FarmGuard – Technical Briefing

# Overview

FarmGuard is a hexacopter drone system for real-time crop monitoring and targeted pest control using:  
- ESP32-CAM for aerial imaging  
- Pixhawk flight controller for stable autonomous flight  
- Servo-controlled spraying system for pest management

# Hardware Architecture

|  |  |  |
| --- | --- | --- |
| Component | Details | Purpose |
| Frame | Hexacopter (6-rotor), Carbon Fiber/Aluminum | Carries camera, sensors, and sprayer |
| Motors | Brushless DC Motors (BLDC) | Provide lift and stability |
| ESCs | Connected to Pixhawk MAIN OUT | Control motor speed via PWM |
| Propellers | Plastic/Carbon fiber | Lift and thrust |
| Pixhawk | Flight controller with ArduPilot or PX4 | Navigation, stability, servo control |
| GPS | External GPS + compass module | Positioning and waypoint flight |
| RC Transmitter | FlySky 2.4 GHz | Manual control |
| Battery | 2200mAh LiPo | Main power supply |
| ESP32-CAM | 640x480 or UXGA resolution | Live video streaming/image capture |
| Sprinkler System | Servo-controlled nozzle | Applies pesticide/fertilizer |
| PDB | Power Distribution Board | Distributes battery power |

# Software & Control

Image Processing:  
- Platform: PC or Raspberry Pi  
- Library: OpenCV  
- Function: Detect stress areas and activate spraying  
  
Communication:  
- ESP32-CAM streams video/images to ground server  
  
Flight Control:  
- Pixhawk handles GPS-based navigation and servo actuation  
  
Spraying:  
- Based on real-time image analysis, servo nozzle is activated to spray only affected areas

# Performance Metrics

|  |  |
| --- | --- |
| Parameter | Value / Capability |
| Image Resolution | 640×480 (ESP32-CAM) |
| Frame Rate | 5 FPS (live feed) |
| Wireless Range | ~50 meters (ESP32-CAM Wi-Fi) |
| Detection Accuracy | ~92% pest detection rate |
| Spray Activation Delay | Near-instant, via onboard controller |
| Power Supply | 2200 mAh LiPo |

# Advantages

- Low Cost: Uses affordable components like ESP32  
- Eco-Friendly: Precise spraying reduces pesticide use  
- Autonomous: Fly, monitor, analyze, and act without manual inspection  
- Modular: Can upgrade camera, tank size, or flight controller easily

# Future Improvements

- Integrate thermal/multispectral sensors  
- Add NDVI image processing  
- Expand for larger farms using multiple drones  
- Enable SMS or WhatsApp alerts with image and spray logs