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FIRE-FIGHTING ROBOT

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ABSTRACT: The Arduino Uno-powered "Automatic Fire-Fighting Robot" is a cutting-edge safety automation project made to recognize and put out tiny flames on its own. With the use of straightforward, affordable, and scalable technologies, this system prioritizes quick fire detection, precise navigation, and efficient fire suppression. The Arduino Uno microcontroller serves as the foundation for the robot, which incorporates servo motors, water/sprinkler pumps, motor driver modules, flame sensors, and ultrasonic sensors. After identifying a fire, the robot automatically moves toward the flame and activates its extinguishing mechanism. This project is aimed at reducing fire-related risks, particularly in domestic, laboratory, and industrial settings. Future developments may include thermal imaging, remote monitoring, and enhanced fire suppression techniques.

Index Terms: Fire detection, Arduino robot, flame sensor, autonomous fire-fighting, ultrasonic navigation, firefighting robot, fire suppression system, robotic safety, obstacle avoidance, smart automation.

I. INTRODUCTION

Life and property are seriously threatened by fires, thus quick action is essential. A safety-focused invention, the "Automatic Fire-Fighting Robot" is made to identify flames and put out fires before they spread. Conventional approaches depend on delayed reaction times and human presence. This project uses automation and robotics to overcome these obstacles by providing a

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clever, Arduino-controlled robot that can find and put out minor flames on its own.The core of the system is the Arduino Uno, which interprets input from flame and ultrasonic sensors and issues commands to control motors and the extinguishing mechanism. The robot operates independently, moving in an environment while scanning for flames. Upon detection, it alters its path and deploys its fire suppression system, typically a water or CO_2 spray. This system is highly beneficial in laboratories, server rooms, and other sensitive areas where human intervention may be delayed or dangerous.

1.1 IMPORTANCE

This project serves as a crucial safety enhancement tool for environments prone to fire hazards. The Fire-Fighting Robot is a cost-effective, portable, and user-friendly alternative to traditional fire alert systems. It minimizes human risk, provides faster response, and can be deployed in unmanned areas.Traditional fire safety mechanisms often require manual operation or are limited to detection without suppression. This robot combines both detection and extinguishing capabilities, enhancing reliability. It can be customized with additional sensors or wireless communication modules, making it suitable for varied applications ranging from home safety to industrial automation.

II. METHODOLOGY

ObjectiveDefinition:

The objective is to build a robot capable of detecting fire, navigating toward it while avoiding obstacles, and extinguishing it autonomously.

LiteratureReview:

Prior work in robotic fire suppression, Arduino-controlled navigation, and sensor integration was reviewed to inform the design.

Hardware Assembly:

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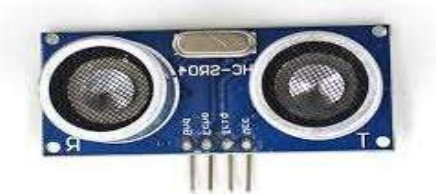
2.1 **Flame sensor** detects fire direction.

2.2 **Ultrasonic sensors** :aid in obstacle avoidance.



Arduino Uno : acts as the central controller

2.3 **Motor driver module (L298N):** controls the DC motors.

2.4 **Servo pump** or **DC pump** :controls water or extinguisher spray.

2.5 **Chassis and wheels :** support mobility.

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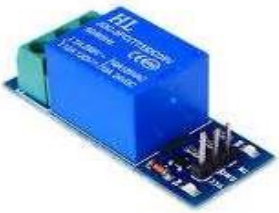
2.6 **Relay module** may be used to activate higher-powered extinguishing devices.



III. PROGRAMMING

Arduino IDE is used to code fire detection, movement logic, and extinguishing actions. Obstacle-avoidance algorithms ensure the robot doesn't collide while navigating.

3.1 Testing and Troubleshooting:

The robot is tested in simulated fire environments (e.g., using candles or alcohol flames). Sensor sensitivity, navigation precision, and extinguishing accuracy are calibrated.

3.2 Performance Analysis:

System evaluated based on flame detection range, reaction time, obstacle avoidance efficiency, and extinguishing success rate.

3.2 Components:

3.1 **Arduino Uno** – Central microcontroller.

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3.2 **Flame Sensors** – Detect the presence of fire.

3.3 **Ultrasonic Sensors** – Help avoid obstacles during navigation.

3.4 **DC Motors with Driver Module (L298N)** – Movement control.

3.5 **Water or CO_2 Pump System** – Fire extinguishing mechanism.

3.6 **Relay Module** – Controls high-power components safely.

3.7 **Chassis and Wheels** – Mechanical framework.

3.8 **Bluetooth Module (Optional)** – Enables remote control via smartphone.

IV.IMPLEMENTATION

The robot uses ultrasonic sensors to detect surroundings and a flame sensor to locate fires. On flame detection, the robot adjusts its path toward the flame. Once close, it activates its extinguishing mechanism (water spray or fan-based flame dispersal). A Bluetooth module can optionally be used for remote operation.

Power is supplied via a rechargeable 12V battery for motors and sensors. The fire detection algorithm prioritizes direction and proximity, enabling a direct approach toward the flame. After extinguishing the fire, the robot can either reset to standby or return to a designated home base.

V. RESULTS AND DISCUSSION

The fire-fighting robot demonstrated successful detection of flame sources and autonomous movement toward the fire. It avoided obstacles efficiently and activated the extinguishing system upon close proximity to the flame.The system proved reliable in indoor environments with minimal airflow. Flame sensors showed good response within a 60–80 cm range. Testing showed successful extinguishing of small alcohol flames and candles.

VI. CONCLUSION

The automatic fire-fighting robot is a compact, effective solution for early-stage fire

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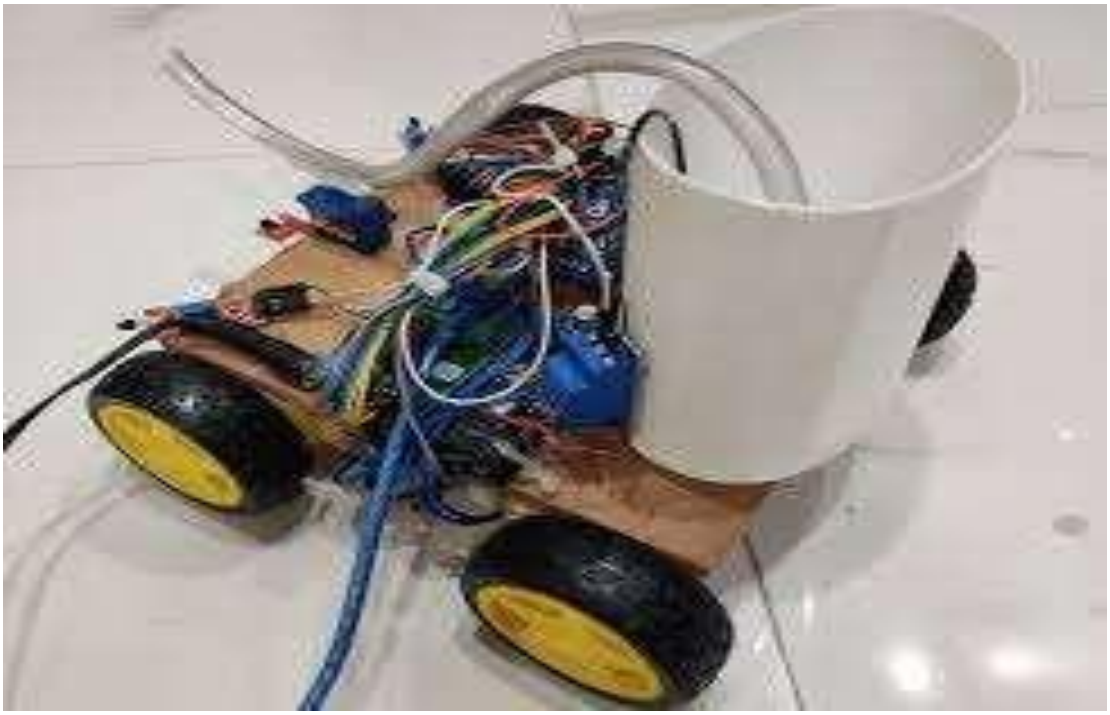
suppression. With Arduino as its brain, the robot successfully integrates sensors, motors, and pumps to deliver a practical, low-cost safety automation system. It responds rapidly to fire incidents, significantly reducing the risks of escalation in controlled environments.



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VII. FUTURE SCOPE

7.1 **Thermal Imaging Cameras:** For better heat detection.

7.2 **AI Integration:** For smarter flame differentiation and decision-making.

7.3 **Remote Surveillance:** Integration with IoT and camera modules.

7.4 **Advanced Navigation:** SLAM (Simultaneous Localization and Mapping) for complex environments.

7.5 **Auto Docking:** Charging stations for longer operation.

7.6 **Larger-Scale Versions:** For use in warehouses or chemical plants.

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