RESEARCH ON SPRAY PRECISELY TOWARD CROP-ROWS BASED ON MACHINE VISION

Honghui Rao[1], Changying Ji[2,*]
[1] *College of Engineering, Jiangxi Agricultural University, Nanchang, China, 330045;*
[2] *College of Engineering, Nanjing Agricultural University, Nanjing, China, 210031*
[*] *Corresponding author, Address: Department of Agriculture machinery, Nanjing Agricultural University, 40 Dianjiangtai Road, Pu kou,Nanjing, 210031, P. R. China, Tel:+86-25-58606670, Email: chyji@njau.edu.cn*

Abstract: A method to aim toward crop-rows was put forward for spray control in this article. At first, the image of crops captured by a CCD camera was passed on computer, then crops were segmented from background by obtaining H value and its binary image was obtained by means of OSTU. Finally, the center line of crop-row was regressed by Hough transform after the binary image was morphologically eroded. A spray control system was designed to move the spray nozzle accurately on crop row.

Keywords: machine vision; Hough transform; center line of crop-row.

1. INTRODUCTION

The characters of modern agriculture are precise, environmental and sustainable. With the development of agriculture, more and more pesticide is used to protect crops, which leads to soil pollution and reduction of pesticide. Both soil pollution and reduction of pesticide give much trouble to human and environment. It is necessary to use precision technique for various types of agriculture operations, so that the pesticides can be placed where they have an optimal effect with minimum quantity. Machine vision, a classic technique used in precision agriculture, has been applied widely in agricultural production. Many researchers have investigated strategies to control weeds with less herbicide to reduce production costs and to protect

the environment. For example, Lei Tian has developed an automated equipment of weed control in tomato fields based on machine vision and spraying system based on differential GPS (Tian et al., 1997; Tian et al., 1999). A machine-vision guided precision band sprayer for small-plant foliar spraying demonstrated a target deposition efficiency of 2.6 to 3.6 times than that of a conventional sprayer, and the non-target deposition was reduced by 72% to 99%(Giles et al.,1997). For high-value crops, high-accuracy machine vision and control systems have been studied for outdoor field applications in California (Lee et al., 1999). To detect line structures, a method to determinate crop rows by image analysis without segmentation was put forward (Søgaard et al., 2003). What's more, a vision based row-following system for agricultural field machinery has been designed in Halmstad University (Björn et al., 2005). It was showed that mobile robots could be most probably navigated through the fields autonomously to perform different kind of agricultural operations. In China, there are also some researchers to study smart spraying based on machine vision. A method based on vertical projection was described to detect orientation of crop rows (Yuan et al., 2005). However, with the exception of a few recent studies, much vision recognition of crop-rows is still at the stage of studying artificial crops in the laboratory, or studying the target crops under a controlled indoor lighting environment. So there still is a long way to make autonomous mobile robots based on machine vision practical in China.

In the research on the autonomous variable spraying systems based on machine vision, there are three problems need to be solved. At first, recognizing the target autonomously under complicated lighting environment is a dilemma, the algorithm on segmenting crops from background and segmenting crops from weed mostly depend on the lighting conditions. This is an area needs to deep research in spite of many scientists putting forward many efficient ways. Secondly, the form of spraying control toward the crops have two ways: one way the nozzles are fixed to spray where there are crops or weed; the other way is moving the nozzles toward the crops. Compared with the former, moving the nozzles is obviously more difficult and practical, which is becoming a hotspot all over the world. Thirdly, the variable technology of spraying is still explored in recent years, some researchers put forward to using PWM technology on changing the flux of nozzles (Cheng et al., 2003).

2. MATIERIALS AND METHOD

As many field crops are planted by rows and each crop grows like blob in

early state, in order to make study conveniently, it is supposed that all row pitches are equal, the crops in different rows have not been interleaved and there is no weed in the field. Under these conditions, a horsebean image of 640×480 pixels was captured by a CCD camera, then the image was passed to computer for processed and later the center line of crop-row was obtained by Hough transform.

2.1 Image preprocessed

The true color of horsebean image (figure a) was transformed from the RGB model to HSI model, which can be segmented from its background by obtaining its H value of HSI model. Before the horsebean image is processed with morphological erode method, its binary image should be obtained. Through many experiments it was fund that using the OSTU algorithm can make perfect performance (He et al., 2001).

After obtaining its binary image by the algorithm of OSTU, we used the structure 3×3 to process the image with morphological erode. Through which the binary image was processed by 12 times, the result showed as figure b. Then the center line of horsebean (figure c) was regressed by Hough transform. Finally, the subtract image (figure d) is to test its efficiency. Obviously the method is available to detect the center line of crop-row.

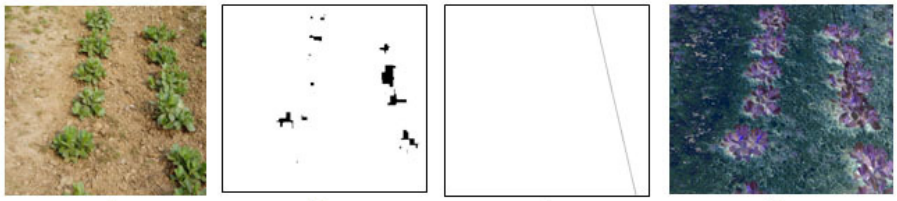

Figure 1: Original image (a), erode image (b), the center line of crops by Hough transform (c) and its subtract image (d)

2.2 Experiment and procedures

A spray control system based on machine vision was designed to move the nozzle toward the centerline of the crop row. The basic structure and working principle are shown as follows:

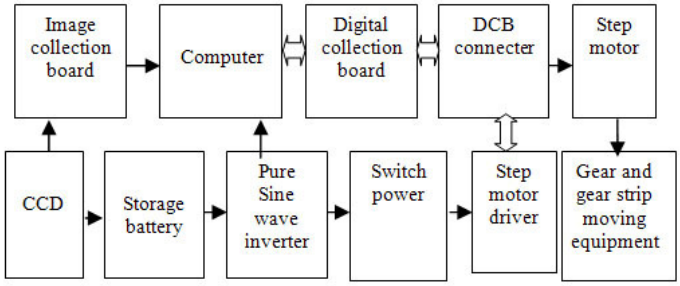

Figure 2: Spray control system for field crop-rows based on machine vision

When the system works, a crop image is obtained by CCD camera and passed to computer through an image collection board firstly. After the centerline of the crop row is obtained with the method as mentioned above. The distance from the nozzle mark to real crop row can be computed. At the same time, the corresponding pulses are sending through a counter of digital collection board to move the equipment toward the right crop row.

The character of the equipment lies in its adaptation. Before sending pulses, the direction and quantities of the pulse should be computed firstly. Experiment was implemented with a computer of Pentium Π and the results showed that the method is available to aim at the crop row.

3. CONCLUSIONS AND FUTURE WORKS

1) The center line of crop row detected by Hough transform is efficiently after its binary image was processed by means of morphological erode of structure 3×3.

2) A vision based smart system for precision band spraying is established.

3) Future work is using intelligent sensor to develop closed-loop control system for higher performance.

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