A vision based row detection system for sugar beet

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1 Introduction

In organic farming no herbicides are used. In a lot of crops manual weeding is needed to remove the weeds in the crop row. This labor involves high cost and is not always available. Autonomous weeding robots might replace this manual weeding in the future in a lot of crops. The work described here is part of a project with the objective to develop an autonomous weeding robot for sugar beet. A vision based row detection system must determine the position and orientation of the crop rows relative to the robot. This information is needed for steering the robot while it is driving along the rows. The algorithm should work at reasonable weed infestation and during different growth stages of the crop. The image processing should not limit the driving speed of the robot. The maximum driving speed of the robot during weeding is expected to be 1 m/s. In this paper a vision based row detection system for sugar beet is presented.

2 Materials and method

A sugar beet field was prepared in a greenhouse. Images were acquired using a color camera mounted on a wheeled platform. The platform was pulled by hand over the sugar beet field. The camera is mounted at an angle of about 40 degrees from the vertical, The area that is covered by one image is 2.5 meters long in row direction and 1.5 meters wide at the side closest to the camera. This means that at least three rows are visible in the image.

The first step in the row recognition algorithm, is transforming the color image to a gray scale image with good contrast between green plants and soil background [1]. Because the camera is looking downward at an angle, the image undergoes a perspective transformation. The image is corrected by an inverse perspective transformation using a built-in calibration procedure of Labview®. The resulting image is thresholded with a low threshold to get rid of pixels which are surely deemed not to be plant. Next the image is divided in three sections that are merged into one image, creating less data while still having information of three rows. Hough transform is applied on the merged image, thus improving the speed of image processing. Instead of Hough transform on a binary image made by thresholding, gray-scale Hough transform was applied directly on the merged grey-scale image [2]. Finally the position of the rows found by the algorithm are compared by the position determined manually.

3 Results

The algorithm is able to find the crop rows at various growth stages of the crop. The system did find the crop rows in images with heavy weed infestation. The average deviation between the estimated and real crop row varied from 6 to 223 mm. The higher deviations in this range can be explained by the number of plants visible in early crop stage, overexposure of the camera, and the presence of a lot of green algae due to the experimental setup. If the measurements under these conditions are left out of consideration, the algorithm was able to find the row with an average error of 6 to 18 mm. The measured processing time did not exceed 1.5 seconds per image. While images cover 2.5 m in row direction, the image processing will not limit the driving speed of the weeding robot.

References

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