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## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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# Metal Explosive Detection through Drones

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**ABSTRACT:** The increasing threat of improvised explosive devices (IED s) and concealed metal-based explosives in public spaces, border areas, and conflict zones demands advanced detection technologies that minimize human risk. This paper presents a drone-based metal explosive detection system integrating aerial platforms with metal detection sensors, real-time image processing, GPS tracking, and wireless communication modules. The proposed system enables remote detection of metallic explosive components in hazardous environments without direct human intervention. The system model incorporates lightweight metal detectors, ground-penetrating sensing principles, onboard micro-controllers, and AI-assisted object recognition for enhanced accuracy. Experimental results demonstrate improved detection efficiency, reduced response time, and enhanced operational safety compared to traditional manual inspection methods. The system offers a scalable and cost-effective solution for military, disaster management, and law enforcement applications.

**KEYWORDS:** Metal explosive detection, Unmanned Aerial Vehicle (UAV), Drone surveillance, IED detection, Metal detector sensor, AI-based image processing, remote sensing, GPS tracking, Security systems.

## I. INTRODUCTION

The detection of metal-based explosives and improvised explosive devices (IED s) has become a critical concern in modern security operations. Traditional explosive detection techniques involve manual inspection, ground patrol units, or trained animals, which expose personnel to significant risk. Recent advancements in Unmanned Aerial Vehicles (UAV s), sensor technologies, and artificial intelligence, have opened new possibilities for remote surveillance and detection systems. Drones provide mobility, aerial coverage, and access to hazardous or hard-to-reach locations.

Metal-based explosives often contain metallic casings, triggering mechanisms, or shrapnel components. Detecting these metallic elements using aerial platforms can significantly reduce risk and improve response efficiency.

This paper proposes a drone-integrated metal detection system designed to:

- Detect metallic explosive components remotely
- Provide real-time location tracking
- Transmit live alerts to control stations
- Minimize human exposure to danger

## II. SYSTEM MODEL AND ASSUMPTIONS

### 2.1 System Architecture

The proposed system consists of:

UAV Platform (Quadcopter)

Metal Detection Sensor Module (GPS Module) Microcontroller Unit (e.g., Arduino/ESP32) Wireless Communication Module (Wi-Fi/LoRa) Ground Control Station (Monitoring System) Camera with AI-based Object Detection

### 2.2 Working Model

The drone flies over the target area at a predefined altitude.

The metal detector sensor scans the ground for metallic objects. Sensor data is processed onboard using a microcontroller.

If metal presence exceeds a threshold value:

An alert is triggered.

GPS coordinates are recorded.

Live data is transmitted to the control station.



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### 2.3 Assumptions

Explosives contain detectable metallic components.

Flight altitude is maintained within sensor detection range. Environmental interference (soil minerals, debris) is manageable. Weather conditions are suitable for drone operation.

Communication network is stable.

### III. METHODOLOGY

The methodology involves the following stages:

#### 3.1 Hardware Integration

Mount a lightweight metal detector coil under the drone. Connect sensor output to a microcontroller.

Integrate GPS and communication modules.

Attach a high-resolution camera for visual confirmation.

#### 3.2 Data Acquisition

The metal detector generates analog signals based on electromagnetic induction. Signals are converted into digital values.

Data is continuously monitored during flight.

#### 3.3 Signal Processing

Threshold-based filtering removes noise.

Signal strength analysis estimates metal proximity.

AI-based algorithms differentiate between harmless metallic debris and suspicious patterns.

#### 3.4 Alert Mechanism

When suspicious detection occurs: A buzzer alert activates onboard. Coordinates are logged.

Alert message is sent to the ground station.

#### 3.5 Ground Monitoring The ground station: Displays live drone feed.

Shows detection intensity graph. Maps GPS location in real time.

### IV. IMPLEMENTATION

#### 4.1 Hardware Components

Quad-copter frame with brush less motors Metal detector sensor module ESP32/Arduino microcontroller

NEO-6M GPS module

Wi-Fi/LoRa communication module Li-Po battery

HD camera

#### 4.2 Software Tools

Arduino IDE for microcontroller programming Python (for ground station interface)

Open CV for image processing

Google Maps API for GPS visualization

#### 4.3 Operational Workflow Drone take-off and stabilization.

Continuous metal scanning during flight. Real-time transmission of sensor values. Automatic marking of suspicious zones. Data storage for post-analysis.

### V. RESULT AND DISCUSSION

#### 5.1 Experimental Setup

Test field with buried metallic objects. Drone altitude maintained at 1–2 meters.

Multiple trials conducted under controlled conditions.



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### 5.2 Observations

Detection accuracy: ~85–92% for medium-sized metal objects. Response time: <2 seconds after detection.

GPS accuracy: ±2.5 meters. False positives due to:

Mineral-rich soil Scrap metal debris.

### 5.3 Advantages Reduced human risk. Faster area coverage.

Real-time detection and mapping.

Cost-effective compared to advanced military systems.

### 5.4 Limitations

Limited detection depth. Environmental interference. Battery life constraints.

Cannot detect non-metallic explosives.

## VI. CONCLUSION

This research presents a drone-based metal explosive detection system capable of remotely identifying metallic explosive components using electromagnetic sensing and real-time communication. The system reduces operational risk and enhances situational awareness in hazardous environments. Experimental results validate its effectiveness in controlled scenarios.

Future enhancements may include:

Integration of ground-penetrating radar (GPR) Machine learning for improved object classification Autonomous navigation using AI. Multi-drone coordinated detection systems. The proposed model demonstrates strong potential for applications in defense, disaster management, border security, and public safety.

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