基于机器视觉的印刷质量检测研究

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摘 要:为了实现对物品印刷质量的高效检测,通过机器视觉技术,采用图像处理的方法来实现印刷品质量的检测。根据印刷检测的功能需求,设计了三个具体的功能模块,并在 VS2008 和 OpenCV1.0 平台下实现了印刷质量检测的功能,支持印刷品图像的输入、人机交互处理、划痕和偏色检测、结果输出等功能。与传统采用的手工方法相比,提高了印刷质量检测的效率,检测速度快,准确率高,检测结果客观,能够迅速而精确地检测出目标印刷品的外观缺陷程度。

关键词:机器视觉;印刷质量检测;图像处理;区域检测
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Printing Quality Detection Based on Machine Vision

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Abstract:In order to realize the efficient quality detection of printed matters,by machine vision technology,adopt the method of image processing to realize the prints quality detection. According to the functional requirements of printing inspection,design three specific functional modules,and realize it in VS2008 and OpenCV1.0 platform,supporting the printed image input,interactive processing,scratching and color cast detection,results output and so on. Compared with the traditional manual methods,the efficiency of the printing quality detection is improved,also with high detection speed and accuracy,and the results are objective,which can detect the targets' printed appearance defects quickly and accurately.

Key words:machine vision;printing quality detection;image processing;region detection

0 Introduction

With the development of society and computer technology as well as improvement of automatic control theory, production has become automated increasingly in printing industry, thus, people have higher requirements for quality of today's print. During the printing process, there would often arise some defects such as misting, blur, stains, cast, misregistration and other drawbacks, impacting on quality of products seriously, because of imperfect printing equipment and materials, as well as some unpredictable external factors.

In order to detect the individual items with defect from printing products rapidly and effectively, stand by manual testing only is not enough[1]. Thus, propose that by technology of image processing and machine vision processing, combined with image feature detection, and then build an efficient detection platform which can solve a variety of deficiencies existing in today's production line and improved the production efficiency and product quality to a large extent.

1 Fundamental of image detection

Collect the image of items on assembly line and then processing them in real-time, which is, compared

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to the standard image which have set in advance. After a series of operations, determine it whether defective or not, and then feedback and output the consequence.

Firstly, divide difference images generation algorithm into three categories:

The first one is to convert color image to grayscale image, and then get difference images by subtracting between it and standard image[2-3]. The second is let two color images do subtract operation directly, and then convert the image to grayscale. The third is after subtracting operation between two color images, analyzing the pixel values of RGB channels of the deference image respectively[4].

The formula of conversion from color image to grayscale is

$$gray = (r \times 30 + g \times 59 + b \times 11)/100$$

After cautious analysis among these three types of algorithm presented above, it is obviously that the first two algorithms might miss some detail in processing of conversion and leading to inaccurate results because they need to transform to grayscale firstly. Therefore, employ the comparison between RGB image directly algorithm as well in following operations[5].

During scratches detection, as for the difference image in RGB color model, the differences between each channel of the same part of the two images are 0 (i. e. black) admittedly; When comparing the different parts, cannot use a single channel as a reference. Now have two algorithms to do so. One is computing the average pixel value of these three channel, then compared with the established threshold, that is

$$value = |(r + g + b)/3 - t|$$

The other one is let pixel of each channel compared with the established threshold, and it is viewed as meeting the qualifying conditions as long as there isone channel meets, that is

$$value = Max\{|r - t|, |g - t|, |b - t|\}$$

Where value is the new pixel value evaluate to difference image, t is the established threshold.

Now, simulate the two algorithms above respectively, the thresholds were taken as 12 and 20, which is obtained after several tests.

Note that, before execute the algorithms proposed above, need a pre-processing operation to ensure that there are no dislocation exists between corresponding pixels of these two images. Called this operation location proofreading. In this case, can use the algorithms for the detection and following operation freely.

Summarizing, three channel pixel value averaging algorithm is more accurate and more suitable for the printing detection. In the following section, will introduce the concept of color cast. 12 and 20 were taken as the threshold among cast, scratches and standard parts.

2 Selection of comparison region

2.1 Overall detection

Overall detection is the all-round quality testing of products to ensure that each region of each product within the range of detection[6]. The black dots in Figure1 are the scratch points detected, similarly the gray dots are cast points (where (b) is an enlarged area shown in rectangular rim, and the rim doesn't exist actually). After that, set a standard value according to the demand of products. If there are scratches or cast points exceeds this threshold is considered as substandard products in printing.

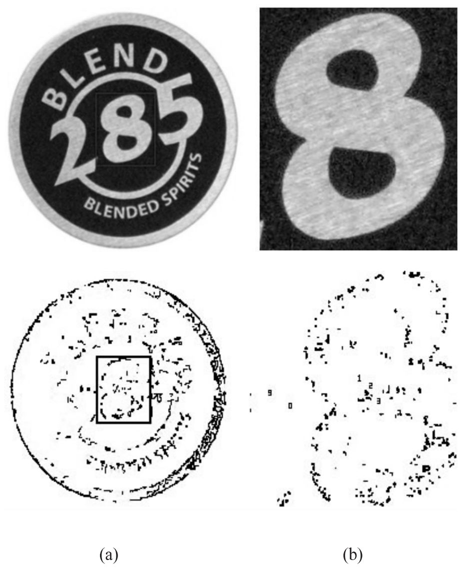

Figure 1 Results of detection when $t_1 = 12$, $t_2 = 20$

(a) Overall results, (b) enlarged area of rectangular rim

While this detection method may exanimate the target completely, but in a large number of productions, the slight difference in efficiency will also be a huge difference.

2.2 Detection of region with similar color

In the actual production, target objects always consist of two components with quite different color[7]. Most of them can be ignored the background and shading while focusing on test the main part. For example, for a printing plate with solid shade, product is only adding additional print based on the original shading. So do not need to care about how the quality of shading, since there are no defections would appear here. Therefore, let the main portion as a detection region and the efficiency can be improved effectively[8]. Whereas such an image performance in a histogram shows two peaks obviously, so using the region of interest through detecting the pixel point range of the histogram can separate interested region effectively, and then to the next step[9].

For example, in the case showed in this essay, have shading part with light color and main part with dark color. The RGB channel histogram is shown in Figure 2.

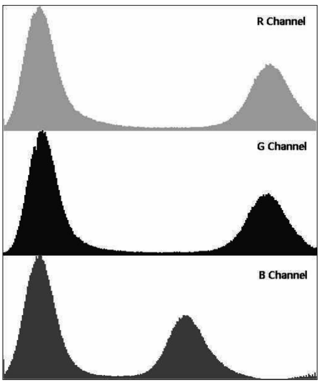

Figure 2　Histogram of each channel of original image

Observe that, the R channel and G channel maintains the same shape of the histogram, even though the B -channel varies from them, but can also determine a threshold value to separate the two different color tones.

The first point is selected with mouse by user. Also take the average pixel of its 8-neighbourhood as a standard of this point to prevent haphazard[10-11]. The system detects the corresponding peak where the point located, then finds the peak value of the peak and extend in two directions until find out a suitable interval. Any point in this interval would be extracted (and do binarization operation)[12].

Take channel B for example

$$v_l = \mathrm{AVG}\left(\sum_{i=1}^{m}(v_{p-i}+v_{p+i})\right), \text{ when}$$

$$\sum_{i=1}^{m}(v_{p-i}) \geqslant \sum_{i=1}^{m}(v_{p+i}), \text{for } p \text{ is decreased}$$

Similarly

$$v_r = \mathrm{AVG}\left(\sum_{i=1}^{m}(v_{p-i}+v_{p+i})\right), \text{ when}$$

$$\sum_{i=1}^{m}(v_{p-i}) \leqslant \sum_{i=1}^{m}(v_{p+i}), \text{for } p \text{ is increased}$$

Where v_l and v_r are boundary value of interval R respectively, m is a particular value represents a tolerance interval.

Table 1　Collection of detection image

Number	B	G	R	Interval(R)
1	147	218	218	(156,250)
2	152	223	227	(156,250)
3	151	217	216	(156,250)
4	145	212	215	(156,250)
5	145	214	217	(156,250)

Table 1 shows the data obtained by a random collection of five different tests, all of them got a interval of (156,250), and do binarization based on it[14]. After preliminary processing (binarization) by histogram (Figure 3(top left)), do morphological closing operation once to eliminate redundant points (Figure 3(top right)). There are also remaining few miscellaneous points, constitute a number of small connected regions.

Detect these connected regions and placed anti-color which can eliminate the isolated white points in black background and isolated black points in white background. The processed image can be view as the template for next detection (Figure 3 (lower left)).

Next will detect the scratches and color cast after getting the template. In this way, only scratches in the range of template (white area) can be picked out. That is, test results include the "1, 2, 3, 7, 8" in the selected area other than "4, 5, 6, 9, 0" out of this area, as shown in Figure 3(lower right).

Figure 3　Detection of colored region

2.3　Detection on self-selected region

This part is the improvement of the previous method, and the results are based on the statistics. However, it usually can be obtained through a large number of statistical data, thus computing the areas where may appear detections easily.

In this case, the users do not need to detect the whole object, but prefer detection range delineated by them. Users pull the mouse on a standard template to draw a rectangle, and set it as the ROI[14-15], thus, system detects the part of the rectangular region only, in order to meet user's needs. In this way, can save a lot of unnecessary consumption of resources and time. However, it does not guarantee the areas out of detection are necessarily qualified. In Figure 4, set the ROI region where the number "8" located in. The result by execute algorithm above on selected region shown in Figure 5. The scratch "1, 2, 3, 0" in this region are detected, and the remaining gray parts are color cast.

Figure 4　Original image of self-selected region

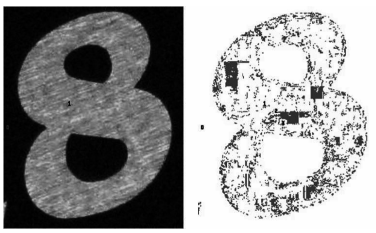

Figure 5　Comparison and result of selected region

3　Conclusion

According to the algorithm proposed, can test out those who do not conform to the specification of products effectively. In the process of actual detection, the value of the threshold is related to the results of the test. So combined with the production specification, determining a suitable threshold is extremely important.

With increasingly preciseness of image acquisition device, as well as improvement of computing capacity, industrial automation and production will become more prevalent. Combined with machine vision and image processing technology in this field will achieves extensive application prospects.

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