GRADUATE INDUSTRIAL RESEARCH SYMPOSIUM 2023

"Reshaping the Future through Science and Technology"

Development of an Open Source Connected Autonomous Rover (OSCAR) for Under Canopy Row Crop Sampling

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ABSTRACT

High density sampling of row cropping systems can enable a variety of agronomic research that is currently too labor intensive to feasibly pursue by hand. While aerial drones are commonly used to collect field data, there are numerous measurements of interest that require sensors deployed under the crop canopy. This project examines the development of a robust autonomous rover (OSCAR) that can travel through rows of corn throughout the growing season. OSCAR has a 22" wheelbase with differential steering allowing it to navigate through corn rows without damaging the plants. OSCAR is equipped with an RTK GNSS module and stereo vision camera which allows it to navigate through rows autonomously. The robot's ability to reliably navigate and avoid obstacles continues to be improved upon in simulation and in real fields.

Presenter Bio

Nathan Sprague

Nathan is a first year Masters Student in ABE. He works for Dr. John Evans on robotics, specifically computer vision.

OSCAR enters, navigates and exits corn rows autonomously

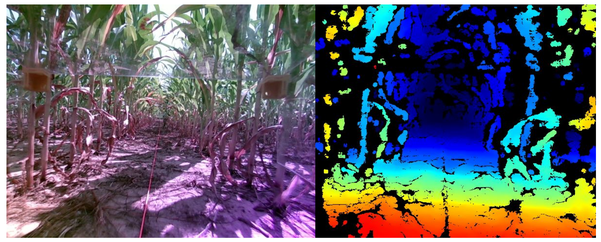
Built for Autonomy

OSCAR is intended to move non-destructively from point to point and through fields without direct human supervision. It is capable of navigating to any number of destinations inside and outside of corn rows. At each destination, it can autonomously take samples or images, depending on what the user specifies.

Hardware-Agnostic

OSCAR with a LiDAR for analyzing plant physiology

OSCAR is designed to carry a variety of sensors. Unlike drones, weight is less of an issue. The robot is equipped four 330 W motors, allowing the robot to carry or trail a several hundred pound payload. The frame is made out of 12 gauge sheet metal and has 8020 attachment points as well.



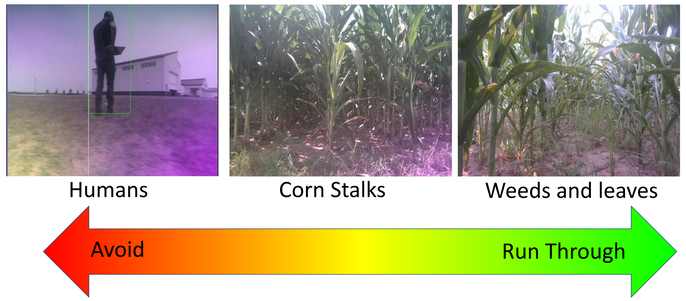
The Realsense D455 Stereo vision camera provides color and depth footage. Both streams are used for navigation.

Navigation

Oscar uses the Ardusimple RTK2B GNSS and Intel Realsense D455 Depth Camera for navigation. These components cost significantly less than common agricultural RTK units and LiDAR scanners. OSCAR uses RTK GNSS to navigate from point to point outside rows and line up with target row. With accuracy up to 10mm, accurate positioning and pose can be determined, which provides consistent sampling locations throughout the season. OSCAR uses the depth camera to detect obstacles and navigate through row. It is able to locate the row entrance and obstructions using depth and blob detection. OSCAR has proven to be able to travel autonomously for the entire life of the batteries (~2 hours) and can reliably travel through the full length of the row.

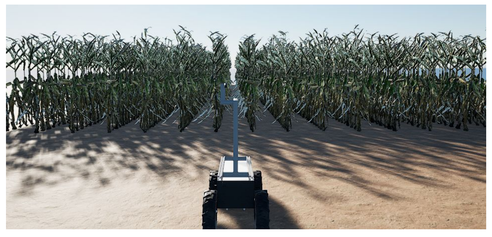
Path Planning & Playback

Target destinations and sample points are given as coordinates to OSCAR and it will automatically create an optimal path to take. The path planned can change real time if obstacles are found. All hardware inputs and outputs are recorded throughout the entire run. This way, OSCAR's performance intentions can be evaluated both in real-time and after the run.



Safety vs Functionality

While there are fewer obstacles on a farm compared to roads, safety remains a priority. OSCAR is capable of injuring humans and running over full grown corn plants. While under no circumstance it should hit a human, there are situations where it is necessary to run down corn. There is a tradeoff between not moving and safety. The robot's ability to differentiate between weeds and corn continues to be developed.



World simulating OSCAR and a corn field using Unreal Engine

Next Steps

OSCAR is under continuous development. Its ability to differentiate between stalks, weeds, and humans continues to improve. Work is being made to create a simulation environment to test its behavior under different conditions. New applications and uses for the robot are still being determined as well.

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