American Society of Agricultural and Biological Engineers

2015 ASABE Robotics Student Design Competition

Challenge

Soybean was first introduced to the United States from China in 1765. Since then, soybean has become an essential crop to the U.S., second only to corn in crop popularity. About 90% of the oilseed production in the United States comes from soybean. The U.S. is the world's largest producer and exporter of soybean, contributing to just below 50% of the total global market. In 2012, the state of Louisiana was ranked 9th in the United States in goods exports and 27th in agricultural product exports; the approximate export value of their grain and oilseed products that year was $4.4 billion.

Phenotyping is the measurement of a living organism's apparent characteristics. Plant phenotyping parameters include, but are not limited to, plant color, plant height, stalk diameter, leaf area, and chlorophyll content. Phenotyping is an important activity in plant breeding, since it gives breeders an observable representation of the plant's genetic code, which is called the genotype. In addition, phenotyping helps breeders to identify the behavior of plants under certain conditions and to determine which plant strains are best suited for those conditions. Unfortunately plant phenotyping is a time consuming task when completed by hand, therefore delaying the work of breeders. A current area of research is automated plant phenotyping. This avenue has shown promise of increasing efficiency and facilitating the work of breeders.

This year's assignment will require the construction of a fully automated robotic system designed to simulate the assessment of soybean plants in a field. The parameters that will be assessed are plant color and height. A sample of each phenotype present in the field must be collected and delivered to the reporting station.

Course

1. The field will consist of an 8 x 8 ft board, as shown in the following diagram:

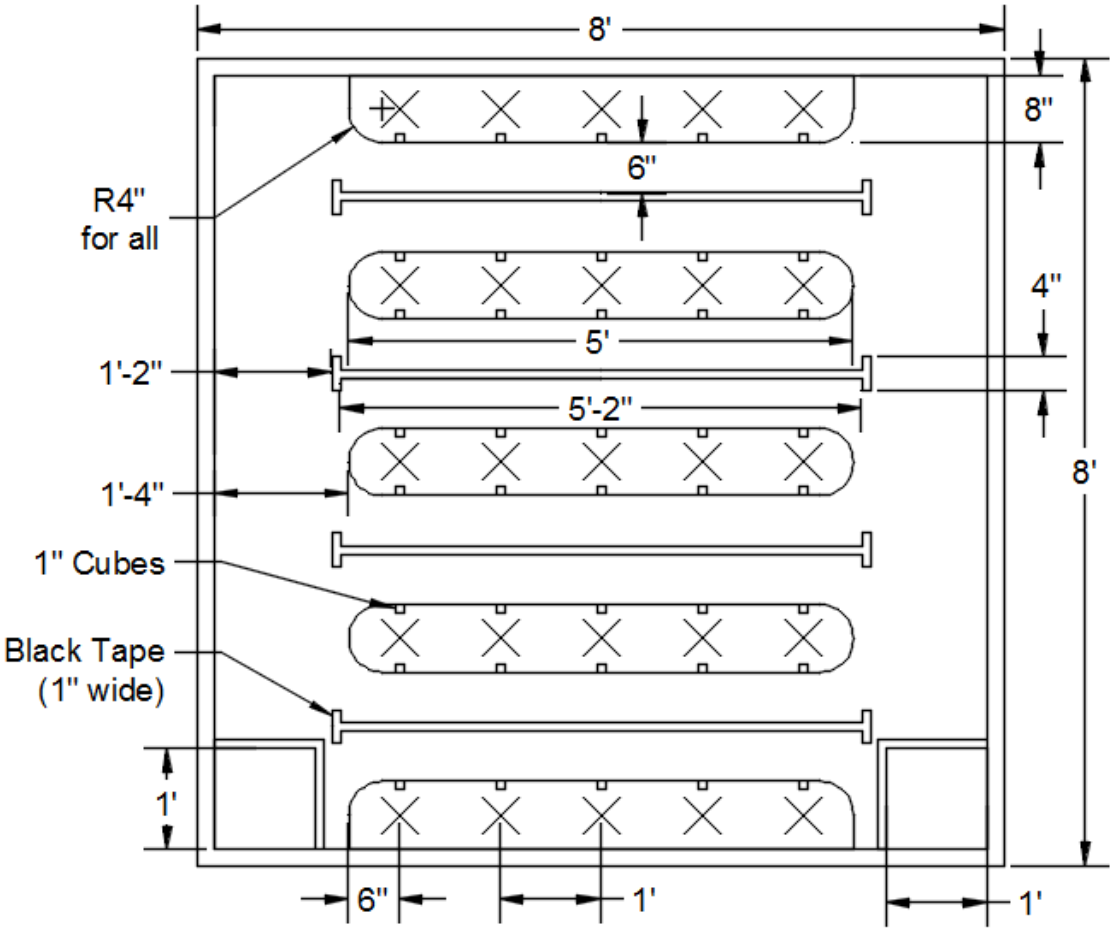


Figure 1. Board layout and dimensions.

2. The five rectangular rows upon which plants will be placed are raised an inch above the rest of the board. There will be three-dimensional paper cutouts, representative of soybean plants, placed along the rows at 20 of the 25 possible locations (fig 1). The plants, when present, will be positioned so that the base is in the orientation indicated by the “X”s. Appendix A provides a template for the plants and a guide to their construction. They can be Short (6 in) or Tall (8 in). Plants of each size can be painted either Dry (Yellow), Healthy (Green), or Overwatered (Brown).

3. No more than seven plants of each phenotype will be placed on the board for a single run. A sample marker should be collected for each phenotype on the board. Samples will be 1 x 1 x 1 in wooden cubes, and they will be placed on the platform at the base of each plant. The location of the cubes is represented by the small squares in figure 1.

7. The robot(s) may start within either (or both) of the two squares on the left and right sides of the board.

Trial Runs

1. There will be three rounds of trial runs, and the highest scoring round for each team will count toward its overall score.

2. For each round, every team will be given one opportunity to complete a trial run. Teams will be required to verbally confirm their participation in a trial run within 30 seconds of their announcement. If no confirmation is received, their trial run will be considered forfeited.

3. The timer starts upon receiving confirmation that the team will be participating in the round. Each team is responsible for setting up and completing its trial run within an 8-minute time limit, after which no more points will be awarded or deducted. After the team has finished preparing their robot(s) for the run they shall say “Set,” and the robot will be required to run autonomously for the remainder of the time.

4. For a single round, the layout of plants on the grid will be the same for all teams.

5. At the end of each run, the collected samples must be returned to either the right start square or the left start square, and a report must be produced and displayed that indicates the absence or phenotype of the plant in each of the 25 positions. A pictorial representation is preferred, but use of a traditional x,y coordinate system with an origin located at the bottom left plant position is allowed.

Constraints

1. All of the robots for a team must be able to fit within a 1 x 1 x 1 ft box at the beginning and end of the trial.

4. The capability to extend beyond the maximum dimensions during operation is allowed.

7. Plants should not be toppled from their upright position.

Report

1. Each team must submit a report of their design; the report must not be more than 10 pages.

2. Each team must provide three printed copies of their report to the judges prior to the start of the competition.

Presentation

1. Each team must give a presentation of their design which will be limited to 10 minutes and this will be followed by a 5 minute question and answer period.

2. A projector and a computer will be equipped with Microsoft PowerPoint at the time of the presentations.

Scoring

Scoring will consist of two main sections, the robot design and presentation and report. Below is an outline of the scoring system.

Robot Design:

a. Completes required tasks

I. Displays results

i. Report identifies correct location of plants:

Each plant (5 pts)
Maximum (100 pts)

ii. Report correctly identifies characteristics of all located plants:

Correct color of plant (75 pts)
Correct size of plant (75 pts)

II. Collects samples

i. One sample collected per each type of plant on the board (75 pts)

ii. Plant samples delivered to a single start square (25 pts)

b. Performance

I. Robot size does not exceed size limitations (25 pts)

II. Correct location and characteristics for all 20 plants (30 pts)

III. Human intervention deduction **(-50 pts/occurrence)**

IV. Damage to plant deduction **(-15 pts/plant)** (toppling plant)

c. Elegance of Design

    I. Use of real time progress display (+30 pts)

    II. Robot design is sleek or otherwise aesthetically appealing (+50 pts max)

Report & Presentation:

a. Written summary of design project (75 pts)

    I. Parts list (+20 pts)

    II. Concise and organized report (+25 pts max)

b. Presentation (75 pts)

Appendix A: Templates

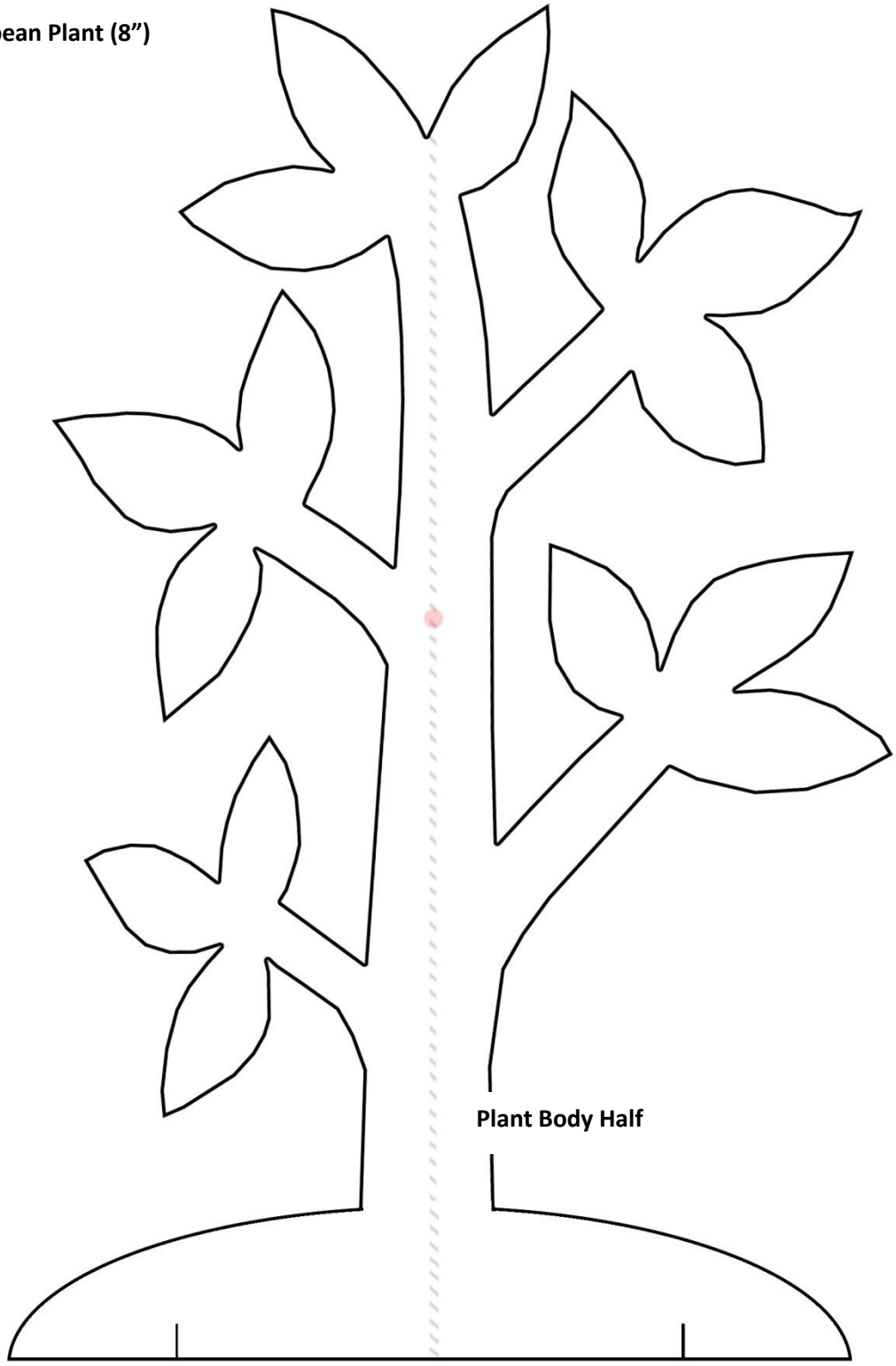
To make a single plant, print and cut two Plant Body Halves and one Stabilizer Strip out of cardstock (110# or above will be used for the competition). The Plant Body Halves should be cut along the perforated line until the center dot is reached. Start from the top downwards on one half and the bottom upwards on the other. The two halves will then nest together to create a Plant Body, which should form an X at its base. The shaded area on the Stabilizer Strip should be attached to the back of the non-shaded end so that a ring is formed. Please note that the four short lines on the Stabilizer Strip and the four short lines on the base of the Plant Body correspond. These should be cut and nested to complete the base. When this assembly is complete, paint the plant accordingly with yellow, brown, or green paint. We will be using Krylon ColorMaster Enamel Spray Paint in Gloss Sun Yellow, Gloss Leather Brown, and Gloss Hosta Leaf.

http://www.krylon.com/products/colormaster-enamel-paint/

Tip: Remember to verify the scaling of the printer by checking the physical dimension from base to tip.

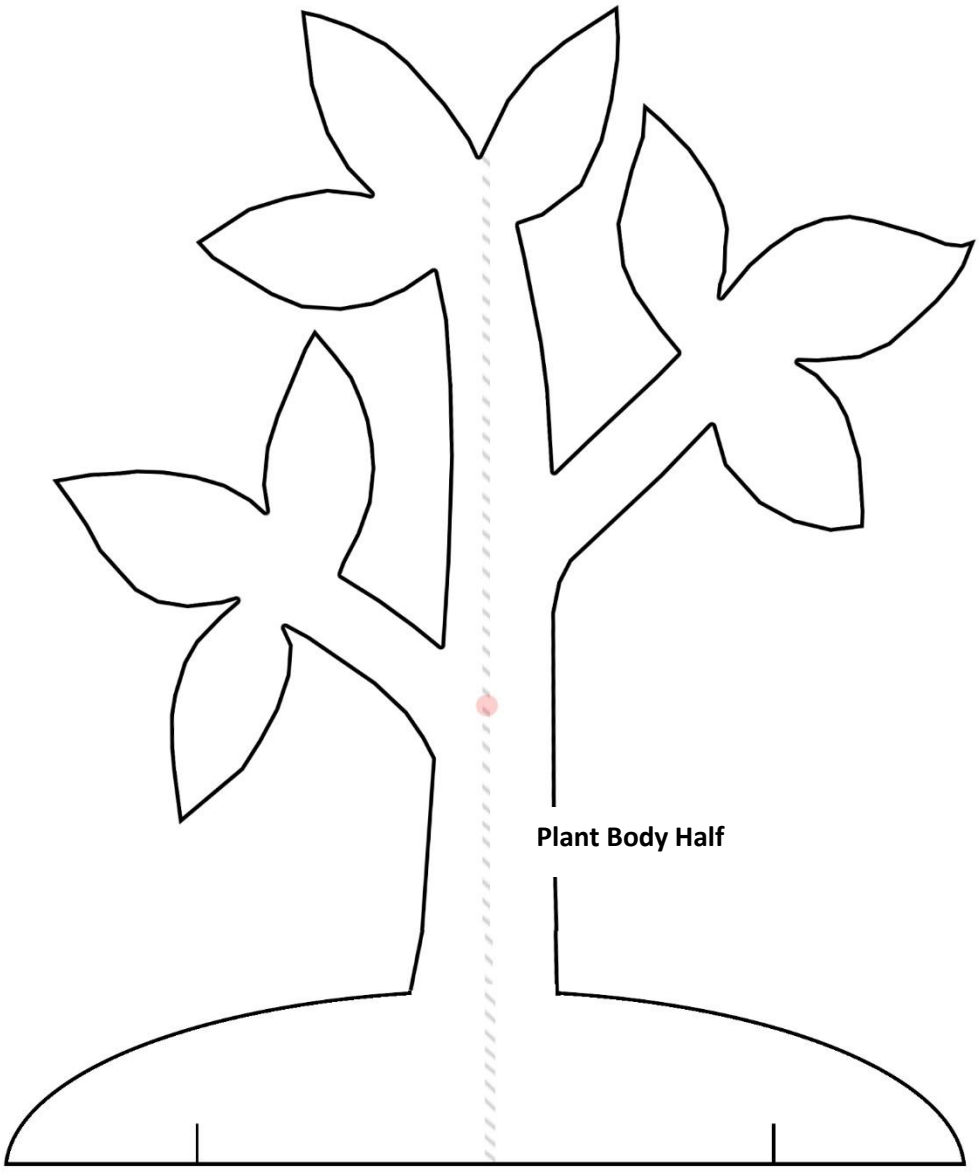
Stabilizer Strip

Tall Soybean Plant (8”)



Plant Body Half

Short Soybean Plant (6”)



Stabilizer Strip