American Society of Agricultural and Biological Engineers
July 17-20, 2016
Disney's Coronado Springs Resort
Orlando, Florida

2016 ASABE Robotics Student Design Competition

The first orange trees were planted near St. Augustine, Florida in the 1500's by Spanish explorers. Since then, orange trees were farmed commercially well into the 1800s. Florida's unique soil type and climate provides an ideal environment for citrus and is now well-known as the lead in agricultural crops.

Florida growers produce different types of citrus; including oranges, grapefruits and some specialty fruits. Orange season spans from September to June, and specialty fruit season starts from October to April. Florida produces more than 70% of the US supply of citrus and is currently the world's leading grapefruit producer. In terms of global orange production, Florida is ranked as second only to Brazil. This accounts to a $9 Billion industry and employs more than 70,000 Floridians.

There is an estimated 560,000 acres of citrus groves and more than 70 million citrus trees. Approximately 90% of the harvest will be processed into juice and the remaining 10% will be sold as fresh fruit. One of the challenges for growers is to harvest the fruits in a timely manner as putting off the harvest can affect tree growth and future fruit crops.

Although most of the 90% is still harvested manually, a handful of growers have been employing mechanized harvesting machines due to the lack of available laborers. There are several types of citrus harvesting systems in terms of how they remove fruit from the tree (air, water, and shake) and one of the methods used is by simply shaking the tree (canopy shake) to catch the fruits with a conveyor placed underneath the tree. The fruits are then transferred to a haul truck (goats (what do you mean by goats?)) which when full, transfer the fruits to the waiting trailer.

This year's objective will require the construction of a fully automated robotic system designed to simulate the transfer of fruits from the harvester to the processing plant. Two mobile robots will be required for this competition where one will haul the fruits and transfer the fruits to the other robot, which will then move the fruits to its final

destination (processing plant). The main emphasis on this year's competition is on a cooperative, harvesting robot.

A. Course Layout

The field will use the same size 8 ft. x 8 ft. board normally used on previous competitions (Figure 1). Figure 2 shows the dimension in scale format. Note that in Figure 2, the dimensions should be multiplied by 2 to get the foot equivalent.
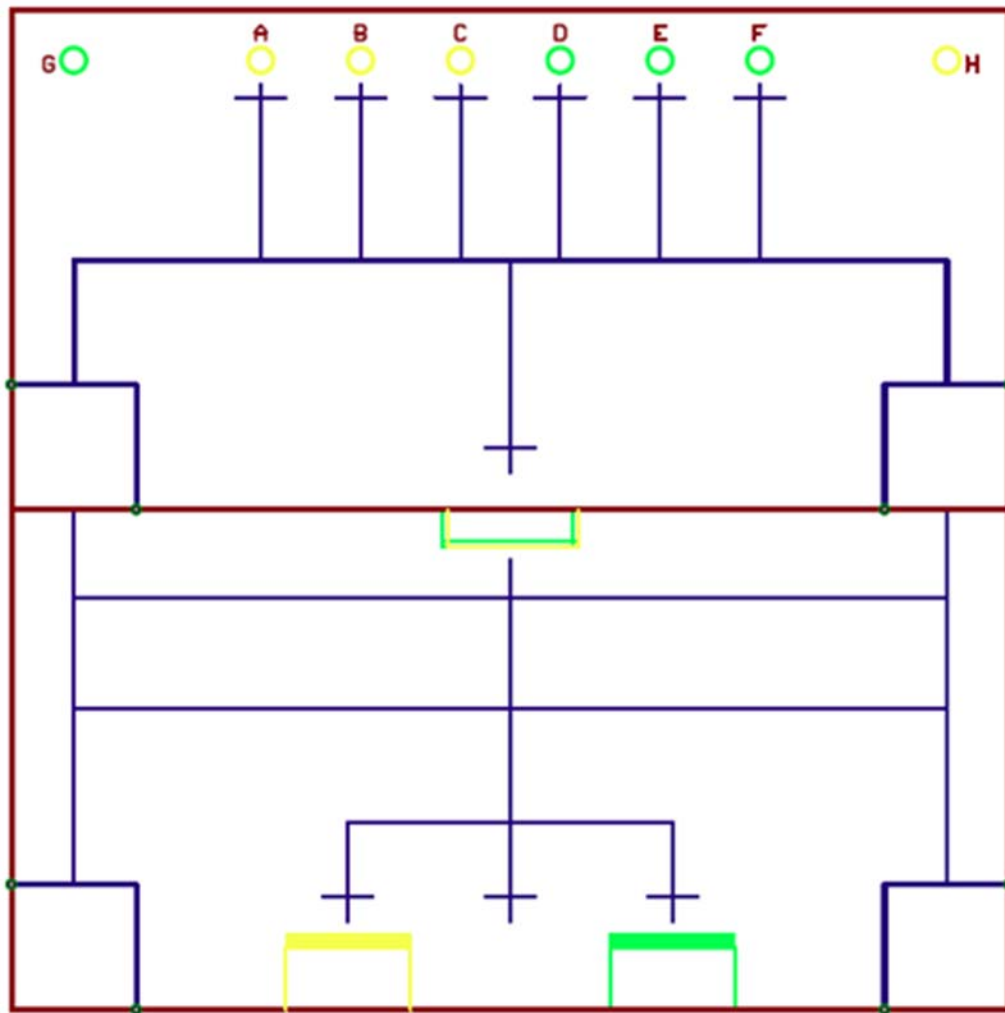

Figure 1. Board Layout for ASABE Robotics Competition - 2016

Figure 2. Dimension of the Board Layout for the competition.

Figure 3. Trailer Robot area (Green) is raised by 2 inches.

Figure 3 is a 3D rendition of the platform, where half of the platform is raised by 2 inches as shown on the green colored area. This is the working area for the Trailer Robot. Also shown in the same Figure are two walls which are 2 inches above the plane on each end. There are no walls on both sides. The blue colored lines shown on both Figures 1 and 2 are black electrical tape (0.75 inch).

Robots

Robot 1 (Haul) can start on either of the two squares defined as HAUL_START while Robot 2 (Trailer) can start on either of the two squares defined as TR_START. TR_START will also serve as the Hold location where the Trailer Robot will wait for the Haul Robot signaling when the ball/s are ready for pick up.

Each robot should perform all operations autonomously. There are no restrictions on the sensors that may be used within the robot. No other sensors will be placed elsewhere on the table or outside the table.

Locations

There will be two different colored ping pong balls which will be used for the competition, Green and Orange. The ping pong balls will represent ripe (orange) and unripe (green) oranges. A, B, C, D, E, and F are the locations of the oranges (ping pong balls [colored]) which will be picked up by the haul truck. The color of the ping pong balls from these locations will be randomly selected.

Locations **G** and **H** are two locations of oranges where the color are already fixed. **G** will have green ping pong balls while H will have an orange ping pong balls.

The start locations for each robot (TR_START and HAUL_START) is measured 12 inches x 12 inches (1 ft. x 1 ft.) but the Robot size can exceed up to a maximum of 14 inches x 14 inches. Robot size maximum volume therefore will be **14 inches x 14 inches x 14 inches = 2,744 inches³.**

Task
1. The task for the Hauler Robot is to collect the oranges from all locations (A, B, … , and H) and deliver it to the PICK_UP area. The Hauler Robot will then send commands to the Trailer Robot to pick up the delivered ball and deliver it to the Processing plants (designated as PR_Y and PR_G).
2. The Hauler Robot is to deliver the collected ball depending on what color the ball is:
    a. Orange ping pong balls should be delivered to PR_Y.

b. Green ping pong balls should be delivered to PR_G.
3. Delivery from the pick-up locations (A,B,C,D,...H) to the Processing Plant (PR_Y, PR_G) will be performed within 5 minutes.

Rounds

There will be 3 rounds for each team and the final score will be based on the average of the two highest-scoring rounds for each team. For example, if Team OptimusFarm scores 55, 65, and 35 for the first, second and third round respectively, the average of the first two rounds will be 60. This will be the final score for Team OptimusFarm plus the Document score of 10 points if the team submitted their documents on or before the deadline.

Each round will have 5 minutes, plus 1 minute allocated for setup. The 5 minutes will start automatically even if the team does not finish setting up their robot in the 1 minute given. The time will start once the team places their robot on the table. The team can use the remaining 1 minute setup time to their advantage if they can run their robot earlier before the 5 minutes time allocation will start.

Visualization

Visualization part for this year will now be implemented using a common visualization program provided by the Clemson University Edisto-REC Sensor Laboratory. The standard communication protocol for each team to transmit their robot locations and other pertinent information is shown below:

"X, Y, Ball Color, Ball_Green_Count, Ball_Orange_Count, StopTimer\r\n"

where

X = x location with respect to the Table Origin (See Figure 1 (0,0)).
Y = y location with respect to the Table Origin.
Ball Color = Current Ball being delivered (Green or Orange), 1 = Orange, 0 = Green
Ball_Green_Count = Total Number of Green Balls delivered.
Ball_Orange_Count = Total Number of Orange Balls delivered.
StopTimer = [0,1] Signals the timer to stop.

Only the Trailer robot will have to transmit the following strings to the Visualization Computer.

Two XBee's will be provided by ASABE 2016 Execom during the competition. Note however that the ASABE Robotics EXECOM staff will not provide the following module

to each team prior to the competition. The official Xbee Pro that will be used is available in Digi, Sparkfun, Adafruit, Newark, Digikey and most electronic online stores.

Scoring

Score sheets will be provided to the official judges for the competition. Scoring will be the same for each round. Maximum score will be 100 points based on a 1 minute run with all balls correctly delivered.

Scoring: (+)

Time   (No. of Balls Delivered/8)*(5 – Team_Performance Time)*15
Correctly delivered balls   5 points per ball (8*5 = 40 max)
Incorrectly delivered balls   2 points per ball   (8*2 = 16 max)

Orange balls delivered to PR_Y and Green Balls delivered to PR_G are considered correctly delivered balls. Orange balls delivered to PR_G and Green balls delivered to PR_Y are considered incorrectly delivered balls. Note that only delivered balls will have points.

Scoring: (-)

Human intervention   5 per occurrence
Robot size exceed size limit   10

Robot size can extend beyond the 14 in x 14 in x 14 in size limit during a run, however robots may not extend beyond 24 in x 24 in x 24 in during a run. Doing so will result in a penalty for exceeding the size limit.

Time Score calculation is based on the 5 minutes allocated time minus the Team performance time. For example, in round 1, Team OptimusFarm completely delivered all the balls and transmit to the visualization software the following:

"12, 23, 1, 4, 4,1\r\n"

And the timer from the visualization displays a *3.5 minutes* Performance time. OptimusFarm Time Score will be calculated as:

Time Score = (8/8)(5 – 3.5) * 15 = 22.5 pts.

With all the balls correctly delivered, Team OptimusFarm total score will be

Total score (Round 1) = 22.5 + 40 = 62.5 pts. + 10 pts. (Documents) = 72.5 pts.

Notice that the Time Score is dependent on the number of balls delivered. Thus, sending a termination code to the visualization even if there are still balls to be collected will result on lower points on Time Score.

With this, each team will have the capability to calculate their own scores but only the judge-signed form will have the official scores for each team. The judges' score sheet will be available, posted online.

Reports and Presentations

There will be no presentations for this year but documents are required. Contents are the following:

- Written Summary of the design project
- Materials & Methods
- Members
- Funding & Support

A score of *10 points* will be added to the total score of the team once their report has been received on the deadline – *July 11, 2016 5:00 PM Eastern Time*. *5 points* will be added for reports submitted after the deadline and before *July 15, 2016, 5:00 PM ET*.

Registrations

Registration for each team (per university) is required. Send an email to

Email: jmaja@clemson.edu

Subject Header: ASABE Robotics Team Registration: *University Name*

In your email content: List the following:

Team Name:

Team Member: members of the team (specify the Team Leader)

Corresponding Member: email address (you can include your Team adviser)

As suggested, there will be a **$100.00** registration Fee which will cover the cost of running this event. A paypal account will be provided by the end of December 2015. **Registration Deadline: January 24, 2016 at 5:00 PM ET**.

Checks made payable to: Clemson University
And note under *"memo: ASABE Robotics 2016 – University Name"*

Other Important Information
Ping Pong Balls:
http://www.amazon.com/Balls-Assorted-Color-Table-Tennis/dp/B00ZR28LS4/ref=lp_3419331_1_21?s=leisure-sports-games&ie=UTF8&qid=1445883444&sr=1-21

Black electrical Tape:
http://www.lowes.com/pd_39340-98-4218-DL-4W___?productId=50148224&pl=1&Ntt=electrical+tape

XBee:
https://www.sparkfun.com/products/8742

ASABE 2016 EXECOM (Executive Committee)

Joe Mari J. Maja	**Clemson University**
Philip Astillo	**Clemson University**
Adam Blocker	**Clemson University**
Tony Grift	**Illinois University**

SPONSORS
- ASABE
- 4PCB
- Sensor Laboratory, Edisto Research and Education Center, Clemson University

Revisions

1.0   *First Draft*
2.0   *Added New Drawings, including dimension*
  2.1   *Added Draft Score Sheets*
3.0   *Added Score Calculation*
  3.1   *Updated Score Calculation*
  3.2   *Updated Drawings for Robot Start Location*
  3.3   *Time Score Calculation Revision*
  3.4   *Omission of* "Inadvertently sending time termination code" *deduction*
4.0   Addendum
  4.1   *Robot can be place inside the start area or partially inside the start area*
  4.2   *The 5 min timer is automatically started by the visualization program.*
  4.3   *Typos on the final score of the team, from "…the final score will be based on the average of the two rounds" to …the final score will be based on the average of the two highest-scoring rounds for each team."*
5.0   Additional changes, maybe added to FAQs
  5.1   *Small stand for the ping pong balls to hold them in place.*
  5.2   *Trailer can be anywhere on its designated area but will have to pick up the ball from the PICK UP ZONE.*

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OFFICIAL SCORE SHEET

ROUND: _____

TEAM _____

SCORE

Documents   _____
Time   _____ Calculated Time Score _____
Delivered Ball/s
Correct _____   Calculated Score   _____
Incorrect _____   Calculated Score   _____

Deductions:
Robot Exceed Size Limit   _____ (-)
Interventions _____ x 5   _____ (-)

                              TOTAL SCORE: _____

_____   DATE: _____

JUDGE (Write name and signed)

Certified:

_____   DATE: _____

Joe Mari Maja, PhD