Center for Distributed Robotics & Sentera, LLC
Academic and Industrial Collaboration on Precision Agriculture Research

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Nitrogen Deficiency

- Nitrogen deficiency is the most common and severe nutrient stress on corn.
- Application of an excess amount of Nitrogen fertilizer is costly and environmentally harmful.
- Current methods for stress detection are able to detect stress but are unable to characterize it.
- We developed an algorithmic approach based on imagery from drones, that detects Nitrogen deficiency on individual leaves.
- The spatial concentration of the Nitrogen deficient leaves is associated with the stress severity.
- This tool will be commercially available in the summer of 2019.

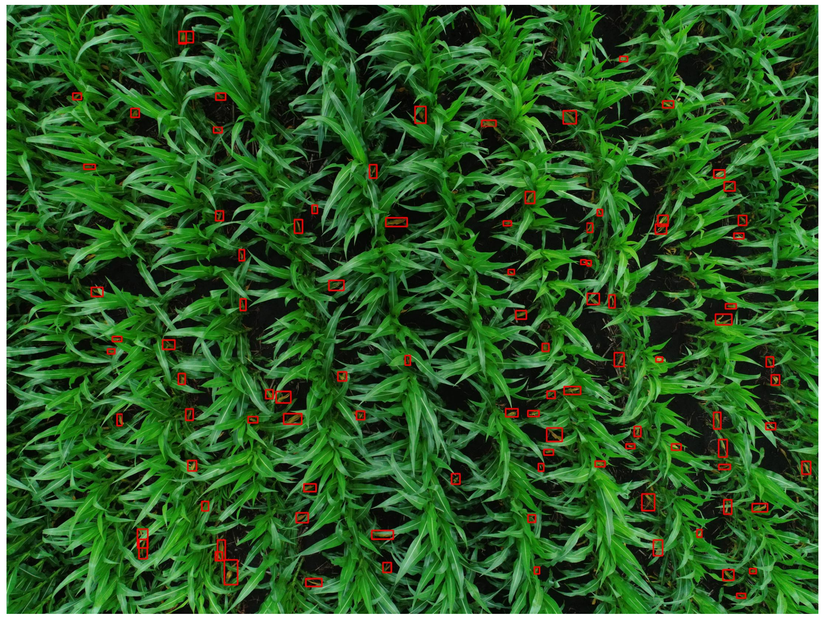

Figure 1: Nitrogen deficient leaves are detected in a real world scenario. The spatial concentration of the nitrogen deficient leaves implies a moderate nitrogen stress.

Leaf Area Index

- The estimation of Leaf Area Index (LAI) is one of the most sought-after goals in Precision Agriculture.
- Current approaches try to approximate the LAI through 2D images and light incidence measurements of the canopy.
- We developed an algorithmic methodology that estimates the leaf area directly through the reconstruction of 3D plant models.
- Consecutive steps of 3D reconstruction and processing of the 3D models allow us to isolate the leaves and estimate their area.

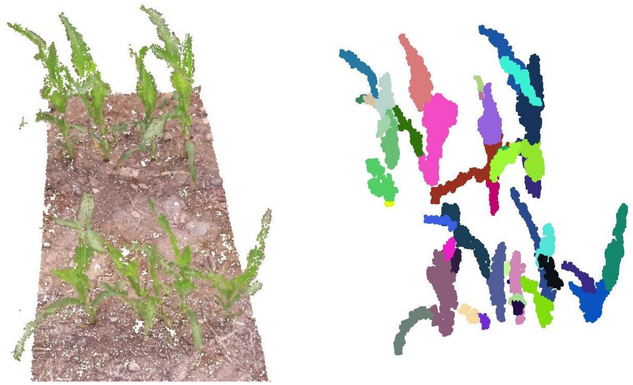

Figure 2: The 3D reconstruction produces real scale corrected plant models (left). The 3D models are segmented down to individual leaves and stems (right).

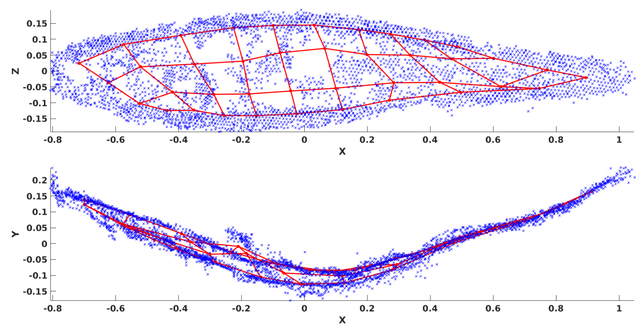

Figure 3: The leaf area estimation is performed using morphable 3D planar geometric entities (red lattice) that adapt to the shape of a given collection of 3D points (blue dots).

Weed Identification

- 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 automatic identification of weed species allows for weed specific herbicide application.
- We are actively developing a deep learning methodology to simultaneously detect and identify weeds from imagery collected by a drone.
- Our efforts are concentrated in the classification of the most common weeds in the Midwest; Giant Ragweed, Waterhemp, and Lambsquarters.

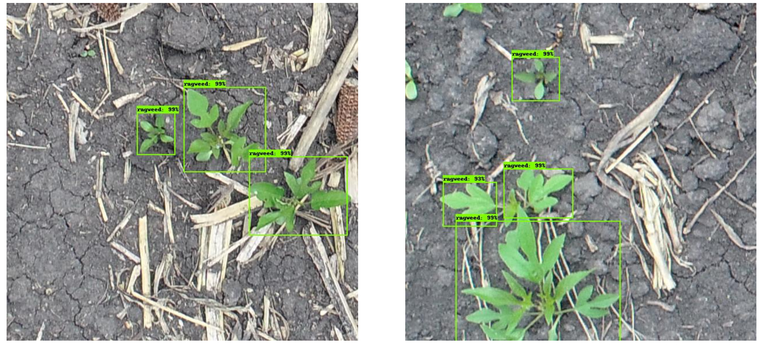

Figure 4: Results from pre-emergence field. All plants are detected and classified, while soil and field residue are ignored.

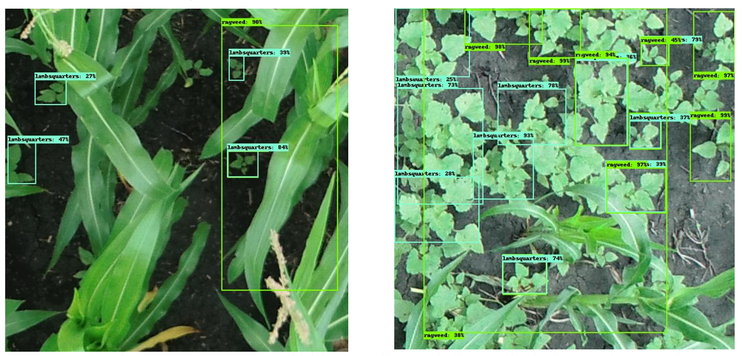

Figure 5: Results from early-season field. Small, partially occluded weeds are detected and correctly identified while another is mistakenly detected and one is not detected (left). Many weeds are detected but misclassified (right).

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