

Inspection of flatness using vision system

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Abstract

Evaluation of flatness of machined components has assumed considerable significance because of its role in predicting functionality during application. Standard flatness assessment techniques used in industries as contact in nature which limits its measuring speed. Though, contact measuring technique is very accurate, speed of inspection is not fast enough to be used as an online measurement technique. To overcome these drawbacks, many non-contact measurement techniques came into being. Many of these techniques are electro optical in nature. These techniques are reasonably fast however; the method can be used only in laboratory environments. The proposed method uses a machine vision system for flatness measurements uses a relatively low-cost vision system and can be used in industrial environment. In this context, the proposed methods assume special significance. Both the accuracy of measurement and speed are not available in online measurement of flatness. Hence, the proposed method use as a vision system for flatness measurement the method is non-contacting in nature and hence higher inspection speed are possible and finds application in online assessment of flatness.

Keywords

Flatness measurement, Inspection, Non-contact method, Industrial inspection

1. Introduction

In this paper, Inspection of Flatness of specimen surface using vision system is presented with two methods. These techniques are developed with focus on industrial application that can use not only in lab environment but also in industrial environment. The method is unique by its concept, experimental arrangements, and algorithms. Method is non-contacting in nature and doing 100% inspection of surfaces.

2. Methodology

2.1 Specimen preparation

Specimens are prepared by shaping and grinding operations as per table 2.1. Specimens were prepared in square shape to have dimensional advantage for calibration. As this is novel measurement technique, to prove that there is no significance difference between standard methods and proposed method, specimens are prepared in 25 quantities to prove statistically and compare with standard methods.

Shaping	Feed	2mm/stroke	Specimen Dimension	50mm*50mm
	Cutting to return ration	3/2	Specimen Material	Mild steel
	Cutting speed	21m/min	Number of specimen	25
Grinding	Cutting Speed	560m/min		
	Feed Rate	0.130mm/rev		

Table 2.1

2.2 Set up of a vision system



Fig: 2.2.1 Vision system

Charged coupled device Camera with auto gain and auto exposure properties to control quality of images, DC connector as an input of camera for power supply and Ethernet interface as an output connected to computer system with image processing software to store image. System also consist of highly advanced software Matrox Imaging Library and MATLAB to process the image. Illumination by discharged light like monochromatic sodium light is preferable for reflective materials, for non-reflective surfaces normal light can be used. Quality of a raw image depends upon the data transferring cables, voltage variation of inputs. Camera was mounted on the highly flexible tripod. Specimen surface images were grabbed by CCD camera and were pre-processed to eliminate effects due to improper illumination and noise.

2.2.1 Side view method

Experimental arrangement for method-1 is as per shown in Fig 2.2.1, in this arrangement side view of the surface get captured with keeping white background to distinguished grey values and identify peaks and dents. Illuminations by natural light were used. Data mining techniques were used in this technique to reduce the size of the data that is discussed later in this paper.

2.2.2 Top view method

Experimental arrangement for method-2 is as per below figures, projector and cameras were kept according to basic optics law. Incident angle equals to reflection angle. Projector incident grid lines on the specimen at 70-72-degree angle and at other side camera was kept at 70-72-degree angle to have optical advantage. Projector was connected to the computer for the grid lines, three different grids were used in experimentation for accuracy. Camera and vision system set up as per above arrangement.



Fig: 2.2.2.1 Setup



Fig: 2.2.2.2 Spectroscopic

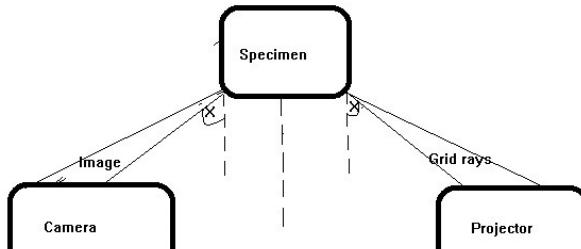


Fig: 2.2.2.3

2.3. Measuring specimen using standard technique

To compare novel method with standard technique, specimens were measured using dial indicator. Dial indicator kept on a stand with adjustable jacks and granite plate. Zero off the surface directly above the jacks to create a plane on the surface requiring flatness. Once that has occurred, then sweep the surface with the dial indicator and take the FIM or TIR shown on the indicator. That is your actual flatness of the surface. There is no plus flatness or minus flatness only a flatness value or range. All the specimens were measured using dial indicator and the measurement were recorded with the function of distance as per Fig: 2.3.1., in this figure flatness is measured for each 10mm square block

Deviation=0.01mm

0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.09	0.09	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.09	0.09	0.02	0.02	0.02	0.02	0.02
0.03	0.03	0.03	0.03	0.07	0.07	0.09	0.09	0.03	0.03	0.03	0.03	0.03
0.03	0.03	0.03	0.03	0.07	0.07	0.09	0.09	0.03	0.03	0.03	0.03	0.03
0.03	0.03	0.03	0.03	0.07	0.09	0.1	0.1	25	0.03	0.03	0.03	0.03
0.03	0.03	0.03	0.03	0.07	0.09	0.1	0.1	24	0.03	0.03	0.03	0.03
0.03	0.03	0.02	0.03	0.09	0.09	0.1	0.1	24	0.03	0.03	0.03	0.03
0.03	0.03	0.02	0.03	0.09	0.09	0.1	0.1	28	0.03	0.03	0.03	0.03
0.03	0.03	0.02	0.03	0.09	0.09	0.03	0.03	0.03	0.03	0.03	0.03	0.03
0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Specimen no. 6 Fig: 2.3.1: Dial indicator readings

2.4 Development of software

Image processing software consist of two parts one is image pre processing software and second is main part of the software. Raw image may have blurr and noise, for removing them image preprocessing is required. In image pre processing software consist of image enhancement, noise removal, blurr removal etc.

2.4.1 Flowchart 1

Flowchart for method 1 is shown in fig 2.4.1, as per this flowchart code has been generated in MATLAB.

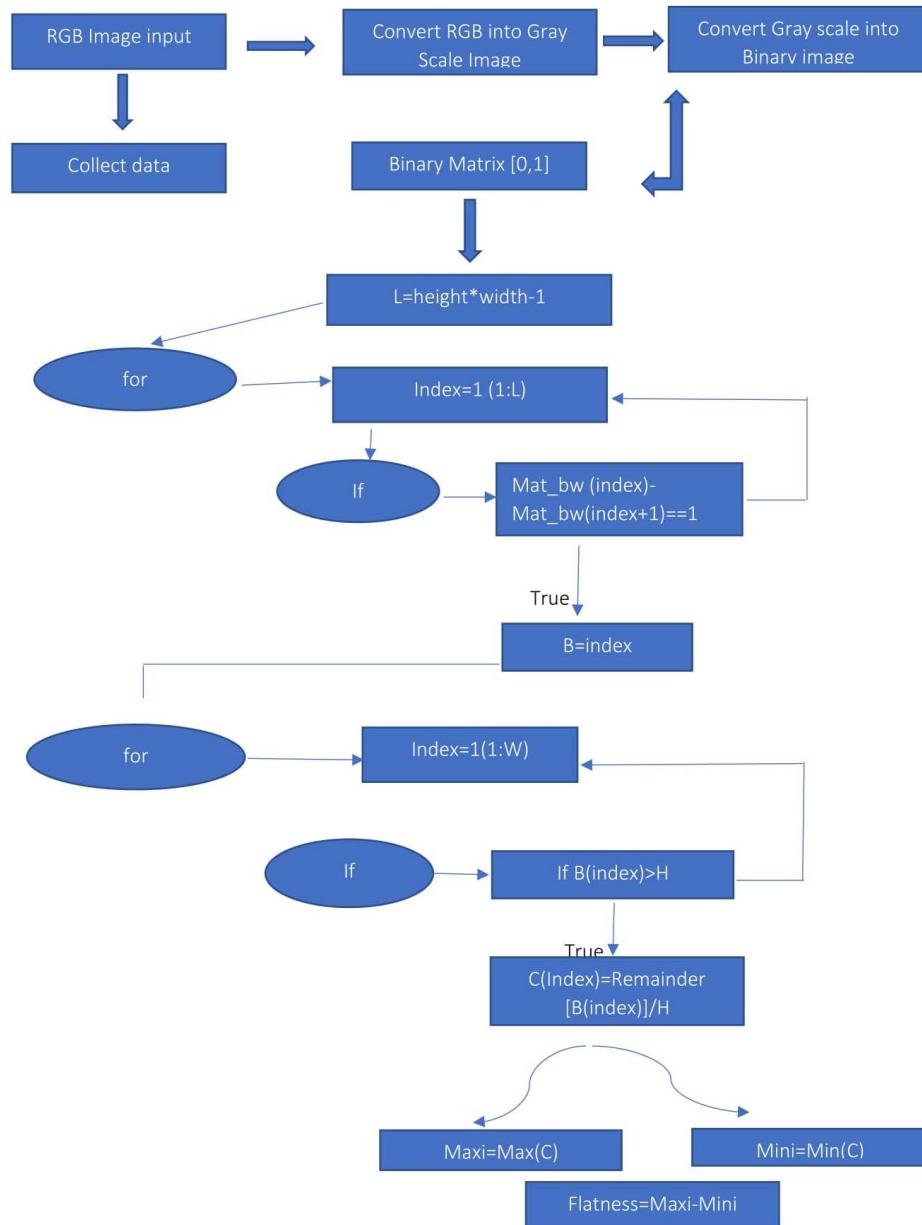


Fig.2.4.1: Flowchart 1

2.4.2 Flowchart 2

Flowchart for method 2 has shown in fig 2.4.2.

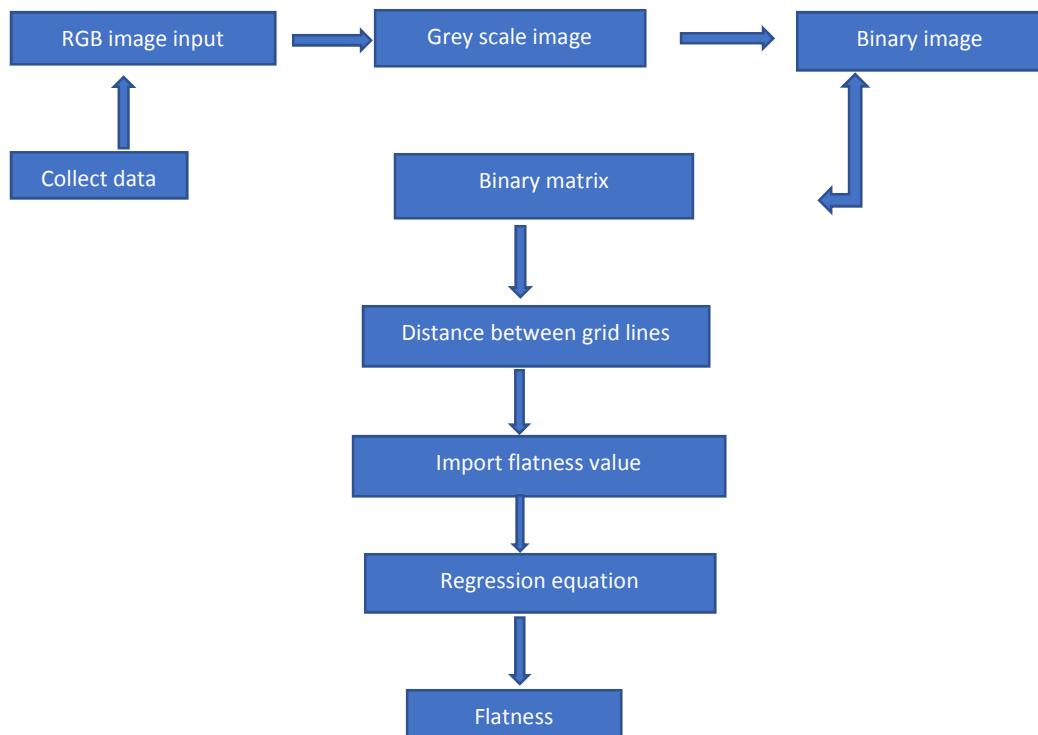
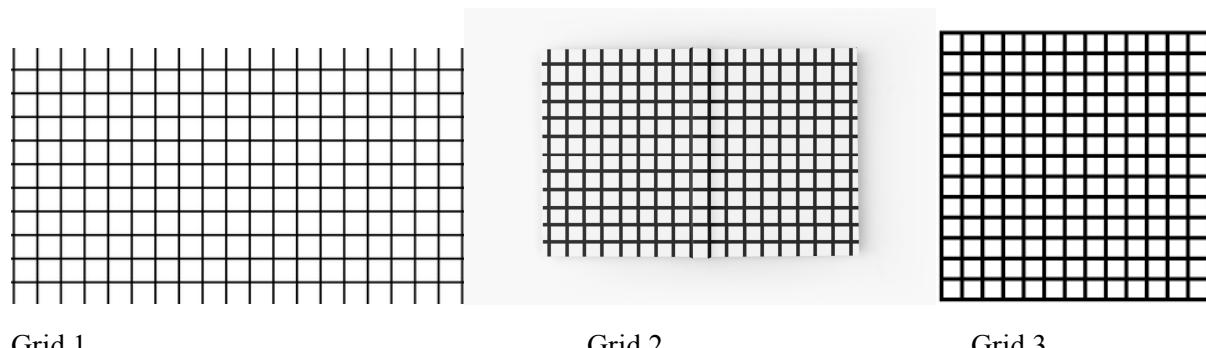


Fig.2.4.2: Flowchart 2

Flowchart 2 is for top view method for inspection of flatness. Flowchart is showing step by step process for evaluation of flatness using vision system and comparison with standard method. In this method images of three different grids will be incident on the specimen through the projector and distance of grid lines were measured to compare with standard measurement.



3. Analysis & Conclusion

3.1 Side view method

According to algorithm MATLAB will give three quantities maximum height of peak, minimum height and flatness value, here flatness value comes as a result is in pixel unit. Pixel values were calibrated according to distance of the camera from the object. As per shown in fig.3.1, pixel values are plotted against flatness value measured by standard method. However, method is showing insignificance with measurement readings of standard method. It is due to the setup or camera orientation we may conclude that this method is better for lab environment where discharged light is available. .

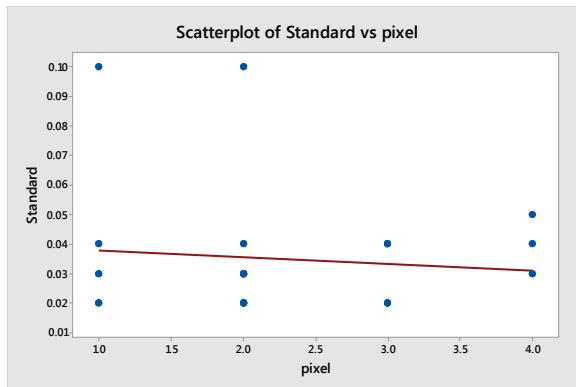


Fig 3.1 Scatter plot with regression line

2 Top view method

Analysis of Variance					
Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.006	0.00594	0.00	0.961
Standard Method	1	0.006	0.00594	0.00	0.961
Error	110	278.414	2.53103		
Lack-of-fit	10	40.601	4.0601	1.71	0.089
Pure Error	100	237.812	2.37812		
Total	111	278.420			

Regression Equation

$$Vm = 24.745 - 0.0008 Sm$$

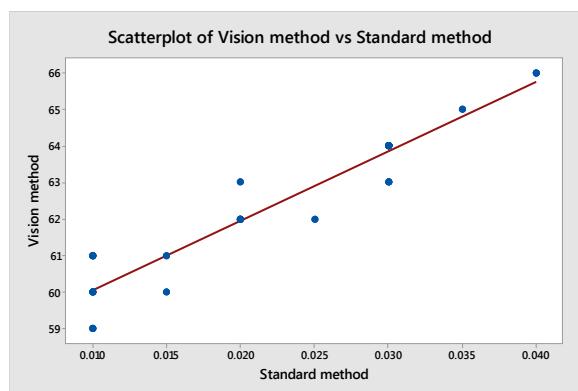


Fig 3.2 scatter plot with regression line

As per the statistical result as shown above, null hypothesis is accepted that there is no significance difference between two methods.

References

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