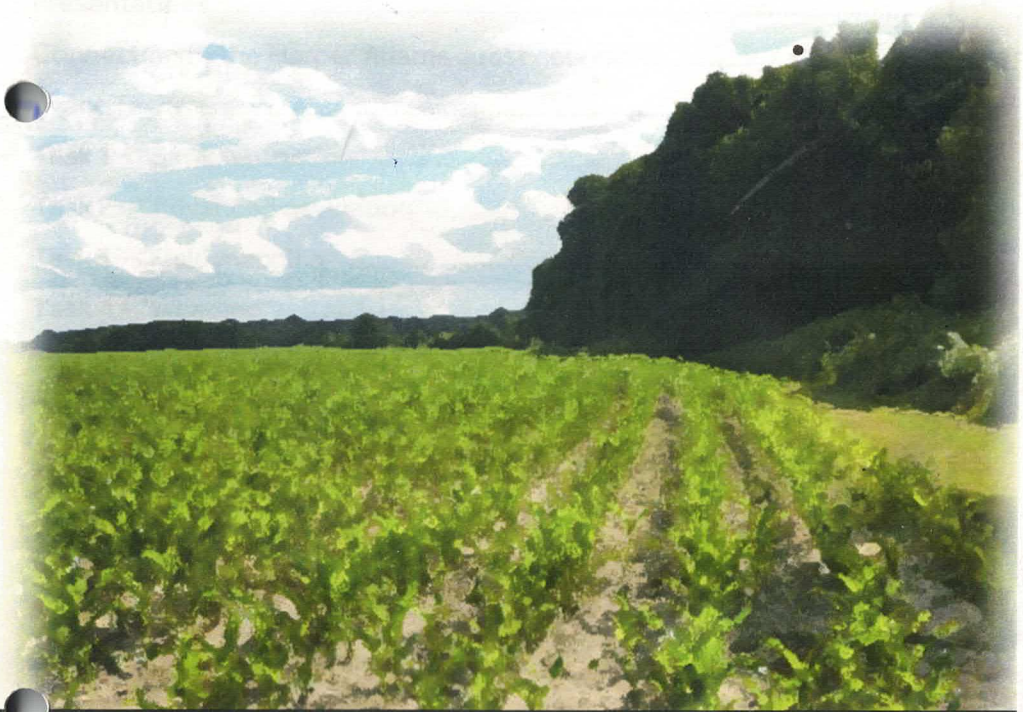
Harper Adams University



FIELD ROBOT EVENT

PROGRAMME 13 June – 16 June 2017

14th Ed.

Select "Download" (no software is downloaded or run for guest users) which will take you to the registration page. Please enter the requested details on the form and then select "Continue". The system will then complete the registration process and connect you to the guest network to allow internet access. If you encounter difficulties accessing websites on completing this last stage please restart your web browser. If you still encounter a problem please briefly turn your wifi off and then back on which will clear the connection and allow it to connect correctly.

Event Tasks.

Comprehensive competitions rules and regulations can be downloaded from http://www.harper-adams.ac.uk/events/fre/files/rules-and-regulations.pdf

Task 1 - "Basic navigation"

General description

For this task the robot has three minutes to navigate as far as possible between the rows of maize plants, starting in the first row and travelling sequentially into rows 2, 3, 4 etc. (figure 2). On the headland, the robot has to turn within the 2m field boundary and return in the adjacent row. This task is all about accuracy, smoothness and speed of the navigation operation between the rows.

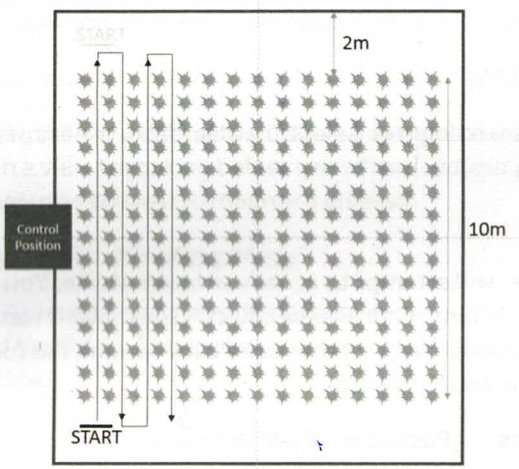


Figure 1: Task 1 Basic Navigation

Field conditions

Random stones will be placed along the path to represent a realistic field scenario. The stones will not exceed 25 mm from the average ground level. The stones may be small pebbles (diameter <25 mm) laid in the ground and large rocks that push (max 25 mm) out from the ground, both are installed. In other words, the robot must have ground clearance of this amplitude at minimum, and the robot must be able to climb over obstacles of max 25 mm height.

Rules for robots

The robot will start the task from the start line. The start line may be on the left or right of the field. The position of the start line will be notified to the teams before the start of the task.

If the robot is about to deviate out from the path and hit maize plants, the team member with the remote controller must press STOP button immediately. The STOP button must be pressed before the robot damages stems of the maize plants.

Penalties

Crop plant damage by the robot will result in a penalty of 1 meter per plant.
Manual intervention to move or adjust the robot will result in a penalty of 1 meter for each time the robot is STOPPED.

Assessment

The distance travelled in 3 minutes is measured. If the end of the field is reached in less than 3 minutes the remaining time will be used to calculate a bonus factor = total distance x 3minutes/measured time.

The total distance includes travelled distance and the penalty values. Distance and time are measured by the jury officials.

The task completing teams will be ranked by according to the total distance values.

The best 3 teams will be rewarded.

Task 2 - "Advanced navigation"

General description

Under real field conditions crop plant growth is not uniform. Sometimes plants may fail to germinate or may be attacked by pests. We will approach these field conditions in the second task.

As in task 1 the aim is to navigate as far as possible between the rows within 3 minutes.However in this task the robots have to follow a certain predefined path across the field. Additionally at some locations, plants will be missing (gaps) at either one or both sides with a maximum length of 1 meter. There will be no gaps at row entries. The robot must drive the paths in the order given before the start of the task. The code of the path pattern through the maize field is done as follows: S means START, L means LEFT hand turn, R means RIGHT hand turn and F means FINISH. The number before the L or R represents the row that has to be entered after the turn. Therefore, 2L means: Enter the second row after a left hand turn, 3R means: Enter the third row after a right hand turn. The code for a path pattern for example may be given as: S - 3L - 2L - 2R - 1R - 5L - F.

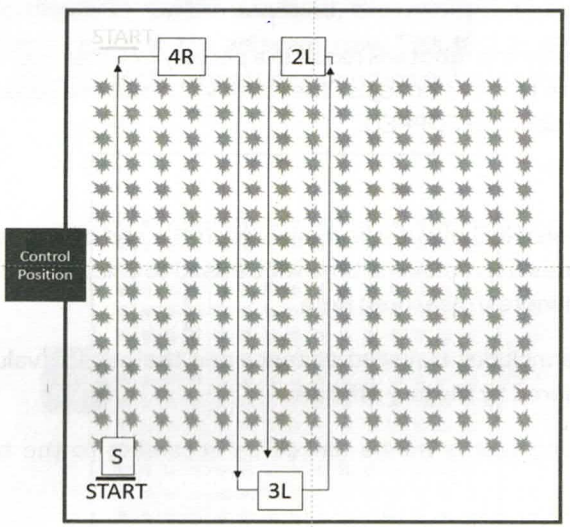


Figure 2: Task 2 Advanced Navigation

The code of the path pattern is made available to the competitors 15 minutes before putting all robots into the parc fermé. Therefore, the teams will not get the opportunity to test it in the contest field.

Field conditions

Random stones are placed along the path, to represent realistic field scenario where the robot should cope with holes etc. The stones are not exceeding the level of 35 mm from the average ground level in the neighbourhood. The stones may be pebbles (diameter <35mm) laid in the ground and large rocks that push (max 35 mm) out from the ground, both are installed. In other words, the robot must have ground clearance of this amplitude at minimum, and the robot must be able to climb over obstacles of max 35mm high. No maize plants are intentionally missing in the end of the rows. However, due to circumstances of previous runs by other robots, it is possible that some plants in the end of the rows are damaged.

Penalties

Crop plant damage by the robot will result in a penalty of 1 meter per plant. Manual intervention to move or adjust the robot will result in a penalty of 1 meter for each time the robot is STOPPED. The robot must be STOPPED if it navigates into the wrong row.

Assessment

The distance travelled in 3 minutes is measured. If the end of the field is reached in less time, this time will be used to calculate a bonus factor = total distance x 3minutes/measured time.

The total distance includes travelled distance and the penalty values. Distance and time will be measured by the jury officials.

The task completing teams will be ranked by according to the total distance values. The best 3 teams will be rewarded.

Task 3 - "Field mapping"

General description

In this task teams have 5 minutes to map the field using autonomous systems, recording the positions of weeds represented by pink golf balls and obstacles represented by yellow tennis balls. Task 3 is conducted on the area used in tasks 1

and 2. The map created in this task will be used in task 4. Up to ten obstacles may be placed in the field, either between rows or in the headland. Obstacles must not be passed regardless of whether the robot can do so without touching them. Up to ten weeds may be placed in the field. All weeds will be placed between rows.

Field conditions

As in task 2 random stones are placed along the path, to represent realistic field scenario where the robot should cope with holes etc. The stones are not exceeding the level of 35 mm from the average ground level in the neighbourhood. The stones may be pebbles (diameter <35mm) laid in the ground and large rocks that push (max 35 mm) out from the ground, both are installed. In other words, the robot must have ground clearance of this amplitude at minimum, and the robot must be able to climb over obstacles of max 35mm high. No maize plants are intentionally missing in the end of the rows. However, due to circumstances of previous runs by other robots, it is possible that some plants in the end of the rows are damaged.

The weeds are objects represented by pink golf balls randomly distributed between the rows in the soil so that only the upper half is visible. Robots may drive across or over them without a penalty. The weeds are located in a band 60 cm wide between the rows. No weeds are located within rows or on headlands. A possible example is illustrated in figure 4.

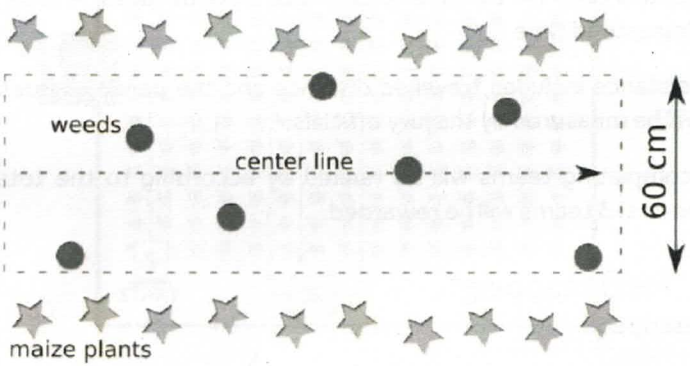


Figure 3: Possible locations of weeds for tasks 3 and 4

Obstacles are represented by yellow tennis balls which will be placed randomly between rows and on the headland. Robots are not permitted to touch or pass the obstacles.

Rules for robots

For this task teams are permitted to use systems other than the main robot, for example an unmanned aerial vehicle or a swarm of small robots. Any system used in this task must still operate autonomously.

Each team has only one attempt. The maximum available time for the run is 5 minutes.

Points will be awarded for detecting weeds and obstacles and for recording their positions.

Teams can nominate whether they wish to indicate the detection of weeds and obstacles separately from the mapping of their locations. Once the nomination has been made then that method must be used for the task.

There is no requirement for the robot to travel along every row, provided that all obstacles and weeds are detected, i.e. it is acceptable for example to have a robot with a high mounted camera which is capable of surveying two or three rows at a time.

Option 1

A single robot navigates between the rows, as in tasks 1 and 2, giving an audible signal when it comes across each weed or obstacle to indicate that it has detected it at that location. The detection of a weed should be indicated by a two second signal and the detection of an obstacle should be indicated by a five second signal. A robot that is capable of surveying more than one row at a time must indicate the row in which it has detected the obstacle or weed.

A robot producing an acoustic signal without any reason will be regarded as a false positive. Failure to produce an acoustic signal when an obstacle or weed is encountered will be regarded as a false negative.

The robot should have some means of storing the locations of the weeds and obstacles as this information will be required to complete task 4.

Option 2

A single robot, a swarm of robots or an unmanned aerial vehicle survey the field to produce a map which indicates the positions of weeds and obstacles in graphical form. The same rules for false positives and negatives will be applied as in option1. The Jury will judge whether the positions of the weeds and obstacles shown on the map are accurate. The map may be generated in real time or can be shown to the Jury at the end of the run. The team will have 2 minutes from the end of the run to produce the map and show it to the Jury.

The map will be required to complete task 4.

Penalties

Crop plant damage by the robot will result in a penalty of 2 points per plant.
Manual intervention to move or adjust the robot will result in a penalty of 2 points for each time the robot is STOPPED.
Indicating the presence of a weed or obstacle when none is present in that location (false positives) will result in a penalty of 1 point per occurrence.
Failure to indicate the presence of a weed or obstacle when one is present (false negatives) will result in a penalty of 2 points per occurrence.

Assessment

The Jury will register the number of true positives, false positives and false negatives:

Each correctly identified and located weed or obstacle (true positives) will be awarded 6 points per weed or obstacle.

The total travelled distance will not be assessed.

If a team completes the task in less than 5 minutes (excluding the 2 minutes allowed to produce a map), this time will be used to calculate a bonus factor = total points x 5minutes/measured time. The task completing teams will be ranked by the number of points as described above.

The three best teams will be rewarded.

Task 4 - "Weeding"

General description

In this task the main robot should be equipped with a crop sprayer capable of spraying water. The robot will use the map created in task 3 to produce an optimised path that allows it to spray all of the weeds in the shortest possible time. Teams will be allowed 10 minutes to configure their robot for spraying and load an optimised path into its navigation system. The path optimisation process can be completed using a computer which is independent of the main robot, but this process must be completed within the 10 minute time window.

The robots shall precisely spray the weeds mapped in task 3. It is not permitted to touch or pass the yellow tennis balls.

Field conditions

As in task 2 and 3 random stones are placed along the path, to represent realistic field scenario where the robot should cope with holes etc. The stones are not exceeding the level of 35 mm from the average ground level in the neighbourhood. The stones may be pebbles (diameter <35mm) laid in the ground and large rocks that push (max 35 mm) out from the ground, both are installed. In other words, the robot must have ground clearance of this amplitude at minimum, and the robot must be able to climb over obstacles of max 35mm high. No maize plants are intentionally missing in the end of the rows. However, due to circumstances of previous runs by other robots, it is possible that some plants in the end of the rows are damaged.

The weeds are objects represented by pink golf balls randomly distributed between the rows in the soil that only the upper half is visible. Robots may drive across or over them without a penalty. The weeds are located in a centred band of 60 cm width between the rows. No weeds are located within rows and on headlands.

Obstacles are represented by yellow tennis balls which will be placed randomly between rows and on the headland. Robots are not permitted to touch or pass the obstacles. The location of the obstacles and weeds will be the same in tasks 3 and 4.

As in task 3, there is no requirement for the robot to drive along every row, provided all weeds are sprayed.

Rules for robots

Each robot has only one attempt. The maximum available time for the run is 3 minutes. The robot must give an audible signal when the sprayer is operated.

The robot must spray only the weeds or the circular area around the golf ball with a diameter of 25 cm. Spraying outside this weed circle is counted as false positive, with no true positive scoring. In the case that the robot is spraying or producing an acoustic signal without any reason, this is regarded as false positive.

Penalties

Crop plant damage by the robot will result in a penalty of 2 points per plant.

Manual intervention to move or adjust the robot will result in a penalty of 2 points for each time the robot is STOPPED.

Activating the sprayer or making an audible signal when no weed is present in that location (false positives) will result in a penalty of 1 point per occurrence.

Failure to spray a weed when one is present (false negatives) will result in a penalty of 2 points per occurrence.

Assessment

The Jury will register the number of true positives, false positives and false negatives:

Each time a weed is sprayed correctly with the appropriate audible signal (true positives) 6 points will be awarded. If a weed is sprayed correctly but without an audible signal 4 points will be awarded.The total travelled distance will not be assessed.

If a team completes the task in less than 3 minutes, this time will be used to calculate a bonus factor = total points x 3minutes/measured time.

The task completing teams will be ranked by the number of points as described above.The three best teams will be rewarded.

Task 5 - "Freestyle"

Description

Teams are invited to let their robots perform a freestyle operation. Creativity and fun is required for this task as well as an application-oriented performance. One

team member has to present the idea, the realization and perhaps to comment the robot's performance to the jury and the audience. The freestyle task should be related to an agricultural application. Teams will have a time limit of 10 minutes for the presentation including the robot's performance.

Assessment

The jury will assess the (i) agronomic idea, the (ii) technical complexity and the (iii) robot performance by giving points from 0 (insufficient) to 10 (excellent) for each.

The total points will be calculated using the following formula: (agronomic idea + technical complexity) x performance.

Task 5 is optional and will be awarded separately. It will not contribute to the overall competition results.