Ph.D thesis - English summary

Precision Weed control is the main theme of this thesis. The scientific issues addressed in the thesis all originate from subtasks involved in developing agricultural machines for site-specific weed control.

The work described in this thesis has received funding from the projects "BrainWeed - Operator based teach-in system for adaptive high-speed crop / weed classification robot" (BrainWeed) and "Modulation of Fungicides and Herbicides in Potatoes, Corn and Corn Sown in Stub" (GradApp).

The BrainWeed project was designed to test a procedure in which the time-specific appearance of a crop in a particular field were identified using camera footage from part of the field, where pattern sown crops could be identified. A real-time system for plant recognition was trained with the collected information about the appearance of the crop, and the system could then be used to recognize the crop plants in the remainder of the field. Plants that were not recognized as the crop was weeded by the mechanical weeding robot, Robovator, developed by Frank Poulsen Engineering.

The GradApp project consisted of several sub-goals. The sub goal treated in this thesis aimed at developing an algorithm able to recognize at least 5 plant species from image recordings. Information about the plant species that exist in a field is needed to target weeding, for example by spraying with a special mixture of herbicides.

Work on these projects required that various scientific challenges were addressed:

Weeding with Robovatoren demand that the plant base point is determined since this point should be protected from weeding. This task was solved by analyzing the contour of plant objects and identify characteristics such as leaf tips. Subsequently, a model of the geometry of the leaf in relation to the plant's base point is constructed. This model could then be used to estimate plant base points if at least one leaf of a plant could be identified. The method was tested using images from a sugar beet field.

Recognition of crop plants through their shape is a complex task. This is because the plants generally may look different, even if they are of same species, and that the plant appearance changes as a result of their growth. Plant’s location location does not change over time and this can be exploited when combined with the practice that crops in commercial agriculture is often sown in a distinct pattern. By recognizing this pattern, it is possible to identify the crop plants in the field. A system that does this is described in the thesis, and it is also described how the derived information can be used to train a system to recognize crop plants by utilizing shape characteristics.

Plant recognition using shape characteristics have been studied for many years. In spite of this, no general recipe of how this process is carried out with the best possible outcome exists. In this paper we present a new way to characterize shape by deriving numerical features from a so-called distance transform of binary images. The result is a contribution to the possible approaches that can be used for plant recognition through shape characteristics.

Efforts to explore ways of recognizing plants using shape raised the question of how different methods can be compared. This problem occurs because researchers base their findings on very different data. It may be that the number of plant samples vary or plant species examined are different. To overcome this problem it was decided to build and publish an image database of annotated images of plant species that frequently appear in the Danish fieldwork. Furthermore, it is described how the performance of a method can be assessed with a common measurement standard. In the future, researchers in plant recognition could test their methods on the public dataset and make it easier for other researchers to prove or compare the results obtained.