Deep Learning for Maize Mutants: Phenotyping Individual Plants Using UAS Images

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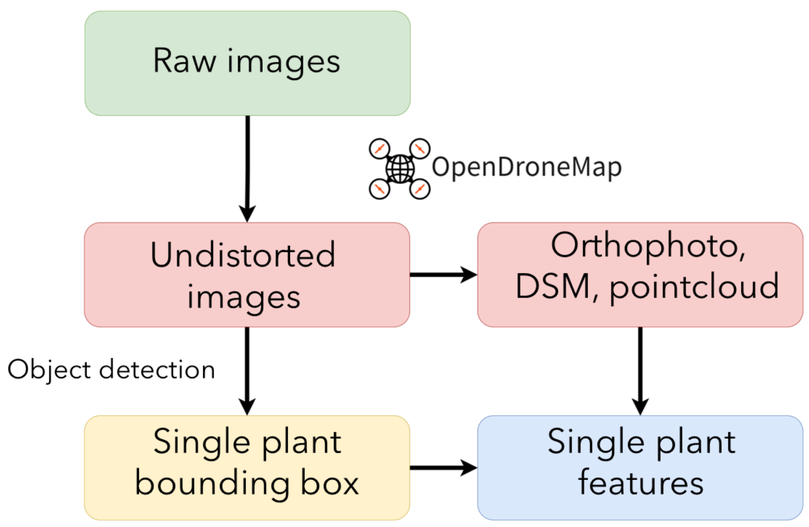
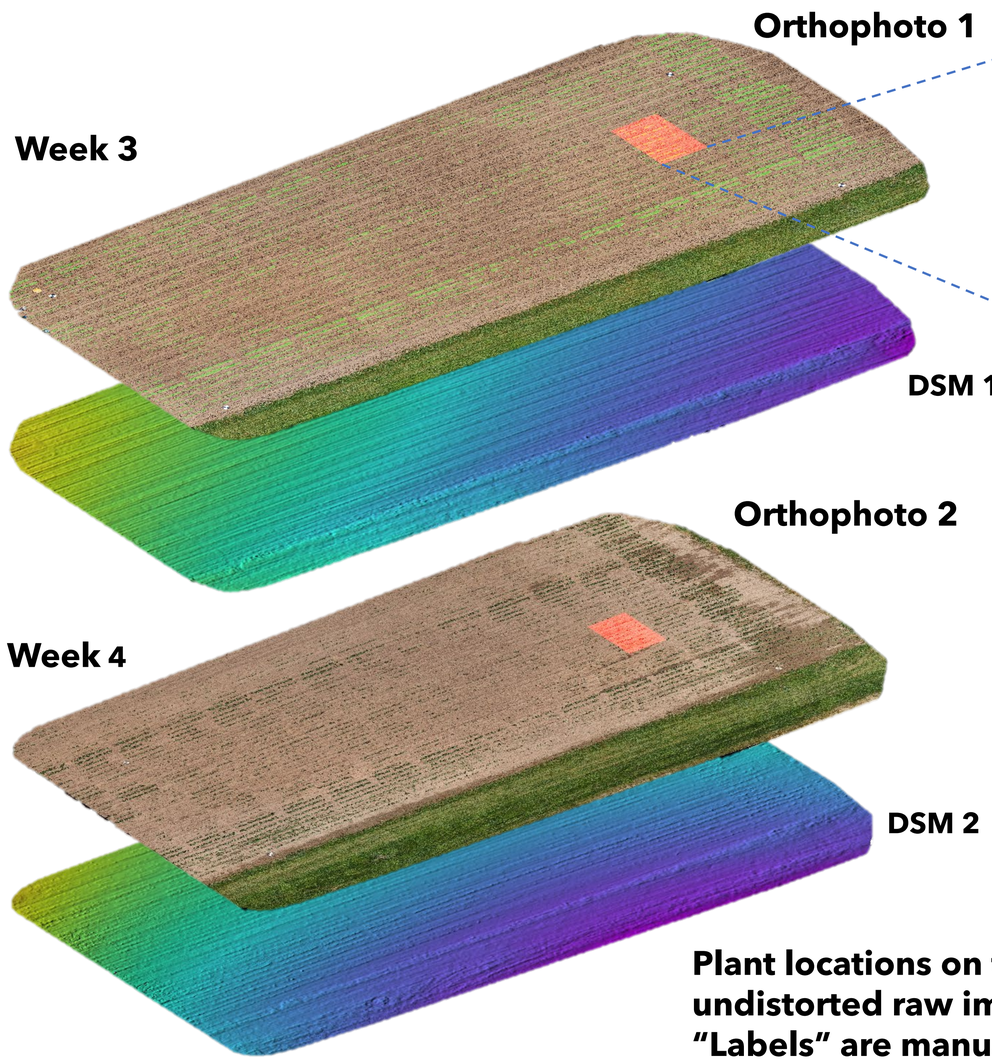
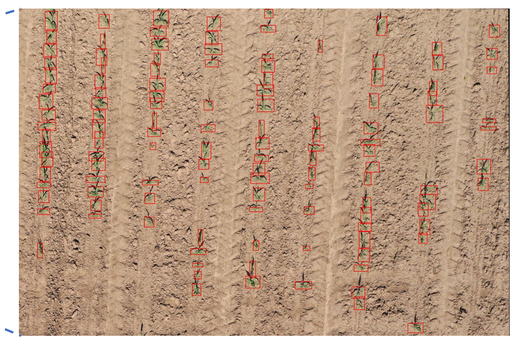
Background

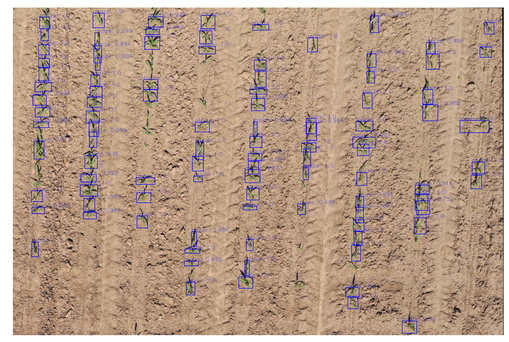
- Studying individual plant phenotypes using UAS images remains a challenge
- This is important in mutant screenings, heterozygous population trials, and other cases involving diverse individuals
- A possible solution is the use of object detection models applied to single plant images

Overview









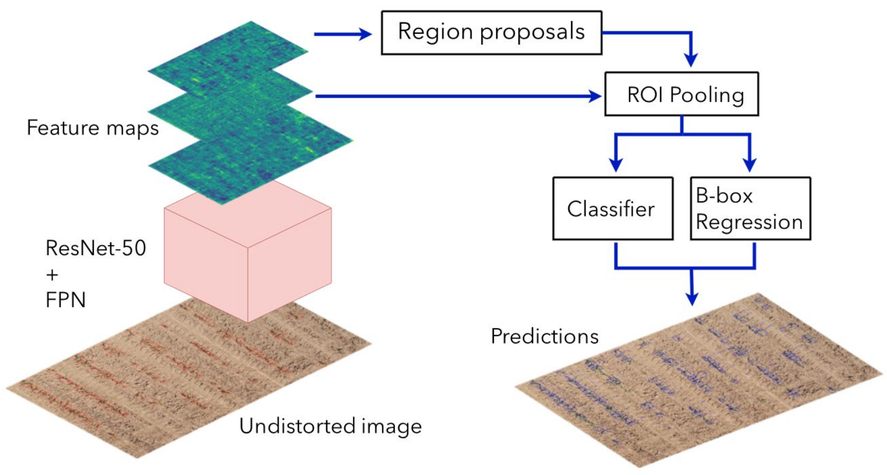
Plant locations on the undistorted raw images. "Labels" are manually drawn and "predictions" are derived from the object detection model.

Test Metrics

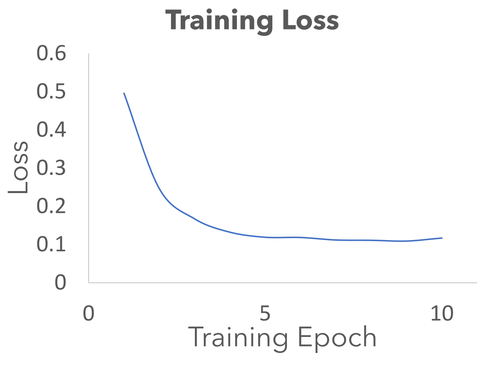
Precision	**0.66**
Recall	**0.70**

Methods

1. Field images acquired in 2021 using RGB and multispectral cameras
2. Orthophotos, DSMs created using OpenDroneMap
3. Single maize plants labeled on undistorted images from OpenSFM
4. Labeled images split into 4 images for training a Faster-RCNN object detection model



5. Image coordinates from individual images projected onto the Coordinate Reference System (CRS) of the orthophoto (by orthorectification)
6. Single plant features extracted from RGB orthophoto, DSM, and multispectral orthophoto

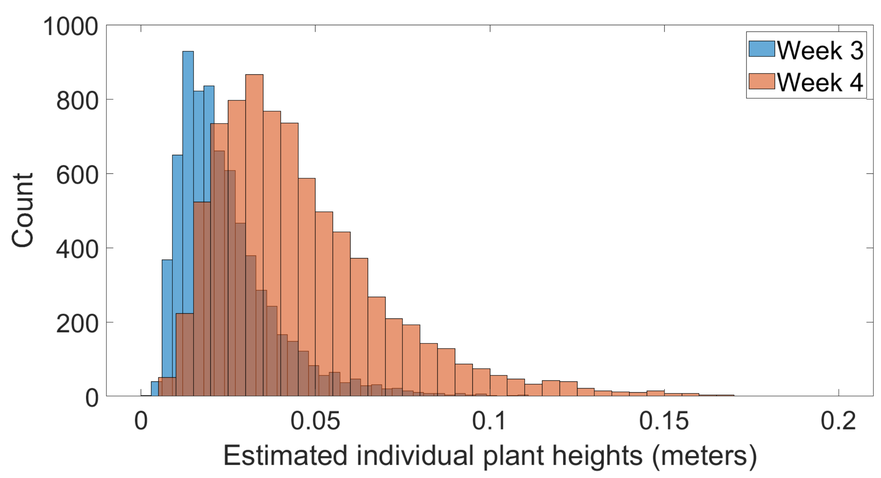


Training curve showing the overall loss

Average Precision (AP) @ IoU=0.50	**0.66**
Average Recall (AP) @ IoU=0.50	**0.70**

Model performance on test images

Results



The histogram shows the difference between the mean of values above the 90th percentile and the mean of values below the 10th percentile.

- Single plant detection model created with a recall rate of 70% (at 0.5 IoU)
- Detection on undistorted raw images projected to the orthomosaic
- DSM values extracted from within the bounding box

Conclusions

- Single plant detection and trait extraction found to be a feasible approach
- More accurate detection possible with a larger training set or an ensemble of models
- Earliest images with the least overlap should be used for the extrapolation of spatial location predicted by bounding boxes

Acknowledgements

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