Advanced Science and Technology Letters
Vol.98 (CES-CUBE 2015), pp.64-68
http://dx.doi.org/10.14257/astl.2015.98.17

A Study on Laser Based Vision System for Inspection Height of Structural Adhesive

Jun-Woo Son[1], Byoung-Ik Kim[2], Kyung-Jin Na[2], Myeong-Hwan Jeong[3], Young-Choon Kim[4] and Sang-Ho Ahn[5]

[1] Shcool of Electronics Engineering, Kyungpook National University, Korea
[2] Advanced Research Team, AJIN Industrial Co., Ltd, Korea
[3] AUTOIT Co., Ltd, Korea
[4] Dept. of Information Communication & Security, Youngdong University, Korea
[5] Dept. of Electronic Engineering, Inje University, Korea,

Abstract. The paper studies about a line laser based vision system to measure structural adhesive as a non-invasive inspection. It proposes a novel vision system to measure height of adhesive (or object) by optical triangulation using line-laser, and analyzes resolution, gaze angle, focal length and baseline of vision camera, proper to measurement. The validity of the proposed method was verified through experiments.

Keywords: line laser, vision system, structural adhesive, optical triangulation, non-invasive inspection

1 Introduction

Lately, in order to enhance hardness, collision performance, and durability of automotive frame, conjugation technique based on structural adhesive, instead of mechnical fastening technique, is widely utilized, for resisting complex production situations; light weight of product, factory dust, and product waterproof etc. [1]

A camera based vision system integrated with inspection equipment using laser is widely used to inspect ointment of automotive structural adhesive. Thickness inspection, as well as adhesive ointment success or failure and width inspection, is also required to recently enhance reliability of product. Optical triangulation allows establishment of metrological systems, due to its inherent relative simplicity, robustness and reliability which can cope with most modern requirements of non-invasive inspection for objects and those surfaces. [2]

In this paper, line laser based vision system was studied to measure height of structural adhesive, as a non-invasive inspection. It introduces a novel measurement system to inspect height of adhesive (or object) through optical triangulation using line laser, and analyzes resolution, gaze angle, focal length and baseline of camera, proper to measurement. The validity of proposed line laser based vision system was verified through experiments for linear object, similar with structural adhesive.

ISSN: 2287-1233 ASTL

2 Line laser based vision system for object inspection

A concept of optical triangulation geometry is shown in Fig. 1. Line laser is vertically installed to reference plane and camera is leaned with gaze angle θ. The image of laser beam mirrored to reference plane falls at zero central coordinates. For distance B between camera and laser, vertical distance D_0 between camera and object is given by

$$D_o = B / \tan\theta \tag{1}$$

When laser beam is shined to an object located at height H from reference plane, the image is mirrored on image plane falls on a location away with h from central coordinates. In other words, as height of object H get higher, position of laser beam mirrored on image plane is dislocated with h, the related formula is as follows;

$$\phi = \tan^{-1}\frac{h}{f} \tag{2}$$

$$D_h = \frac{B}{\tan(\theta+\phi)} \tag{3}$$

$$H = D_o - D_h \tag{4}$$

where f is the focal length of the lens.

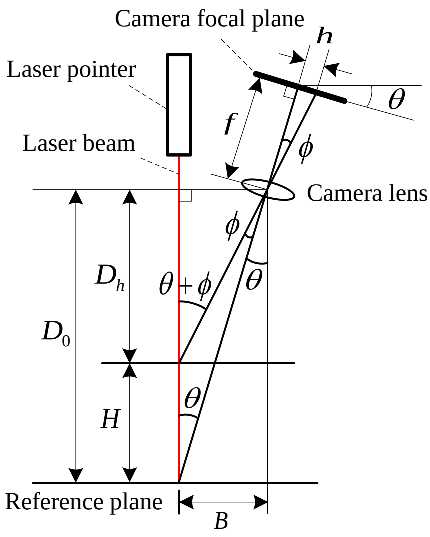


Fig. 1. Concept of optical triangulation geometry.

Parameters related to laser based optical inspection system are focal length *f*, baseline *B*, gaze angle θ of camera. Figure 2 shows the relation between object height *H* and image displacement pixel corresponding to focal length *f*. The image displacement pixel is proportional to *h*, and we assumed that one pixel size is 7.4μm. The gaze angle θ depends on *B* and D_0 from eq. (1). The higher focal length is (similarly, zoom-in effect), the smaller object can be measured.

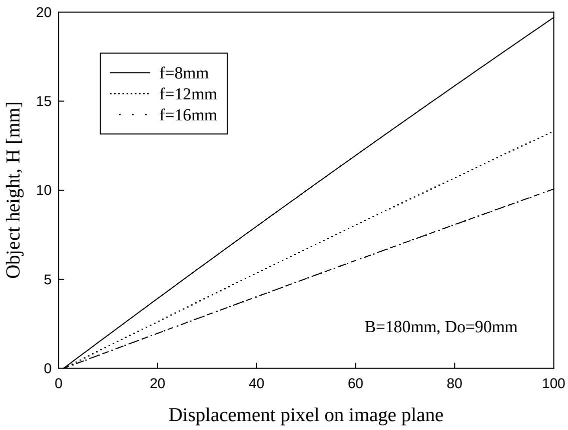


Fig. 2. Object height *H* vs. displacement pixel corresponding to baseline *B*.

3 Experiment Results

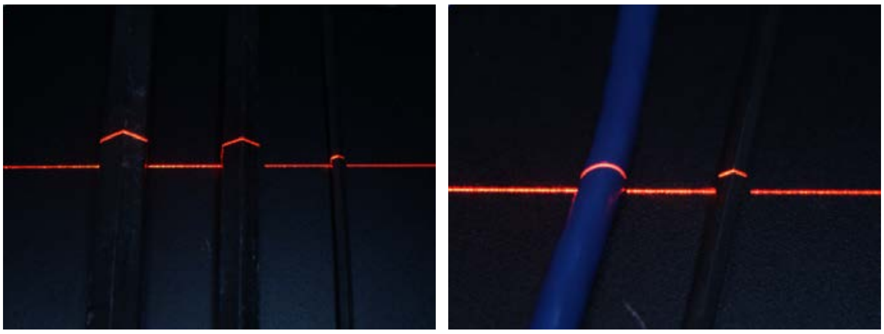
Experiments for measuring height of structural adhesive were conducted through the proposed line laser based vision system. The camera specification used in the experiment is shown in Table 1.

Table 1. Specifications of the camera used in experimentation

Sensor size	Resolution	Focal length	Pixel size	Image area
1/3 inch	976(*H*) x 496(*V*)	8 & 16mm	5.00um x 7.40um	4.88mm x 3.67mm

Figure 3 shows an example of experiment for measuring height of 3 type (10mm, 8mm, 3mm) hex wrenches and mock adhesive. Then, the measured height and actual one were compared from the result image. At focal length of 8mm, as shown in Fig. 3(a), wrenches of 10mm and 8mm are seen with high visibility, on the other hand, one of 3mm is not seen with good resolution. Fig. 3(b) shows images for mock adhesive and wrech of 3mm, acquired at focal length of 16mm. We can know that wrench image of 3mm has high resolution compared to the wrench image in Fig. 3(a), due to zoom-in effect by high focal length.

Table 2 represents experiment results. It includes displacement pixel corresponding to object height from captured image, height calculated theoretically, and measurement errors. Error between actual height and measured one is caused by inaccuracy of parameters included at system modeling causes. Therefore, compensation process through precise experiment is needed to reduce the measured errors.



(a) (b)

Fig. 3. Captured images: (a) 3 type (10, 8, 3mm) hex wrenches (f=8mm) and (b) mock adhesive and 3mm hex wrench (f=16mm)

Table 2. Results of experiment (B=180mm and D_0=90mm)

Test object	Hex wrenches			Mock adhesive
Actual height	10mm	8mm	3mm	3.7mm
Displacement pixel	50 (f=8mm)	40 (f=8mm)	30 (f=16mm)	37 (f=16mm)
Measured height	10.17mm	8.17mm	3.10mm	3.82mm
Mesurement Error	0.17mm	0.17mm	0.10mm	0.12mm

4 Conclusions

In this research, line laser based vision system to inspect status of structural adhesive was proposed. Based on triangulation using line laser, height measurement method of objects was introduced. The validity was confirmed through experiments. Because height of actual structural adhesive are small, width of laser beam should be slender and imaging sensor with high resolution is required.

Acknowledgments. This work was supported by a research project of SMBA(small and medium business administration) in Korea.

References

1. T. Satoh, On the development of structural adhesive technology for the automotive body in Japan. JSAE Review. 17-2, pp. 165-178, (1996)
2. Manuel F.M. Costa, Optical triangulation-based microtopographic inspection of surfaces. Sensors, pp. 4399-4420, (2012)

