# COASTAL SECURITY DRONE FEATURED WITH DUAL BATTERY SOLAR CHARGING & SWAPPING SYSTEM

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**Keywords:**
Autonomous drone, battery swapping, coastal surveillance, computer vision, dual battery system, hazard detection, MPPT, solar charging

**Introduction:**

Coastal communities rely on fishing, tourism, and maritime activities but are highly vulnerable to sudden weather events. Traditional alert systems—such as sirens, radio, and patrols face issues like poor coverage, delayed communication, and lack of location-specific warnings, especially during fast-developing emergencies.

Although modern technologies like environmental sensing, AI, and drones improve monitoring, existing drone systems are limited by short flight times (10–15 minutes), reducing effectiveness in prolonged situations.

This work proposes an integrated solution featuring weather API-based autonomous deployment, computer vision for human detection, dual-battery intelligent switching, and solar-powered charging, enabling extended operation and real-time warnings in coastal risk zones. The figure 1 shows final look of the drone.

**Figure 1: Final look of the Drone**

**Objectives:**

1. To develop a stable drone structure capable of carrying solar panels, dual batteries, sensors, and all electronic modules efficiently.
2. To build an autonomous surveillance system that uses weather alerts, camera vision, and AI to detect humans or boats and provide immediate on site hazard warnings.

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**Methodology:**

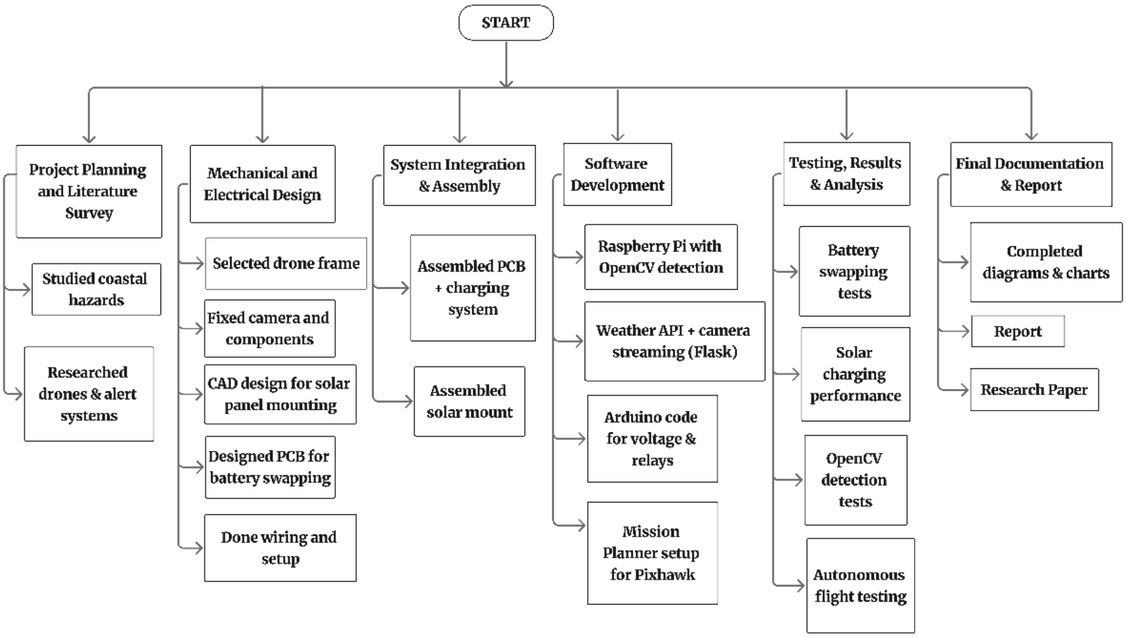


Figure 2: Block Diagram of Methodology

Figure 2 shows the complete development cycle of the coastal hazard alert drone system, covering all major stages from the beginning of the project to the final documentation phase.

**1. Project Planning and Literature Review**

The project started with structured planning and a review of existing coastal monitoring solutions. Research on coastal hazards and drone based alert systems helped define the system requirements and design strategy.

**2. Mechanical and Electrical Design**

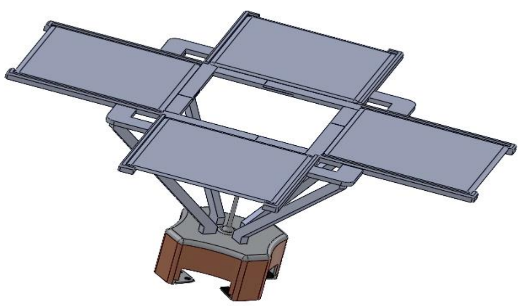

Figure 3: 3D model of Solar Panel Frame for Mounting the Solar Panels

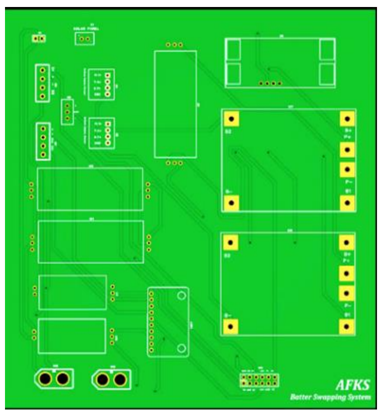


Figure 4: PCB development for Battery Swapping

The drone frame and components were selected, and the camera and sensors were mounted. Figure 3 shows that CAD modelling was used to create the solar panel mount, and Figure 3 shows that a custom PCB was designed for the battery swapping system. All wiring and electrical connections were completed during this stage.

### 3. System Integration and Assembly

**Figure 5: Complete Drone Assembly**

The Figure 5 shows the PCB, charging module, and solar mount were assembled and integrated into the drone. This phase ensured that the mechanical structure and electrical systems operated together smoothly.

### 4. Software Development

The Raspberry Pi was configured with OpenCV for detection, weather alerts were integrated through the API, and Flask was used for live streaming. Arduino code was written for voltage monitoring and relay control, while Mission Planner was configured for autonomous flight behaviour.

### 5. Testing and Result Evaluation

(a) (b)

Figure 6: Field Test: Drone going for Surveillance and Human Detection

The Figure 6 (a) shows the drone going for surveillance and (b) shows the human detection and the testing included battery swapping trials, solar charging assessment, OpenCV accuracy checks, and autonomous flight validation. Results were analyzed and used to fine tune system performance.

## 6. Final Documentation

The final report was prepared with all system details, including diagrams, test results, and technical explanations.

**Result and Conclusion:**

1. Flight testing showed that the dual battery + solar setup nearly doubled flight time (e.g., 10.4 - 21.1 minutes), despite added weight. Battery switching was seamless (≈200 ms) with stable voltage and 100% reliability.
2. Human detection accuracy reached 87% in daylight and ~72% in low-light, with low false positives (<8%) and real-time processing (~180 ms). Alerts were triggered within 340 ms, with an effective audible (50 m) and visual (100 m) range.
3. The system achieved stable 4G-based monitoring with 720p video (15–20 fps, ~500 ms latency) and reliable telemetry. Detection events and system data were transmitted in real time, with 99.2% uptime.
4. Autonomous navigation maintained ±2.5 m accuracy, and weather-triggered deployment worked reliably with <30 s response time.

In conclusion, the proposed system successfully enhances coastal monitoring by combining extended drone endurance, real-time detection, and autonomous deployment. Solar-assisted dual battery design overcomes traditional flight limitations, while AI-based detection and live monitoring enable rapid, location-specific alerts. Overall, the system demonstrates a scalable, reliable solution for improving safety in coastal hazard scenarios.

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**Future Scope:**

The future scope of this project includes:

1. Enhanced Autonomous Intelligence and Surveillance
2. Improved Power System and long endurance Flight Capability with extra payload capacity