Center for Distributed Robotics & Sentera, LLC
Weed Detection and Classification in High Altitude Aerial Images

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Introduction

- The excess and uniform application of generic herbicides (glyphosate) has resulted in herbicide-resistant weeds.
- The detection of weeds in the field can reduce the application of herbicides by up to 60%.
- The offline image processing of the aerial imagery helps the sprayer to quickly cover large areas of the field, efficiently using herbicide.
- We are actively developing an imaging pipeline (**Fig. 1**) to simultaneously detect and identify weeds from imagery collected by a drone. The different stages of the pipeline follow the different sections of this poster.
- The drones must fly fast at a high altitude to efficiently image entire fields within short flight time and path.

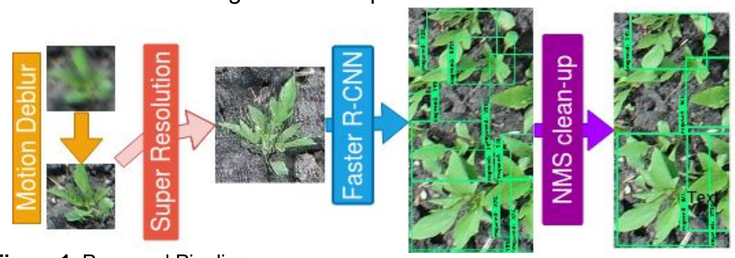


Figure 1: Proposed Pipeline

Motion Deblur

- Motion blur is a common issue in aerial imaging which is a result of the fast moving drones and swaying plants.
- We utilize a Generative Adversarial Network (GAN) trained on artificially blurred images from our dataset, allowing the network to closely approximate the original images (PSNR 21.17).

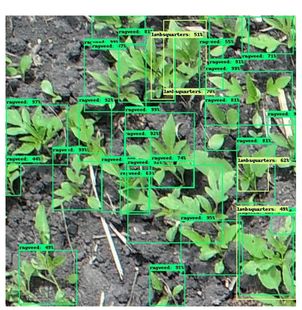


Figure 2: Results from the deblurring stage of the pipeline. The blurred image (left) shows detection results on the original image and the deblurred image (right) shows results after processing.

Super Resolution

- Because of the high altitude of the drone there are very few pixels per plant with which to run detection and classification.
- We utilize another GAN architecture (ESRGAN) trained on downsampled images from our dataset, allowing the network to approximate the images at a larger size (PSNR 20.23) allowing for improved detection and classification.

Figure 3: Results from the super resolution stage of the pipeline. The low-resolution image (above) and the super-resolved image (right) show the relative size increase (4x) and results given from this stage of the pipeline if the small image is input the large image is output.

Weed Detection and Classification

- For the detection and classification portion of the pipeline we utilize a Faster R-CNN object detector trained on three classes of weed and one crop: Waterhemp, Lambsquarters, Giant Ragweed, and Corn.
- After training on our dataset the classifier achieves 93.8% classification accuracy but produces many false positives and negatives because of the way the images are tiled and fed into the detector. To manage this, an overlapping tile and Non-Maximal Suppression (NMS) technique are used.

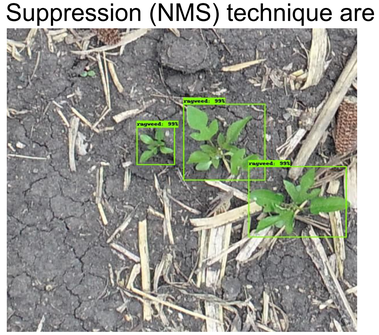


Figure 4: Results from pre-emergence field. All plants are detected and classified, while soil and field residue are ignored.

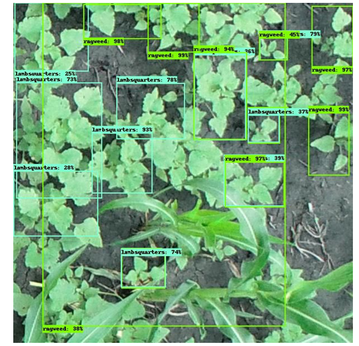
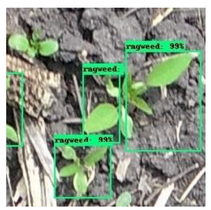


Figure 5: Results from early-season field. Small, partially occluded weeds are detected and correctly identified while another is mistakenly detected and one is not detected (left). Many weeds are detected but misclassified (right).

Image Tiling and NMS Cleanup

- When tiling the images for detection and classification, plants that fall on the edge between tiles can be cut and separated between different tiles making them hard to classify.
- To combat this we use overlapping tiles (50% overlap) to ensure each plant appears near the center of some tile. The detections and classifications of all tiles are merged and processed with our NMS procedure to eliminate multiple detections of the same plant or parts of the same plant.



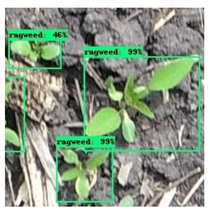


Figure 6: Results shown without the tiling and NMS technique (left) and with the tiling and NMS technique (right). In the left image plants are cut by a tile edges causing multiple detections or no detections for a plant while these situations are remedied in the other image.

Acknowledgement

This work was supported by ROSE-HUB as part of the NSF IUCRC program and we thank both organizations for their support.

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