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PROJECT INFORMATION

- **Problem Statement ID**: 25015
- **Problem Statement Title:** Intelligent Pesticide Sprinkling System Determined by the Infection Level of a Plant
- **Theme:** Agriculture, FoodTech & Rural Development
- **Organization:** Government of Punjab
- **Category:** Hardware
- **Team ID:**
- **Team Name:** TopCoders

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INTELLIGENT PRECISION PESTICIDE SPRINKLING SYSTEM

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Solution/Idea:

Implementation of an Intelligent Precision Pesticide Sprinkling System using a Geo-Locating Dual Drone Setup with Imaging and Spraying Capabilities.

- ***Scout drone*** equipped with synchronized ***RGB and NIR cameras*** captures geo-tagged multispectral images for infection detection.
- ***Spraying drone*** follows infection heatmaps for targeted pesticide application, minimizing chemical use.
- Drone control and mission planning supported by ***FC-F722*** and ***Pixhawk flight controllers*** with u-blox M10 GNSS modules for precise navigation.
- Data preprocessing and edge AI inference are conducted on onboard **Jetson Nano** or **Raspberry Pi 5**.
- Communication via **FlySky FS-i6** controller, supplemented by 5G/LTE and LoRa for real-time telemetry and control.
- Data uploaded securely to the cloud using 5G/LTE or Wi-Fi, processed by AI models deployed on ***AWS, GCP, or Azure.***

Problem Resolution:

AI-Based Precision Pesticide Sprinkling System:

- Accurately **detects crop infections** using advanced imaging and AI analysis.
- Targets only infected zones, **cutting chemical use** and reducing environmental impact.
- Replaces blanket spraying, **lowering costs** and **protecting healthy crops.**
- Automates monitoring and spraying, **reducing labor** and **human error**.
- Delivers timely treatment, **improving yield** and crop quality.

Unique Value Proposition (UVP):

✈️**Dual-drone system** ensures precise detection and spraying, reducing pesticide use.

📡**Automatic data** upload via 5G/LTE or Wi-Fi for real-time monitoring.

☁️**AI cloud integration** delivers accurate infection classification.

🗺️**Geo-tagged maps** for targeted treatment decisions.

🔒**Encrypted data** accessible only to authorized users.

⚙️**Designed** to minimize operating costs while maximizing efficiency.

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TECHNICAL APPROACH

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Hardware:

Scout & Spray Drones (FC-F722/Pixhawk, RGB+NIR cams), brushless motors, 4-in-1 ESC, u-blox M10 GNSS/RTK, optical flow/range sensor, Jetson Nano/RPi 5 companion, FlySky FS-i6, 5G/LTE/LoRa, 5L tank, pump, precision sprayer, charging dock.

Machine Learning:

TensorFlow ONNX PyTorch FastAPI OpenCV

Website / Backend:

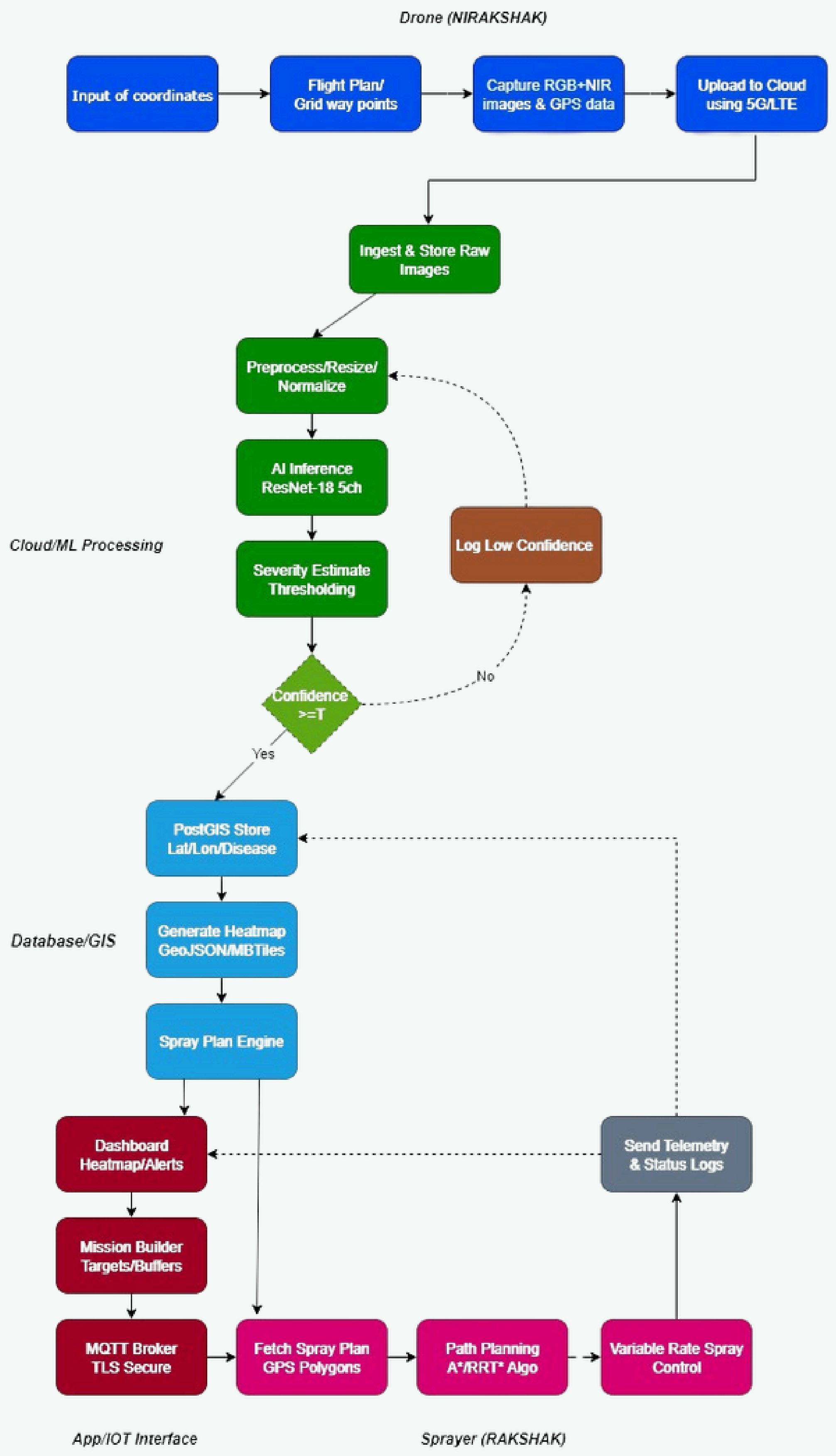
React (Vite) frontend, Express/Node.js backend, WebSocket, ML inference microservice, Firebase/Firestore, PostgreSQL.

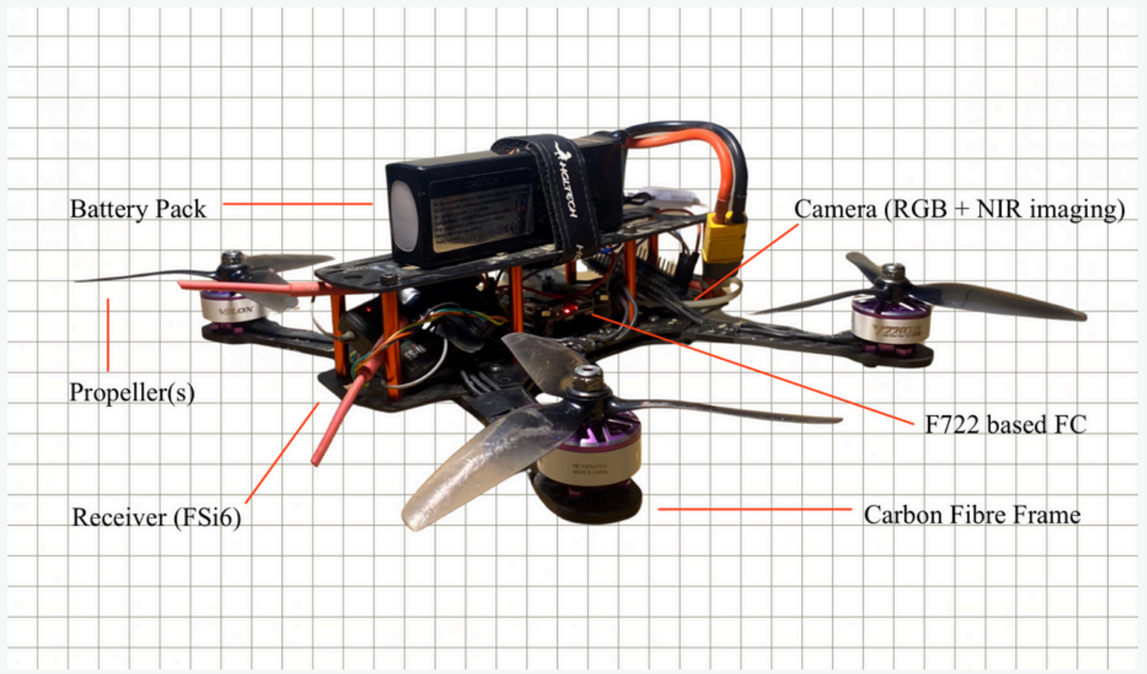
Application Development:

React Native (Expo) mobile, React PWA, offline (IndexedDB, Service Worker), QGroundControl integration.

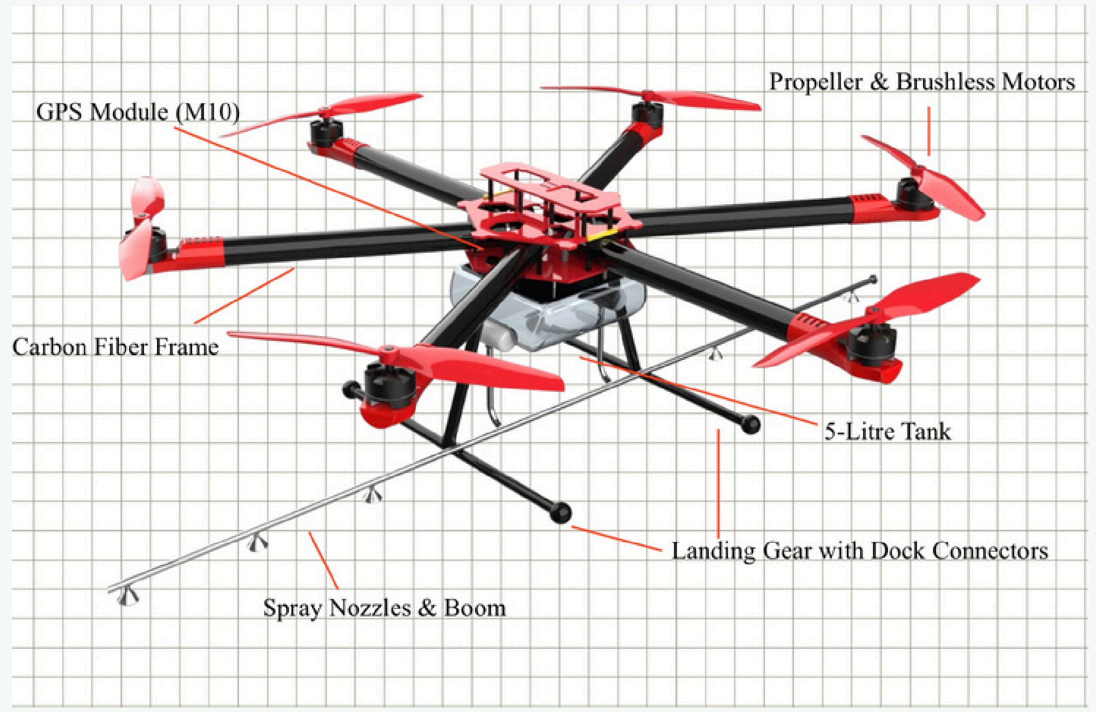
Cloud & DevOps:

AWS IoT/Core, Lambda, SNS, S3, DynamoDB/RDS, Elastic Beanstalk/ECS/EKS, GCP/Azure optional, CloudFront, Terraform.





(a) Scouting Drone fitted with F722 FC, FSi6 Receiver and NIR+RGB imaging camera



(b) Spray Drone equipped with M10 GPS module, 5L Capacity Tank, Spray Nozzles and Boom

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FEASIBILITY AND VIABILITY

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Feasibility

⚙️ Technical Feasibility

All system components - including drones, sensors, companion computers, and communication modules - are commercially available and proven. Initial expertise required for setup, but routine maintenance is simplified via automated diagnostics and remote monitoring.

💰 Financial Feasibility

Estimated one-time capital expenditure (CAPEX) for full system assembly and deployment ranges between ***₹1,15,000 to ₹1,75,000*** per hub. This includes drones, cameras, edge computing, software, and autonomous docking systems.

🔧 Operational Feasibility

Efficient maintenance and damage control reduce future running costs. Cloud service subscriptions are capped at ***₹5,000 to ₹10,000*** monthly. Variable costs account for hardware replacement and miscellaneous consumables.

📈 Market Demand

Strong demand exists among Indian farmers seeking affordable, precision pesticide solutions. The system offers a cost-effective alternative to expensive commercial drones with added features like community ownership and shared service models.

Overcoming Challenges

Protecting drones from farm hazards
Heavy-duty airframes and sealed electronics resist dust, spray, and rough landings to reduce field damage and downtime.

Maintaining precision despite GPS or signal loss
Backup GNSS/RTK, on-board flight ogging, and image buffering ensure reliable mapping even with connectivity drops or weak GPS.

Connectivity gaps and interrupted data flows
Seamless shifting between LTE, Wi-Fi, and LoRa modules, with secure caching, guarantees no data loss or mission interruption.

Minimizing false detections and misclassification
Data from RGB+NIR, zone overlap, and ML cross-checking filters out noise and continuously improves accuracy through farmer validation.

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IMPACT AND BENEFITS

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Impact on target audience

Positive Impacts:

Pesticide reduction: targeted spraying cuts inputs by ~30–45% per season on treated plots.

Cost efficiency: ~20–30% lower spend on chemicals and labor via zone-based missions.

Time saved: 3–5× faster scouting/spraying versus manual coverage.

Negative Impacts:

Weather/terrain limits: wind, rain, dense canopy, or uneven fields can affect image quality and spray uniformity.

Maintenance & training: batteries, pumps, nozzles, and firmware need care; operators require periodic upskilling.

Benefits of solution

Social Benefits:

Improved Access: *Safer* and more comfortable journeys.
Empowerment: Empowers railways with *data-driven decisions*, enhancing the ability to preemptively maintain infrastructure.
Reduction in Accidents: *Significant reduction* in accidents caused by faulty tracks.

Economic Benefits:

Increased Productivity: Automation of inspections and real-time monitoring leads to more *efficient track maintenance.*
Cost Reduction: Reduces *long-term manual inspection costs* and *minimizes train delays* due to maintenance. .

Environmental Benefits:

Energy Efficiency: Efficient monitoring *reduces the need for manual inspections*, which helps in cutting costs.
Waste Reduction: Reduces infrastructure wear and tear by *identifying defects early*, thereby lowering resource waste.
Sustainable Maintenance: *Optimizes maintenance schedules*, ensuring less frequent and more targeted interventions.

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RESEARCH AND REFRENCES

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