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Study on the Method of the Self-adapting Image Threshold Divided in the Surface Image of the Tubular Cartridge Case

Wu Qizhou*, Jin Yong, Wang Zhaoba
[1]National Key Lab for Electronic Measurement Technology North University of China, Tai Yuan 030051, China, Ph./Fax: (0086) 351-3559321/3559321
Corresponding author, e-mail: qizhouwu@126.com*, jiny@nuc.edu.cn, wangzb@nuc.edu.cn

Abstract

The technology of detecting the internal and external diameter of the tubular cartridge case that using scanistor to obtain the image of the tubular cartridge case surface, aiming at the difference in the image of the surface between the degree of color gray. This article proposed the self-adapting image threshold divided method that base on mean and standard difference of the image of the surface using to definiting threshold, solved the key question of the surface image manipulation, make the detecting result reaching the upper precision.

Keywords: *surface image, self-adapting, threshold divided*

1. Introduction

A grain as the non-metallic and opaque objects, is an important part of the weapon launch system and it has a cylindrical hole shape (Shown in Figure 1). The geometry of internal diameter (ID) and outside diameter (OD) is directly related to system performance.

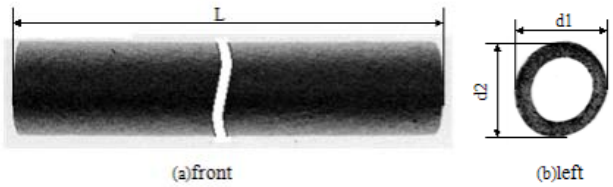

Figure 1. Schematic Diagram of Tubular Grain

In this article, we process and segment at the face image, then use the edges of the image to strike ID and OD.

When used this method to detente the ID and OD of many grain, the sharpness of image edge and the size of the background noise which we get had a significant impact on accuracy and repeatability of the final test results. Therefore, to obtain images of objects, we need an object with uniform light exposure, or the inconsistent gray scale of images must cause the accuracy and repeatability down in test results. As light source of the scanner is owned, has uniform illumination, can obtain a good consistency of gray-scale image. Therefore, in this paper, the scanner was used as an image acquisition system.

2. The Process of Grain Face Image Acquisition

In the production process of grain, there are some chemical reactions are sometimes incomplete components, resulting in uneven color of grain, coupled with the dark color of grain (Figure 1), so, to take full advantage of the dynamic range of the scanner, we need scanner to scan under the high sensitivity. In this paper, we used the methods of lose background image,

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that is, when detection, first scan the background to get the background image (Figure 2(a) shows), and then placed the measured grain vertically in the detection region (Figure 2(b) shows). Figure 2(b) minus Figure 2(a) is Figure 2(c), that is the final scan image of end grain.

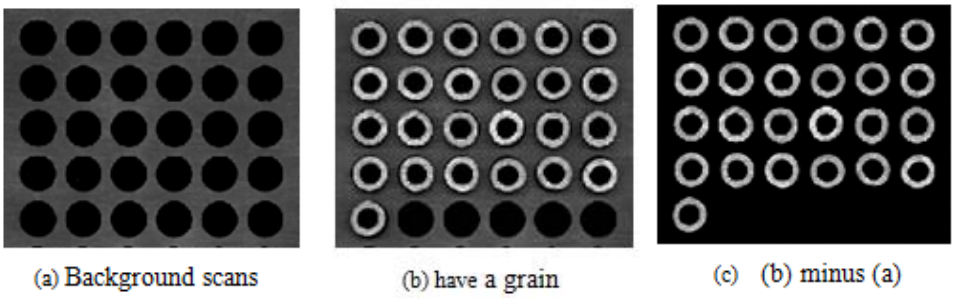


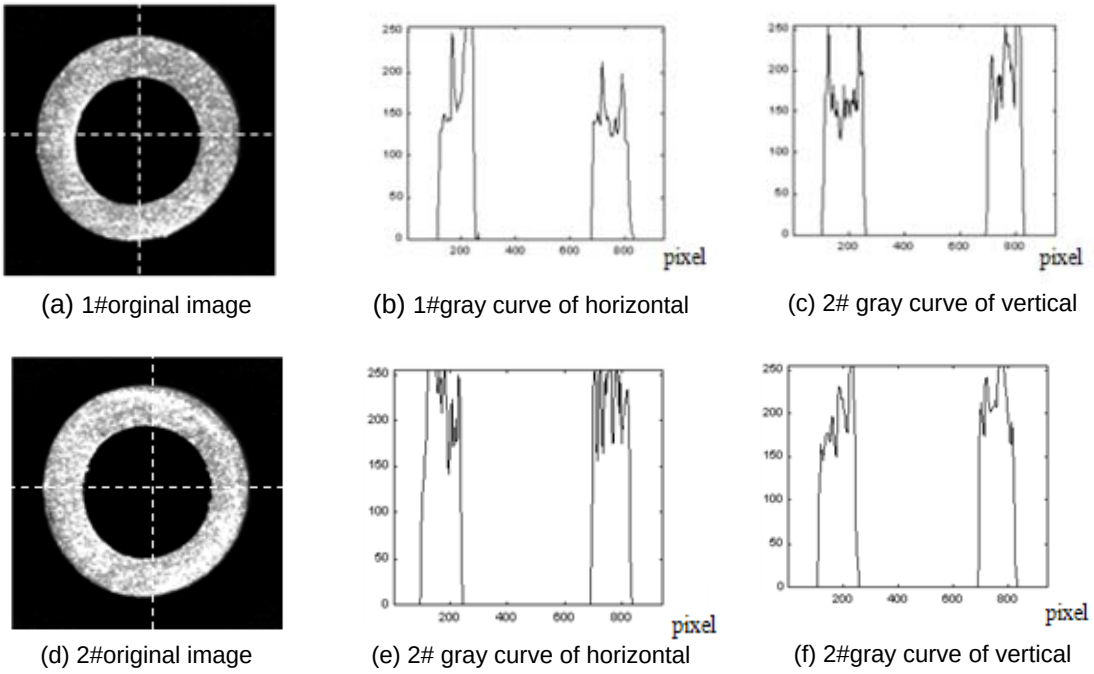
Figure 2. The Process of Grain Face Image

3. The Image Threshold Segmentation of Adaptive

Figure 3 shown that two typical grain face images and gray curve in the same collection. Grain face image has two characteristics:

The gray value of face image quite different in the same grain; Different grain face images have different brightness in the same acquisition, Figure 3. That is because, in the grain production process caused the grain color uneven and the gray value of face image quite different.

Grain face images were non-circular and the inside and outside diameter have different heart. That is because, in the cutting process, grain by uniform force.



(a) 1#orginal image (b) 1#gray curve of horizontal (c) 2# gray curve of vertical

(d) 2#original image (e) 2# gray curve of horizontal (f) 2#gray curve of vertical

Figure 3. The Face Image of Single Grain

With the purpose of easy to read the size, image must be binaried, therefore we have to select a threshold to separate the image. In the general image, grain face image have high gray

level than background, when the threshold is too high, part of edge points were wrong to background points, made the size of ID and OD too small. Otherwise, too large. The key to segmentation is select the appropriate threshold. From the two features of the above image, we can see, if we use a fixed threshold to split multiple grain we collected, the measured grain size in diameter must be some larger, some smaller. So we research a method which according to the image information can determine the threshold automatically.

This paper presents a segmentation, known as adaptive thresholding segmentation of image, that is a method to determine the threshold according to mean and standard deviation of gray. This method can solve the problem.

The image is set to, $f(i,j)$, $i \le M$, $j \le N$, μ, σ, are the mean and standard deviation of the image, then the segmentation threshold (TH) of the image can be determined as follows:

$$TH = \mu - a \cdot \sigma \tag{1}$$

In the above formula, a is a factor for adjusting, it can be calibrated according to the actual grain size and the test results. After obtained the threshold value v_0, we can binary segmentation the image according to the following formula:

$$u(i,j) = \begin{cases} 1 & f(i,j) \ge v_0 \\ 0 & f(i,j) < v_0 \end{cases} \tag{2}$$

After a number of experiments, calibrate the adjustment factor a = 0.5, all of the following diameter measurements were used in this value. Figure 4 is the images after adaptive image threshold segmentation of 1 # grain.

(a) Original image (b) Binary segmentation

Figure 4. Adaptive Image Segmentation of 1# Grain

4. Analysis

To test the results of adaptive image segmentation technique compared with six grains to do experiments. Figure 5 is the original image of six grains, table 1 are the measurement results of the adaptive image segmentation techniques and fixed threshold segmentation techniques.

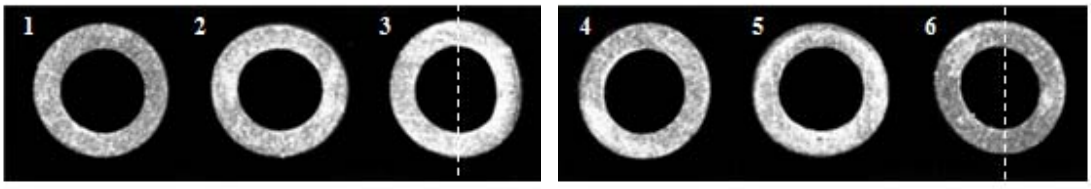
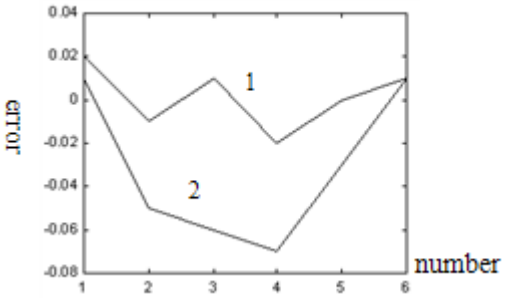


Figure 5. The Original Image of Six Grains

Table 1. Compare Adaptive Image Segmentation Technique with Fixed Threshold Segmentation

number		1	2	3	4	5	6	mean
mean gray		47.6	57.5	61.1	55.0	58.0	44.4	——
Standard value of OD(mm)		8.69	8.70	8.72	8.66	8.72	8.56	8.675
Standard value of ID(mm)		5.32	5.28	5.30	5.27	5.34	5.12	5.275
adaptive threshold（TH=μ-0.45σ）	TH	31	38	41	37	38	28	——
	OD(mm)	8.67	8.71	8.71	8.68	8.72	8.55	8.673
	error(mm)	0.02	-0.01	0.01	-0.02	0	0.01	——
	ID(mm)	5.33	5.29	5.32	5.29	5.34	5.10	5.278
	error(mm)	-0.01	-0.01	0.02	-0.02	0	0.02	——
fixed threshold（TH=28）	TH	28	28	28	28	28	28	——
	OD(mm)	8.68	8.75	8.78	8.73	8.75	8.55	8.707
	error(mm)	0.01	-0.05	-0.06	-0.07	-0.03	0.01	——
	ID(mm)	5.33	5.32	5.32	5.31	5.36	5.10	5.297
	error(mm)	-0.01	-0.04	-0.02	-0.04	-0.02	0.02	——

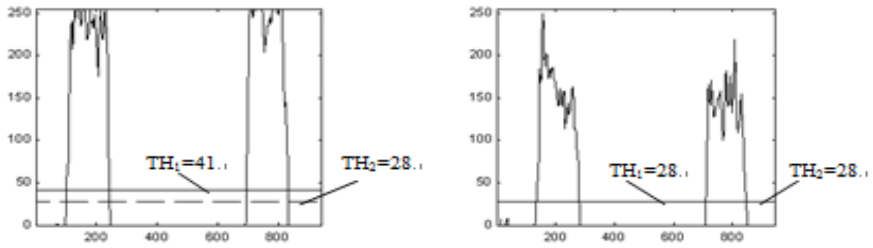
As can be seen from Table 1, 3# grain face image with the largest mean of gray (61.1), 6# grain face image with the minimum mean of gray (44.4), 3# grain can also be seen that is the brightness. Therefore, when the image binarization, we should be based on the status of the face image of grain to select corresponding threshold, so that to measure the ideal size of ID and OD. Use the adaptive image segmentation technique to the grains from 1# to 6#, the threshold values were obtained 31, 38, 41, 37, 38, 28. Measured the maximum error of outside diameter is 0.02mm and the maximum error of inside diameter is 0.02mm can meet the requirements of technical indicators. If the threshold of grain # 6 (28) as the standard, use the fixed threshold technique to dismember the images, can we measured the maximum error of outside diameter is 0.07mm and the maximum error of inside diameter is 0.04mm, that is far beyond the requirements of the technical indicators. In Figure 6, we use the two technologies measured the error curve of ID and OD, that fully describes the effective of adaptive image segmentation technique which proposed in this paper.



1—measurement error of adaptive threshold segmentation technique
2—measurement error of fixed threshold segmentation

Figure 6. Measurement Error of Adaptive Thresholding and fixed Thresholding

To illustrate the differences between the two methods more directly, plotted the gray curves of 3# and 6# grain in Figure 6, TH1 is the threshold determined by adaptive image segmentation techniques. TH2 is the threshold determined by fixed image segmentation techniques. The figure shows, the gray of edge is gradient, not Step mutation that is not ideal. The image gray of 3# grain is big, 6# grain is small, the size by TH2=28 to segment 3# grain must be larger than TH1=41. Therefore, in order to measure the desired size of grain, we should according to different images characteristics select different threshold segmentations to binary.



(a) 3#grain (b) 6#grain

Figure 7. Gray Curve of 3# and 6# Grains

To sum up, adaptive image segmentation technique is based on the mean and standard deviation of grain face image to determine the threshold. It obtained high precision, very suitable for image segmentation of grain. Solved the key technologies which using the scanner to get the face image of grain to detect the size of ID and OD.

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