# USING DRONES AND AI FOR CROP HEALTH MONITORING

## INTRODUCTION

Our project's goal is to have a modular system for crop monitoring, to be mounted on a drone or tractor. Our system uses a multispectral camera for imaging and a Raspberry Pi computer for communication.

## OBJECTIVE

The main objective for our group is to put together a more accessible crop monitoring system than is currently available. This is to be done by creating an open source learning model that could be trained to specific crop types. Our end goal is to also find a cheaper camera and drone combination to make our findings more financially accessible.

## PARTS

Camera - Micasense Red Edge MX
Computer - Raspberry Pi 5
Drone - Holybro X650 development kit
Batteries - Drone and Module
Cables
Enclosure - 3D printed
Web Interface and Cloud Computing

X650 Development kit drone with camera module attached.

Local vineyard where live testing will be executed.

## TESTING & RESULTS

Data Preparation:
• Input: aligned multispectral images (Blue, Green, Red, NIR, RedEdge).
• Feature Engineering:
– Compute vegetation indices (NDVI and NDRE) from the Red, NIR, and RedEdge bands.
– Combine these indices with the original 5 bands to form a 7-channel image.
• Normalization & Labeling:
– Normalize each channel using global statistics computed over the dataset.
– Extract 64×64 pixel tiles from the imagery and label them using geospatial shapefiles that delineate vine rows, disease clusters.
– Total samples: ~1500 non-vine ~1500 vine with 824 labeled as diseased.
– In masked (non-relevant) regions, NDVI/NDRE values are set to 0 to avoid spurious signals. Model Architecture & Training:
• Network: A modified ResNet-18 adapted to accept 7-channel inputs
• Tasks:
– Vine Detection Model: Classifies tiles as vine or non-vine.
– Disease Classifier: Operates on vine-positive tiles to classify them as diseased vs. healthy.
• Training Details:
– Data augmentation (random rotations, flips) is applied.
– Models are trained using cross-entropy loss and the Adam optimizer.

Evaluation & Visualization:
– classified vines at an F1 score of ~0.946, disease clusters of ~0.880. Results in a theoretical F1 score of ~0.832 for the entire pipeline (0.946 x 0.880)
– Grad-CAM is applied to the disease classifier to generate heatmaps that highlight disease relevant regions.
– Bounding boxes are automatically extracted from the CAM output and applied to an rgb composite image

| Vine Classifier | Precision | Recall | F1 Score |
| --- | --- | --- | --- |
| 0 | 0.9724 | 0.9216 | 0.9463 |
| 1 | 0.9216 | 0.9724 | 0.9463 |
| Average F1 | | | 0.9463 |

| Disease Classifier | Precision | Recall | F1 Score |
| --- | --- | --- | --- |
| 0 | 0.9189 | 0.6800 | 0.7816 |
| 1 | 0.8760 | 0.9741 | 0.9224 |
| Average F1 | | | 0.8800 |

## FUTURE PLANS

When conditions are favorable testing will commence in a vineyard northwest of Cincinnati. This testing will be done to confirm the theoretical testing we have completed with the learning models. This will show whether our models will be able to interpret brand new images in live testing conditions.

## CONCLUSION

There is a functioning prototype that is ready to be tested; it may be possible to test before the end of the month. Currently we are limited by the weather and crop growth for live field testing.
In the future we would like to find cheaper alternatives for both the drone and camera to make the technology more accessible.

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