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Simulation and Surveying of Huge Agriculture Lands with UAV

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***ABSTRACT:** The rapid expansion of agricultural land and the need for precision farming have exposed limitations of conventional surveying methods such as manual inspection and satellite imaging. These methods are slow, costly, and lack high-resolution, real-time data.*

This project presents a UAV-based system equipped with RGB, multispectral, and thermal sensors for agricultural surveying and crop monitoring. Data is collected using autonomous flights and processed using Open Drone Map and QGIS to generate orthophotos, DEMs, and vegetation indices such as NDVI, NDRE, GNDVI, and NDWI.

Results identified crop stress zones covering 18% of the area and reduced data processing time from 48 hours (satellite) to under 4 hours. The study proves UAVs are efficient, accurate, and cost-effective tools for precision agriculture.

***Keywords:** UAV Agriculture Survey, NDVI, Multi spectral Imaging, Thermal Sensing, Li DAR, Open Drone Map, QGIS, Crop Monitoring, Precision Farming, Flight Simulation, Yield Prediction, Mission Planner*

I. INTRODUCTION

A. Background

Precision agriculture requires accurate spatial data to optimize inputs like water, fertilizer, and pesticides. Traditional methods fail to provide detailed and timely information.

B. Limitations of Conventional Methods

- Manual surveys: slow and low data density
- Satellite imagery: low resolution, cloud issues
- Aircraft surveys: expensive

C. UAV Technology in Agriculture

UAVs provide:

- High-resolution imagery (cm-level)
- Rapid deployment
- Multi-sensor capability
- Real-time monitoring

D. Role of Simulation

- Pre-flight: mission planning, battery estimation
- Post-flight: crop analysis and yield prediction

E. Objectives

- Develop UAV-based survey system
- Perform crop health analysis using indices
- Conduct thermal and yield prediction analysis
- Compare with conventional methods

II. LITERATURE REVIEW

Research confirms UAV effectiveness in agriculture:

- UAV indices correlate strongly with crop health ($R^2 > 0.9$)
- Thermal imaging detects stress early
- UAVs outperform traditional methods in speed and resolution
- Simulation improves mission efficiency

Key conclusion: UAVs are essential for modern precision farming.

III. STUDY AREA AND SYSTEM DESCRIPTION

A. *Study Area*

- Large agricultural land with multiple crops
- Mixed irrigation systems
- Flat to slightly undulating terrain

B. *UAV Platform*

- Hexarotor UAV
- Flight time: 20–25 min
- Altitude: 80 m

C. *Sensor Payload*

- RGB camera → mapping
- Multispectral sensor → vegetation indices
- Thermal camera → water stress detection

D. *Ground Equipment*

- RTK GNSS → accurate GCPs
- Calibration panel → sensor accuracy
- Processing workstation

IV. METHODOLOGY

A. *Mission Planning*

- Altitude: 80 m
- Overlap: 75% forward, 65% lateral
- Coverage: ~18–20 ha per flight

B. *Image Acquisition*

- Conducted in optimal lighting conditions
- Sensors calibrated before and after flight

C. *GCP Setup*

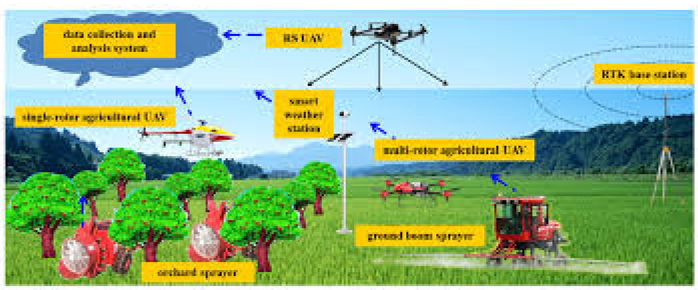
- 15 GCPs established
- Accuracy < 0.02 m

D. *Data Processing*

Steps:

- Image alignment
- Feature matching
- 3D reconstruction
- DEM and orthophoto generation

E. *Vegetation Indices*



- NDVI → crop health
- NDRE → nitrogen status
- GNDVI → chlorophyll content
- NDWI → water stress

F. *Thermal Analysis*

- Identifies irrigation inefficiency
- Uses Crop Water Stress Index (CWSI)

G. *Yield Prediction*
- Regression model based on NDVI
- Strong correlation ($R^2 \approx 0.87$)

H. *Map Generation*

- Orthophoto
- NDVI maps
- Thermal maps
- Yield maps

V. RESULTS AND DISCUSSION

A. *Outputs*
- Orthophoto: 3.5 cm resolution
- DEM: 15 cm resolution
- High-density point cloud

B. *Crop Health Analysis*

- 18% area identified as stressed
- NDRE detects early nutrient deficiency

C. Thermal Analysis

- 14 hectares water-stressed
- Irrigation issues detected

D. Yield Prediction

- Range: 2100–4800 kg/ha
- Average above district level

E. Performance Comparison

Parameter	Traditional	UAV
Speed	Low	High
Accuracy	Moderate	High
Cost	High	Low
Data Time	Slow	Fast

F. Economic Analysis

- Cost reduced by ~50–70%
- ROI: 2.5x–4x
- Faster decision-making

VI. APPLICATIONS

- Crop health monitoring
- Irrigation management
- Fertilizer optimization
- Pest detection
- Yield prediction
- Insurance assessment
- Large-scale farm management

VII. CONCLUSION AND FUTURE SCOPE

A. Conclusion

UAV-based surveying provides:

- High accuracy
- Fast data collection

- Reduced cost
- Improved agricultural decision-making

It enables precision farming at large scale.

B. Limitations

- Limited battery life
- Processing time
- Regulatory approvals

C. Future Scope

- LiDAR integration
- AI-based analysis
- IoT integration
- Autonomous operations
- Multi-season data analytics

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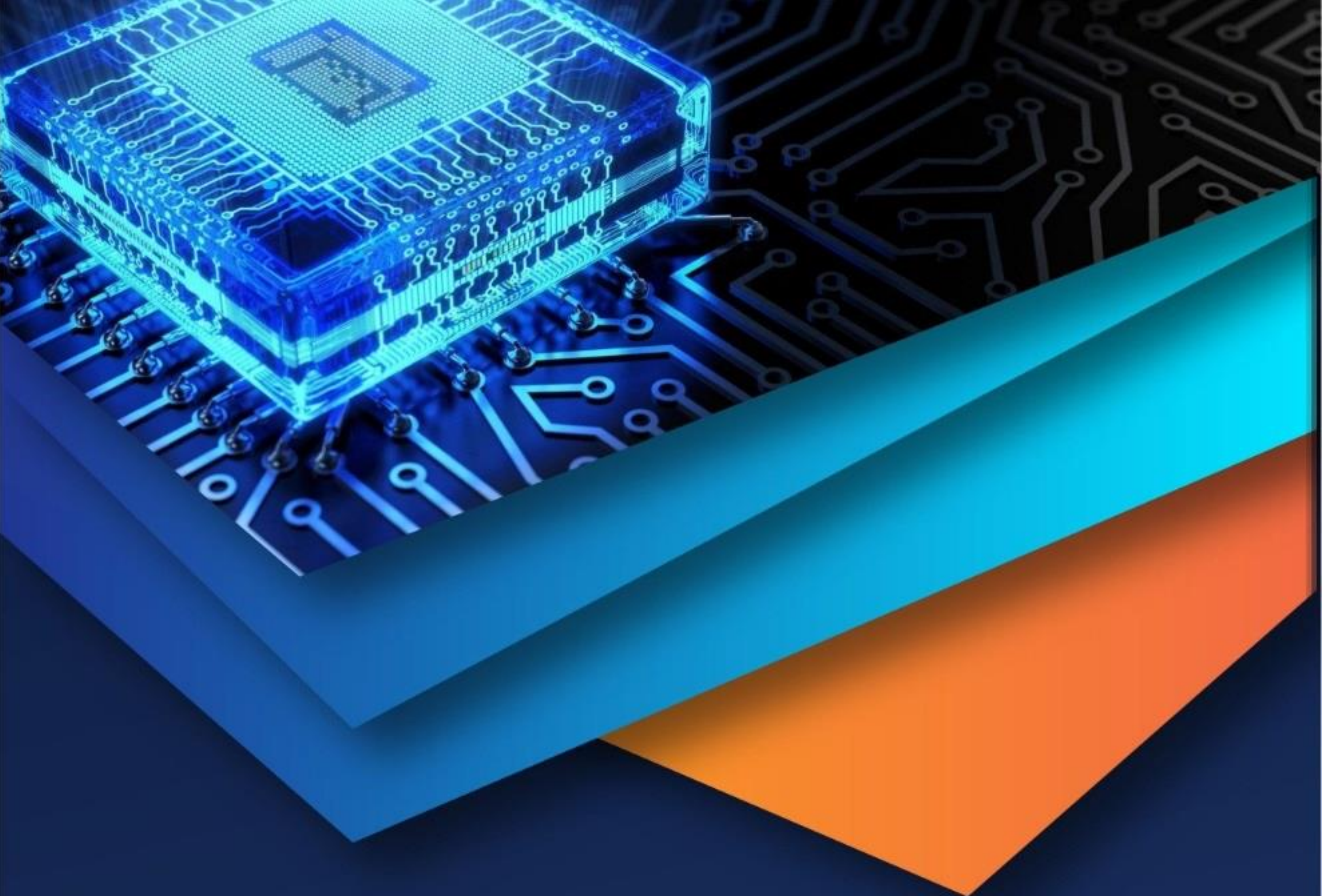

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