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AUTOMATIC FIRE SUPPRESSION SYSTEM

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ABSTRACT-

The system includes dualaxis servo motors for directional alignment, an active fire suppression water p ump managed by a relay, and a flame sensor module for fire detection.Accurate identification, precise nozzle placement, and adaptive responses based on real-time feedback were made possible by a closed-loop control architecture and structured input-process-output (IPO) paradigm.

Experimental testing has been conducted under different fire circumstances to assess detection accurac y, mechanical reliability, and response consistency.The results demonstrate that the system can efficien tly neutralize medium to large fire sources, with a 100% response rate for fire detection and.

Keywords: Arduino R3, Fire suppression system, Fire, Flame sensor

I. INTRODUCTION

Indeed, one of the main causes of deaths, property damage, and economic disruption is fire.The usage of readily burnt materials increased the frequency of fires and caused significant damage as societies a nd cities flourished.These fires have been so frequent throughout history that almost all of the world's major cities have at some point been completely destroyed by fire.Based on data provided by the Burea u of Fire Protection (BFP)

1.1 Objective

The goal of this project is to create an automated fire suppression system that uses a mist-based mechanism to detect fire early and control it.The device helps stop the spread of fire in vulnerabl e locations and reduces the need for human involvement.

1.2 System Components

IR Flame Sensor: Detects infrared radiation emitted by fire and provides a digital output signal.
Relay Module: Acts as an electrical switch to control high-power devices using a low-power signal.
24V DC Fan: Helps in spreading the water mist evenly toward the fire source.
Mist Maker: Produces fine water mist using ultrasonic vibration for effective fire suppression.
Controller (Optional): A microcontroller such as Arduino can be used for logic control and automation.
Power Supply: Provides required voltage levels for sensors, relay, fan, and mist maker.

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II. RELATED LITERATURE

Arduino-based control system

In the study of Abdul Kareem, J. (2025), the robot operates using an Arduino-based control system, fire sensors, and a motorized water spraying mechanism. When a fire is detected, the sensors transmit a signal to the Arduino, which activates the motor driver to spray water toward the fire source. This automated approach reduces risks to firefighters, minimizes damage, and enhances fire safety by providing a quick and efficient fire suppression response.

Fire control system

Rashid, R. et al. (2018) developed a fire control system that can reduce these hazards to a great extent. The technology is completely automatic and requires no human intervention to eliminate the unpleasant event. Additionally, it is self-sufficient. When a fire starts, the fire alarm will sound, which will activate the solenoid valves attached to water pipes via a controlling device (Arduino Uno). Relays are connected between the Arduino and the solenoid valve to supply the necessary voltage to the valve. The sprinklers utilized in this system may cover a broad area and efficiently extinguish the fire in seconds.

Fire-fighting robot

S. Jakthi Priyanka and R. Sangeetha proposed an android controlled fire fighting robot that uses Arduino Uno R3. The robot consists of a gas sensor for fire detection, a gear motor and motor drive for the movement of the robot, a Bluetooth module to connect the robot with the Android device, and a control system to control the robot with the smartphone as well.

III. PROBLEM STATEMENT AND METHODOLOGY

Extreme operating conditions, such as fast movement, high engine temperatures, and severe mechanica l stress, are experienced by motorsport vehicles.Because of these elements, fire breakouts pose a signifi cant risk to the safety of both the driver and the car.The majority of racing car fire suppression systems now in use rely on manual activation, which necessitates the driver's awareness, consciousness, and ph ysical ability to react in an emergency.This dependence on human input may result in a delayed or uns uccessful firing in highstress or postcollision situations.suppression, raising the possibility of harm or d eath.Furthermore, the automated systems now in use in highend racing are either too costly for amateur or grassroots motorsports or do not have the realtime environmental monitoring capabilities needed to identify early fire indicators like smoke and increasing temperatures.An inexpensive, quick, and compl etely automated fire safety system that can identify overheating or the presence of dangerous gasses an d initiate a suppression mechanism without driver participation is desperately needed.

IV. WORKING PRINCIPLE

The IR sensor detects the infrared radiation that the flame emits when a fire breaks out.
The relay mechanism is activated by the sensor output.The fan sends the tiny water droplets produced by the mist generator toward the fire once it is turned on.The mist suppresses the fire by lowering oxyg en concentrations and cooling the flame.Once the fire is put out, the device may be programmed to shu t down on its own.

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4.1 Control Logic

If fire is detected, the fan and mist maker are turned ON. If no fire is detected, both devices remain OFF.

4.2 Advantages

Fast fire detection and response
Automatic operation
Low water usage
Reduced damage compared to traditional sprinklers
Suitable for electrical and enclosed areas

4.3 Applications

Electrical control panels
Server rooms
Laboratories
Warehouses
Industrial safety systems
Residential fire safety

V. CONCLUSION

An efficient and dependable method for early fire detection and control is the automated fire suppressi on system.The device improves safety and lowers the danger of fire damage in delicate surroundings b y integrating forced air dispersion, mist-based suppression, and infrared detection.
In conclusion, the created system provides a workable answer to a significant safety issue in racing and establishes the groundwork for further improvements like IoTbased telemetry, data recording, and wir eless warning systems.The creation of a dualaxis automated fire suppression system served as an exam ple of how integrated control theory may be applied practically to reduce risk.A responsive closedloop system that can independently locate fire sources within a 120degree area and execute a suppression pr ocedure was developed by fusing the Arduino microcontroller with infrared sensing technology.
The operational work, which comprised dynamic vertical fluid discharge, precise angle alignment, and continuous scanning, showed how well the recommended hardware design closed the detection-mechanical action gap.The system's performance is physically limited by the intensity of the infrared s ource, but the test phase results show that it achieves high tracking accuracy and short reaction time for flames within the typical operational range of 30 cm-80 cm. Specifically, the surrounding sunlight.
The prototype consistently serves as a local safety device for regulated indoor environments in spite of these environmental constraints. Lastly, this study demonstrates that inexpensive automation components may be successfully incorporated into useful safety systems, providing a strong basis for next developments in intelligent fire suppression technology.

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