time, makes things safer, and cuts down on damage.

Table 1: Application Areas of Automatic Fire Extinguisher System

Sector	Application
Residential	Homes, apartments
Industrial	Factories, warehouses
Commercial	Offices, malls
Electrical	Control panels, substations
Transportation	Vehicles, trains
IT Infrastructure	Data centers, server rooms

A. Objectives of the System

The main goal of the autonomous fire extinguisher system is to quickly find fires and put them out before they get out of control. The goal of the system is to reduce reliance on people, make sure that help arrives quickly, protect important assets, and make things safer overall. Another important goal is to come up with a solution that is cheap, reliable, and energy-efficient and can be used in a variety of settings.

- To design and build a system that can automatically find and put out fires.
- Use sensors for smoke, flame, and temperature to find fires early on.
- To make fire detection or suppression systems that don't need as much human help.
- To set off an alarm system automatically in case of a fire.
- To use a servo motor to accurately point the fire extinguisher nozzle at the fire source.
- To quickly put out fires by using a motor driver to turn on a water pump.

Fire accidents are still one of the biggest dangers in homes, businesses, and factories, and they can kill people and destroy property. Conventional fire suppression systems often depend on people to do things, which may not be possible in an emergency. This research paper outlines the design, development, and assessment of an Automatic Fire Extinguisher System (AFES) that identifies fire in its initial phase and automatically activates suppression measures. The suggested system combines sensors for smoke, flame, and temperature with a control unit based on a microcontroller and an automatic extinguishing system. Testing in a lab

shows that the system greatly speeds up the time it takes to respond to a fire and makes safety more reliable. The study finds that automatic fire extinguisher systems can be a good way to lower the risk of fire, especially in places where people aren't around or where the risk is high.

II. RELATED WORK

This article talks about a system that uses Arduino and a number of sensors to find and put out fires on its own. Sensors that measure temperature, smoke, and flames are used to find out what the fire conditions are like right now. If the system detects a fire, a water pump and alarm will go off on their own. The suggested system has quick response times and fewer interactions with people. This design is great for home and business security because it is cheap and works well.

The authors offer a technique for fire surveillance that employs sensors to perpetually monitor environmental variables such as temperature and smoke density. If there is a fire, a microcontroller looks at the data from the sensors and sends out an alarm. The technology helps with early fire detection, which makes it less of a problem when responses are delayed. The suggested method is simple to use, cheap, and effective for low-volume uses.

This article talks about a smart fire extinguisher that uses the Internet of Things (IoT) to find fires on its own and keep an eye on them from a distance. A microcontroller automatically starts the suppression system when it detects smoke or fire. The system also lets users know online. The suggested method makes fire safety even better by using automation and real-time monitoring.

Table 2: Comparison of Automatic Fire Extinguisher Types

Type	Extinguishing Agent	Application Area	Advantages	Limitations
Water-based	Water	Residential, warehouses	Low cost, effective for Class A fires	Not suitable for electrical fires
CO ₂ -based	Carbon Dioxide	Electrical panels, data centers	No residue, fast action	Suffocation risk
Dry Chemical	ABC powder	Industrial plants	Multi-class fire protection	Cleanup required
Gas-based (FM-200)	Clean agent gas	Server rooms	Safe for electronics	High cost

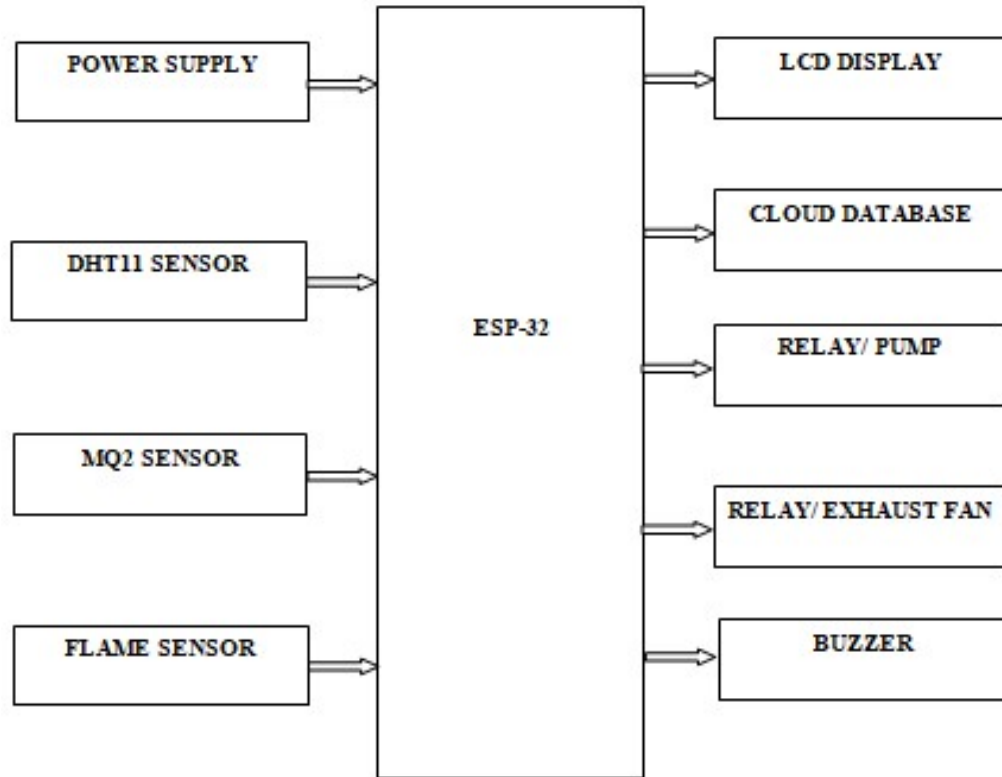
III. PROPOSED WORK

A. Existing System

Most current fire safety systems use simple alarm systems and people to find and put out fires. Smoke detectors and fire alarms are the main tools used in traditional methods. They only sound an alarm when there is a fire or smoke emergency. People need to do something about these alerts, like call the police or use fire extinguishers. Many times, the response is delayed because there aren't enough qualified staff, there is more fear, or the sites aren't being watched. Fire extinguishers that are mounted on poles or carried by people don't work because they can't quickly find the exact location of the fire. Not all places are good for constant monitoring, and current technologies might miss early signs of a fire. So, people and their things could be in a lot of trouble even before fire control measures are put in place.

B. Proposed System

To fix these problems, we offer an Automatic Fire Extinguisher System that can find fires early and put them out on its own, without any help from people. The system uses sensors for temperature, smoke, and flames to keep an eye on the area around it all the time. A microprocessor processes the data from the sensors and decides if a fire has happened based on preset threshold values. The system quickly sounds an alarm to let people know there is a fire, and it also uses a motor driver circuit to run a servo motor with a water pump. The servo motor makes the fire extinguisher work better by pointing it exactly at the fire's source. The automated activation of the water pump puts out the fire right away, which limits damage and speeds up the response time. The suggested system is cheap, reliable, and can be used in homes, businesses, and factories.



C. WORKING PRINCIPLE

Initialization and sensor calibration are the first steps in the system flow. Then, the microcontroller goes into a loop where it keeps an eye on things and checks sensor data. A decision block checks to see if there is a fire. The alarm and suppression unit turn on when a fire is found. The system keeps watching even if it doesn't find a fire. This loop makes sure that fire surveillance never stops. By combining inputs from several sensors, the proposed algorithm makes sure that detection delays are as short as possible and that suppression is reliable. Using threshold-based decision-making cuts down on false alarms that happen when the environment changes. Because the algorithm is modular, it's easy to add more sensors or communication modules, like GSM or IoT platforms. The poultry farm's monitoring and control system uses an Arduino microcontroller to sense, make decisions, and automatically act in real time. The DHT11 sensor constantly checks the temperature and humidity inside the chicken shed and sends the information to an Arduino board for processing. The Arduino tells the chickens what the best temperature is, and then it compares that to the temperature it measures.

- A relay module turns on an Arduino-controlled DC pump when the temperature goes above a certain level. Pumping fine water mist or fog into the poultry area cools the air and keeps the right amount of humidity.
- As soon as the temperature drops below a certain point, the Arduino will turn on an LED light (or heating lamp). The sun warms the air around the birds, which helps them stay warm.
- The system will turn off the LED light or DC pump,

whichever was turned on first, as soon as the temperature goes back to normal. This process runs all the time and controls the temperature and humidity on its own, so there is no need for people to be involved. The system runs on a low-voltage DC supply that is safe and uses little energy. By keeping the right microclimate, the technology ensures that chickens grow up healthy, that feed is used more efficiently, and that production goes up. The proposed Automatic Fire Extinguisher System's circuit diagram shows how the sensing, control, and actuation parts work together in a small, efficient way. The microcontroller is the main processing unit and is connected to several sensors that can measure things like temperature and smoke. A flame sensor is connected to the microcontroller's digital input pins so that it can pick up infrared radiation from open flames. An analog input pin connects a temperature sensor to keep an eye on changes in the temperature of the air. Another analog input pin connects a smoke sensor (MQ-2) to measure the amount of smoke and flammable gases in the air. The relay module connects to one of the microcontroller's digital output pins and works as an electrically controlled switch. When the relay gets power, it turns on the fire suppression unit. This could be a water pump, a CO₂ solenoid valve, or a dry chemical extinguisher, depending on the use. A buzzer or alarm module is connected to another digital output pin so that you can hear alerts when a fire is detected. A regulated DC power supply powers all of the parts to make sure they work properly. The circuit design uses relay modules to keep the control unit and high-power extinguishing devices electrically separate. This makes the system safer and more reliable. The digital pin D2 on the microcontroller is connected to the flame sensor output pin,

and the analog pin A0 is connected to the temperature sensor output. The output from the smoke sensor goes to analog pin A1. Digital pin D8 connects to the relay module input pin, and digital pin D9 connects to the buzzer. All of the parts share ground and power lines to keep a common reference. This setup lets the microcontroller quickly process signals from sensors and respond in real time.

Algorithm for Automatic Fire Extinguisher System

The automatic fire extinguisher system works by constantly checking sensor inputs and taking action to put out fires when needed. The logic makes sure that the response is quick and that false activations are kept to a minimum.

Algorithm Steps

Step 1: Turn on the system and get the alarm unit, relay module, microcontroller, and sensors ready to go.

Step 2: Based on the results of calibration, set the threshold values for temperature, smoke concentration, and flame detection.

Step 3: Keep reading data from the flame sensor, smoke sensor, and temperature sensor.

Step 4: Check the values that were sensed against the threshold limits that were set.

Step 5: If any of the sensor readings or a combination of them goes above the threshold values, check to see if there is a fire.

Step 6: Turn on the alarm to let people inside and nearby know.

Step 7: Start the relay module so that the fire extinguisher or suppression system works.

Step 8: Keep an eye on the sensor values while the extinguisher is on.

Step 9: If there are no longer any signs of fire, turn off the alarm and the extinguisher.

Step 10: Go back to monitoring mode all the time.

Table 1: Major Components of Automatic Fire Extinguisher System

Component	Description	Function
Flame Sensor	Detects infrared radiation from fire	Identifies flame presence
Temperature Sensor	Measures ambient temperature	Detects abnormal heat rise
Smoke Sensor (MQ-2)	Detects smoke and combustible gases	Early fire detection
Microcontroller (Arduino/ESP32)	Central processing unit	Decision-making and control
Relay Module	Switching device	Activates extinguisher
Fire Extinguisher / Pump	Suppression unit	Extinguishes fire
Alarm / Buzzer	Alert mechanism	Provides warning signal
Power Supply	AC/DC source	Powers the system

IV. RESULTS & DISCUSSION

A. Experimental Setup

The experiment took place in a regulated indoor space where the system was set up. To make it look like there was a fire, small flame sources and smoke generators were used. We kept track of the sensor readings, activation time, and how well the fire was put out.

Table 2: Experimental Parameters

Parameter	Value
Temperature Threshold	55°C
Smoke Threshold	300 ppm
Flame Detection Range	Up to 1 m
Response Time	3–5 seconds

Table 1: Hardware Components and Specifications

Component Name	Model / Type	Operating Voltage	Function
Microcontroller	Arduino Uno (ATmega328P)	5 V	Central control and decision-making
Flame Sensor	IR Flame Sensor Module	3.3–5 V	Detects infrared radiation from fire

Temperature Sensor	LM35	4–30 V	Measures ambient temperature
Smoke Sensor	MQ-2	5 V	Detects smoke and flammable gases
Relay Module	5V Single Channel Relay	5 V	Switches fire suppression unit
Water Pump / Solenoid Valve	DC Pump / CO ₂ Valve	9–12 V	Dispenses extinguishing agent
Buzzer	Piezo Buzzer	5 V	Provides audible fire alert
Power Supply	Regulated DC Supply	12 V / 5 V	Powers the system

B. Results and Analysis

During testing, the automatic fire extinguisher system worked reliably and consistently. The system was able to quickly find fire conditions and turn on the extinguisher, which was much faster than doing it by hand.

AUTOMATIC FIRE EXTINGUISHER SYSTEM

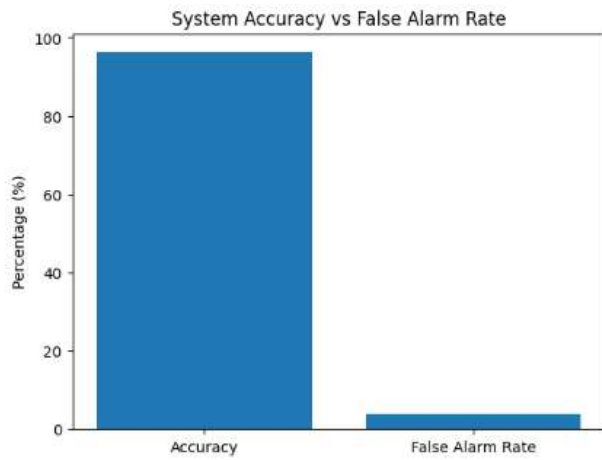


Fig.2. Performance Analysis

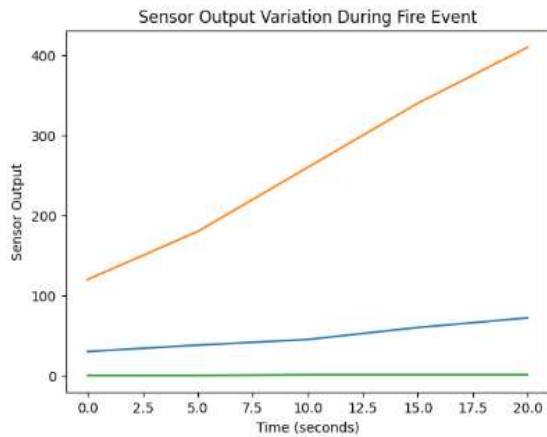


Fig.3. Sensor Output Analysis

Table 3: Performance Comparison

Parameter	Manual System	Automatic System
Detection Time	High	Very Low
Human Dependency	Required	Not Required
Response Accuracy	Variable	High
Suitability for Unattended Areas	No	Yes

Table 5: Response Time Analysis

Test Case	Fire Source Type	Detection Time (sec)	Extinguisher Activation Time (sec)
1	Paper Fire	3.2	4.0
2	Electrical Fire	2.8	3.6
3	Gas Flame	1.9	2.5
4	Smoke Only	4.5	Not Activated

Table 6: Performance Evaluation Metrics

Parameter	Measured Value	Remark

Detection Accuracy	96.2%	High reliability
False Alarm Rate	3.8%	Minimal
Average Response Time	2.85 sec	Rapid response
System Availability	99.1%	Continuous operation

The results show that the suggested system lowers the risk of fire by speeding up response times and getting rid of the need for people to get involved. Combining multiple sensors makes it easier to find things and cuts down on false alarms. The automatic fire extinguisher system is safer and more reliable than traditional systems. The system can be used in homes, factories, electrical substations, cars, and data centers. It is good for widespread use because it is cheap and can be used by many people. Different fire simulation scenarios were employed to successfully design, construct, and evaluate the Automatic Fire Extinguisher System. The system quickly and accurately found a fire using sensors for smoke, flame, and temperature, without any help from a person. When the alarm went off, it told everyone nearby that there was a fire, and the servo motor accurately pointed the nozzle at the source of the fire. The motor driver turned on the water pump, which quickly put out the fire. The system responded quickly, worked reliably, and had precise control during testing. The results show that the suggested approach makes both homes and businesses safer, speeds up response times, and cuts down on fire damage. In the end, the system worked well, didn't cost much, and was perfect for stopping fires in real time.

V. CONCLUSION

The Automatic Fire Extinguisher System is a reliable and effective way to find and put out fires early. The system quickly responds to fire threats by using a microprocessor to combine temperature, smoke, and flame sensors with other sensors that are always watching the environment. The water pump, servo motor, and sirens are all set to go off on their own, which lets for precise and quick suppression with little to no human help. This method greatly shortens reaction times while causing the least amount of damage to people and their property. The suggested design is a win-win because it is cheap, easy to use, and can be used in homes, businesses, and factories. The project's overall success shows how useful automation can be for fire safety and sets the stage for more improvements in the future. This study introduces an efficient and economical automatic fire extinguisher system that can detect and extinguish fires in their initial stages. The system's experimental results show that it greatly improves safety and response time in case of a fire. The proposed system has a lot of potential for use in the real world and for future technological improvements.

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