Keyboard Defects Detection Based on Template Matching Method

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Abstract. A method based on the template matching is proposed for the defects detection of keyboard. The local threshold method is used to calculate the threshold value for image binarization. Two features are used for target segmentation. One is the sum of white pixels value in vertical. The other is the height-width ratio of target contours. After getting the character region, a template is used to matching with the area to be detected. The experiments show the method is feasible.

Introduction

The characters detection on the keyboard plays an important role in the keyboard production. However, it is not viable for the requirements of the modern production standard because of the lower precision and efficiency by human beings. With the development of the AOI (Automatic Optic Inspection), it becomes one of most efficiency method to detect the characters defect. The AOI technology need further development for the large numbers and different sizes of the characters. The ‘Double contrast’ method[6] is used to detect the flaws on the keyboard by Wang Qing from Huazhong University of Science and Technology. The ‘Contour features’ method[5] is used by Guan Xingjian. But their method cannot solve the problem in the detection of the red-black keyboards. So that a method is proposed to solve this problems: a linear array CCD camera is used to detect the ROI area. The local threshold method is used to get the feature of the character and the template method is used to detect the defect of the keyboard. The experiment can be proved it has higher precision than the other methods.

keyboard detection system

The detection system of keyboard can be divided into two parts, one part is the hardware and another is the software. These two parts play the function like the eyes and the brains in human beings. The lighting and electric transfers are used to get the pictures into the PC. The information of the pictures is analyzed and conduct by the image processing software. There are two different kinds of the machine vision systems, one is based on PC, another is based on smartphone. The system based on the PC is used in this paper.

The whole system shows below as Pic.1. It contains the lighting, the image processing program, transmission device and the controller. The rate of detection, precision and the stability of the system are the most important evaluation standards for this system.
Image segmentation

The pre-processing is one of the most important parts in the character recognition. Eliminating the non-correlation information, recovering the real information, strengthening the correlation information and maximally simplifying data are the main purposes of the pre-processing. It also improved the reliability of the feature extraction, image segmentation, template matching and the accuracy of recognition. To pick out the region of interest, binarization is the most important part. During the on-line detection system of image processing, the goal of the binarization is the defect images or identify key information from other demarcation of the background image. It also facilitates the defect extraction and recognition.

Gray image threshold segmentation is to make a gray threshold out of the image gray value range. The gray value of each pixel in the image are compared with the threshold value. According to the comparison results, the corresponding pixel (division) is divided into two categories: the pixel gray value is greater than the threshold, others less than the threshold. (gray value is equal to the threshold value of the pixel can be classified as one of the two) Image binarization is mainly divided into three categories, manual setting of binarization, global threshold and local threshold. Binarization segmentation algorithm has two main steps:
(1) confirm the threshold value of the image
(2) compare the threshold value of the image with standard pixel value
The expression of the image gray processing as below:

\[
g(x, y) = \begin{cases} 
1 & \text{if } \text{threshold} \\
0 & \text{if } \text{not threshold}
\end{cases}
\] (1)

Manual setting of binarization sets the threshold value by human beings. This method is using the experiment to get the perfect point of binarization image comparison, however, the work is harder and the portability is also very poor. The ‘OSTU’ is one of most famous adaptive binarization in global binarization. It defines a connection area called \( S \), the range of the gray value is from 0 to 255. The points’ value are defined as \( I(x, y) \), the probability of grayscale \( x \)
point is \( p(x) \); The function of OSTU is to find out the maximum value of the gray level \( m \). The expression shows below:

\[
Y_m = \left( \frac{\sum_{x=0}^{255} xp(x) \times \sum_{x=0}^{m} p(x) - \sum_{x=0}^{m} xp(x)}{\sum_{x=0}^{m} p(x) \times \left( 1 - \sum_{x=0}^{m} p(x) \right)} \right)^2
\]  

\( Y_m \) The categories of spacing \( p(x) \) the gray level probability for \( x \)

The greater the value of \( Y \) the better of the effect of binarization. The best way to use the OSTU is when the gray Image value have twin peaks. However, the effect of the background between character segmentation will influence the OSTU method. So that the local OSTU is used in this paper. A circle window is generated about 10 pixels. The OSTU can be used in this area. The result shows that the local OSTU method is better than global OSTU method.

character recognition

The character segmentation is used to pick out the target in the picture. The accuracy of the character recognition is influenced by the quality of the character segmentation. Two features are used for target segmentation. One is the sum of black pixels value in vertical. The other is the height-width ratio of target contours. According to the projection on the keyboard in the vertical direction, not only the character area can be primarily confirmed, but also the avoid the influence of the white area. The process is as follows:

1. scanning image points from bottom to up, find out the white pixels is larger than the threshold \( T_1 \), record down this number of the row \( n_b \)

2. scanning image again and find out the white pixels is less than the threshold \( T_2 \)
Using the sum of white pixels value in vertical can judge whether it is the character area. This method also distinguishes the character area with other area. The height-width ratio of target contours is also used in the character segmentation. The noise processing is taken into consideration at the first place due to some noise generated by the shooting. Then the connection area are tagged to find out the white area connection. The height-width ratio of target contours is calculated to choose the character segmentation. The Fig. 8 shows the character segmentation.

The better quality of the character segmentation, the higher accuracy of the character recognition. The template matching is used to recognition in this paper. The method is as following:

(1) A template library is set up before the template matching. The pre-processing is necessary at the beginning of the template matching. Then the normalized follows the pre-processing. It makes the size of the character template is about $24 \times 42$ pixels.

(2) The sum of white pixels value in vertical method is used to reduce the area of the ROI. The normalized will be use again in order to make the same size as the template ($24 \times 42$ pixels).

(3) The target image is used to compared with the template pictures from character library. The correlation is the mainly factors to judge the kinds of the character. The accuracy will be improved by the increased of character template library.

The similarity of the two-dimensional is the key point in template matching. The similarity is a non-deterministic relationship. It is mainly study the relevance of the variables. The function of the principle is as following:

$$
 r = \frac{\sum_{m} \sum_{n} (A_{mn} - \bar{A}) (B_{mn} - \bar{B})}{\sqrt{\left(\sum_{m} \sum_{n} (A_{mn} - \bar{A})^2\right) \left(\sum_{m} \sum_{n} (B_{mn} - \bar{B})^2\right)}} \tag{3}
$$

$\bar{A}$: the average of the matrix $A$; $\bar{B}$: the average of the matrix $B$. $r$: the correlation coefficient. When the $r$ gets near 1, the more similarity the two matrix are. When the $r$ gets near 0, the less similarity the two matrix are.
Keyboard defect detection system

Keyboard defect detection system include: Reading template images, image processing, defect discrimination and character recognition. As the pictures below, the character in top of the left picture is not the same as the bottom one. It means that when the defect occurs the correlation coefficient cannot arrive at the value we set.

Figure 8. result of the defect keyboard.  
Figure 9. result of non-defect keyboard.

Conclusion

This paper introduce the design of the Keyboard defect detection system: the structure of the keyboard defect detection system, the method of the character segmentation, the template matching method and the design of the Graphical User Interface. Although the template matching method is confirmed to be useful, it still need to be improved because the different kinds of the keyboards.

Reference


[5] Guan Xingjian. The Research of the Key AOI Inspection Technologies for the Keyboard Defective Characters [D]. Shang Hai University. 2014.03
