Crop Health Monitoring using Drone Imagery and AI

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Abstract

Crop health monitoring plays a vital role in precision agriculture, helping farmers and researchers detect early growth stages, bare soil, and potential diseases. This project leverages drone-based RGB and multispectral imagery to generate Normalized Difference Vegetation Index (NDVI) values using PIX4Dfields. The NDVI data is then used to train a machine learning model based on YOLOv8 for predicting NDVI from RGB drone images. Finally, a Streamlit-based web application was deployed, allowing users to upload drone images and receive real-time NDVI estimations for crop health monitoring. This approach provides a cost-effective, accessible, and efficient tool for agricultural decision-making.

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Chapter 1

Introduction

Agricultural productivity heavily depends on timely monitoring of crop health. NDVI (Normalized Difference Vegetation Index) is a widely accepted metric for vegetation monitoring and assessment of crop vigor. Traditionally, NDVI requires specialized multispectral sensors, which are costly and less accessible. This project explores the use of drone-based RGB and multispectral imagery combined with AI to predict NDVI and deploy it as a user-friendly tool for real-time crop monitoring.

1.1 Objectives

- To generate NDVI values from RGB and multispectral drone images using PIX4Dfields.
- To train an AI model (YOLOv8) for predicting NDVI values from drone images.
- To develop a Streamlit web application for real-time NDVI estimation and crop health analysis.

Chapter 2

Methodology

2.1 Data Collection

Drone-based RGB and multispectral images were collected from agricultural fields. These images served as the primary dataset for generating ground-truth NDVI values.

2.2 NDVI Generation

PIX4Dfields trial version was used to process RGB and multispectral images and compute ground-truth NDVI indices. These NDVI maps were then used for training and validation.

2.3 Machine Learning Model

- YOLOv8 was used primarily as a **feature extractor**.
- The extracted features were mapped to NDVI values through a regression approach.
- The model was trained and validated on Google Colab.

2.4 Deployment

A Streamlit web application was developed where users can upload drone images. The trained model processes the input and outputs NDVI estimations in real time.

Chapter 3

Results

The YOLOv8-based model demonstrated the feasibility of using RGB imagery for NDVI estimation. Predictions were compared with ground-truth NDVI generated from PIX4Dfields.

- NDVI classes such as bare soil, early growth, healthy vegetation, and dense vegetation were successfully identified.
- The Streamlit app enabled real-time NDVI estimation, making the tool accessible to non-technical users.

Chapter 4

Conclusion

This project demonstrated a practical approach to crop health monitoring using drone imagery and AI. By combining PIX4Dfields-generated NDVI with a YOLOv8-based regression model, and deploying the system through Streamlit, a cost-effective and accessible solution for precision agriculture was developed. Future improvements could involve larger datasets, alternative CNN regression models, and integration with IoT sensors for continuous monitoring.

Chapter 5

References

1. Rouse, J. W., et al. ”Monitoring vegetation systems in the Great Plains with ERTS.” NASA special publication 351 (1974): 309.

2. Ultralytics YOLOv8 Documentation: `https://docs.ultralytics.com`

3. PIX4Dfields Documentation: `https://www.pix4d.com/product/pix4dfields`

4. Streamlit Documentation: `https://docs.streamlit.io`