# Research on Surface Defect Detection of Aluminum based on Image Processing

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**Abstract**

Aluminum material is relatively smooth. Aluminum surface engender scratches and bruises easily when collide with other metal. Surface defect detection of aluminum products is particularly important. It is very convenient to use machine vision method for defect detection. Defect contour extraction is an important part of machine vision for defect detection. The surface of aluminum metal is very reflective and shallow scratches are easily mistaken for defects. There are many kinds of filtering, such as the mean filtering, gauss filtering, median filtering and directed filtering. With the help of filtering, dynamic threshold can achieve a good effect. The severe scratch defect and the slight scratch can be clearly separated from the surface of the aluminum product.

*Key words*: defect detection, Aluminum metal, machine vision, Industrial Light source, Visual inspection

## 1. Introduction

In the traditional machining industry, the quality of the finished workpiece will be different due to various factors. Due to the improvement of industrial requirements, the quality requirements of customers are more and more stringent. At present, the quality of the products is judged by human eye in the piston processing factory made of aluminum alloy. This method not only has great labor intensity, but also has a high rate of missing detection in the finished workpiece. A simple method of image contrast can be used in a few cases. But there is no standard device that can detect complex defects such as scratches. The quality inspection requirements and difficulties of aluminum alloy pneumatic piston are studied in this paper.

The study of aluminum piston scratch detection is made in this paper. And the results showed that the workload of the staff was reduced by 3 / 1 and the miss rate was reduced to less than 1 / 1000.

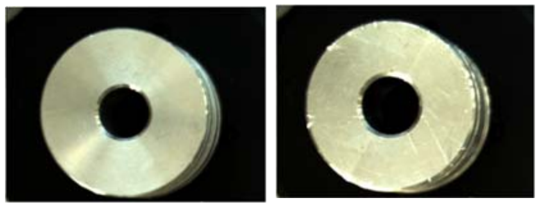

Fig.1 Normal product and Abnormal product

## 2. Defect detection method

The first is to build the experimental platform. A 2048 x 1536 pixel color industrial camera is mounted on a retractable camera mounting bracket. The camera captures at 10 FPS. The light source is an integral sphere blue light source. The distance between the camera and the workpiece is 300 mm. The sample taken is shown in the following figure.

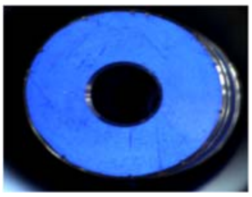

Fig.2 Blue Light

The camera is connected to the computer through the mini USB signal line for image acquisition. The entire research platform is shown in the figure below.

Fig.3 Experimental Platform

The mode and intensity of illumination have been determined and the inner wall of the spherical light source is hemispherical. It has the effect of converging light. The light comes from a 360-degree circular light source at the bottom and bounces off evenly. It equalizes the brightness of the entire image. It is suitable for metal surface defect detection.

Image processing is the key process of the whole system, which includes image acquisition, image pre-processing and defect extraction. The read image is collected by industrial camera. The image is then written using Halcon software. Image pre-processing is also the key step to determine whether the defect can be accurately extracted. For this reason, we have done the following processing.

The time domain image is transformed into the frequency domain image by Fourier affine transformation. Generate a bandpass filter with sinusoidal shape and set the distance of the filter's maximum from the DC term is 0.4.Use rft mode to set location of the DC term in the frequency domain.

Set the filter size as with original image size.

Convolve original image with the bandpass filter in the frequency domain, then we can get an image without high-frequency noise in frequency domain.

Fig.4 Image in frequency domain.

In order to give people a sense of what's going on, we need to compute the real-valued with fast Fourier transform for the image in frequency domain. After threshold setting we can get an image in time domain.

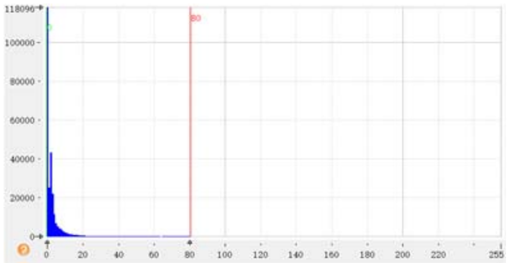


Fig.5 Gray histogram

Segment the image using global threshold to get an image with isolated each defection. Compute connected components of all region for next step. As show in the image below.

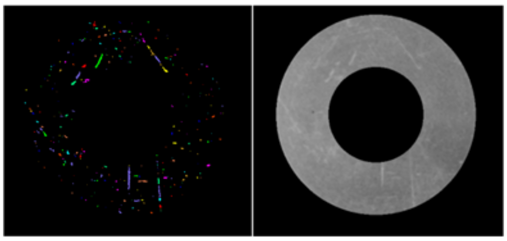

Fig.6 Influencing factor

The surface of aluminum alloy has the characteristics of gray level approaching to the defection. We're going to do the first selection of the defect area. At this point, the approximate defect region can be obtained without the effect of the material surface.

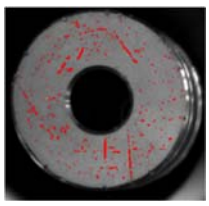

Fig.7 Defect display

In order to ensure that the image defect area is not missing, we dilate a region with a circular structuring element. The expanded region is extracted from the source image, It cut down the running time of the program and reduces the amount of data to process objects. In order to avoid separation of lines due to overlapping scratches, we need to extract complete lines from the image. We use the method of line segment fitting after extracting the region skeleton to connect the continuous defects. Select the length of the line segment to determine defect of scratches. The extracted lines are returned in Lines as sub pixel precise contours.

Based on the customer requirements we can get criteria for defection which size is 0.5 Square millimeter.

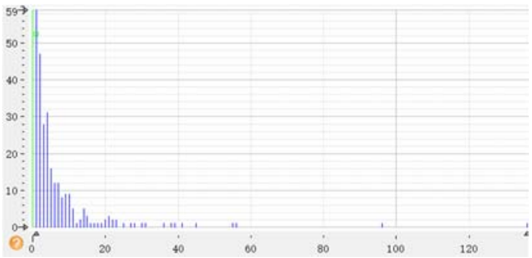


Fig.8 Area histogram

We can select the size of the area to get real defect region. And obtain a roughly selected defect position in the original image.

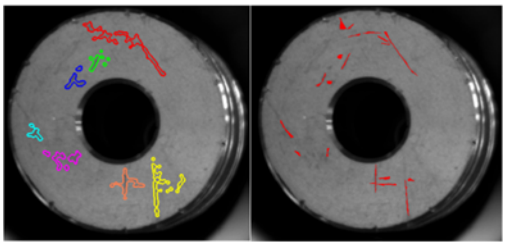

Fig.9 algorithm research

In this project, the pixel value of the scratches in the image can be placed in the lower level by changing the illumination. So that the degree of the scratches can be increased when the image is collected. Bandpass filter with sinusoidal shape enhancement of the high-frequency signal is better than most. So that we use 255 to subtract the Pixel value of the source image to achieve the image Pixel inversion effect.

The inverted image is transformed by Fourier affine transformation. Convert the image to the frequency domain. The next step is the same as before. we make the

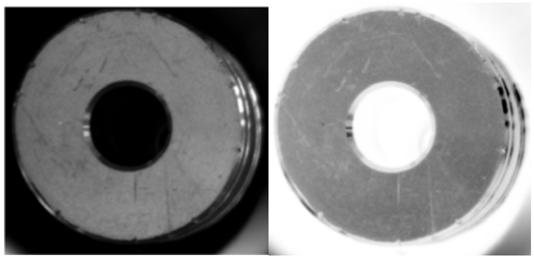

Fig.10 original image and inverted image

two images be convolved in the frequency domain. The pixels of the affine transformed image are multiplied by the corresponding pixels of the filter image. Compute the real-valued in time domain by fast Fourier transform of an image.

## 3. Testing and conclusion

### *3.1 The miss detection rate of detection has been greatly improved*

Compare to the mode of manual inspect scratch defects, application of machine vision in scratch defect recognition has many advantages. The recognition ability can be improved a lot by adjusting parameters. The miss rate can be reduced to less than one in ten thousand. With the increase of working time, the miss detection rate of manual detection will increase. Unlike manual inspect, the vision detection system studied in this paper runs stably. The most important miss rate in detection attains one in a million. The results are as follows.

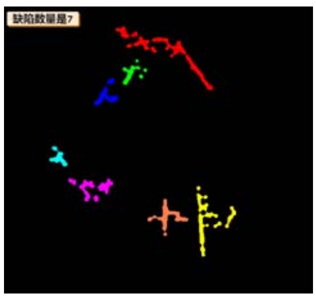

Fig11. Decision result

### *3.2 The detection time reduced*

Compared to manual inspection of scratch defects machine vision well reduce the detection time. Using machine vision to detect surface scratch of Aluminum alloy material defects, the detection time is reduced to about 0.1 S. For different defects, the manual detection time may be vary greatly. And there is double-checking situation. The algorithm of this paper is stable in the detection period. The experimental results show that the detection time of the single piece is reduced to 0.127518 seconds. It can't do that manually。As shown in the image below.

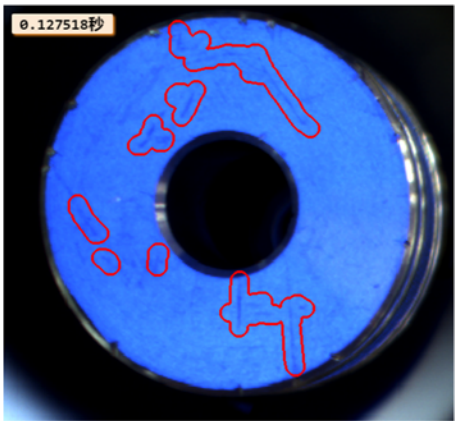


Fig12. Detection time

## 4. Conclusion

The quality inspection requirements of the workpiece and the problems existing in the current quality inspection are known by us. In this paper, machine visual inspection method is used to detect the surface scratch defect of Aluminum Alloy Cylinder Piston. The goal of reducing the Labor Force by 1 / 3 and the rate of missed inspection by less than 1 / 10000 was achieved. In the image processing process, the algorithm is optimized by studying the defect gray value. The algorithm is more accurate for defect detection. This paper also has some shortcomings. Depth of field has a huge impact on the algorithm. A surface with depth of field less than 0.05 will improve the detection rate.

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