



American Society of Agricultural and Biological Engineers

2017 ASABE Robotics Student Design Competition

Challenge

Agriculture accounts for 12% of Washington's economy and employs over 160,000 people in a state which leads national productions in 11 different commodities, including apples, pears, hops, and red raspberries. Washington State has a particularly large share of the domestic raspberry crop, producing 95% of the nation's raspberries, with 93% of that number produced in Whatcom County alone.

A biennial raspberry crop is managed through many pruning and harvest methods. Many of these pruning methods involve selective pruning of 1-year old raspberry canes (floricanes) to limit total plant density, and suppression of young raspberry canes (primocanes) to prevent them from competing with the fruiting floricanes. These operations are typically accomplished through manual pruning and herbicide application, respectively, in the field, the desire for farmers to cut labor costs and use less chemicals on their crops opens the door for new methods of accomplishing these necessary production tasks.

The challenge of this year's competition will be to simulate a full primocane suppression and selective floricane removal pruning operation using autonomous robots. The competition will require teams to develop robots which can identify primocanes and floricanes, selectively cut irregularly distributed primocanes and floricanes to a given row density, and remove the cut plant material from the rows to clear debris.

Changes made to this document to reflect rules clarification are highlighted.

Board Layout and Canes

1. The "Raspberry Farm" shall be constructed using an 8x8 foot board, as shown in the Competition Board Layout.
 - a. The board will be $\frac{3}{4}$ " Plywood painted white using a standard matte interior paint, such as [BEHR Premium Plus Ultra Medium Base Plat/Matte Interior Paint and Primer in One](#)
2. Two type of raspberry canes will be simulated: weak (primocanes) and strong (floricanes).
 - a. Weak canes will be represented by 1/16" balsa wood strips, 6" long, with the top 4" of the strips painted green using [Rust-Oleum Painter's Touch 2X Meadow Green spray paint](#)
 - b. Strong canes will be represented by 1/8" balsa wood strips, 6" long, with the top 4" of the strip painted yellow using [Rust-Oleum Painter's Touch 2X Sun Yellow spray paint](#)
3. There will be two rows of raspberry canes. Canes will be randomly assigned to the intersections shown within the rows.
 - a. Row 1 will consist of 3-5 strong canes and 1-3 weak canes per zone
 - b. Row 2 will consist of 5-8 strong canes per zone
 - c. Each zone in both rows will start with at least 6 canes
 - d. Each randomly generated board will have an equal number of weak and strong canes

- e. Canes will be held in place by 3D-printed cane holders, .STL files for which are provided [here](#) and [here](#).
 - f. The center of each grid square in zones 1-5 will be drilled through using a 3/8" drill bit. These holes will hold the 3-D printed cane holders.
 - g. Holes without canes will not have a cane holder in them, and the hole will be exposed
4. Four location datums are provided to assist with mapping. These will be painted red along their entire length using [Rust-Oleum Painter's Touch 2X Apple Red spray paint](#).
 5. A 6" tall wall will surround the entire board to prevent background colors from interfering with visual detection of the canes.
 - a. The wall will be made of the same plywood as the board and painted the same color as the board surface.
 6. Canes will be placed such that no cane will be obscured from both sides. Put another way, you will not need to look at the row at an angle to see all of the canes.

Trial Runs and Scoring

1. The goal is to remove all weak canes from the board and enough strong canes to make sure that only 5 canes exist in each zone at the end of each trial.
2. There will be three rounds of time trials. The two highest scoring rounds for each team will be used to determine their final score. Teams will take turns competing on one competition board. A second board may be used if more than twelve teams compete.
3. At the start of each round, Robots must start and end the trial run at either the north or south ends of the board. No part of the robot may extend beyond 18" from the north or south edge of the board. Put another way, no part of the robot may cross an imaginary line created by connected adjacent datums. Teams are allowed to choose the exact starting and ending locations of their robots within these limits.
4. To ensure that all teams have enough time to complete all three trial runs, each round will consist of three phases over a ten (10) minute period
 - a. During phase one, judges will set up the randomly generated cane positions and prepare scoring sheets for the round.
 - b. Once the judges are ready, teams will be given two (2) minutes to set up their robots. Teams may start their trial before this period is finished
 - c. Teams will then have five minutes to complete the task. Once time expires, teams will have to remove their robots from the field of play
 - d. Judges will then convene to corroborate scores

PHASE	FUNCTION	DURATION
PHASE 1	Competition Board Setup	2 Minutes
PHASE 2	Team Preparation	2 Minutes
PHASE 3	Time Trial	5 Minutes
PHASE 4	Scoring	1 Minute

5. Scoring for this competition is designed to be completely objective, with scores calculated based on finite conditions. The scoring rubric shown below will be used to score each trial.

Round __	Team _____	Count		Value		Subtotal
Weak Cane	Full Cut		X	5	=	
	Partial Cut		X	3	=	
	Removed		X	2	=	
Strong Cane	Full Cut		X	10	=	
	Partial Cut		X	6	=	
	Removed		X	4	=	
Number of zones with <6 canes			X	10	=	
Add'l strong canes removed			X	-15	=	
Weak canes left standing			X	-5	=	
Interventions			X	-5	=	
Poster Deductions			X	-25	=	
Time remaining (seconds)			X	1	=	
Total						

6. Weak and strong cane scoring:
- Full points will be awarded for fully cut canes.
 - Partial points will be awarded for partially cut canes. A partial cut is when the robot's cutting mechanism makes contact with the cane, but the cane is not cut all the way through.
 - Cut canes which are removed from the row will be awarded bonus points
 - Strong canes will be scored higher due to the added difficulty
7. Bonus points will be given for each zone with less than 6 canes at the end of the session. This bonus will not be counted if weak canes are left standing in the zone.
8. Deductions will be given for:
- Cutting more canes than are needed (Add'l strong canes removed)
 - Weak canes left standing, and the total number of interventions
 - An incomplete poster, unattended poster session, or poster submitted after the June 30 deadline will result in a 25 point penalty per round (maximum penalty of 75 points per round)

Display Poster

- Instead of a written report, teams will submit a display poster which details the function, design, and specification(s) of their robot(s).
- A poster template and specifications will be provided to the teams in the spring once the competition area has been finalized by ASABE. Posters must be submitted by Midnight on June 30th so that the competition committee can provide feedback and last-minute changes.
- If a team is unable to attend the conference in person, the robotics committee will stage the poster for them.
- A poster session will be held prior to the competition. At least two (2) team members must be present during the poster session. This requirement will be waived for teams which are unable to send participants to the competition due to financial restraints.

General Regulations

1. Robots must be fully autonomous.
2. No more than 3 robots may be used.
3. No more than 2 robots may have devices for cutting, breaking, or otherwise severing the cane.
4. The robots cannot drive over the tops of the cane. However, parts of the robot (such as an arm) may extend above the cane.
5. Each robot used by a team must fit within a 12inch x 12inch x 12inch box at the beginning and end of each trial run. Robots which do not fit into this envelope at the beginning on the trial run will be disqualified. Robots which do not fit in this envelope at the end of the trial run will be deducted 25 points.
6. The capability to extend beyond the maximum dimensions during operation is allowed.
7. Canes may not be pulled up from the cane holder. Canes removed in this way will not be considered cut or removed.
8. The cane holders will not be secured to the table against vertical forces. They will sit in the holes drilled in the board, but will not be glued, clamped, or screwed into place.
9. To preserve the safety of competitors and spectators, rotating blades or chainsaw-type mechanisms are not allowed.

Team Registration and Parts from igus

1. Teams must register with the competition committee no later than February 1, 2017 by submitting a letter of intent via email to jtrotochaud@gmail.com.
2. Teams that register after the deadline may be assessed a point penalty.
3. Igus inc. is providing parts for construction of robots for free to the ASABE Robotics Competition through their [Y.E.S. program](#). Please look at their website and [fill out this form](#) to register.

Contact the Competition Committee

Please direct all questions or comments about the competition to:

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