American Society of
Agricultural and Biological Engineers

ASABE Robotics Student Design Competition 2010

Committee P-127

Challenge Subcommittee:

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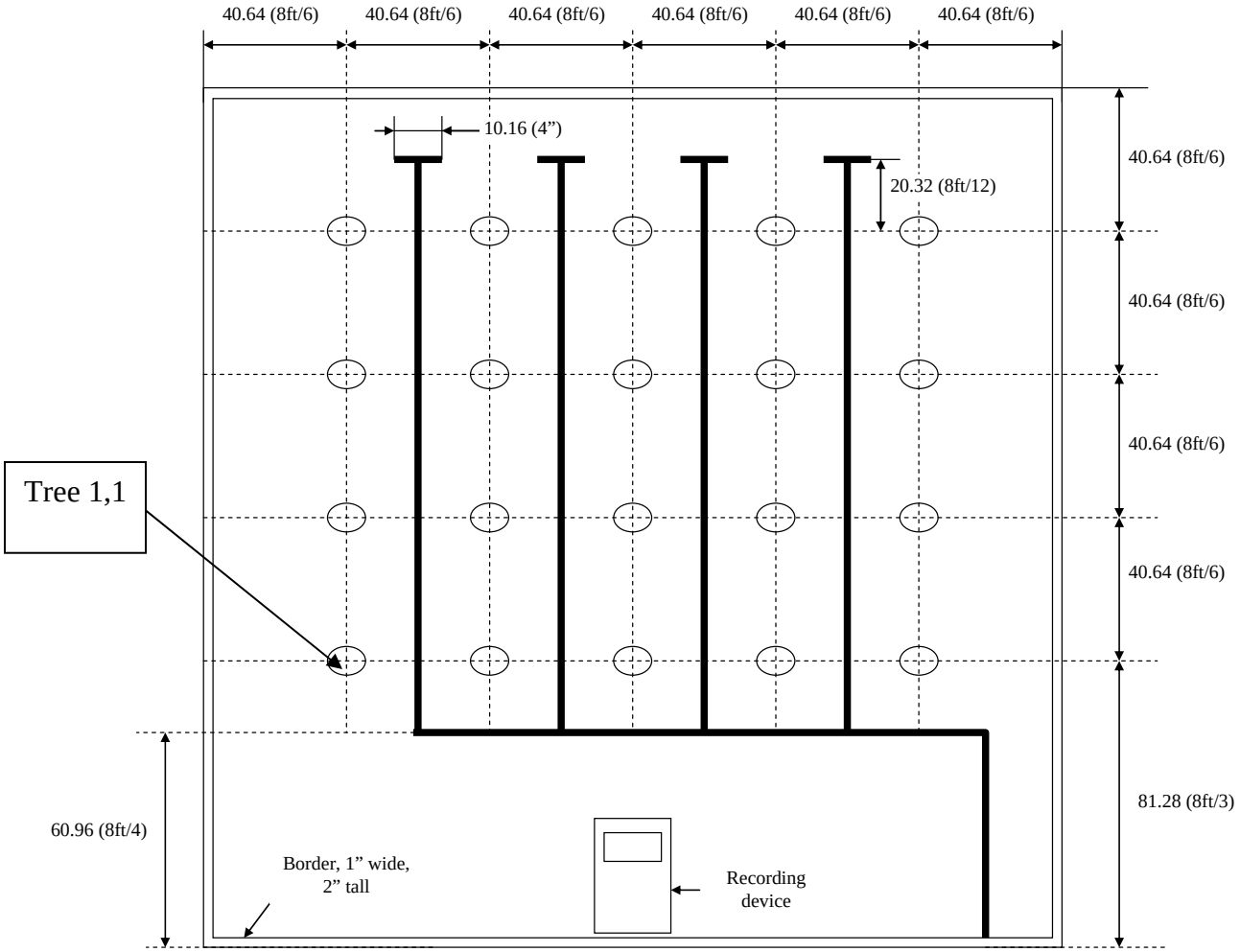

All dimensions are given in cm (English unit)

Challenge

The challenge board is 8 ft square and it has a border that is 2 inches tall and 1 inch wide. The borders are mounted on top of the boards, so the inside area is reduced by 1 inch all around the circumference. The board will be made of ¾ inch thick Medium Density Fiber board. The surface and borders will be painted flat white. Guidance lines will be provided in the form of one-inch wide black electrical tape as shown in the figure. The trees are represented by red painted flat-headed rods with a diameter of 1 inch. They are held in position on the board with a small protruding cylinder that fits in a hole; it is however possible to knock them over. All 20 trees will be present on the board.

The height of the 20 trees varies randomly (according to a uniform distribution) between 50mm and 250mm with a resolution of 10mm. The locations of the trees are fixed (see figure) but the trees will be randomly placed in these locations for each team. In other words, there is no correlation between the tree height and its location.
The task is to determine the location and height of all 20 trees on the board and to communicate these data wirelessly to a 'recording device' in the least amount of time.

The **tree height** must be measured to the closest mm. The **tree location** is in a row/column format where column 1 is on the left and row 1 is at the bottom. The recording device can be anything from a LEGO Intelligent Brick to a laptop computer. The data needs to be presented in a table with the row,column data and height in mm, as shown in this example table. The data does not need to be ordered on location. However all locations must have a tree height value. If **in addition**, your team wants to present the data graphically, you are welcome to do so, you may earn extra 'elegance of design' points.

1,1	56
1,2	125
1,3	45
..	
4,5	26

Rules

1. Multiple vehicles are allowed and in fact encouraged. Although not recommended, vehicles are allowed to collide with each other.

2. The vehicle(s) starting location is in the right bottom corner, and they have to be returned to this location although not necessarily in the same order, or in the same direction. When the vehicle(s) have returned and are stationary, the clock stops.

3. The vehicle volume is limited to 40*40*40 cm at the start and end of the run. During the run the dimensions may exceed these values.

4. There are no limitations on costs or technologies.

5. The total time allotted per trial is 5 minutes. There will be two runs per team and the highest score stands.

Presentation

Each team will present their design in a 15 minutes PowerPoint presentation discussing details of design, algorithms, and effectiveness of mechanical, electrical and software components. The presentation session will be held separately from the competition.

Scoring

There will be three judges and a separate time keeper present during the competition. Scoring is as follows:

1. Performance: This value depends on a) the functioning of the height measurement, b) the total time spent and c) the functionality of the wireless communication/recording device.
    a. The height measurement points are calculated using an algorithm (Appendix A). The Location/Height data is ideally obtained from the recording device. However, if the network and/or recording device fail, the data may be obtained directly from the robot(s) if the team elected to have this as a backup plan. In the latter case, obviously no Recording/network points are earned. The maximum score is 20 per tree, for a total of 400 points.
    b. The time points are inverted: Each team starts with 300 points and every second that is spent on the challenge costs 1 point. If the team takes more than 5 minutes (which represents 5*60 = 300 points), the clock will be stopped and no time points will be earned.
    c. If the recording device and wireless communication work flawlessly, 100 points are earned. If it malfunctions no points are earned, if it works erratically, the judges determine the points in the [0,100] range.
2. Elegance of design. This is a qualitative indicator that adds to the total score at the judges' discretion (up to 100 points). For instance presentation of the data in an exciting form can add to the elegance points.
3. Points will be deducted if the team manually assists a vehicle (10 points for each assistance).
4. The presentations will be scored by the judges based on the teams' a) presentation performance, b) report. The total points available to the judges are 300 for the presentation and 300 for the report. The maximum score is now: 1500.

Example scoring table:

	'Height' points	Time points	Recording / network points	Elegance of design	Assistance deductions	Presentation	Report	Total
Max	400	300	100	100	-10 per	300	300	

Rules arbitration

Although the rules presented here have been developed to be as encompassing and unambiguous as possible, it is possible that questions, the need for clarification and concerns arise up to and during the competition. Rules have been defined by the P-127 Challenge Subcommittee and they will make the final decision regarding any and all concerns as well as ruling when a team violates the rules. Unless otherwise specified, any rules violation or attempt to bend the rules will result in disqualification of the team.

However, teams are very much encouraged to develop 'out of the box' solutions as long as those solutions are within the rules. If the team is in doubt whether a proposed solution is legal, contact the Challenge Subcommittee with detailed explanation by emailing Dr. Tony Grift, grift@illinois.edu. We will maintain a Q&A page on the Website, where questions and answers are shown, unless the teams instructs us not to post the question/answer, so as to not give away good ideas.

Hints

In the past, wireless communication has shown difficult: if a solution works in your lab, it will not necessarily work in the ASABE Meeting building, where cell phones, computers, and other networks are present, all of which can cause interference. The problems are not limited to a specific network topology: In 2009, WiFi, BlueTooth and Zigbee communications failed. It is very important to test your connection and to make the communication bulletproof.

If you are not sure of your wireless connection, you need to make sure that the robot(s) can also present the height/location information locally. In case that your wireless connection fails, you will get points for the correct height/location information, but obviously lose points for network failure.

This Challenge document can also be downloaded from:

http://abe-research.illinois.edu/ASABERobotics/2010/ASABERoboticsCompetitionRules2010.pdf

Appendix A: Scoring algorithm

The points to be earned for the tree height measurements depend on two values, the location of the tree and its measured height. The procedure is as follows:

After the run, the judges create a table where the ordered locations (in row/column format) are related to the measured tree height (MeasuredHeight). They enter the ordered MeasuredHeights vector and the corresponding TrueHeight vector in a program that calculates the total score as follows.

The value that is earned for the tree height measurement is proportional to the relative difference between the MeasuredHeight and TrueHeight. A parameter K (0.1) represents the spread around the TrueHeight in which you earn points. Here are two examples:

1. If the TrueHeight is 100mm, with a K of 0.1 you earn points if the MeasuredHeight is in the range [90,110]. If MeasuredHeight (100) = TrueHeight (100), you earn the maximum points P_max (20). If MeasuredHeight = 95, or MeasuredHeight = 105, you earn 5 points.

2. If the TrueHeight is 200mm, with a K of 0.1 you earn points if the MeasuredHeight is in the range [180,220]. If MeasuredHeight (200) = TrueHeight (200), you earn the maximum points P_max (20). If MeasuredHeight = 190, or MeasuredHeight = 210, you earn 5 points.

The MatLab® program that calculates the points is given here:

```
function P_vec = ScoreRobot(H_Meas, H_True, P_Max, K)

for i = 1: length(H_Meas)

   if H_Meas(i) == H_True(i)
      P = P_Max;
   elseif (H_Meas(i) > H_True(i)*(1-K)) && (H_Meas(i) < H_True(i))
      a = P_Max/(K*H_True(i));
      b = P_Max*(1-1/K);
      P = a*H_Meas(i)+b;
   elseif (H_Meas(i) > H_True(i)) && (H_Meas(i) < H_True(i)*(1+K))
      a = -P_Max/(K*H_True(i));
      b = P_Max*(1+1/K);
      P = a*H_Meas(i)+b;
   else
      P = 0;
   end

   P_vec(i) = P;

end

disp(['Total score is: ',num2str(round(sum(P_vec)))])
```