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Smart Drone System for Apple Orchards

- **Problem Statement ID –** SIH1611
- **Problem Statement Title-** Drone-Based Intelligent Apple Orchard Management in Himachal Pradesh
- **Theme-** Agriculture, FoodTech & Rural Development
- **PS Category-** Hardware
- **Team ID-** 41
- **Team Name (Registered on portal) –** Aikyam Innovators

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Smart Drone System for Apple Orchards

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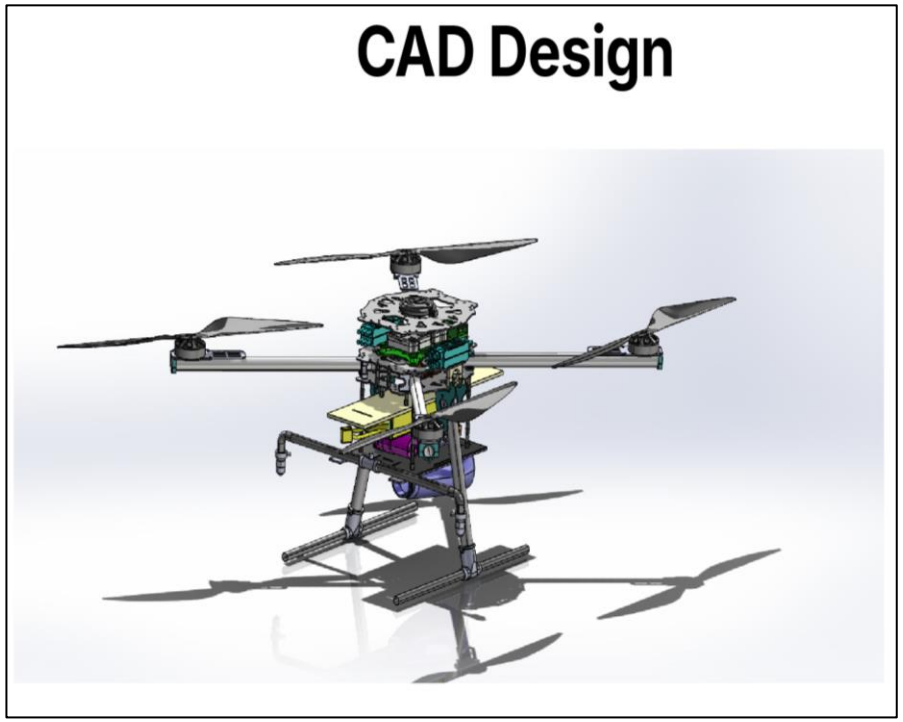
❖ Design a Smart Drone System to achieve the solution to the proposed problem statement in the following ways -

- The proposed drone aims to use thermal imaging, multispectral imaging, multiple sensors and efficient flight control to achieve the given objectives.
- It aims to address the solution to the problem statement by-
  1. Monitoring Plant Health
  2. Using Deep Learning Models to Predict Yields
  3. Using Variable Rate Technology [VRT] to spray fertilizers
- The proposed smart drone system aims to fill the **implementation gap** by using specific technology to achieve objectives, while proposing a significantly **LOW-COST Indigenous Solution**.



Full CAD Design

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TECHNICAL APPROACH

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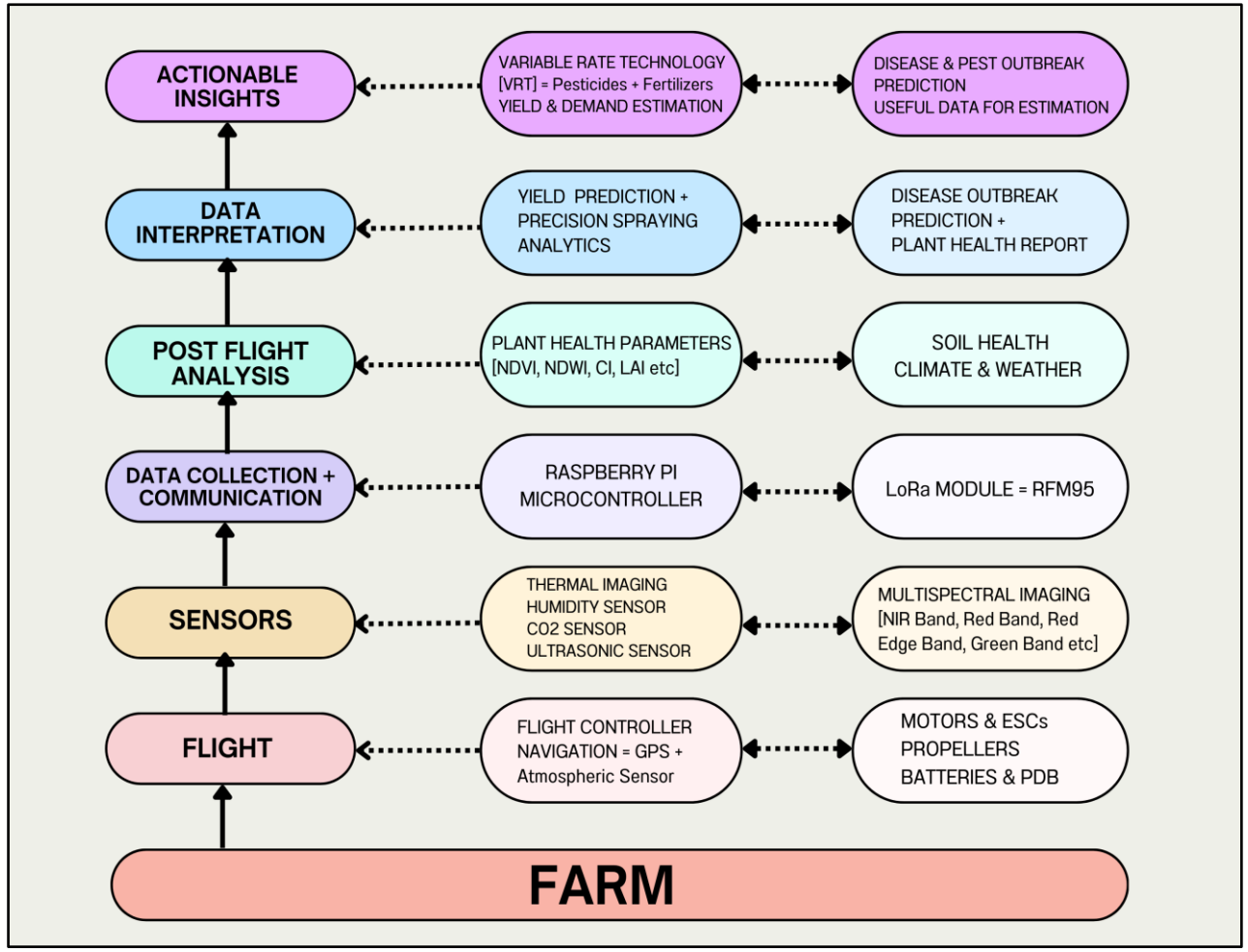
Electronic Components

Component	Model
Flight Controller	Pixhawk PX4
GPS Module	Ublox NEO-M8N
PDB	Matek PDB-XT90
Multispectral Camera	Filters [NIR, Red, Red Edge, Green]
Thermal Camera	Waveshare MLX90640
RGB Camera	Raspberry Pi Camera Module 3 NoIR [5]
Communication Module	RFM95 LoRa Module
Microcontroller	Raspberry Pi 4/5
Minor Sensors	DHT22, BMP280, MH-Z19, HC-SR04
ESC	T Motor F60A
Controller	Ground Station Interface

Mechanical Components

Component	Model
Spraying System	1. Tank Material - High Density Polyethylene [HDPE] Capacity - 10L 2. Sprinkler TeeJet AIXR 11004-VP
Frame	Material - Carbon Fiber or Aluminum Alloy Dimensions - 1000mm to 1200mm (Diagonal Motor-to-Motor)
BLDC Motor	3508 700KV
Propellers	Gemfan 15×6 [15 inch]
Battery	Tattu 6S 22000mAh 22.2V 25C LiPo Battery Pack



[All Component Documentation]

[Flight Duration & Weight Documentation]

[Datasheet Documentation]

[Working Principle]

[Estimated Budget]

We have prepared extensive documentation for each section of our project proposal, we request you to kindly click on the respective links and assess them.

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FEASIBILITY AND VIABILITY

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- **Limitations:**

1. Expensive Multispectral Cameras [3L+ INR]
2. Limited Range of inbuilt communication modules

- **Solutions:**

1. Low-Cost DIY Spectral Band Cameras by using filters with RGB cameras

i. NIR band [700-1000nm]

ii. Red band [620-750nm]

iii. Red Edge band [700-750nm]

iv. Green band [500-600nm]

2. Using LoRa Modules for long range communication

- The proposed solution to the multispectral cameras **reduces costs by 70-80%** for multispectral imaging, while providing the same functionality.

Plant Health Parameters

Vegetation Index	Formula	Expresses	Required Spectral Bands
NDVI [Normalized Difference Vegetation Index]	(NIR - RED) / (NIR + RED)	Health and vigor of vegetation	NIR (700-1000 nm), RED (620-750 nm)
GNDVI [Green NDVI]	(NIR - GREEN) / (NIR + GREEN)	Green pigment content in vegetation	NIR (700-1000 nm), GREEN (500-600 nm)
CI [Chlorophyll Index]	(NIR - RED) / (NIR + RED - GREEN)	Chlorophyll content in vegetation	NIR (700-1000 nm), RED (620-750 nm), GREEN (500-600 nm)
LAI [Leaf Area Index]	ln(NIR / RED)	Leaf area per unit of ground surface	NIR (700-1000 nm), RED (620-750 nm)
NDWI [ND Water Index]	(GREEN - NIR) / (GREEN + NIR)	Water content in vegetation	GREEN (500-600 nm), NIR (700-1000 nm)
RE NDVI [Red Edge NDVI]	(NIR - RE) / (NIR + RE)	Chlorophyll content and plant stress	NIR (700-1000 nm), RE (700-750 nm)

Plant Health Parameters Documentation

Cost Analysis of Multispectral Cameras

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IMPACT AND BENEFITS

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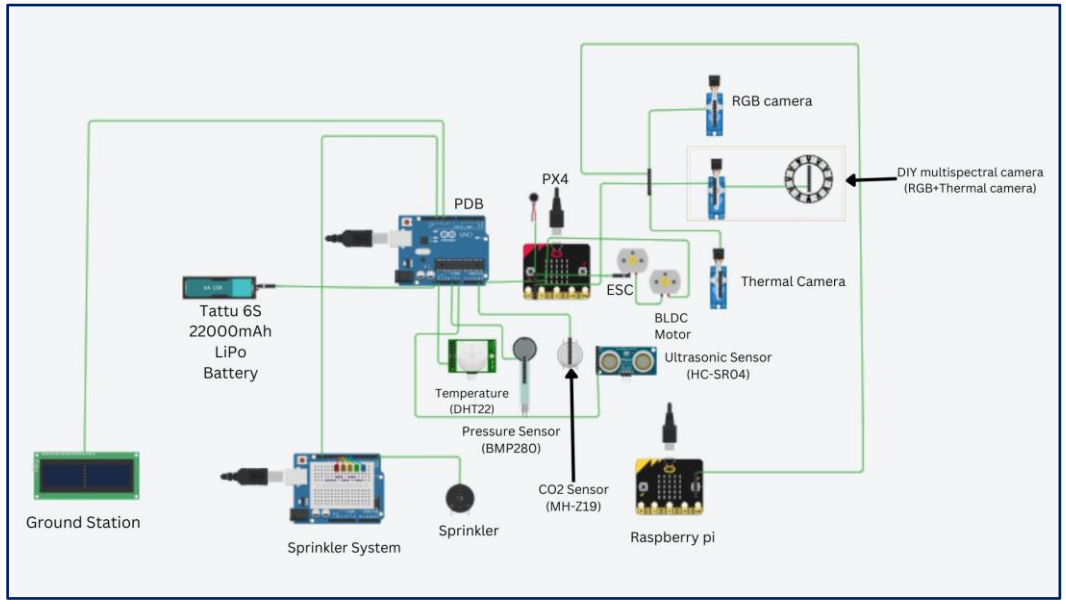
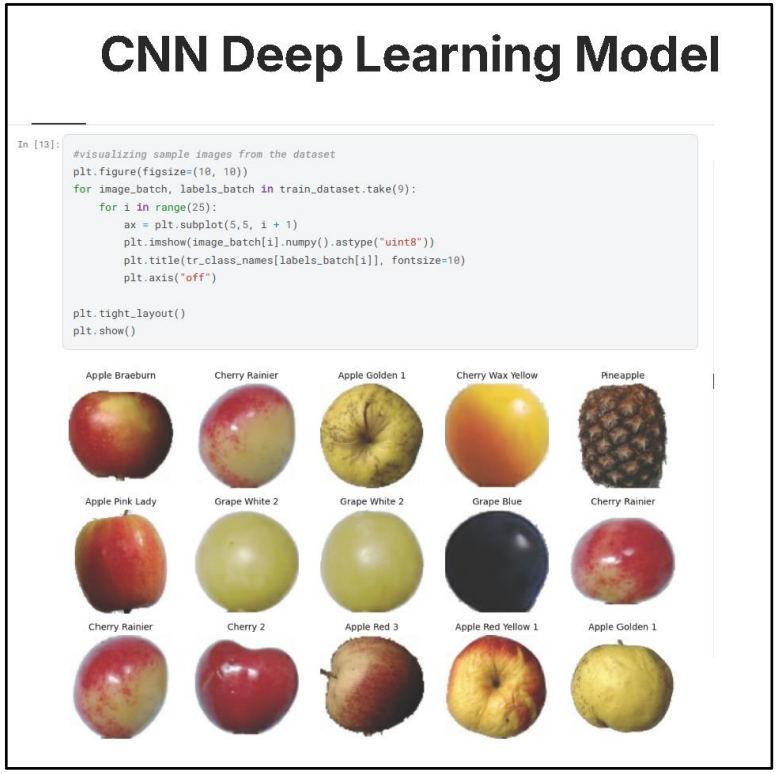
BRIEF ELECTRONIC CIRCUIT DIAGRAM





- Early detection of plant disease. Crop management & Yield prediction leads to better produce, ultimately leading to higher income.
- Future Scope – Autonomous Navigation
- Novelty – Low-cost solution for expensive multispectral cameras, **reducing overall drone cost by 70%** compared to commercial drones in India.

Deep Learning Model Documentation

Detailed Electronic Circuit Diagram

Cost-Feature-Benefit Analysis

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RESEARCH AND REFERENCES

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- Himachal Pradesh Apple Orchard Details
- Working Principle
- Estimated Budget
- Electronic Circuit Diagram
- Plant Health Parameters
- Flight Duration & Weight Calculation Documentation
- Cost-Feature-Benefit Detailed Analysis
- Literature –
  - AgrOne Drone Design
  - Application of Drone in Agriculture
  - Design and Development of a Drone for Spraying Pesticides, Fertilizers and Disinfectants
  - Custom and Design of Agri Drone
- All Component Documentation
- Datasheet Documentation
- Deep Learning Model Documentation
- Electronic Component Documentation
- Mechanical Component Documentation
- Expected Progress Timeline
- Multispectral Camera Solution Cost Analysis