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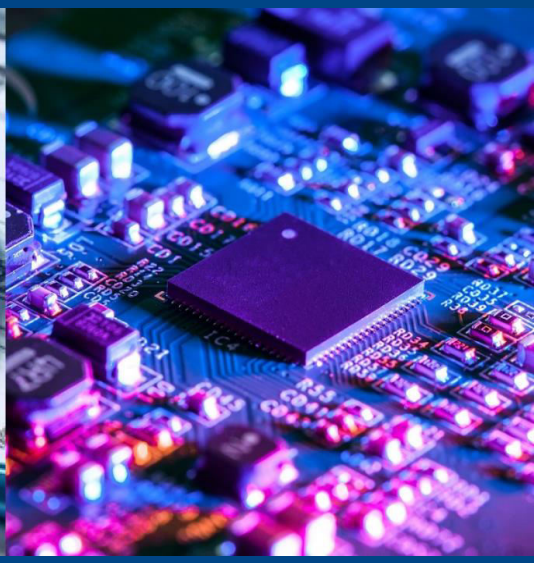

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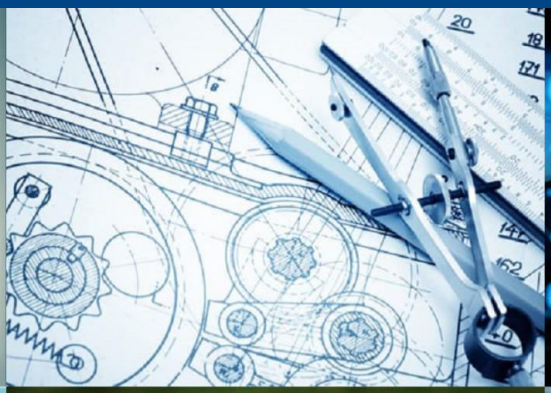

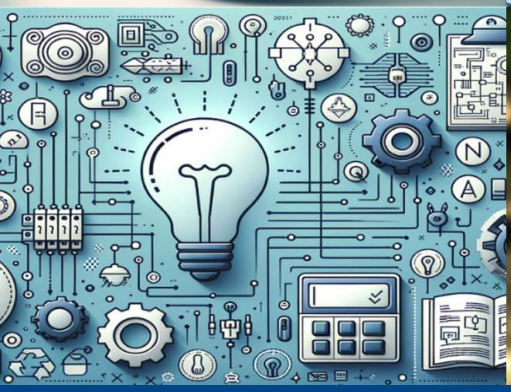

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Arduino based Fire Fighting Robot

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ABSTRACT: The increasing frequency and intensity of fires, coupled with the risks to human life, have highlighted the need for innovative solutions to enhance firefighting techniques. This paper presents the design and development of an Arduino -based firefighting robot, which aims to autonomously detect and extinguish fires in hazardous environments. The robot utilizes the Arduino platform, integrating various sensors and actuators to enable realtime decision-making and autonomous fire-fighting capabilities.

The core functionality of the robot is centered around fire detection using flame sensors and temperature sensors, which allow the robot to identify fire sources accurately. Once a fire is detected, the robot automatically navigates toward the fire using an array of motors and sensors for obstacle avoidance and pathfinding. A water or fire-extinguishing mechanism is employed to combat the flames, ensuring the safety and efficiency of the process.
The system is powered by a combination of microcontroller programming and hardware integration, making it highly flexible and scalable. The Arduino platform, known for its versatility and ease of use, provides a robust foundation for this autonomous robot. The robot's design prioritizes safety, reliability, and efficiency, making it suitable for deployment in a variety of fire-prone areas, such as industrial facilities, residential complexes, and forests.

KEYWORDS: Flame Sensor , Arduino Uno

I. INTRODUCTION

Firefighting is a critical and dangerous task that often involves risks to both human life and property. Traditional methods of firefighting, while effective, are limited in certain scenarios, particularly in environments that are too hazardous or difficult for humans to access, such as industrial settings, high- rise buildings, or forests. In these situations, the use of autonomous systems can play a crucial role in improving safety and efficiency during firefighting operations.

The Arduino-based firefighting robot is an innovative solution designed to autonomously detect and extinguish fires in various environments. Built around the Arduino platform, this robot integrates a range of sensors, including flame and temperature sensors, to detect the presence of fire. Once a fire is detected, the robot navigates toward the source using motors and sensors for obstacle avoidance and accurate movement. It is equipped with an extinguishing mechanism, such as water pumps or fire retardant spray systems, to combat the fire without human intervention.

Arduino, an open-source electronics platform, serves as the backbone of this robot, offering both flexibility and ease of use for building custom systems. The platform allows for easy integration of sensors, actuators, and controllers, enabling developers and hobbyists to design affordable, reliable, and scalable solutions for fire detection and suppression. The robot's programming is simple yet powerful, ensuring real-time responsiveness to fire hazards and effective navigation in unpredictable environments.

II.METHODOLOGY

- The development of an **Arduino-based firefighting robot** involves a series of systematic steps to design, build, and program the system to perform fire detection, navigation, and suppression autonomously. Below is an outline of the methodology followed for creating the firefighting robot.

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- **Objective Setting**: Define the core goals of the firefighting robot, such as fire detection, autonomous navigation, and fire suppression.

- **Component Selection**: Choose appropriate sensors (e.g., flame sensors, temperature sensors), actuators (e.g., motors for movement), and other components (e.g., water pump or fire suppression system) based on the desired functionality.

- **Hardware Design**:
- **Robot Chassis**: Design a mobile chassis for the robot to house all components, including motors, sensors, and the fire extinguishing system. It should be compact and capable of moving in confined spaces.

- **Fire Detection Sensors**: Select **flame sensors** to detect the presence of fire based on the light emitted by flames, and **temperature sensors** to sense abnormal heat levels that could indicate a fire.

- **Fire Suppression Mechanism**: Implement a water pump or fire retardant spraysystem that can be controlled by the Arduino to suppress fire. The system is activated once fire detection occurs.

- **Motors and Navigation**: Use **DC motors** or **servo motors** for movement and steering, along with **ultrasonic sensors** for obstacle detection and avoidance to help the robot navigate towards the fire source

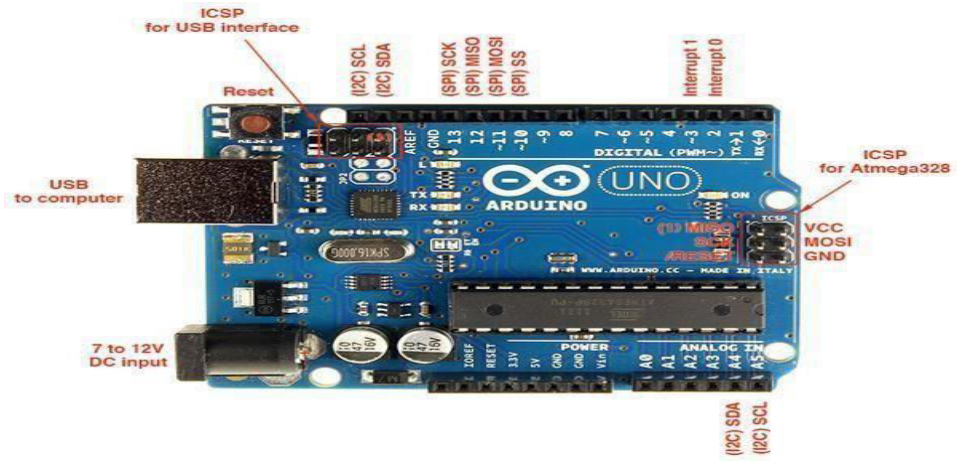

Figure 1.1: Arduino R3

III. MODELING AND ANALYSIS

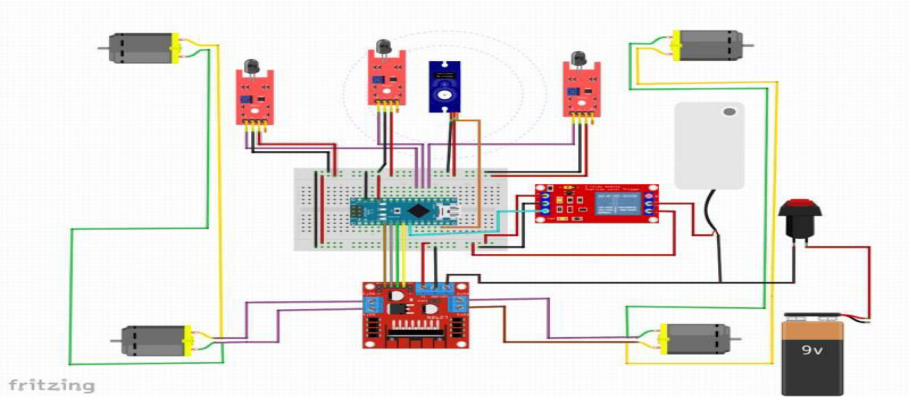

Figure 2.1: Diagram of model

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In an **Arduino-based firefighting robot**, the circuit is designed to integrate several components that help the robot detect fire, move towards it, and extinguish the flame. The robot utilizes a combination of sensors (such as flame sensors and ultrasonic sensors) and actuators (such as motors for movement and a water pump for extinguishing the fire). The **Arduino UNO** serves as the central controller that processes sensor data and controls the actuators accordingly. The primary fire detection system operates through a computer vision algorithm. In this system, we utilized the Open CV module in Python to detect fire in the camera feed. The camera feed is processed by scanning each frame, and the program identifies the presence of fire by evaluating the colour code of the screen pixels within a specific range of the HSV (Hue Saturation Value) colour scale values. If the colour code falls within this predefined range, the program successfully detects the presence of fire. The secondary fire detection system operates based on sensors. Once the primary fire detection system signals the presence of fire, the secondary system comes into play. It consists of flame sensors, gas sensors or smoke sensors that take readings and assess the presence of fire based on a predefined algorithm. If all the sensors confirm the presence of fire, a buzzer is activated, and a water jet is initiated using a relay circuit. The robot in this system can be controlled remotely using a Bluetooth module. Commands such as forward, backward, left-turn, right-turn, and stop can be sent to the robot. While navigating through the environment, the

IV. RESULT

System Working

The "result" of an Arduino-based firefighting robot can vary significantly depending on the specific design, components used, and the environment in which it's tested. However, here's a general breakdown of the expected and potential results:

Expected Results (Under Ideal Conditions):

Fire Detection:

- The robot should reliably detect flames within its sensor range.
- It should be able to differentiate between flames and other light sources (with proper sensor calibration and filtering).

Fire Localization:

- The robot should be able to determine the direction of the fire source using multiple flame sensors.
- **Fire Localization:**
- The robot should be able to determine the direction of the fire source using multiple flame sensors.
- It should be able to move towards the fire.

- **Movement and Navigation:**
- The robot should move smoothly and accurately in response to sensor input.
- If equipped with obstacle avoidance, it should navigate around obstacles effectively.

- **Fire Extinguishing:**
- The water pump or extinguishing system should activate when the robot is in close proximity to the fire.
- The extinguishing system should effectively suppress small fires.

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Figure 3.1: Model

V. CONCLUSION

The **Arduino-based firefighting robot** is an innovative and practical solution for fire detection and suppression, typically designed to autonomously detect and extinguish fires. In conclusion, this project demonstrates how microcontroller-based systems, like Arduino, can be used to integrate various sensors and actuators to perform complex tasks in real-world applications. In conclusion, the development of an Arduino Uno-based Fire Fighting robot represents a transformative synergy of technology and emergency response, offering the potential to revolutionize fire management through advanced sensor integration, autonomous mobility, and real-time communication capabilities. By addressing the challenges of accurate fire detection, safe navigation in hazardous environments, and autonomous fire suppression, this innovation holds the promise of minimizing risks to human firefighters, enhancing overall response times, and safeguarding lives and property. As these robots continue to evolve and find their place in the realm of disaster management, they underscore the remarkable potential of technology to mitigate the devastating impact of fires on communities and urban landscapes. This model of Fire Extinguishing Robot aids to share out the burden of fire fighters in firefighting task. Our project aims to build a real time firefighting robot which moves in a constant speed, identify the fire and then extinguish it with the help of pumping mechanism. The detection and extinguishing was done with the help basic hardware components attached with the robot. Firstly, IR Flame sensors are used for the detection of fire. Secondly, BO Motors and Rubber wheels are used to navigate the robot to reach the fireplace. Finally, the robot extinguishes the fire with the help of submersible water pump and servo motors. An Arduino based autonomous firefighting robot is a viable solution for hazardous fire-fighting situations where human intervention is not possible. With the use of various sensors, it can detect fires with high accuracy, and its water spray mechanism can extinguish fires effectively. Additionally, it can navigate through narrow passages and avoid obstacles to reach the fire source quickly and safely. Good programming and control can also ensure that the robot can detect and extinguish fires effectively while avoiding obstacles and navigating safely. Although challenges and limitations exist, such as the need for optimized sensors and programming, the potential benefits of such robots make them a promising area for future research and development. Overall, Arduino based autonomous firefighting robots have the potential to save lives and property and can serve as a valuable addition to current fire-fighting methods. In conclusion, This model of Fire Extinguishing Robot aids to share out the burden of fire fighters in firefighting task. Our project aims to build a real time firefighting robot which moves in a constant speed, identify the fire and then extinguish it with the help of pumping mechanism. The detection and extinguishing was done with the help basic hardware components attached with the robot. Firstly, IR Flame sensors are used for the detection of fire. Secondly, BO Motors and Rubber wheels are used to navigate the robot to reach the fireplace. Finally, the robot extinguishes the fire with the help of submersible water pump and servo motors.

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