Research on Ball-Pen Writing Quality Detection based on Machine Vision

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Abstract. Writing fluidity is one of the most important quality inspection items in the ball-pen production. In order to realize the automatic inspection of ball-pen writing path quality, this paper developed the methods of threshold segmentation and morphology in image processing by Halcon and Visual Studio. Compared with the traditional manual detection method, the test results showed that this method improves the detection efficiency while ensuring the accuracy.

1. Introduction

One of the most important tests is to check the writing fluent, and to detect any breakage of the writing path or ink accumulation that would breakdown the ball-pen quality. Based on the machine vision software Halcon, a Halo detection method is proposed to improve the ball-pen production quality detection.

2. Machine vision testing process

The ball-pen machine vision inspection system includes the following components:

The image capture device can continuously capture the optical characteristics of the target object into two-dimensional information of the electrical signal, and then through the data acquisition card or collection device itself brought sampling and quantization function, which will be converted into digital images. After that, the computer processes the digital image, including a series of steps such as image preprocessing, image enhancement, image segmentation and feature extraction. Finally, the image analysis is used for measurement and judgment.

A subsection. The work process is: the ball-pen path image was captured into the CCD camera; captured images computer process, set a certain image range according to the interest area. Calculate the area of ball-pen path gray value. The threshold of grey value is different from each other ball-pen.

Image analysis software. HALCON is a complete image processing library, which covers more than a thousand independent image processing operators, and also includes the underlying data management. It is generally used in image processing. We can use the HALCON powerful image analysis capabilities to complete the image processing.

System software structure. The system software can be basically described according to the image processing flow, including the source image acquisition, gray-scale transformation, image filtering, image segmentation, morphological processing, parameter analysis and several other modules. The composition of the block diagram is shown as following.

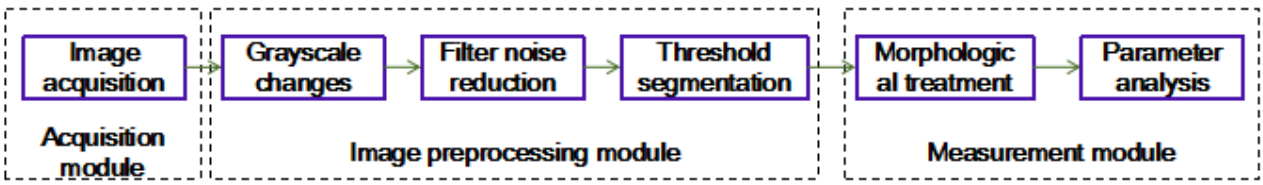


Figure 1. constitutes a framework

3. The writing path detection

For the writing path defect detection, we use HDevelop HALCON software platform for image analysis and processing through a series of algorithms.

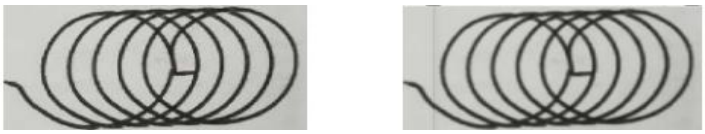
Image processing. To extract these feature blemishes, you first need to select the appropriate lighting to enhance the surface blemishes. Then, the area of each flaw is segmented on the image and the flaw information is extracted. This design of the image processing algorithm comprises an image enhancement, image segmentation, feature extraction and morphological processing.

Image filtering. During image acquisition, random interference can occur due to the environment or the machine vision system itself. In order to eliminate the noise brought by the image acquisition, we use a linear filter based on local averaging to eliminate some high-frequency noise. In HALCON, we call the mean_image operator to average the read image. The sentence is:

mean_image（Image,ImageMean,3,3）

Among them, Image for the input image, ImageMean for the output image, 3 for the window size.

Output after the operation as shown:



（a）The original image （b）Filtered image

Figure 2. image preprocessing of writing path

Image enhancement. The main purpose of image enhancement is to improve the image quality so that people or computers can understand and analyze it. According to the different scopes, image enhancement can be divided into spatial domain processing and frequency domain processing. The former is to process the image pixels directly, and the latter is to realize the transformation of the image first by transforming the image first, then calculating the transform coefficients in the transform domain, and then obtaining the enhancement effect by the inverse transform.

The mean filter is also called linear filtering. In other words, for target pixels (x, y), a filtering template is adopted and the template is composed of a plurality of pixels in its neighbor. The equations of u(x,y) are as follow.

$$u(x,y)=1/n\sum f(x,y)$$

where n is the total number of all pixels except the current pixel for this template.

Image segmentation. In order to separate the target from the background, it is necessary to segment the gear images. Binarization processing is to use the difference of the gray characteristic between the gear and its background. In the acquisition of the image, if the intensity of a pixel value is less than this threshold, it is assumed that the pixel belongs to people interested in the target. Otherwise, it belongs to the background. The image after Binarization processing g(x,y) be determined by original image f(x,y).

$$g(x,y)=\begin{cases}0 & f(x,y)\geq T\\ 1 & f(x,y)<T\end{cases} \quad (1)$$

Where T is the threshold of original image. The value of 1 represents the target line segment, and the value of 0 represents the background.

The gray level difference between the target and the background is large, and the histogram shows the two-peak curve, which is very suitable for threshold segmentation. The sentences used for segmentation are as follow.

Threshold(ImageMean,Region,0,150)

Where ImageMean is input picture, Region is the threshold segmentation image, and 0 and 150 represent the minimum and maximum gray values of the target respectively.

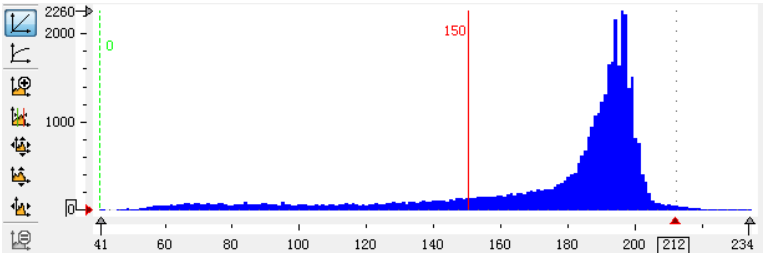


Figure 3. gray histogram

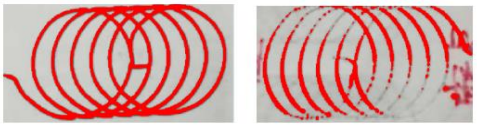


Figure 4. image segmentation process

Morphological processing. Threshold segmentation algorithm is to segment the region of interest based on image enhancement, so there are still a lot of interference points in the region after segmentation. For the interference point, the best solution is the morphological processing. It can not only eliminate the interference, but also keep characteristics of shape defect.

The dilation operation is one of the most widely used algorithms in morphological processing. It refers to the integration of all the background points that are in contact with the target object in a certain range, and promotes the process of external expansion, which can be used to fill the void in the target object.

$$X \oplus B = \left\{ z \middle| \left(\hat{B} \right) \cap X \neq \varnothing \right\}$$

B is a collection of Z^2. x is the processed object. B refers to the structural elements. definition of X is the B expansion for type (1). In X structural elements of B expansion is the set of all displacement z, $\hat{B}$ and X at least one element is overlapped.

$$X \oplus B = \left\{ z \middle| \left[\left(\hat{B} \right) \cap X \right] \subseteq X \right\}$$

Specific statements are as follows:

connection(Regions, ConnectedRegions)

select_shape (ConnectedRegions, SelectedRegions, ‘area’, ‘and’, 626.15, 661)

dilation_circle(SelectedRegions, RegionDilation, 2.5)

boundary(RegionDilation, RegionBorder, ‘inner’)

Parametric Analysis. Through the above steps, judging the characteristics of defect segments, area feature is an important basis for feature extraction algorithm. Its basic principle is the extraction of defects based on histogram area. When the area (i.e. the number of pixels) is less than 6000, it is defined as broken line, and more than 7000 are classified as ink.

The defective line segments are separated according to the area attributes, and the HALCON operator is used as the area_center correlation statement.

area_center(ConnectedDefect,Areas,Rows,Columns)

Where Areas is the area of each line, and Rows and Columns are the abscissa and ordinate of the line segment respectively.

Finally, the defect area is judged by setting threshold, and the judging rules of the system are as follows.

$$\begin{cases} normal\ region & 6000 \le Area \le 7000 \\ defect\ region & other \end{cases}$$

4. Conclusion

In summary, based on Halcon combined with a series of image processing methods in this paper, the methods can detect on defects of line, and can satisfy the requirements of fast, stable and accurate product inspection process. This method reduces the production cost in a certain extent, and has

played a positive role for promoting the application of machine vision technology in the production of office stationery, and in line with the development needs of industrial automation.

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