Automatic 9 Row Corn Harvester Based on Labview Image Recognition

Xiangwen SONG 1, Shukun CAO 1*, Chong WANG 1, Xiangqian XU 2, Tao HAN 2 and Hejia GUO 2

1 Nanxinzhuang West Road 336Jinnan, School of Mechanical Engineering, University of Jinan, Jinan 250022, Shandong Province, China
2 Shandong Jindafeng Machinery Co, yanzhou city, Shandong Province, China

*87756997@qq. Com

Abstract. With the continuous expansion of China's corn planting areas, a variety of situations continue to emerge, corn harvester to adapt to the different habits of different regions in China, such as different row spacing, plant spacing. In this paper, nine rows of maize harvester with adjustable row spacing are designed, which greatly increases the ability of maize harvester to adapt to different areas and different environments, so as to solve the existing technical problems of maize harvester, greatly improve the design and manufacturing level of maize harvester in China, and promote agricultural machinery products. Technological innovation the main purpose of this paper is to collect the information of maize plant by building an image recognition system on the harvester. Through the method of image processing and mathematical calculation, the line distance of the maize plant is calculated. Then the signal is processed to automatically adjust the row distance of the cutting table so as to realize the automatic line of the harvester, the design of large-scale corn header is based on image processing technology, it needs to segment corn straw in the complex background of farml and natural light conditions. Compared with the traditional corn harvesting method, this design can accurately judge the distance between corn stalks before harvesting corn. Using LabVIEW software and according to the principle of camera calibration, the image distance is converted to the actual distance.

1. Introduction
This paper introduces an automatic pair of corn harvester based on image recognition to realize automatic alignment. First, we need to know the plant spacing of corn planting, and do automatic measurement. According to the distance between the plants, the collected signals are transmitted to the DSP controller, and the cutting table is adjusted by the control system. In this paper, through the method of image recognition, in this paper, the area of interest in the image is extracted, and the region of interest is further analyzed or measured by a certain method. At last, the signal is transferred to the control system to realize the automatic alignment of the corn harvester.

2. The construction of image recognition system
The CCD industrial camera used in this paper shows that the CCD camera is installed in front of the cab of the harvester, as shown in Figure 1, so that sufficient illumination can be obtained to capture the image of the maize plants.
3. Image recognition and automatic alignment of corn plant in field

The images of corn plants collected in the field are preprocessed by the method of image acquisition, which mainly include gray, two value, segmentation, denoising and corrosion expansion of the corn plant image. The whole image preprocessing process is carried out by LabVIEW as a platform[1].

In this paper, the harvester is the 9 line corn harvester, and the adjustment range of each set of picking rollers is between 400mm and 600mm. Therefore, in the process of realizing the automatic alignment of the cutting table by image recognition, the corn plant spacing is determined within the range of adjustment, and the collected image signals will be collected within the range of adjusting and adjusting. Passing to the control system, adjusting the row spacing through the control system, and finally carrying out the operation of the corn machine, the specific process is shown in Figure 2.

3.1 Image preprocessing of maize plants

In the process of actual operation, because of too many interference items in corn, it will interfere with the two value processing of the image, so that the results of its processing will appear a lot of
independent and irregular noise, and can not use the RGB color segmentation method to extract corn plants[2]. Therefore, in this paper, using the shape of corn stalk, using image processing, image enhancement, two value processing, low pass filtering, segmentation and particle filter and other basic methods of image processing, the specific flow chart of image pretreatment of maize plants is shown in Figure 3.

3.2 Image grayscale processing
Therefore, in this design, we need to convert the RGB color images of the collected field maize plants to gray scale first. RGB represents three channels of red, green and blue. If the three components are all equal, then the color of corn plant image is converted to gray scale[3].

![Figure 4. original image](image.png) ![Figure 5. grayscale of maize plants](image.png)

In this paper, the average value of the three values is not considered, and the average value of the three components is used as the gray value. The weighted average is the value obtained after the weighted average of the three components as the final gray value through the image of the Tian Jianyu rice plant collected after the collection of the images, as shown in Figure 4. The results of the row grayscale processing are shown in Figure 5.

3.3 Image grayscale processing
The purpose of image two value is simple. It is simply to separate the region of interest from the non interested area, set the required color part to 1, then the other parts are all set to 0, so that other unimportant areas can be removed. In the subsequent image processing, only the region of interest needs to be processed again.

![Figure 6. Two value processing of image](image.png)
In this paper, the threshold value is adjusted by LabVIEW software, and the image is processed by two values, and the gray image is converted to two value image. In the Vision control, by manually adjusting the threshold, and through the collection of multiple images to test and contrast, the final threshold position is 120, two value processing of the program calls and effects as shown in Figure 6.

3.4 Low pass filtering and expansion corrosion

The noise is usually used as the high frequency part of the image, so in this paper, the low frequency filter can be used to effectively remove the noisy noise in the image. The signal is assigned to 1, the interception of the signal is 0, and the unnecessary image elements can be removed by the expansion and corrosion processing of the image, and the sense of the image can be removed. The area of interest keeps its original shape[4].

Set “G” as gray image, “X” as structural element, “A” can be any geometric primitives, and if the asymmetric base element will make the image produce displacement, it needs to use the symmetric set “Av” of A to calculate, set the expansion to +, corrosion process is equivalent to scanning all the other pixels with an element “X”, each other “And” “calculation. If each other is 1, the pixel of the image is 1, and the pixel information is retained. If 0, the pixel information is not preserved[5]. The process of corrosion can be expressed as:

\[
E(x, y) = (G \otimes A)(x, y) = A_{i,j}^{\text{AND}} [F(x+i, y+j) \& A(i, j)]
\]

\[
D(x, y) = (G \otimes A)(x, y) = A_{i,j}^{\text{OR}} [F(x+i, y+j) \& A(i, j)]
\]

On the basis of the above two valued images, the first noise reduction processing is done. The parameter settings are shown in Figure 7 (a), The Vision Assistant low pass filter is used to reduce the noise. The first low pass filtering results are shown as shown in Figure 7 (b):

![Parameter setting](image1)

![Low pass filtering effect](image2)

**Figure 7. Low pass filtering**
Next, the image is processed with grayscale morphology, and the first expansion processing is performed on the image, as shown in Figure 8 (a). After processing, the result is as shown in Figure 8 (b). After the expansion is processed, it is found that many of the interference items in the graph are smooth and the noise becomes clearer after the expansion. The image is further processed with noise reduction, and the setting parameters are shown in Figure 8 (c). The results are shown in Figure 8 (d).

Figure 8. Expansion and low pass filtering
The noise points are distinguished by swelling treatment, so that the noise points are independent and the edges are smooth. At the same time, the edges of the corn stalks are smoother and the corn stalks are more obvious. The adjusting parameters are shown in Figure 9 (a) and the effect is shown in Figure 9 (b). At this time, the noise points in the image can be clearly divided from the branches and trunks of some disturbances, such as large leaves.

After corrosion treatment, the big leaves have been separated from the straw. The parameter settings are shown in Figure 10 (a). Here, particle filtering is used to further filter out noise, hole and convex hull elements, as shown in Figure 10 (b). As you can see, all the independent noise has been filtered out, and the edges of the protruding are smoother. In this case, the straw part is obvious, and there is no obvious interference factor.
It is clear from the diagram that the target area is clearer and the edges are smoother, which has been convenient for subsequent position calibration. The contrast diagram before and after the image preprocessing is shown in Figure 11.

4. Summary
In this paper, the image recognition and field corn spacing are obtained through LabVIEW software. The image preprocessing part belongs to the image recognition under the complex background. Considering the light and the complex environment background, a reasonable image preprocessing scheme is selected, and the effective coordinates and the corn spacing are obtained.

Acknowledgements
This work was supported by the Shandong Province, the major project of science and technology (item number: 2015ZDZX10001) "the development and industrialization demonstration of intelligent corn combine harvester" and important projects for independent innovation in Shandong Province.

References
[1] E.Raymond Hunt, Jr.W.Dean Hively, Stephen J.Fujikawa, etc. Acquisition of NIR-Green-Blue Digital Photographs from Unmanned Aircraft for Crop Monitoring[J].Remote Sens,2010,2:290-305.
[2] Shinners K J, Boettcher G C, Hoffman D S, et al. Single—pass harvest of corn grain and stover: performance of three harvester con—figurations[J].Transactions of the ASABE,2009,52(1):51-60.
[3] Thomas Burnell Colhert. Iowa farmers and mechanical corn pickers[J].Agri-cultural History,2000,74(2):530-544.
[4] Yang Weiyu. Present development in China's maize harvesters and proposals[J].Agri-cultural Science and Technology and Equipment,2011(2):128.
[5] Manh A G, Rabatel G, Assemat L, Aldon M J. Weed Leaf Image Segmentation by Deformable Templates.Agric Eng Res,200180(2):139-146.