DaNet

August 2005

Content

This NewsLetter is dedicated to four ongoing DaNet projects on field robots in agriculture which focuses on the possibilities, challenges and development of robots and intelligent equipment in crop production systems.

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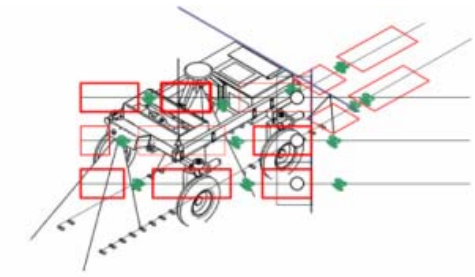
Field Robots in Agriculture

There are a number of finished and ongoing DaNet R&D projects on field robots in agriculture. The projects embrace the complex innovation of technologies operating in dynamic biosystems. The vision of the research is to develop robotic that improves the crop production systems economically and at the same time reduces the environmental impact, by increasing precision and efficiency of crop management.

AgroBots

AgroBots will through presentation of knowledge and research results, test of robots and equipment, and the cooperation of the participants, contributes to the ongoing and future development in equipment to cultivation of crops in conventional as well as organic agriculture, as well as in the new market for medical plants.

The activities are split in two:
- Development and demonstration of a robot that will establish, care for, survey and/or harvest the crops according to conventional as well as organic site specific weeding.
- Development of IT-systems for central planning and follow-up on crop related tasks, as well as IT-systems, that can be used for coordination and optimisation of the cooperation between manned and unmanned vehicles.



So far requirement analysis and definition of scenarios for the use of robots in organic agriculture have taken place. The requirement analysis regarding fleet management has shown that the proposed requests can be split in two general groups which are: systems for transport administration and control, and optimization of supply chains. The former concerns planning of routes, surveillance, invoices to the customers, technical data regarding vehicle economy etc., while the latter concerns optimization of vehicle routing and material flow, documentation and traceability, registration of detailed production data etc.

Contact: Project Co-ordinator Thomas Bak, DIAS
Homepage: http://www.agrobot.dk/.

Autonomous weeding of Christmas trees

Weed control in Christmas tree plantations is essential for good tree growth and quality. The most common method of control is herbicide applications. Alternative methods have been developed to decrease environmental effects, but these are all more costly to use, mainly because of much higher labour requirements. One way of decreasing labour costs is robotic weed control. In this work an autonomous weeder is being developed to cut weeds around Christmas trees. The machine is adapted from a commercial lawn mower and it is designed to follow a predefined route and to cut the weeds by means of a rotary cutter that can be moved in between the trees in the row area. The route plan is based on a map of tree positions and field boundaries, as measured by a high accuracy RTK-GPS, and adjusted by a tilt-meter to give centimetre accuracy. The preliminary test results have shown that the machine is able to follow a defined route with sufficient accuracy and able to cut nearly all weeds without essential damages to the trees.

The first phase of the project looked at the feasibility of the concept and concluded that it was realistic. In the second phase a prototype was adopted from a commercial 4-wheel lawn mower. This machine has demonstrated good primary performance, but also that a better operational reliability and safety behaviour is required. These issues will be focus areas of the future work.

Contact: Project Co-ordinator Henrik Have, KVL.
Homepage: http://www.agsci.kvl.dk/agrotechres/projects/acw

Robotic Weeding

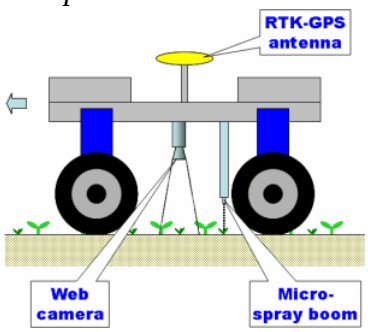
The vision of the Robotic Weeding project is to develop new weeding measures that can reduce the manual weeding effort in organic vegetables and beets by 50-100% and reduce herbicide use in conventional grown row crops by 75-100%, by developing a hybrid system, which integrates:

- High-precision seed mapping
- Computer vision for plant recognition
- Advanced tools for weed removal/control

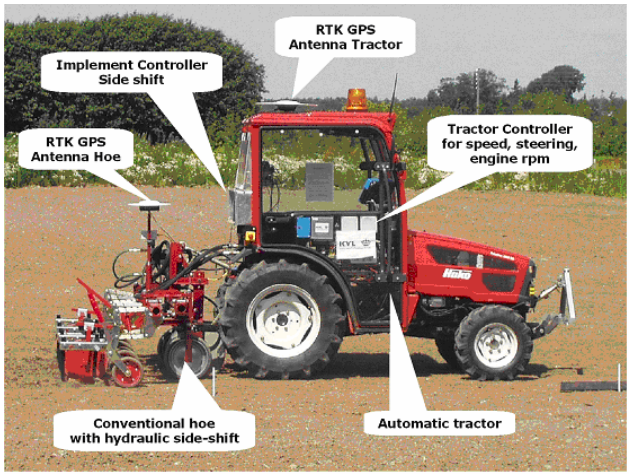
Seed mapping and computer vision localisation of crop and weed plants
The efficiency of computer vision based recognition of crop plants by field robots can be improved with the availability of prior knowledge of the plant positions. Such knowledge is obtained by mapping the seed positions when the crop is seeded. The determination of seed positions is based on Real Time Kinematic Global Positioning System (RTK-GPS) and the

seed position maps produced imply that the emerging points of the crop plants will be known within few centimetres. The crop position information is utilised as starting point when the computer vision system of the weeding robot is identifying the precise (sub-centimetre) positions of the crop plants. The computer vision system identifies the contour and the centre points of the crop plants by an Active Shape Modelling technique and instructs the weeding equipment to remove/control all green vegetation that is not identified as crop.

Computer vision based micro-spraying



One of the goals of the project is to establish knowledge of advanced technology for computer vision controlled robotic weeding between crop plants. Preliminary conclusions on the micro-spray system: There is sub-centimetre accuracy under indoor conditions, and the accuracy is close to the theoretically achievable level with the present system design. A higher accuracy is achievable by increasing the ground resolution. Therefore a new micro-spray design is being developed. The ground resolution of this system is 5 mm. The potential herbicide reduction (Glyphosate) is from 540 g/ ha to less than 10 g/ha. Next stage is the field trials.

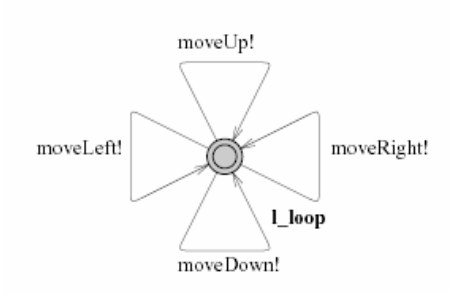


Physical weed control

Today standard inter-row hoeing in combination with band spraying or hand weeding requires high input of labour costs. Sometimes even two operators are needed to control both the tractor and the hoeing implement. For those systems the operation speed (capacity) and working quality (crop losses) are depending on the operator skills and attention. Within the project ‘a fully automatic system was developed to reduce both the labour costs and the crop losses. The tractor and the hoe are both equipped with a highly accurate Real Time Kinematic Global Positioning System (RTK-GPS) on cm level. Both are using the same defined navigation routes across a field which was generated from a seed map. The hoe’s lateral movement is variable relatively to the tractor and controlled by an electro-hydraulic side-shift system. The performance of the fully automatic and driverless tractor-hoe-system was investigated in field experiments. The measured cross track errors from both the GPS and distance of hoe track to crop rows showed excellent results compared with similar systems from the literature (Ibarra 2005).

Contact: Project Co-ordinator: Svend Christensen, DIAS.
Homepage: http://www.danet.dk/danet/danet3H.html.

AgroBotics



Successful development of multiple small autonomous vehicles calls for a software framework that can handle the complex, dynamic and semi-natural environment specific to agricultural fields. A context for investigating and developing such novel software architecture are set-up. The challenge involves establishing the basis for understanding of desirable agent behaviours; this is done by analysing and defining operational tasks to be performed by such a vehicle. The project has:

- described a framework for formalizing component based systems in general as illustrated by an agricultural robot (Piotr Makowski's PhD-thesis)
- a software packages (SaTool) has been extended and tested to embrace the complete analysis of all possible faults in a safety driven design of a robot
- a hardware abstraction layer has been adapted to the existing architecture of API, building on a framework around RT Linux with Simulink code running as a real-time application.

Contact: Project Co-ordinator Thomas Bak, DIAS.
Homepage: http://www.agrobotics.dk/

Topics of coming newsletters

Monitoring and management of ammonia emission
Farm Wet Scrubber
HortiBot - A Plant Nursing Robot