Team 11: The Weed Assassin

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Problem

The United States produces and exports over 420 million metric tons of soybean a year, and in 2021 alone, it generated over $27.37 billion in export value. One of the most common threats to soybean, a very important crop for the United States, is the growth of volunteer corn. Volunteer corn, a weed to soybean, grows in crop rotations where soybean is grown in a rotation soon after corn. They also germinate from kernels dropped from combines. Leftover seeds germinate and compete for nutrients, resulting in a 54% to 13% loss in soybean production.

The Team

Results

The team accomplished the following:

- Image classification model with 86% accuracy overall
- Automated traversal of farmland plot
- Accurate path recognition guidance system to stay within rows
- 87% reduction in herbicide usage, meeting the team's goal of providing an environmentally sustainable design

Objectives

About our Solution…

- This automated ground vehicle is designed to move between rows of soybeans, identify volunteer corn (weeds), and spray them with weedicide.
- This would allow farms to efficiently dispense herbicides, reducing the time and cost of manual weeding or the cost of mass spraying of herbicides.
- Furthermore, targeted herbicide usage would help reduce the problematic situation of excessive herbicide runoff, which pollutes the ecosystem near farmlands.

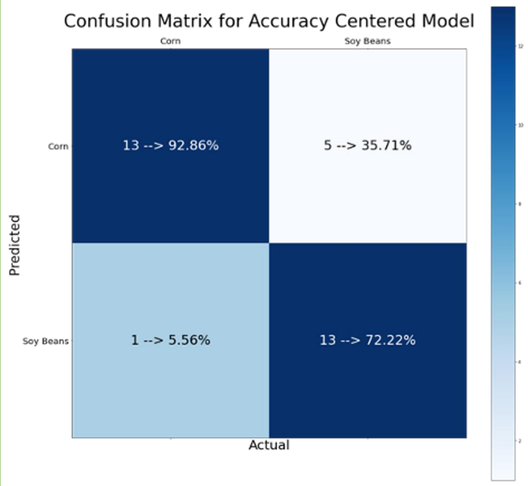
References

Our most sincere gratitude goes to
Professor Phillip Johnson, Business Department
Professor Warners, Biology Department
Professor Dornbos, Biology Department
Professor Michmerhuizen, and Professor Walstra, Engineering

Design

Image Classification

A core pillar of our design solution is the use of a TensorFlow Efficient-net-b0 feature vectorization model. We defined and trained this model for binary classification between the image classes of corn and soy. Preprocessing layers were also added to the model for optimized predictions.



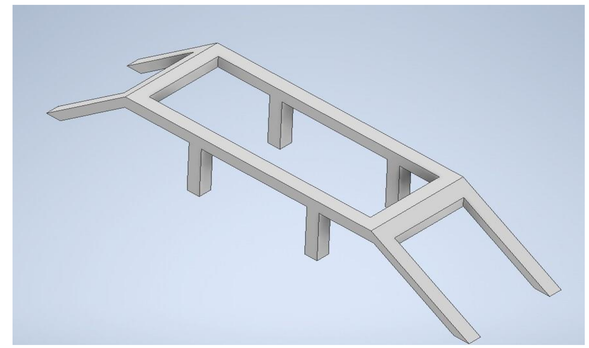
Confusion Matrix for Image Classification Model (Corn prediction accuracy : >90%)

Spray System

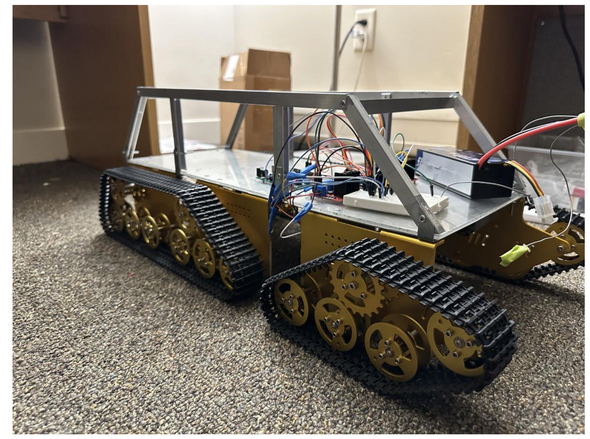
The electrical system consists of a spray bottle, a servo motor, an Arduino microcontroller, a 3D printed casing, and a rope. The Arduino code is controlled by code uploaded to the microcontroller. This code initializes the position of the servo motor arms to their initial position and rotates the arm 180 degrees. The program is triggered by a signal from the Raspberry Pi upon the detection of weeds and maintains continuous spraying for the desired amount of time.

Vehicle and Motion System

The vehicle is made of aluminum to provide a sturdy and lightweight platform. The motors are controlled by an Arduino, which provides the necessary distance, angle, and direction for movement. The program receives a signal from the Raspberry Pi indicating the direction of motion, as well as the distance for forward or reverse movement and the angle for left or right turns.



Frame CAD Model



Weed Assassin prototype before installing all components and outside panels