Program Booklet of the 7th

Field Robot Event

Prototype Contest

Party, Workshop

July 7 2009

WAGENINGEN UNIVERSITY

WAGENINGEN UR

sciences and sometimes social sciences on one hand and technology on the other hand, the group holds a unique position both within Wageningen UR and nationally. Many scientific challenges arise on the edge between nature and technology. It is the ambition of the Farm Technology Group to play a competitive role in this scientific field, nationally and globally. We expect to achieve this through targeted networking and collaboration with research groups in related non-technological and technological fields to develop new scientific knowledge in support of the challenging field of Biosystems Engineering.

Exploiting the potential of technology, some examples

Systems engineering and systems optimization. Through networking with stakeholders, group members identify needs of mankind and nature as well as the pertaining sustainability issues and translate these in innovative system designs. Instead of focusing on single disciplinary solutions but using the paradigm of systems engineering and the development of new methods, the group is able to produce new farm system concepts based on a multidisciplinary approach. Examples of projects include the design of protected cultivation systems with for instance low inputs of fossil energy when focusing on the Netherlands. Another project, with a more global view, deals with the design of protected cultivation systems that are adapted to local climate and economic conditions. In a parallel project especially the ecological sustainability of organic laying hen systems is analyzed and redesign of such systems is pursued. In past years a new system for laying hen production was developed, the so called Roundel. A pilot of that system is currently being built and under investigation.

Welfare of animals and health of animals, plants and humans. Assuring health of animals, plants and humans in agricultural production is of growing concern in the Netherlands and considerable costs are associated to maintain required health levels not to mention the input and potential emission and transfer to the food chain of chemicals to cure occurring diseases. One way our group tackles this issue is to design so called robust livestock systems in which implicit robustness of the system with animals reduces health problems. The group is involved in projects on the design of husbandry systems where welfare, health and environment are substantially improved. An alternative approach we take is to detect health issues for instance in plants as soon as possible, so that early and plant specific treatment is possible. Stress detection based on the emission of volatile organic compounds by the stressed plants is used as a cue in this line of research. This approach will be extended to livestock farming as well.

High-tech automation and robotics. To maintain a healthy and productive crop, satisfy food safety concerns, reduce the use of chemicals and improve the efficiency of production, all within the limitations of the availability and cost of labour, requires automation and precision technology. A system has been developed for plant specific removal of volunteer potatoes in sugar beet fields to prevent spreading of Phytophthora infestans. It includes vision, perception and precision spraying. Such fundamental technical components are also used in other farm automation projects. The group developed a small robot WURking to be used for crop scouting in arable farming as well as a large autonomous robot called the Intelligent Autonomous Weeder (IAW). Complexity and variability of the biological working environment are challenging issues.

Contest information

Tasks during the 2009 Field Robot Event

Introduction

The field robot event has essentially three objectives:

1. Competitive hands-on learning for students and professionals.
2. A PR-instrument. 'Robotics is hot', so let's use this event as a PR instrument to promote agricultural engineering as a hightech tech profession.
3. Robots are the future in agriculture and horticulture. This event can be used to demonstrate a vision about the future of robotics in agriculture and horticulture and to show technical progress.

So, tasks should be:

1. A challenge for competitors to learn and improve robot building skills,
2. Appealing to the spectators,
3. Contribute to building a knowledge base on farm robotics including intelligent navigation and sensing and acting on the field.

Technical problems observed during the past field robot events:

1. Navigation between maize rows still is not robust. Sensors fail, electronic circuits fail and last but not least the software fails, the robot goes mad and crushes the maize plants.
2. Head-land turnings still seem to be a major challenge. It already seems difficult to turn from one row into the next row. Turning from one row into the second next row is even more difficult. Additionally, in some cases, robots need a complete extra field for a headland turning. Also, the implemented headland-turning algorithms seem only appropriate for situations in which the headland border is about perpendicular to the crop row orientation, which is often not the case in practice.
3. It still seems difficult for robots to distinguish between the end of a row and missing plants within a row, a common situation on the field in practice.
4. The weed killing action performed by the field robots is not very precise. Robots start spraying very early and stop very late in order to be sure 'weeds' are killed.

If we want to make small robots and robot swarms reality in agricultural practice, the navigation should be robust against changing environmental conditions and tasks should be performed precisely. So, the main challenge this event will be to improve the robustness and precision of the robotic systems.

Changes compared to last year's event

The tasks for the FRE 2009 are:

1. Navigation
2. Advanced Navigation
3. "Weed" Control
4. Freestyle

Tasks 1,2 and 3 are very similar to those of the FRE 2008 with a few exceptions. In task 2 the predefined pattern may now also require returning in the same row and the headland border may not be perpendicular to the crop row orientation. In Task 3 the precision of the performance of the 'weed' killing operation will be assessed this year. Numbers 1, 2 and 3 of each task will receive an award. Tasks 1 to 3 together will yield the overall winner of FRE2009. Awards will be available for the numbers 1, 2 and 3 as well.

The Freestyle must be demonstrated on the field, and must be relevant from an agricultural point of view. The freestyle competition is not included in the evaluation of the overall winners. It will be a separate award, it is completely left to the jury what aspects to evaluate. Awards will be available for the numbers 1, 2 and 3 of the free style task.

Tasks

Task 1: Navigation

The robot should cover as much distance as possible in 3 minutes time while navigating between curved rows of a maize field, making a head-land turn and returning in the adjacent row. See figure 1 for illustration. If mother nature is willing to support this task, there won't be plants missing in the rows. This task is all about speed, accuracy and robustness of navigation and smoothness of operation.

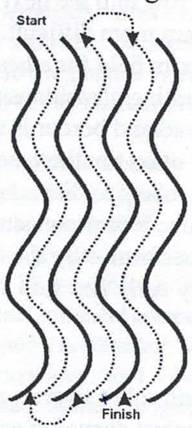

Figure 1. Navigation in a maize field with curved rows.

Assessment:

1. The distance travelled in 3 minutes is measured. If end of field is reached within 3 minutes, the time counts. Distance and time are observed by officials.
2. Touching the robot results in a penalty of 5m (per touch); number of touches are counted by officials.
3. Distances and time result in a ranking of teams; points are based on ranking number; the following sequence is used: 25-20-15-12-10-9-8-7-6-5-5-5-5-…
4. Smoothness of operation is judged by a jury.
5. Each member of the jury gives a score between 1 and 5; between 5 and 25 points can be earned.
6. Not participating in a task is 0 points.

Task 2: Advanced Navigation

The robot should cover as much distance as possible in 3 minutes time while navigating between straight rows of maize plants. The robot should be able to follow a certain pre-defined pattern over the field. See figure 2. At various places in the maize field, plants will be missing in either one or both rows over a length of maximally 1m. The headland border may not be perpendicular to the crop row orientation. The difference in length of two subsequent rows will be 1m maximum. A head-land of only 1.5m will be available for turning.

Coding of the pattern of the path through the maize field is done as follows. S means Start, L means left-hand turn, R means right-hand turn, F means Finish, the number before the L or R represents the path that has to be entered after the turn and the single number 0 means return in the same path. So, 2L means: enter the second path after a left-hand turn. 3R means: enter the third path after a right hand turn. The path shown in figure is coded as follows: S - 4L - 0 - 3L - 3R - 1R – 3L - 1R – F.

The code of the path is made available to the competitors 1 hour before the start of the competition without having the opportunity to test it in the maize rows.

Assessment:

1. The distance travelled in 3 minutes is measured. If end of field is reached within 3 minutes, the time counts. Distance and time are observed by officials.
2. Touching the robot results in a penalty of 5m (per touch); number of touches is counted by officials.
3. Crossing the headland boundary located at the end of the rows by a distance of more than 1.5m (or in case the length of the robot is bigger than 0.75m, by a distance of more than 2 times the length of the robot) results in a penalty of

5m per crossing. Number of crossings is counted by officials
4. Distances and time result in a ranking of teams; points are based on ranking number; the following sequence is used: 25-20-15-12-10-9-8-7-6-5-5-5-5-…
5. Smoothness of operation is judged by a jury.
6. Each member of the jury gives a score between 1 and 5; in total between 5 and 25 points can be earned.
7. Not participating in a task is 0 points.

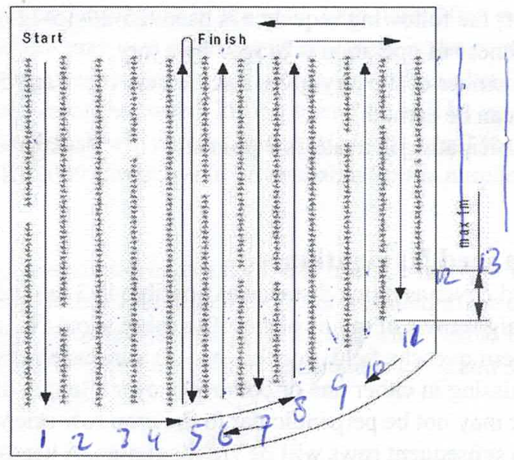

Figure 2. : Advanced navigation along a complex pattern in a maize field with straight rows with plants missing.

Task 3: 'Weed' Control

The robot should cover as much distance within 3 minutes time while navigating between straight rows of maize plants. In the maize field randomly distributed artificial weeds green golf balls have to be detected. Detection of a 'weed' should be demonstrated by producing a signal such as a flash-light or a sound. Additionally, a 'weed-spraying' operation should be performed on the 'weed'. A strip of yellow water-sensitive paper used for measuring the precision of the spraying will be located in the field near the golf ball. At some locations water sensitive paper will be located in the field without a golf ball.

A set of five green golf balls and a strip of water-sensitive paper that will be used during the event will be supplied to the competitors when they register.

Assessment:

1. The precision of the weed killing action (spraying) together with the number of correctly sprayed balls determine the ranking.
2. Each golf ball in the field is accompanied with a strip water sensitive paper before and after the ball; each with a length of 0.5m. The number is the same for each participant.
3. For each correctly sprayed golf ball, the length of 1.0m minus the sprayed length on the water sensitive paper is added to the total score.
4. Not spraying a golf ball yields no length.
5. Touching the robot results in a penalty of 0.5m; number of touches are counted by officials.
6. If end of field is reached within 3 minutes, the time counts.
7. The precision is defined as the total length after 3 minutes. Precision and time results in a ranking of teams; points are based on ranking number; the following sequence is used: 25-20-15-12-10-9-8-7-6-5-5-5-5-…
8. Precision and time are observed by officials.
9. Smoothness of operation is judged by a jury.
10. Each member of the jury gives a score between 1 and 5; in total between 5 and 25 points can be earned.
11. Not participating in a task is 0 points.

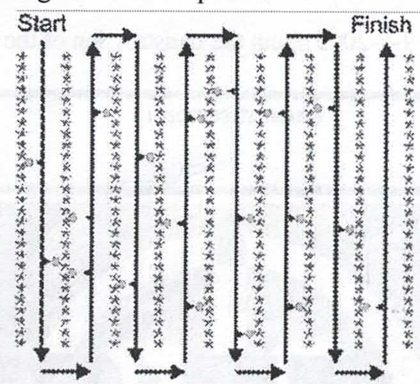

Figure 3. 'Weed'-control in a maize field

Freestyle

Robots are invited to perform a free-style operation on the field. Fun is important in this task but an agricultural relevance of the task is required. One team member has to inform the public about the idea.

Assessment:

1. The Freestyle must be demonstrated on the field, and must be relevant from an agricultural point of view.
2. Assessed by jury.
3. Ranking will be made by the jury after the performance of all teams.
4. Points are based on ranking number; the following sequence is used: 50-40-30-24-20-18-16-14-12-10-10-10-10-…

Additional task information

- All participating robots line up before the start of a task.
- From the moment a robot is given permission to start, it must start within one minute.
- If the robot does not start within one minute, it must go to the end of the line, and it will be given one more chance to start within one minute.
- If it the second time does not start within one minute, the robot is disqualified for that task.

Large robots and/or robots with a probability of destroying the field will always start the last (after all second chances restarted again).

Presentation during Workshop on Wednesday

There will be a fair with stands and posters for all robots. The numbers 1 to 5 of overall best performing teams (tasks 1-3) give a presentation of about 10 minutes.

Submitting a paper

Submitting a paper before 1-7-2009 about the construction of the robot.

Competitors

Field Robot Event