SMART INDIA HACKATHON 2025

Autonomous Hybrid-Control Drone Swarm for Threat Detection and Defense

- **Problem Statement ID –** 25164
- **Problem Statement Title -** Designing an Efficient Algorithm for Coordinated Swarm Engagement among Autonomous Drones aiming to neutralize an adversarial drone swarm.
- **Theme-** Robotics and Drones
- **PS Category-** Software
- **Team ID -** 86511
- **Team Name -** CODEX.PY

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Autonomous Hybrid-Control Drone Swarm for Threat Detection and Defense [HDTD]

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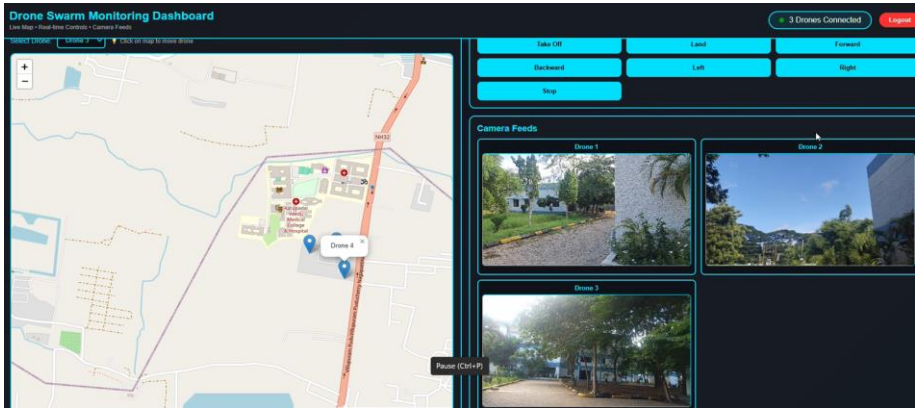
PROPOSED SOLUTION:

Autonomous Hybrid-Control Drone Swarm algorithm for Threat Detection and Defense compatible with all drone types and makes

- **Hybrid Control Centralized** mission planning with **autonomous decision-making** for each drone.
- Swarm Coordination Selecting a leader, controlling formations, and task allocation **based on Coordination.**
- **Autonomous Threat Handling** Avoiding obstacles, tracking targets, and **simulating neutralization.**
- Scalable Attack Mechanisms by Jamming models coordinated movements, and simulations using **Faraday methods.**
- Setting up a **circle of defence** to form a threat layer to **indicate other drones in swarm** for attacking maneuvers and capabilities

Our prototype for testing:



Uniqueness:

1. **Dual Command Mode** — Central & Distributed Control
2.**hybrid handoff** ensures the swarm never freezes even if the operator link fails- drones act intelligently using stored mission logic
3. **Operational Modes** (Mission-Level Control)-search mode, patrol-mode,defence mode
4.. Threat Recognition + Decision Layer + Emergency Override & Safe-Recovery Mode
5. Adding both **air-air attacks by jamming** and **air-ground attacks** in needed situations

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TECHNICAL APPROACH

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FRONT-END STACK

Core UI Technologies

HTML5, CSS3, and JavaScript form the foundation of the user interface.

Responsive Design

Ensures compatibility across various devices.

User Authentication

A simple login system ensures secure user access.

Interactive Mapping

Leaflet.js enables interactive map displays for drone data.

Real-time Communication

WebSocket facilitates real-time data exchange for control.

Camera Access

WebRTC and MediaDevices API provide access to device cameras.

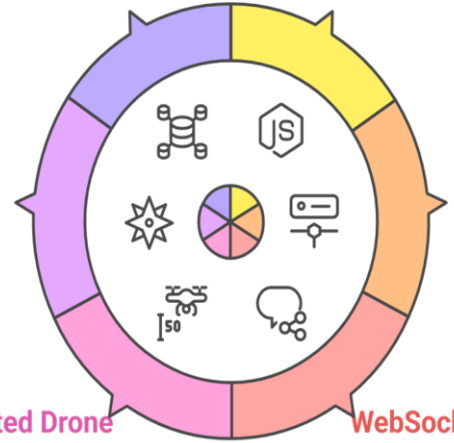
BACK-END STACK

Communication Layer

Not described.

Node.js Runtime

JavaScript runtime environment for backend operations.



Mission Control Logic

Manages missions, roles, and command broadcasting.

Express.js Framework

Web framework serving frontend files and managing routes.

Simulated Drone Engine

Generates periodic telemetry data like battery and position.

WebSocket Library

Enables real-time data exchange between frontend and backend.

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FEASIBILITY AND VIABILITY

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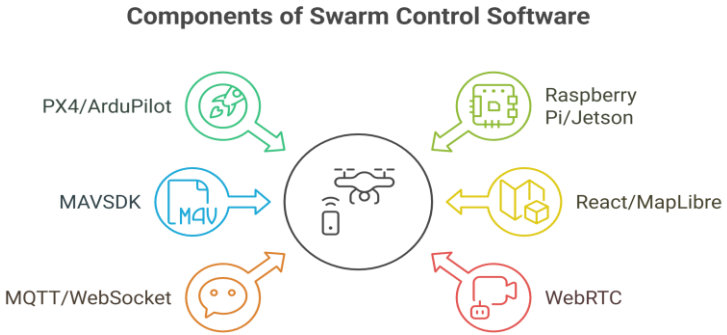
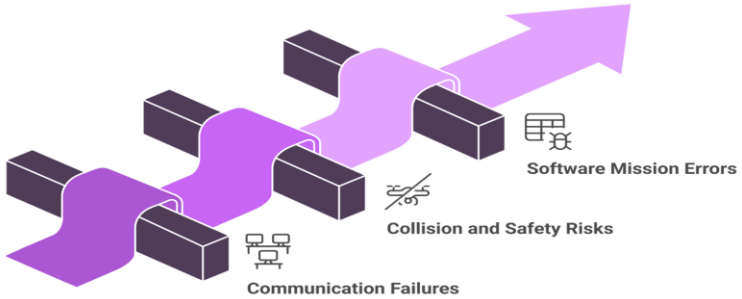
Analysis of the feasibility of the idea



- **Legally safe:** Fully compliant if it avoids jamming or weapons, with geofencing, fail-safes, secure comms, and regulatory approvals for drone operations.
- **Operationally scalable:** Phase-1 software MVP → SITL/HIL testing → small swarm demo (3–5 drones) → gradual scaling; Phase-2 minidrone demo showcases software capabilities effectively.

Technical viabilities in implementation



Strategies to Overcome Challenges

- **Robust networking & fail-safes** – LAN-first design, redundant Wi-Fi/mesh, heartbeat monitoring, and automatic hover/RTB on loss.
- **Collision avoidance & geofencing** – Software geofencing, safe altitude separation, and reactive collision avoidance (ORCA/RVO2).
- **Incremental testing & validation** – SITL → single-drone HIL → small swarm demo → scale; mission simulation and automated test scripts.

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IMPACT AND BENEFITS

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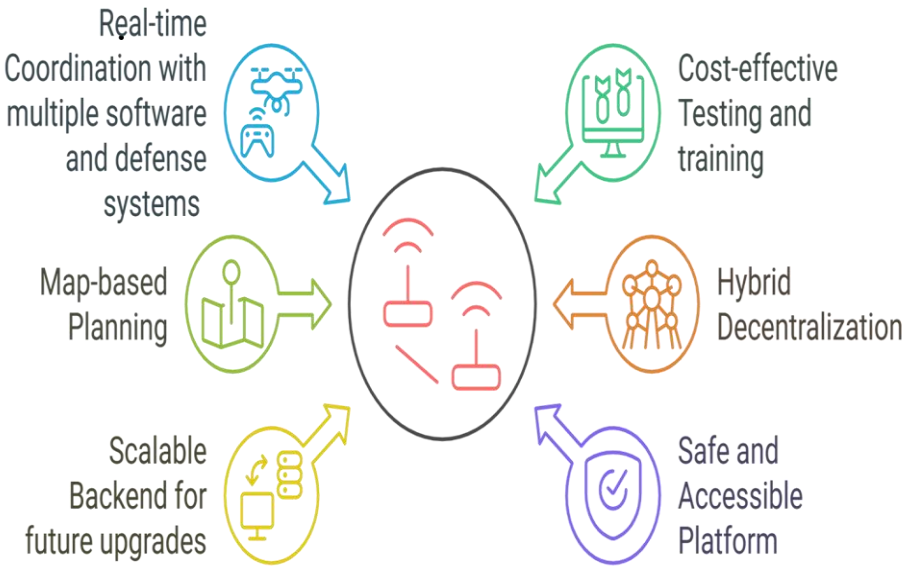
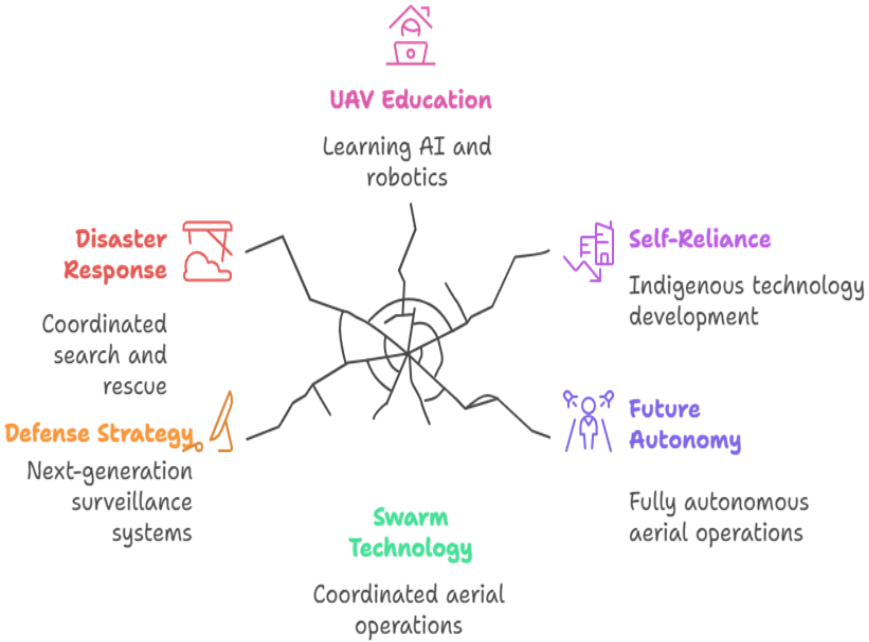
BENEFITS



IMPACT OVER OPERATIONS



RESEARCH AND REFERENCES

Details / Links of the reference and research work

USA fleet forces command"s project on swarm drones
[1] https://www.usff.navy.mil/Press-Room/News-Stories/Article/4225896/navy-successfully-demonstrates-swarm-mission-planning-tech
Mavlink protocols for information security in drone swarm
[2] https://dl.acm.org/doi/pdf/10.1145/3634737.3637672
Drone swarm coordination and characterization with radio frequency signals
[3] https://www.mdpi.com/1424-8220/23/3/1589
JTIR development of the surveillance drone setup
[4] https://www.jetir.org/papers/JETIR2504147.pdf
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[5] https://iopscience.iop.org/article/10.1088/1742-6596/2107/1/012018/pdf
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Collaborative drones in surveillance in indian conditions
[9] https://www.iadb.in/2024/12/31/swarm-intelligence-collaborative-unmanned-drone-systems-for-maritime-surveillance/
Types of drones in Indian Air Force in modern warfare
[10] https://www.insightsonindia.com/2025/06/10/drone-the-new-face-of-warfare/
MavSdk applications on drone development and building
[11] https://circuitcellar.com/research-design-hub/design-solutions/writing-mavsdk-px4-drone-applications/

Our Prototype Short Video

https://youtu.be/XBf8pqd_HZo

Github repo

Project_Repo_Click_Here