PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

agBOT Challenge: Weed & Feed

Agricultural & Biological ENGINEERING

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Problem Statement and Background

agBOT Challenge

The agBOT Challenge is a national level competition hosted by airBridge, llc., designed to encourage and spur innovation around the use of autonomous vehicles in agricultural production. The 2016-2017 Purdue University combined ABE & ME Team will be competing in the agBOT Weed & Feed Challenge, and will need to design a vehicle, called the "agBOT", that can complete the following tasks:

- Autonomously maneuver two or four 1000-ft. rows at a time and turn at each end. The agBOT shall make four 1000-ft. passes
- Autonomously observe crop plants and fertilize plants as needed
- Identify three common weeds: giant ragweed, cocklebur and redroot pigweed, within the row and between the rows
- Eradicate weeds through chemical and/or mechanical means
- Provide real time observation methods of fertilizing and/or treating the plants back to the base station

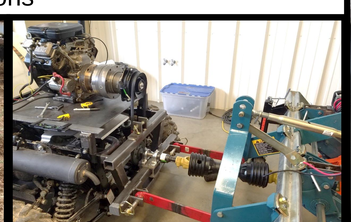
Impact and Sustainability

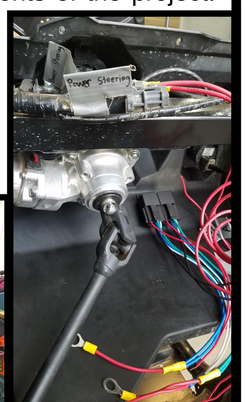
- Prove possibility and versatility of autonomous vehicles
- Decrease labor cost and problems of finding qualified labor for future farms
- Increase efficiency of overall field operations leading to better yield, reduced waste, and better environmental conditions
- Allow farmers more flexibility to focus on and accomplish a variety of other tasks, separate from vehicle operations

Team / Task Breakdown

With the various requirements the team has for this project, it was imperative to delegate tasks between groups of team members. Therefore, the team broke the project requirements down by creating six groups, which each specialize in addressing particular components of the project. These groups include:

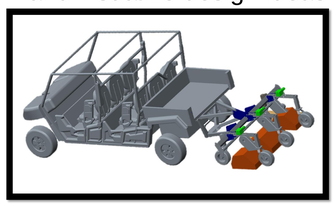
- Chemical Weed Eradication and Crop Fertilization
- Mechanical Weed Eradication
- Vehicle Steering and Controls
- Vegetation Identification
- Systems' Power Supply
- Systems' Communications

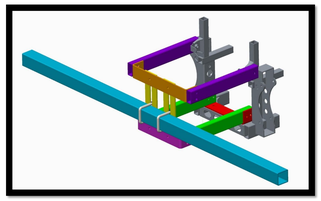




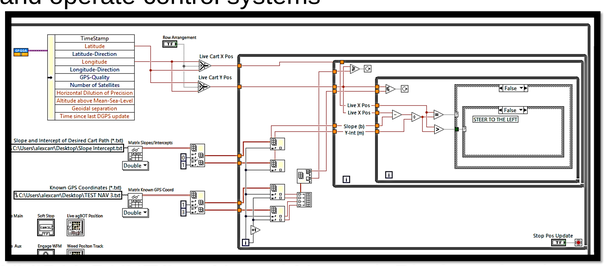
Engineering Tools

- PTC Creo – CAD modeling software used to generate and visualize design ideas and solutions





- National Instruments LabVIEW – Graphical programming software used to acquire data, and design and operate control systems



- NVIDIA DIGITS – Neural Network Platform for deep learning processing used to classify images and thus identify vegetation
- Python 2.7 – A programming language used for camera control, running models, and communicating between systems

```
Processed 1/6 images in 0.003139 seconds ...
Processed 2/6 images in 0.003157 seconds ...
Processed 3/6 images in 0.003504 seconds ...
Processed 4/6 images in 0.003155 seconds ...
Processed 5/6 images in 0.003135 seconds ...
Processed 6/6 images in 0.003275 seconds ...
---------- Prediction for photo from camera No.0: ---
80.1472% - "RedrootPigweed"
---------- Prediction for photo from camera No.1: ---
45.1555% - "RedrootPigweed"
---------- Prediction for photo from camera No.2: ---
76.2644% - "GiantRagweed"
---------- Prediction for photo from camera No.3: ---
94.2090% - "RedrootPigweed"
---------- Prediction for photo from camera No.4: ---
67.9260% - "GiantRagweed"
---------- Prediction for photo from camera No.5: ---
63.7308% - "RedrootPigweed"
Time for each photo group (6): 0.115283
Processed number of images: 48.000000
```

Potential Solutions

Chemical Weed Eradication and Crop Fertilization
- Spray weeds within the row with 4 different dyes, via 4 different mix tanks/pumps or use eductor in lines to limit to 2 tanks
- Use an eductor to mix the dye and limit tank space on the vehicle

Mechanical Weed Eradication
- Individually drive and raise/lower Multivator heads, via hydraulic or electric motors, and hydraulic or electric linear actuators
- Simultaneously drive all Multivator heads with an auxiliary engine, using winches to raise/lower the heads individually

Vehicle Steering and Controls
- Autonomously steer vehicle by using linear actuators/GPS or retro-fit existing GPS/steering system onto the vehicle
- Use Swift GPS to control EPS, and linear actuators to steer vehicle

Vegetation Identification
- Image segmentation with color boundary thresh holding
- Use deep learning to train a neural network for image classification, with NVIDIA DIGITS platform

Systems' Power Supply
- Use a generator to provide electrical power for other systems
- Use an auxiliary engine to provide mechanical and electrical power

Systems' Communications
- Use a Raspberry pi as a micro-controller
- Use National Instruments (NI) myRIO

Final Design

Chemical Weed Eradication and Crop Fertilization
- Spray system with eductors and 8 nozzles

Mechanical Weed Eradication
- Winches and auxiliary engine

Vehicle Steering and Controls
- Swift GPS and linear actuators

Vegetation Identification
- NVIDIA DIGITS

Systems' Power Supply
- Auxiliary engine

Systems' Communications
- NI myRIO and LabVIEW
- Ubiquiti products

Resource Outlay Analysis

Task Group	Cost
Chemical Weed Eradication and Crop Fertilization	$847.37
Mechanical Weed Eradication	$1,092.13
Vehicle Steering and Controls	$3,200.32
Vegetation Identification	$555.06
Systems' Power Supply	$1,367.15
Systems' Communication	$242.90
Total	**$7,304.93**

*Total project also includes numerous donations

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Instructors:
Dr. Bernard Engel
Dr. Robert Stwalley

Mr. Steve Doyle
Ms. Alivia Roberts

Acknowledgements:
Mr. Scott Brand
Mr. Steve Powers
Dr. Jani Heikkinen
Research Machining Services
Ms. Deb Lubelski
Mr. Tom Campbell
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