

Design of Surface Roughness Measuring System Based on Machine Vision

Yao Songli

College of Mechanical Engineering,
Shanghai University of Engineering
Science,
Shanghai, China,

Jin Jiahao

College of Mechanical Engineering,
Shanghai University of Engineering
Science,
Shanghai, China,

Wang Yuxuan

College of Mechanical Engineering,
Shanghai University of Engineering
Science,
Shanghai, China,

ABSTRACT

Aimed at traditional light-section microscope measuring, the surface roughness measurement system based on machine vision was designed. The system configuration and the software principle were introduced in detail. Using measurement system various surface roughness parameters can be measured automatically and fast. Comparing the measurement results with the value of standard parts, it was proved that the system has a satisfying measurement precision.

Keywords

Light-section Microscope; Surface Roughness; Machine Vision; Image Processing

1. INTRODUCTION

Surface roughness means microcosmic geometry shape characteristic (error) composed of minor spaces, peaks and valleys in the machining surface. It directly influences machine and instrument's service performance and life, especially makes important sense to products with high running speed, fabrication precision and tightness request. Therefore, surface roughness measuring technique takes a very important place in engineering and technology, people put forward higher and higher request on surface roughness measurement, thus the need of nondestructive and portable surface roughness measuring equipment emerges as the times require^[1-3].

Light-section microscope is a measuring surface roughness instrument using the measuring principle of light-section method. It can be measured surface micro roughness height in roughly $0.8\mu\text{m}\sim 80\mu\text{m}$. Light-section microscope is mainly used for measuring car, milling, planing and processing method of metal workpiece flat surface and cylindrical surface roughness, it can also be used for measuring surface texture and tiny local damage. Conventional light-section microscope using artificial adjusting and measuring commonly, inevitably produce some human error. In order to improve the microscope measurement precision and efficiency, surface roughness measurement system based on machine vision technology is presented. The computer control is introduced into the microscope and using image processing technology.

2. HARDWARE DESIGN AND IMPLEMENTATION

According to the principle of light-section method and machine vision technology, combined with CCD image acquisition system and computer image processing technology, developed a surface

roughness measuring system to general workpiece. The measurement can quickly, high precision of the workpiece surface roughness. Using light-section microscope and CCD to capture images, and using computer to process the images, finally get the relevant evaluation parameters of workpiece surface roughness and shows the test results in human machine interface. Structure of the measurement is shown in figure 1. It mainly composed of LED light source, CCD camera, image capture card, 9J light-section microscope and computer.

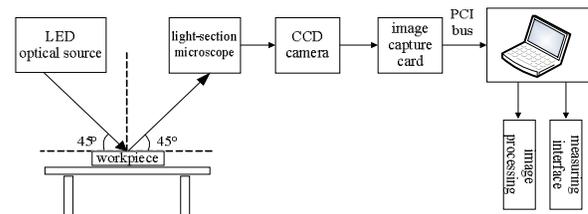


Fig.1 Structure of the measurement

3. SOFTWARE DESIGN

Software design is one of the highlights of the system design, mainly to complete the human-machine interaction interface, image acquisition, processing and storage, etc. Main function modules of the software have image acquisition module, image enhancement edge detection module, parameter calculation module and management module.

3.1 Image Acquisition

Image acquisition is mainly composed of the following process, as shown in figure 2.

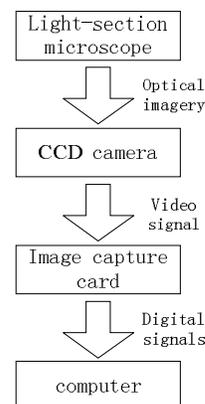


Fig.2 The image acquisition process

In this paper, the measured workpiece surface roughness Ra value in the range of 0.8μm to 6.3μm. According to the light-section microscope measurement range selection principles of the object lens, this paper chooses the objective lens is 60 times. Figure 3 is one of the images captured based on the surface roughness measurement experiments.

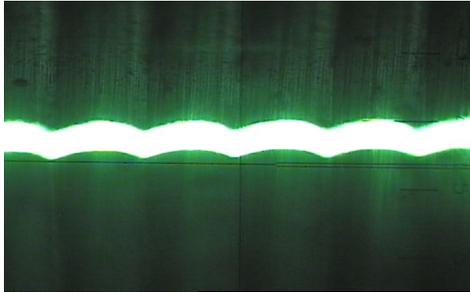


Fig.3 Image of the system capture

3.2 Image Processing

Image processing part mainly includes image preprocessing, edge detection and feature extraction , for the calculation of surface roughness evaluation parameter established main basis.

Surface roughness detection, dust or impurities on the surface of the workpiece, sometimes jitter, tilt, etc., this makes the image obtained by camera noise inevitably exist. After the noise by the digital processing will show the grayscale difference. These differences will give the following roughness calculation big error, so the first thing of image preprocessing is removing the noise.

To remove the image of the gray scale difference and don't have an effect on the edge of the image contour and lines, namely not lose important edge information, we must choose a good filtering method. Through a variety of methods of comparative analysis, this paper choose median filtering to preprocess the image after graying.

Edge detection is often the first step of image analysis and understanding. It holds a special position in image processing and machine vision. It is one of the most important step in the underlying process. Edge detection, not directly depends on the image gray scale, but depends on the image gray level change. So the detection of edges have high stability. Using different edge detection method can obtain different precision of edge information. The edge detection method with high precision is the important way to obtain high quality characteristics of visual information^[4-6].

This paper adopts Sobel algorithm for image edge detection. The edge curve after the algorithm processing as shown in figure 4.

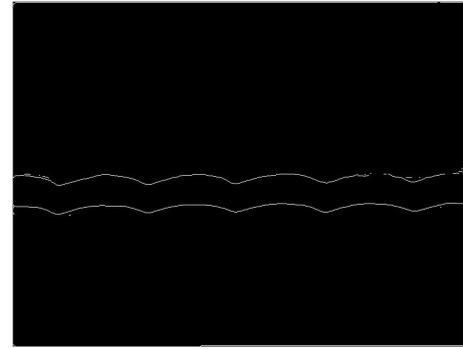


Fig.4 Image after edge detection

3.3 Human-machine Interface Design

The measurement system using Matlab GUIDE development environment to design human-machine interface, the user direct exchange of information with the computer, and by writing the control Callback function to accomplish a specific function.

Through operating the corresponding function button can be obtain the corresponding parameters, The operation interface can realize the original image and edge detection of image display, it is shown in figure 5.

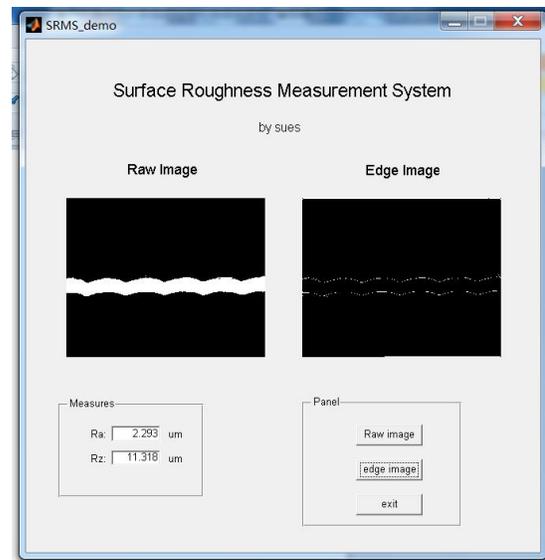


Fig.5 Operation interface

4. EXPERIMENTAL RESULTS

4.1 Evaluation Parameters

Ra and Rz are the essential parameters of surface roughness. Ra is the average roughness, the formula is:

$$Ra = \frac{1}{lr} \int_0^{lr} |Z(x)| dx \quad (1)$$

Where lr is sampling length, and $Z(x)$ is each point ordinate of the contour line.

Rz is height of profile elements. It is defined as:

$$Rz = Zp + Zv \quad (2)$$

Where Zp and Zv are positive value. Zp is the maximum peak height and Zv is the maximum deep valley.

4.2 Experimental Results

To test the reliability of the system, the application of the detection system for measuring experiment, the experimental results and sample standard comparison.

Using multiple samples of different processing methods of workpiece surface roughness detection experiments, the experimental results are shown in figure 6, it can be seen that the system is compared with the standard values close to measured results, has ideal precision.

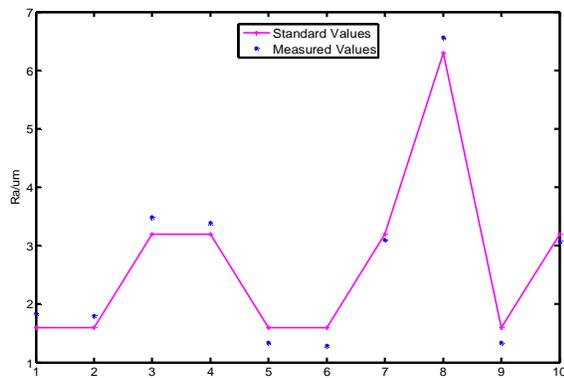


Fig.7 Comparison of measuring

5. CONCLUSION

This paper introduces the application light-section microscope and machine vision in the surface roughness measuring system, and realizes the automatic detection of surface roughness. The system reduces the artificial reading, recording and calculation, greatly improves the measuring efficiency of surface roughness. And by using the standard piece of measurement error is analyzed, according to the experimental comparison results, in this paper, the surface roughness measuring method has higher stably and credibly.

REFERENCES

- [1] Wang Haitao, Liu Weiqiang, Yang Jianguo. Grinding surface roughness prediction model based on RBF Neural Network[J]. MACHINE TOOL AND HYDRAULICS, 2014,42(3): 107-111.
- [2] Ma Cheng, Wang Junwu. On-line measurement of workpiece surface roughness[J]. CHINA INSTRUMENTATION, 2009,27(8): 67-69.
- [3] Lu R and Tian G. On-line surface roughness measurement by laser light scattering[J]. Measurement Science and Technology, 2006, 17 (1) : 1496-1502.
- [4] Tian G and Lu R. Surface measurement using active vision and light scattering[J]. Optics and Lasers in Engineering, 2007, 45 (1) :131-139.
- [5] Zhang Hui, Wang Yaonan, Zhou Bowen. Research on foreign substance detection system for medicinal solution based on machine vision[J]. 2009,30(3): 548-553.
- [6] B. Dhanasekar, B. Ramamoorthy. Assessment of surface roughness based on super resolution reconstruction algorithm. Int J Adv Manuf Technol. 2008,35(1):1191-1205.