

Sanjeevani BattleShield: An AI-Based Integrated Drone and Rover System for Defense, Surveillance, and Emergency Response

Nidhi Saraswat¹, Vidhi Agrawal², Anvi Agrawal³, Kavya Agrawal⁴

¹PGT Physics, Scindia Kanya Vidyalaya Gwalior, Madhya Pradesh

^{2,3,4}Scholar, Scindia Kanya Vidyalaya Gwalior, Madhya Pradesh

Abstract

Modern defense operations and disaster management require intelligent systems capable of rapid surveillance, threat detection, navigation, and rescue support. Sanjeevani BattleShield is an AI-based integrated drone and rover solution that is designed to increase situational awareness and emergency response capabilities. It consists of an aerial surveillance drone that has four Brushless DC (BLDC) motors, GPS navigation, and a live camera system and a ground rover that can navigate terrain, identify obstacles and provide rescue services. They combine Artificial Intelligence (AI), Internet of Things (IoT), computer vision, and wireless communication technologies to deliver real-time monitoring and decision support. The proposed system may be implemented in defense surveillance, disaster response, search-and-rescue operations, and humanitarian operations. The project demonstrates the ability of autonomous air-ground robotic systems to reduce the risk to human operators and increase operational efficiency.

Keywords: Artificial Intelligence, Drone, Rover, GPS Navigation, Defense Technology, Emergency Response, Computer Vision, IoT, Robotics, Surveillance.

1. Introduction

Modern defense and disaster management have been transformed by the rapid development of technologies in Artificial Intelligence, Robotics, and the Internet of Things. Traditional surveillance and rescue operations tend to expose the staff to dangerous conditions, which leads to delays and increased risk.

Sanjeevani BattleShield project would be able to address these challenges by offering an integrated air-ground robotic system, which would consist of an intelligent surveillance drone and a rescue rover. The drone will provide aerial surveillance, location tracking, and real-time video delivery, while the rover performs ground-level inspection, obstacle navigation, and emergency support will be the duties of the rover.

The integration of two platforms enables the overall surveillance of the affected regions, and the system is very efficient in defence operations, disaster management and humanitarian missions.

2. Literature Review

Recent developments in unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs) have significantly extended their use in surveillance and rescue missions.

Studies have shown that drones with cameras and GPS can be effectively used to conduct aerial surveillance, reconnaissance, and mapping. Likewise, rover-based systems have also been found to be beneficial in hazardous conditions where humans have limited access or cannot reach.

Artificial Intelligence also improves such systems by enabling object detection, environmental analysis, and intelligent decision-making. Most of the existing systems are, however, independent, either aerial or ground platforms

Sanjeevani BattleShield project overcomes this drawback by combining both drone and rover technologies into a single intelligent system, which can carry out coordinated surveillance and rescue missions.

3. Objectives

The key aims of the project are:

1. To develop an AI-based integrated drone and rover system.
2. To provide real-time aerial and ground surveillance.
3. To enable accurate GPS-based navigation and tracking.
4. To support defense personnel in monitoring critical areas.
5. To assist rescue teams during disasters and emergencies.
6. To improve situational awareness through intelligent monitoring.
7. To reduce human exposure to hazardous environments.
8. To demonstrate the practical application of AI and robotics in defense and humanitarian fields.

4. System Architecture

Aerial Surveillance Drone

The aerial unit is a quadcopter drone designed for reconnaissance and monitoring.

Components

- ESP32 Microcontroller
- Four BLDC Motors
- Electronic Speed Controllers (ESCs)
- GPS Module
- Camera Module
- Li-Po Battery
- Wireless Communication System
- Drone Frame and Propellers
- Flight controller
- Propellers

Functions

- Real-time aerial surveillance
- GPS location tracking
- Live video streaming
- Area mapping and monitoring
- Threat identification

Ground Rescue Rover

The ground unit is an intelligent rover designed to operate in difficult terrain and disaster-affected areas.

Components

- ESP32 Microcontroller
- DC Gear Motors
- Camera Module
- Ultrasonic Sensors
- GPS Module
- Wireless Communication Module
- Battery System
- Rover Chassis

Functions

- Ground-level surveillance
- Obstacle detection and avoidance
- Navigation in hazardous environments
- Rescue support operations
- Delivery of emergency supplies

5. Methodology**Phase 1: Design and Development**

The drone and rover platforms are designed and assembled using lightweight and durable materials. Hardware components are integrated and tested individually.

Phase 2: Sensor Integration

GPS modules, blood pressure sensor, temperature sensor, cameras, ultrasonic sensors, and communication systems are connected to the ESP32 microcontroller.

Phase 3: Software Development

Control algorithms are developed for navigation, communication, monitoring, and AI-based analysis.

Phase 4: AI Implementation

Artificial Intelligence algorithms process incoming sensor data to identify threats, obstacles, unusual activities, and emergency situations.

Phase 5: Testing and Validation

The complete system undergoes multiple testing scenarios, including surveillance missions, obstacle navigation, and emergency response simulations.

6. Working Principle

Sanjeevani BattleShield is operated on a coordinated air-ground operation.

Step 1: Aerial Assessment

The drone is deployed to survey the target area. The camera captures live footage while the GPS module continuously tracks location coordinates.

Step 2: Data Analysis

Captured information is processed and analyzed using AI-based algorithms to identify potential threats, damaged areas, or victims.

Step 3: Ground Deployment

Once the target location is identified, the rover is deployed for detailed ground inspection and support operations.

Step 4: Obstacle Navigation

Ultrasonic sensors enable the rover to detect obstacles and navigate safely through complex terrain.

Step 5: Rescue Support

The rover provides close-range monitoring and can transport emergency medical supplies or communication equipment.

Step 6: Continuous Monitoring

Both platforms continuously transmit data to the command center, enabling informed decision-making and rapid response.

7. Results and Discussion

The prototype shows that aerial and ground robots can be used effectively to conduct surveillance and rescue operations.

Key Benefits

- Real-time monitoring capability
- Enhanced situational awareness
- Faster threat detection
- Accurate GPS tracking
- Improved rescue coordination
- Reduced risk to personnel
- Cost-effective deployment
- Multi-environment operation

The solution is useful in attaining operational efficiency that is significantly higher than that of single-drone or rover systems.

8. Applications**Defense and Security**

- Border surveillance
- Military reconnaissance

- Threat assessment
- Strategic monitoring

Disaster Management

- Flood assessment
- Earthquake response
- Damage evaluation
- Search and rescue missions

Public Safety

- Crowd monitoring
- Infrastructure inspection
- Smart city surveillance
- Emergency management

Healthcare and Humanitarian Aid

- Emergency medicine delivery
- Disaster relief operations
- Remote area support

Future Scope

Future improvements can include:

- Thermal imaging cameras
- AI-based victim detection
- Autonomous waypoint navigation
- Facial and object recognition systems
- Cloud-based monitoring platform
- Robotic rescue arm integration
- Advanced environmental sensing systems
- Swarm drone and rover coordination

This would help the system be more reliable and self-sufficient in real-life applications.

9. Conclusion

Sanjeevani BattleShield is an emerging AI-powered integrated drone and rover platform that will be developed for defence, surveillance, and emergency response applications. There is an integration of aerial surveillance and ground inspection and rescue services in the system, which allows a comprehensive method of control. Artificial intelligence, computer vision, GPS, wireless communication and robotics show that in the future, some of the practical problems will be solved with the help of modern technologies. The successful performance of this project illustrates their applicability to defence operations, disaster response, public safety, and humanitarian assistance.

References

1. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach. Pearson Education.
2. Kumar, P., et al. "IoT-Based Smart Monitoring Systems for Security Applications." IEEE Access.



3. IEEE Standards Association. UAV and UGV Surveillance Frameworks.
4. World Economic Forum. Artificial Intelligence and Public Safety Technologies.
5. CBSE Innovation and STEM Education Guidelines.
6. Research Papers on UAV-Based Disaster Management Systems.
7. Recent Studies on AI-Driven Drone and Rover Surveillance Technologies.