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Detecting assembling quality of Razor Based on the machine vision system

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Abstract: - Whether the assembling angle and the extension elongation of the razor match the requirement will directly affect the function of razor. In this paper, a new kind of machine vision system for detecting the assembling angle and the extension elongation of razor is designed. And a special measure method——wavelet is applied to check the edge of razor, which can afford the more accurate data of razor edge checking than traditional measure method and has a great help to detect assembling quality of razor. The experiments results show this system has a great accuracy and reached the Standard of blade assemble detecting.

Key-Words: – Assembly detecting, Machine vision, Metal manufacturing, Wavelet transformation, Measure method

1 Introduction

With the development of our nation's economy, the quality of people daily-life has been improved continually. After China entered the WTO, people has the more frequent to contact with the international market, and the corporations export has become a important support of the economy, which makes the product can not only just have functional content, the product should also have other character designed under the requirement of comfort, nice appearance, convenience and so on. Whether the assembling angle and the extension elongation according with the requirement will directly affect the shaving result: is it comfortable and make no damage to the surface while you can shave off your beard completely. But the equipment for detecting the assembling angle and the extension elongation is not available now.

Recent development of machine vision defect detection can be used to solve the problem. The design of a high-speed inspection system based on the machine vision method has been an interesting issue. The main advantages of optical inspection methods are their ability to scan large areas, their applicability to in-process measurement, and their ability to perform fast measurements [1]. Advances in manufacturing automation have created the need to develop in-process measurement techniques for online quality control and online machining compensation [2]. Most component manufacturing cycles include an inspection stage to ensure agreement with design requirements [3]. Automated visual inspection is also rapidly becoming a major factor in manufacturing [4]. Non-contact measurement is also effective since high-speed measurements can be achieved and problem associated with vibration and friction can be eliminated.

In order to match the technology standard of other advanced country, the machine vision technology is applied to detect the assembling angle and the extension elongation of the razor.

2 Image Capture And Character Analysis

The main components of the machine vision used in this work is made up by Linear Laser Source Optical Magnifier CCD Camera image collection clip and process software, as shown in Fig.1. After the tested blade was fixed on the special clamp, the highest surface of the tested blade must be parallel with horizon, so that

we can make it sure that the points have been magnified in the same scale and that the captured image won't be distorted. There is a light source above the clamp, and under the force of the irradiation we get a datum plane. In this paper we set the Laser emission equipment as our light source, under the irradiation we get several datum line. And the thinner the datum lines are, the less errors which are caused through the process of amplify capture measure we should get. So the power of the light should be adjustable. Concerned about the assembling angle and the extension elongation is a kind of subtle matching and has tiny difference, we should not make any damage to the tested blade while testing. We still set the angle to 45 degree between the laser and the surface of the tested blade to get image. Above the ocular of the microscope, we place a high definition digital industrial camera, so that the images we acquired have better definition, resolution and saturation. The USB is adopted which can make the connection more convenient, and the installation of the special software becomes easier.

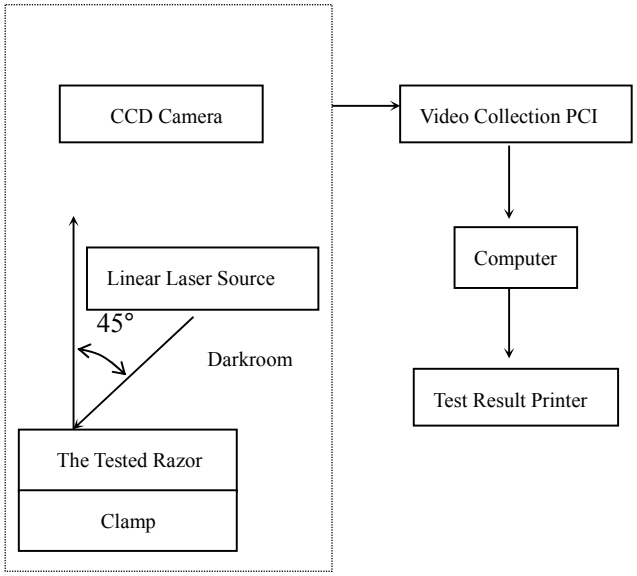


Fig.1 Test System Structure

The tested objects are the double-layer or triple-layer razor and its support pole. After analysis we find that the assembling angle and the extension elongation depends on two basic parameters (1)upper nether blade's assembling angle α and β (α is the intersection angle between the line form the peak of up-blade to the base of support pole and the up-blade; β is the intersection angle between the line form the peak of nether -blade to the base of support pole and the nether-blade) ;(2) upper nether blade's extension elongation m and n (m is the perpendicular distance from the line connecting the peak of up-blade and peak of nether –blade to the peak of up-cover ; n is the perpendicular distance from the line connecting the peak of up-blade and peak of nether –blade to the peak of support pole's base),as shown in Fig.2.

In Fig.2, an auxiliary anchor line and an auxiliary anchor point is set to locate the captured image according to the edge of the blade. Double-layer blade needs four measure points. How to get an accurate and legible blade edge is very important for detecting the assembling angle and the extension elongation .In this paper, we apply wavelet algorithm to get the edge of the image.

3 Image Processing

Too much noise that produced by the complex process of detecting makes the traditional edge detect algorithm such as Roberts, Sigma, Differentiation and Prewitt undesirable. In this paper, an algorithm of edge detection using wavelet transformation is proposed.

A function $\psi(x)$ is called a wavelet if its average is equal to 0.

The DWT can be designed as a multiscale edge detector that is equivalent to Canny edge detector.Suppose that is a differentiable smooth function whose integral is 1 and converges to 0 at infinity. Let wavelet $\psi(x)$ be the first order derivative of $\theta(x)$.

$$\psi(x) = d\theta(x)/dx \qquad (1)$$

Then

$$W_j f(x) = f * \psi_j(x) = f * \left(2^j \frac{d\theta_j}{dx}\right)(x) = 2^j \frac{d}{dx}(f * \theta_j)(x) \qquad (2)$$

The wavelet used in this paper is the Mallat wavelet (Mallat and Zhong, 1992). The corresponding $\theta(x)$ is a cubic spline, and thus $\psi(x)$ is a quadratic spline.

$$\theta(x) = \begin{cases} 0 & |x| \geq 1 \\ \theta(-x) & 0 \leq x \leq 1 \\ -8x^3 - 8x^2 + 4/3 & 0.5 \leq x \leq 0 \\ 8(x+1)^2 & -1 \leq x \leq -0.5 \end{cases} \qquad (3)$$

$$\psi(x)=\begin{cases}0 & |x|\geq 1\\ -\psi(-x) & 0\leq x\leq 1\\ -24x^2-16x & 0.5\leq x\leq 0\\ 8(x+1)^2 & -1\leq x\leq -0.5\end{cases} \quad (4)$$

In the case of images, $\psi^1(x,y)$ and $\psi^2(x,y)$ should be utilized. Suppose $\theta(x,y)$ is a 2-D differentiable smooth function whose integral is 1 and converges to 0 at infinity. The two wavelets are:

$$\psi^1(x,y)=\frac{\partial\theta(x,y)}{\partial(x)} \quad \psi^2(x,y)=\frac{\partial\theta(x,y)}{\partial(y)} \quad (5)$$

Denote

$$\zeta_j=2^{-2j}\zeta(2^{-j}x,2^{-j}y) \quad (6)$$

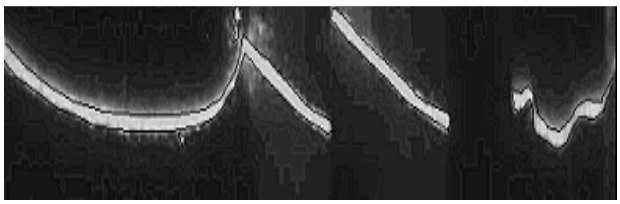
The dilation of $\zeta(x,y)$ by 2^j, the WT of $f(x,y)$ at scale 2j and position (x,y) has two components. Fig.3 shows the detected results.

4 Measuring Method and Result

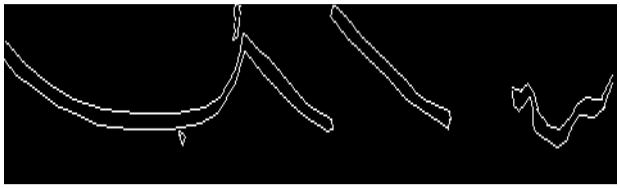
According to the demand of image and actual detecting parameters, the conic fitting of the parameter curve is processed. So the expression of the parameter curve is produced, finally the practicality parameter of the tested blade is calculated by computer program according the expression. The assembling angle and the extension elongation of the tested blade are setup according the corporation standard or state standard, so the testing software can estimate whether the tested blade win the standard value or not, the setting value shown in Fig.4, and the tested result shown in Fig.5. The testing range of assembling angle is from degree o to 90, and the precision is percent 1. The testing range of extension elongation is from -1 to 1 mm, and the precision is ±0.01 mm. The tested result attains the demand standard.

After the test, the image can be printed and saved. After a set of blades being tested, the report forms can be created including the testing result and the detecting information, shown in Fig.6.

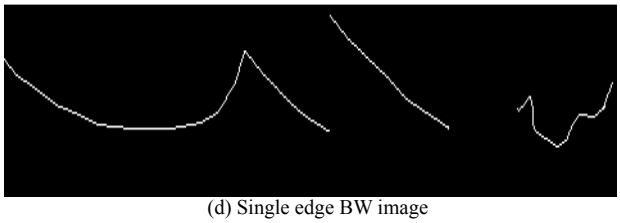
(a) Original image of blade



(b) Edge detecting image of blade



(c) BW image of edge detecting



(d) Single edge BW image

Fig.3 Result of image process

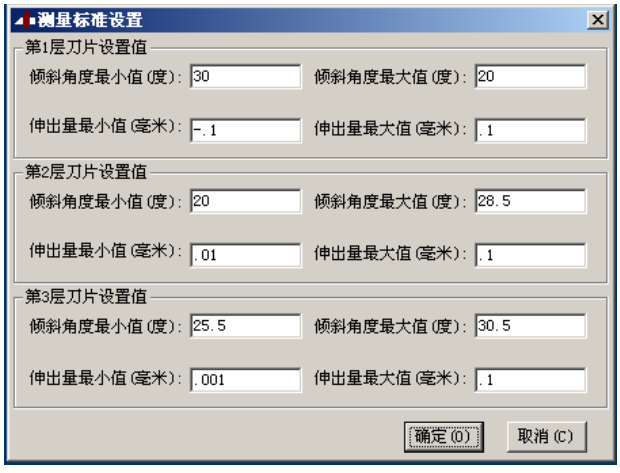
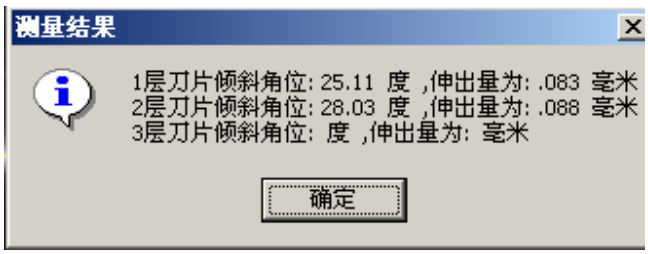


Fig.4 The setting of test standard



5 Discussion

In this paper we apply the machine vision to detect the assembling angle and the extension elongation, and wavelet to detect the blade's edge, and this system also has the following characters:

Use linear laser source to set a light on the blade, transmit the complex measurement of assembling angle and the extension elongation to the measurement of line formed by the light through the blade.

Use microscope to magnify the light, and use digital CCD to capture image, then transmit it to the computer through the USB. This system has characters of wide bandwidth□stable data transmission and support for instantly video play.

Use special software to process image analysis,and then get the assembling angle and the extension elongation. The detecting result can be saved, checked, compared and printed.

The special clamp can be adjusted in four directions in any scale. It can clip single-layer, double-layer, multi-layer etc. razors of different companies and types.

The design of the system is logical. It can detect the assembling angle and the extension elongation of the razor correctly and conveniently.

References

[1] A. Abuazza, D. Brabazon, M.A. El-Baradie, Analysis of surface defects using a novel developed fiber-optics laser scanning system, Journal of Materials Processing Technology, Vol.143–144,2003, pp.875–879.

[2] A. Abuazza, D. Brabazon, M.A. El-Baradie, Multi-beam fibre-optic laser scanning system for surface defect recognition, Journal of Materials Processing Technology, Vol.155–156, 2004,pp.2065–2070.

[3] Byoung Chul Kim, Young Han Kim, Jeong Seb Han, A low-cost thermographic device for the detection of concealed groove in metal plate, Sensors and Actuators, Vol.A 118, 2005,pp. 248–253.

[4] D.M. Tsai, C.Y. Hsieh, automated surface inspection for directional textures, Image Vision Comput. , Vol.18, 1999, pp.49–64.