Journal of Computing and Electronic Information Management
ISSN: 2413-1660 | Vol. 16, No. 1, 2025

Research on Centroid Tracking Algorithm for Oil Stain Defects on the Surface of Silk Cake

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Abstract: As the basic material for the production of specific fabrics, the yarn quality of chemical fiber cake directly affects the fabric quality. The problem of oil on the surface of silk cake will lead to uneven yarn coloring, which will affect the quality of fabric. In order to solve this problem, a method of detecting oil stain defect of textile silk cake based on graph centroid tracking algorithm is proposed in this paper. In this method, the silk cake image is obtained, downsampled and gray-scale processed, and then Gaussian filtering and binarization are applied to enhance the image clarity. Next, the edge outline and its minimum external rectangle are drawn, and a mask image is constructed to highlight the oil area. By setting the oil pollution pixel range and processing the image after mask, log operator and expansion processing are used to enhance the oil pollution characteristics. Finally, the contours are extracted and the centroid coordinates are calculated. By comparing with the vertex coordinates of the minimum external rectangle, the oil pollution is automatically located. The method has high detection accuracy and short time, and can effectively solve the problem of oil stain defect detection of textile silk cake.

Keywords: Silk cake defect; Oil pollution detection; Centroid tracking.

1. Introduction

At present, most textile enterprises use manual defect detection, which consumes time and energy, is easy to be affected by subjective factors, low efficiency and easy to cause missed detection or misjudgment. In recent years, with the rapid development of computer vision technology and high-resolution imaging equipment, automatic surface defect detection methods for industrial products have emerged, effectively improving the operation efficiency of related industrial production processes and greatly saving labor costs. However, most of the automatic detection algorithms are designed for specific products, and there is still a lack of effective automatic detection algorithms for cake defects. Therefore, aiming at this problem, this paper develops an automatic, fast, accurate and stable automatic detection algorithm for the oil pollution defects produced in the process of silk cake production.

2. Image Acquisition And Analysis

The image acquisition device is mainly composed of a mesa array CCD camera and a surface array LED light source. CCD camera has the advantages of small size, low power, low noise and clear image. Area array light source is a machine vision light source, which is a flat light source composed of a number of LED lights. The main advantage of area array light source is that it can provide uniform and strong lighting, which is suitable for detecting flat or curved objects [1]. The area array light source can cover a large solid Angle, closer to the true natural light. In addition, the area array light source can illuminate a large area, and the object does not need to move to take a full image. The CCD camera transmits the image to the computer through the network port for later processing, as shown in Figure 1.

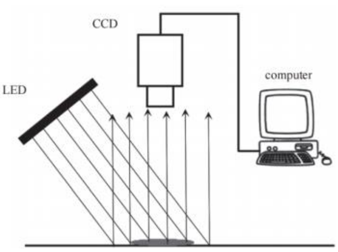

Fig.1 Schematic of the image acquisition

3. Surface oil detection process

Traditional embroidery art still has wide application value in contemporary fashion design. For modern fashion design,

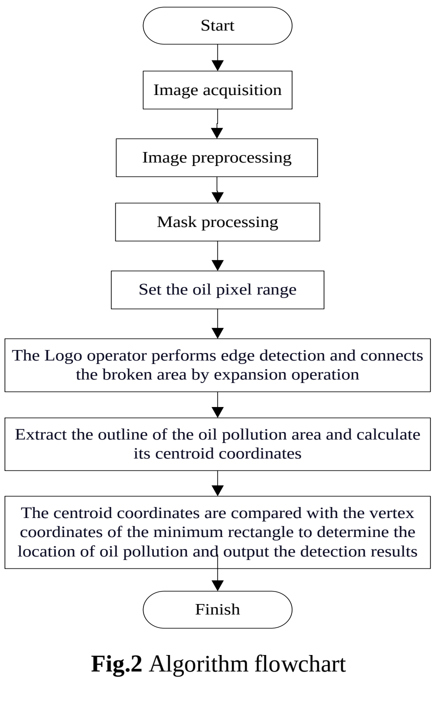

Fig.2 Algorithm flowchart

(1) After reading the silk cake image, the length and width of the silk cake image are equally reduced, and the scaled image is gray-scale processing;

(2) The gray-scale image is processed by Gaussian filtering and binarization. Then, draw the edge outline of the image and the minimum outer rectangle, enclosing the edge outline with the smallest rectangle.

(3) Construct a mask image, and then phase with the image after downsampling processing to obtain the mask image, perform Gaussian fuzzy denoising on the image, and use local histogram equalization to improve the image contrast;

(4) The dirty area was roughly separated by OTSU binarization threshold method, and some non-dirty areas were filtered out by morphological corrosion.

(5) Call FindContours function in OpenCV to extract the image contour after binarization, and obtain the centroid coordinates of the contour according to the extracted contour.

3.1. Image Preprocessing

Image preprocessing refers to a series of processing operations on images in computer vision applications, including gray-scale, denoising, filtering, enhancement, morphological operations, etc. Image preprocessing can improve image quality and lay a solid foundation for subsequent image analysis and processing [2].

First, read all S3 Scone images in the folder, and greatly reduce the length and width of the scone images, as shown in figure 3:

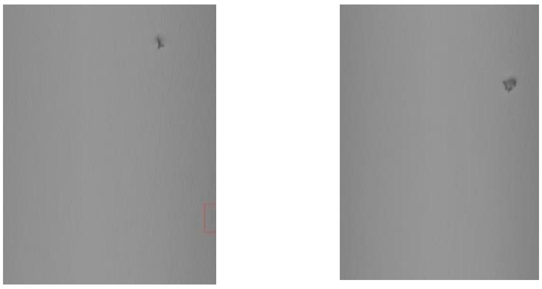

Fig.3 Oil image of textile spindle part

Due to the uneven brightness of the light source and the camera itself, the original image collected by the system often generates a lot of noise. The system adopts the filtering method to filter the original image to remove noise. The filtering operation is a kind of neighborhood operation, and the processed image data is obtained by some specific sliding window operation between the target pixel and the pixels in a certain range of neighborhoods [3]. Image filtering algorithm is also an image convolution algorithm itself, which is mainly divided into linear filtering and nonlinear filtering [4]. Linear filters are implemented by simple addition, subtraction, multiplication and division operations with fixed weights, such as mean filter, Gaussian filter, weighted average filter, etc. Linear filters delimit the domain, and the values in the mask act on the entire image through sliding Windows as fixed coefficients. Compared with the original data, the effect of nonlinear filtering is mostly a logical relationship, such as maximum filtering, minimum filtering, median filtering, etc., which weakens the concept of mask and only delimits the range. As for the value in the mask, it depends on the gray value of the corresponding original image location.

(2) For the images collected by this system, the median filter is selected in this paper to remove the noise of the original image, because the small oil stain itself is very similar to the noise, if the linear filter is selected, the characteristics of the small oil stain will be weakened while the noise is filtered.

The median filter is based on the pixel value ordering in the neighborhood of the target pixel. Generally, 3 pixels×3 pixels is used as the mask size, and the middle value of the sorted gray value is used as the gray value of the target pixel. As shown in Figure 4, the median filter has the characteristics of preserving image details and removing noise quickly.

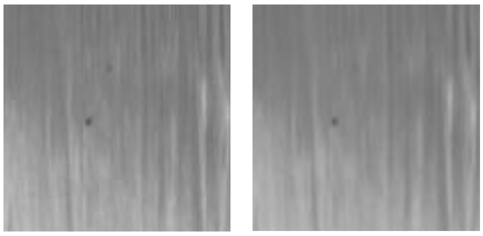

Fig.4 Median filtering

(3) Compared with the original image, the filtered image has a lot of noise filtered out, but the characteristics of oil pollution have also been weakened in different intensity. Although it is not as serious as linear filtering, in order to ensure the effectiveness and stability of subsequent detection, the filtered image needs to be reprocessed to achieve the effect of strengthening the characteristics of oil pollution. In this paper, histogram equalization is used to enhance oil pollution. Because the color of silk cake is white, the stain is black, and the gray values are mostly clustered around 255, the gray histogram equalization can enhance the contrast of silk cake image and enhance the stain information. The effect is shown in Figure 5.

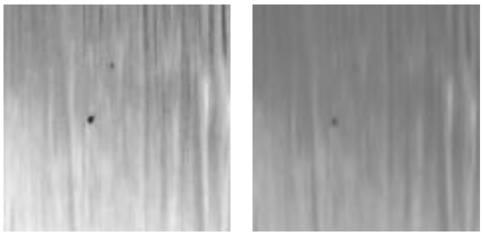

Fig.5 Gray histogram equalization results

Binary processing of the filtered image is carried out to convert the image into a black and white binary image [5]. Then, use the findContours() function in the OpenCV library to find the contours in the binary image, define the background as black (value 0) and the object as white (value 255), extract the contours of the white object, and draw these contours using the drawContours( ) function. Then, the minAreaRect( ) function is used to obtain the smallest outer rectangle of the contour and its four vertex coordinates. Finally, based on the vertex coordinates of the smallest outer rectangle, use the 'line( )' function to draw the smallest outer rectangle box of the outline, as shown in Figure 6.

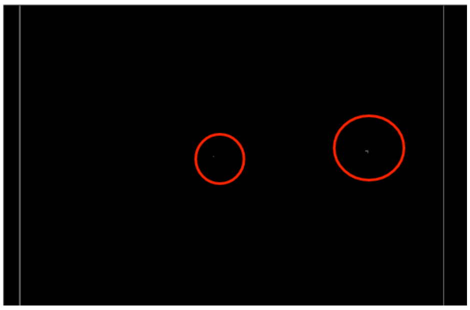

Fig.6 Edge rendering

3.2. Mask processing

The mask image is constructed and then combined with the image after downsampling processing to obtain the mask image. The image is denoised by Gaussian blur, and the image contrast is improved by local histogram equalization. The OTSU binarized threshold method was used to roughly segment dirty areas, and some non-dirty areas were filtered out through morphological corrosion [6].

Create an image of the same size as the downsampled cake image, initialize all pixels on the image to 0, and the image is all black; In this all-black image, the rectangle is drawn with the coordinates of the four vertices of the smallest external rectangle, and the pixel values of all the areas inside the rectangle are set to 255, that is, the areas inside the rectangle are white, and the areas outside the rectangle are still black, and the mask image is obtained. Each pixel on the down-sampled silk cake image is calculated with each pixel in the corresponding position of the mask image to obtain the image after the mask. The image after the mask retains the image in the corresponding rectangle on the down-sampled silk cake image, while the image outside the rectangle is black. Set the pixel of the down-sampled silk cake image to x[i], while the mask image only has black and white, with black pixel 0 and white pixel 1. x[i]&1=x[i]; The result of this formula can be seen to be consistent with the white region on the mask, and finally get the original itself; x[i]&0=0; The result of this formula can be seen to be consistent with the black region on the mask, which eventually becomes black.

3.3. Oil pixel extraction

According to the set range of oil pixels, if it is greater than this range, the pixel will become 255, that is, it will become white; If it is less than this range, the pixel is turned to 0, that is, black.

3.4. Logo calculation and expansion processing

Gaussian filtering and Laplacian operation are performed on the image after mask. The Laplacian calculation formula is as follows:

$$\partial^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2} \quad (1)$$

Interim f(x,y) represents the coordinates of the point on the image$\partial^2 f(x,y)$, where $\frac{\partial^2 f(x,y)}{\partial x^2}$ is the second partial derivative with respect to the function f(x,y), and $\frac{\partial^2 f(x,y)}{\partial y^2}$ is the second partial derivative with respect to the horizontal coordinate x and the second partial derivative with respect to the vertical coordinatey.

3.5. Contour centroid calculation

The center of mass is the center of the mass of the object, and the calculation steps are as follows:

(1) Call the findContours method to find the outline of the oil pollution area, and obtain the centroid coordinates of the outline according to the extracted outline.

(2) Calculate the zero-order moment m_{00} and the first-order moment m_{10}、m_{01} of the contour in the image;

(3) Calculate the centroid of the contour in the image: m_{10}/m_{00} represents the abscissa of the centroid, m_{01}/m_{00} represents the ordinate of the centroid;

(4) If the width of the contour on the image is M and the length is N, the formula for calculating the zero-order moment m_{00} and the first-order moment m_{10}、m_{01} of the contour is as follows:

Zero moment:

$$m_{00} = \sum_{i=1}^{M} \sum_{j=1}^{N} f(i,j) \quad (2)$$

Where, $f(i,j)$ is the pixel value of a certain point of the contour in the image, M is the maximum value of the horizontal coordinate of the contour in the expanded image, and N is the maximum value of the vertical coordinate of the contour in the expanded image.

First moment:

$$m_{10} = \sum_{i=1}^{M} \sum_{j=1}^{N} i \bullet f(i,j) \quad (3)$$

$$m_{01} = \sum_{i=1}^{M} \sum_{j=1}^{N} j \bullet f(i,j) \quad (4)$$

However, on oil images, sometimes darker filaments will appear, because they have large pixel values and are also considered to be oil contours. In order to exclude the contours of such filaments, this paper needs to compare the pixel value of the oil stain with that of a large filament according to the pixel value corresponding to the output centroid coordinates.

3.6. Compare the output results of coordinates

The detection results are obtained by comparing the centroid coordinates of the contour with the four vertex coordinates of the minimum external rectangle. If the abscissa of the centroid of the outline is between the two abscissa of the minimum outer rectangle, and the ordinate of the centroid of the outline is between the two ordinates of the minimum outer rectangle, then the image of the silk cake is judged to be oily. Otherwise, the image of silk cake is judged to be free of oil. The final test results are shown in Figure 7:

Fig.7 Diagram of oil defect detection results

As for the above detection algorithm based on centroid tracking algorithm, a total of 159 images were used to detect the overall image accuracy and kill rate, including 142 normal images and 8 defective images, and the final detection accuracy rate of silk cake oil defect was 99... 60% and the overkill rate was 0%, and the time required to detect each piece was 0.73s.

4. Conclusion

In this paper, the accuracy of the present invention in detecting oil stains on textile bobbins is extremely high; the time required by the present invention to determine whether each textile bobbin is normal or contains oil stain defects is very short; the present invention can locate the position of oil stains on each textile bobbin with oil stain defects; and the present invention can conduct real-time detection 24 hours a day.

Acknowledgements

This work was financially supported by the Scientific Research Project of Anhui Xinhua University (2023zr005); (2024AH050615).

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