PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2019

Robotic Leaf Scanning System

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1. Problem Statement

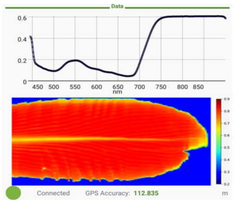
The **handheld hyper-spectral imager** invented by Dr. Jin's group has a need of increasing scanning efficiency and speed.

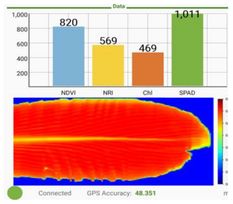
The major tasks of our design is following:

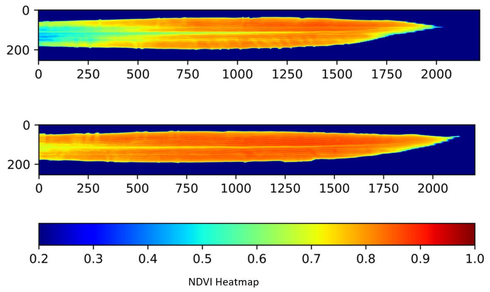
- Design a platform that can automatically scan leaf
- The system is able to be attached to the back of agricultural vehicle
- Cost-efficient

2. Background

Dr. Jian Jin's laboratory has developed a hand-held hyperspectral corn leaf scanner. The accuracy and portability of the scanner are in the leading position in the current market. It can also transmit data to the mobile client through Bluetooth. The purpose of this project is to assemble the hand-held scanner on agricultural vehicles to realize automatic data acquisition.







↑NVDI Heatmap of a scanned leaf. Data is taken from a leaf in ACRE cornfield.
← Leaf Spec APP Users interface

3. Sustainability

- Reduce labor cost by introducing fully automatic system
- Make full use of agricultural vehicles
- Better data quality and quantity
- Easy to learn by users such as researchers or farmers

4. Impacts

Global impact

- Help the growth of data agriculture
- Decrease the consumption of human labor by applying machinery

Economic impact

- Great profit due to cost-efficient of this design

5. Major tasks break down

The robotic leaf scanning system has three main parts. To efficiently approach the goal, we decided to break down the tasks into four parts:

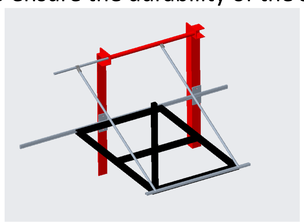
- Design the attachable platform
- Program the ACRO gantry system
- Setup & Train 3D camera image processing system
- Combine platform, gantry and camera to do field-testing

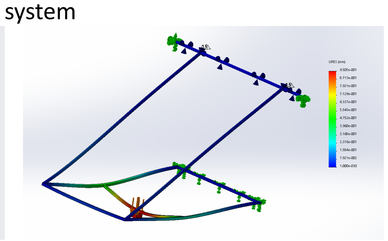
NVIDIA DIGITS

PyTorch

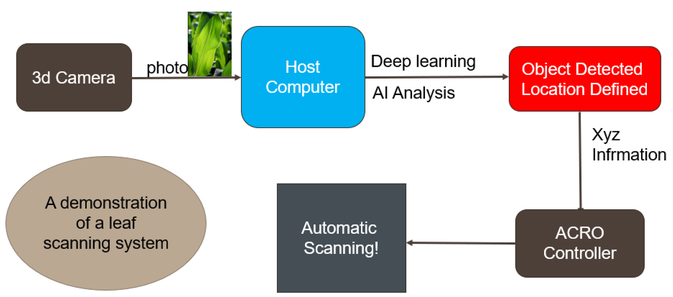
6. Tools and Designs

- **PTC CREO and SOLIDWORKS** – The visualization of design of frame. They are also used to generate finite element analysis of the frame to ensure the durability of the system





- **ADM tools** such as welding station for material processing
- **Openbuilds ACRO system** – A gantry system that contains motor and aluminum V-slots
- **NVIDIA Digits and PyTorch** – Deep learning platform that trains thousands of corn images to increase the accuracy of recognizing real corn leaf via 3D camera



7. Alternative solutions

UAV

- Capable of carrying a robotic arm with the handheld scanner attached
- robotic arm which is connected to the drone through a rod can be operated in the air under the control of computer.
- Due to the uncontrollable wind and turbo effects on the drone and drone load imitation, this solution is not very ideal.

Robotic arm

- Takes lots of space to install
- Might interact with corn plants so it has risks of damaging plants when vehicle is passing through cornfield
- The cost of a robotic arm is very expensive and can only scan one leaf at a time

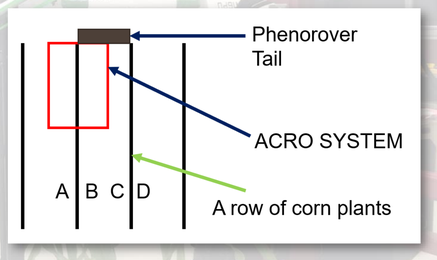
8. Final Design

Platform – Attaches to the Phenorover and holds ACRO system

ACRO system – Scans specific leaf when coordinate is given by the camera

3D camera – Recognizes leaves of plants in the field

- **Robot acquisition range**: 40 "x 60" to ensure that at least one sample can be collected in one area.
- **Single collection time**: 1 min
- **Vehicle range**: 4 rows of corn, 30 inches inbetween
- **Load-bearing structure**: 20kg



9. Cost Analysis

Image Processing	$ 149.00	Structural framing	$ 268.00
ACRO Robotic ARM	$ 300.00	Micro Controller	$ 400.00
Fasteners	$ 118.70	Total	$ 1,235.70

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