

# “DRONE BASED FIRE DETECTION AND EMERGENCY RESPONSE SYSTEM”

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**Abstract:** Fire accidents in forests, industrial zones, and urban areas cause severe damage to life, property, and the environment. Early detection and rapid response are critical to minimizing losses, but conventional fire monitoring systems are limited by fixed coverage, delayed response, and human dependency. This project presents a drone-based fire detection and emergency response system that utilizes a quadcopter equipped with flame, temperature, and smoke sensors along with GPS and wireless communication modules. The system continuously monitors large and inaccessible areas, detects fire conditions in real time, and transmits alert notifications with precise location details to authorities through an IoT platform. A live camera feed further assists in fire verification. The proposed system offers improved accuracy, rapid response, mobility, and reduced risk to human life, making it an effective solution for modern fire monitoring and disaster management applications.

**Quadcopter drone frame:** The physical structure or chassis of the drone that holds all other components. Brushless DC motor with propellers: Provides the necessary thrust and propulsion for the drone to fly. Electronic speed controllers (ESC's): Regulates the speed and direction of the motors based on signals from the flight controller. Flight controller (Pixhawk/KK/NAZA): The "brain" of the drone, processing inputs from sensors and the user to stabilize and control flight. Microcontroller (Arduino/Raspberry Pi): An additional small computer used for processing sensor data or managing specific payloads. Thermal camera or flame sensor: Detects heat signatures or the presence of a flame to identify fire locations. Smoke/Gas sensor, Temperature Sensor: Detects smoke, specific gases, or abnormal temperatures to confirm fire or hazardous conditions. GPS module: Provides location data (latitude, longitude, altitude) for navigation and mapping fire locations. Wi-Fi/RF/-GSM Communication module: Enables wireless communication between the drone and a ground control station or emergency services. Li-Po battery: The power source for all drone components. Power distribution board: Distributes power from the battery to the various electronic components efficiently. Camera module: Captures visual data for monitoring and assessment. Buzzer LED indicators: Provides audible and visual alert

**Keywords:** Internet of things, UAV (Unmanned Aerial Vehicle), sensors, real time monitoring.

## I. INTRODUCTION

Fire accidents are one of the major causes of loss of life, property, and environmental damage. Early detection and quick emergency response are essential to minimize these losses. Traditional fire detection systems often fail in large, remote, or dangerous areas.

To overcome these limitations, drone-based fire detection systems use advanced sensors and real-time monitoring to identify fires quickly and support efficient emergency response.

Drones equipped with thermal cameras, smoke sensors, and AI-based image processing can fly over large areas and detect fires at an early stage. Once a fire is detected, the system can send alerts to emergency teams and provide real-time location data for faster response. Traditional fire detection methods rely on human observation, CCTV cameras, or alarm systems, which may take time to detect fires, especially in forests, industrial areas, or large buildings.

## II. LITERATURE SURVEY

S. Waharte & N. Trigoni (2010):

Demonstrated the use of UAVs for disaster monitoring and showed that drones can quickly survey large areas for fire detection and emergency Response.

Rafael Toledo-Moreo et al. (2018):

Proposed a drone system with environmental sensors to monitor temperature, smoke, and gas for early fire detection.

Tao Zhang et al. (2020):

Developed a fire detection system using drones equipped with thermal cameras to identify fire even in smoky or low-visibility conditions.

S. K. Singh et al. (2021):

Introduced an IoT based drone system that sends real time fire alerts to monitoring centres through cloud communications. Recent research has focused on using unmanned aerial vehicles (UAVs) for early fire detection and monitoring. Verstockt et al. [1] presented a comprehensive review of vision-based fire detection techniques, highlighting the importance of image analysis in identifying flames and smoke. Zhang et al. [3] developed a UAV-based forest fire detection system using deep learning techniques to identify fire patterns in aerial images. Similarly, Yuan [9] proposed a convolutional neural network (CNN) based smoke detection method which achieved high accuracy in identifying smoke patterns in surveillance videos.

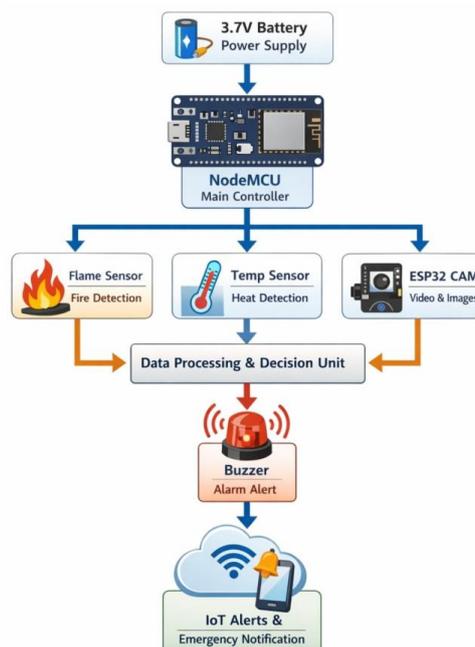
In addition, Merino et al. [12] introduced an unmanned aircraft system capable of automatic forest fire monitoring and measurement, demonstrating the feasibility of UAV-based fire surveillance. Recent studies have also integrated IoT technologies with UAVs to improve detection efficiency. Sharma et al. [11] proposed an IoT-based forest fire detection system where sensors detect temperature and smoke levels while drones provide aerial monitoring. These advancements show that combining UAV technology, deep learning, and IoT can significantly improve fire detection and emergency response systems.

### III. PROBLEMSTATEMENT

Traditional emergency response systems suffer from high latency, limited real-time situational awareness, and inability to access hazardous areas quickly, leading to delayed decision-making and increased casualties. This project proposes a drone-based detection and emergency response system to autonomously detect hazards, locate victims, and provide immediate, low-latency intervention.

Forest fires and fire accidents in remote or large areas are difficult to detect quickly using traditional monitoring methods. There is a need for an efficient system that can detect fires early and send alerts to prevent major damage. A drone-based fire detection system can monitor large areas using sensors and cameras to identify fire or smoke in real time.

### IV. BLOCK DIAGRAM



1.1 Block Diagram

**V. CIRCUIT DIAGRAM**

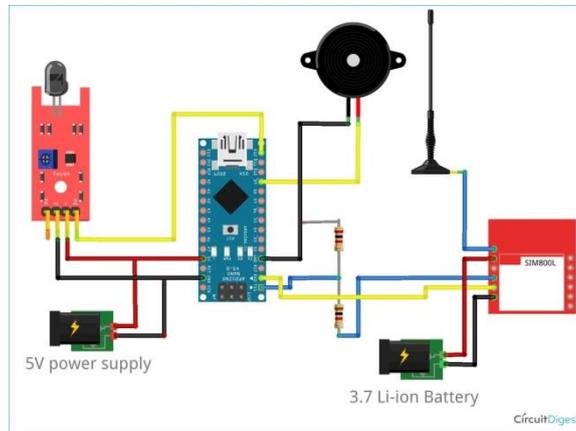
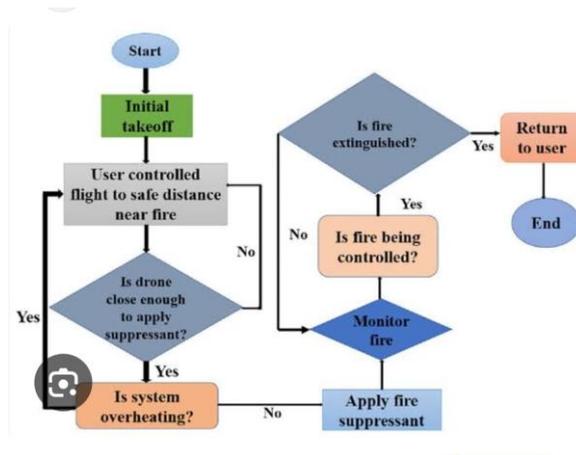


Fig.1. 2: Circuit Diagram

**VI. FLOW CHART**



**VII. SYSTEM ARCHITECTURE OVERVIEW**

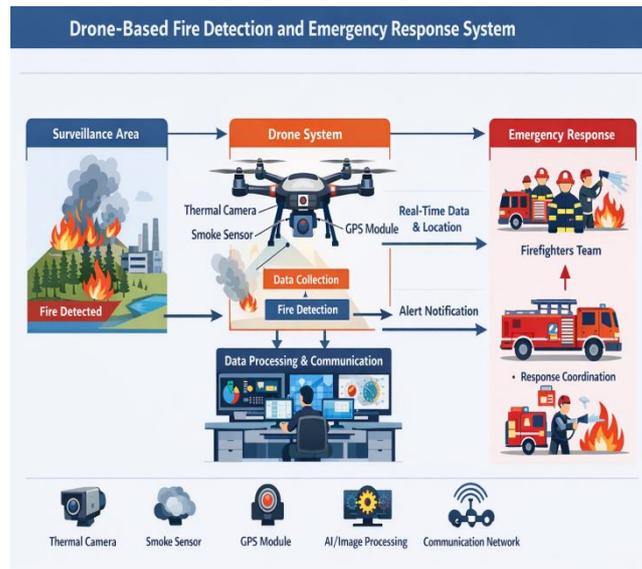
**Unmanned Aerial Vehicle (UAV):** Acts as the primary aerial platform for surveillance and monitoring of fire-prone areas.

**Camera System:** Thermal (IR) camera for heat detection. RGB camera for visual confirmation and live video streaming.

**Sensor Module:** Smoke and gas sensors (CO, CO<sub>2</sub>). Temperature and humidity sensors for fire risk assessment.

**Navigation System:** GPS module for precise location tracking. Autonomous waypoint navigation.

The **System Architecture Overview** of a **Drone-Based Fire Detection and Emergency Response System** consists of several interconnected components that work together to detect fires and coordinate rapid response. The architecture typically includes a drone unit equipped with sensors such as thermal cameras, smoke detectors, GPS modules, and onboard processors that collect environmental data and capture real-time images or video. This data is transmitted through wireless communication networks (such as Wi-Fi, cellular, or radio links) to a central control station or cloud-based server. The server processes the incoming data using image processing and machine learning algorithms to identify fire or abnormal heat patterns. Once a potential fire is detected, the system automatically generates alerts and sends the exact location and live feed to emergency response teams through monitoring dashboards or mobile applications. The control center can also send commands back to the drone for navigation, surveillance, or additional data collection. This integrated architecture enables continuous monitoring, quick fire detection, real-time data analysis, and efficient coordination of emergency response operations.



**VIII. WORKING PRINCIPLE**

The working principle of a drone-based fire detection system is based on aerial monitoring and sensor detection. A drone equipped with cameras and temperature sensors flies over the monitoring area and continuously observes the surroundings.

The sensors detect abnormal heat, smoke, or flames and collect real-time data. This data is processed by an onboard controller, and if a fire is detected, the information is transmitted wirelessly to a ground control station. The system then sends an alert so that emergency teams can take quick action. A Drone-based Fire Detection and Emergency Response System uses unmanned aerial vehicles (drones) equipped with sensors, cameras, and communication modules to quickly detect and respond to fire incidents. The drone continuously patrols or is automatically dispatched to a suspected location where it uses thermal cameras, smoke sensors, and image-processing algorithms to identify signs of fire or abnormal heat. Once a fire is detected, the system sends real-time video, location coordinates (via GPS), and alerts to a control center or emergency services through wireless networks. This allows firefighters to assess the situation quickly and plan an effective response. Some advanced drones can also carry fire-extinguishing materials, drop fire suppressants, or guide rescue teams to the exact location. By providing rapid detection, real-time monitoring, and faster emergency response, the system helps reduce damage, improve safety, and support efficient firefighting operations.

**IX. RESULTS AND DISCUSSION**

The Drone-Based Fire Detection and Emergency Response System was successfully designed to monitor large areas and detect fire incidents in real time. The drone equipped with thermal cameras, smoke sensors, and GPS technology was able to identify heat sources and smoke patterns effectively. Detect fire or abnormal temperature changes in the monitored area.

The implementation of a drone-based system provides several advantages in fire detection and emergency response. The aerial monitoring capability allows drones to cover large areas quickly and reach locations that are difficult for humans to access.



## X. CONCLUSION

In conclusion, the drone-based fire detection system is an effective and advanced method for monitoring and detecting fires. By using drones equipped with cameras and sensors, large areas can be monitored quickly and efficiently. The system helps in early fire detection, real-time monitoring, and faster communication with emergency services. This technology reduces response time, minimizes damage to property and the environment, and improves overall safety. Therefore, drone-based fire detection is a reliable solution for modern fire monitoring and disaster management.

## XI. FUTURE WORK

The Drone-Based Fire Detection and Emergency Response System has significant potential for further development and improvement in the future.

1. **Integration with Artificial Intelligence (AI):**  
Advanced AI algorithms can be used to improve the accuracy of fire detection by analyzing smoke patterns, temperature changes, and fire spread predictions.
2. **Use of Multiple Drones (Drone Swarms)**  
In the future, multiple drones can work together to monitor larger areas simultaneously. This will help in detecting fires faster and covering wide forest or industrial regions.
3. **Automatic Fire Suppression**  
Drones can be equipped with small fire extinguishers or fire retardant materials to control small fires before they spread.
4. **Integration with Satellite and IoT Systems**  
The system can be connected with satellite data and IoT-based sensors placed in forests or buildings to improve real-time monitoring and early detection.
5. **Improved Battery and Flight Time**  
Future drones may have longer battery life and solar-powered charging, allowing them to monitor areas for extended periods.
6. **Real-Time Data Analytics and Cloud Monitoring**  
Data collected by drones can be stored and analyzed in the cloud to predict high-risk fire zones and support better disaster management planning.
7. **Smart City and Forest Monitoring Applications**  
This system can be integrated into smart city infrastructure, wildlife protection systems, and large industrial safety networks.

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