http://dx.doi.org/10.21611/qirt.2017.020

COMPARISON OF RESULTS DUE TO THE VARIATION OF POWER OF HALOGEN LAMP USING INFRARED THERMOGRAPHY AND AVERAGE OF TEMPERATURE DIFFERENCES METHOD

Hyunchul Jung[1†*], Il-Chul Park[2], Juyeop Shin[2], Jun-Ho Yang[2], Kyeongsuk Kim[1]

[1]Chosun University, 309 Pilmun-daero, Dong-gu, Gwangju, 61452, Korea
[2]Graduate School, Chosun University, 309 Pilmun-daero, Dong-gu, Gwangju, 61452, Korea

[†*]Presenting and Corresponding Author: hyunchul.jung@chosun.ac.kr

ABSTRACT

Recently, the defect detection is concerned as one of the important techniques used in the practical industrial fields. Among other nondestructive testing methods, infrared thermographic testing provides relatively more accurate data and less testing time. In this study, a steel plate specimen with FBHs (flat bottom holes) is tested by an infrared thermography system. Each raw of FBHs has the same depth while each column has the same diameter. When a specimen is heated by a halogen lamp whose power is controlled from 10% to 100% with 10% step, the thermographic images are obtained. The size of FBHs are compared using new proposed signal processing technique, the average of temperature differences method.

KEYWORDS: Infrared thermography, Steel plate, Flat bottom hole, Halogen lamp, Heating amount, Signal processing

1. INTRODUCTION

Most of all materials used in the life emits certain amount of the infrared radiation. Infrared thermography can detect the intensity of infrared radiation emitted from the surface of an object, convert to the temperature values, and graphically display the temperature distribution. Infrared thermography has been widely used for diagnosing whether defects are existed or not in and on the surface of an object. [1]

In this paper, a new signal processing method, average of temperature differences method, is presented to find the defect size quantitatively. For this, infrared thermography was applied to a steel plate with FBHs (flat bottom holes). Each raw of FBHs has the same depth while each column has the same diameter. When a specimen is heated by a halogen lamp whose power is controlled from 10% to 100% with 10% step, the thermographic images are obtained. The size of FBHs are compared using new proposed signal processing technique, the average of temperature differences method.

2. AVERAGE OF TEMPERATURE DIFFERENCES METHOD

In the average of temperature differences method, the temperatures of two neighbor frames are subtracted. After when the subtracted results for whole frames are summated, the summated temperature difference is divided by total frame number. This is called as the average of temperature differences. The result of the average of temperature differences is multiplied by the temperature of N frame. From this result, the defect size can be quantitatively measured.

3. EXPERIMENT

STS304 steel plate with FBH is used as a specimen. The steel plate specimen has 180 mm width, 180 mm height, and 10 mm thickness. The diameter of FBHs are varied with 14, 16, 18, 20 mm and the depth are varied with 6, 7, 8, 9 mm. For increasing emissivity of a target, a black paint was sprayed on the surface of the specimen.

Experimental apparatus consists of a IR camera (FLIR SC5000 series), control unit with function generator, halogen lamp (1 kW max. power), and computer. The resolution of IR camera is 320x256 pixels. The power of halogen lamp is controlled from 10% to 100% with 10% step.

http://dx.doi.org/10.21611/qirt.2017.020

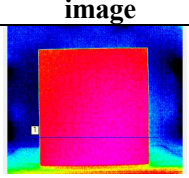
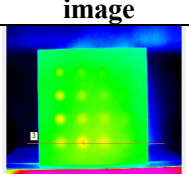
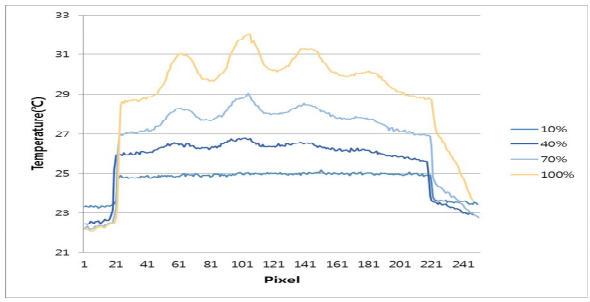
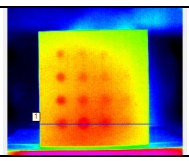
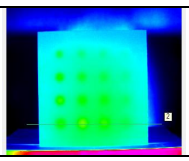
The steel plate specimen is heated by a halogen lamp with each step. The distance between the specimen and a halogen lamp is 80 cm. After the measurement was finished, the result image was stored a computer in real time.

Generally, even though better system can take better results, a good result can be provided when a signal processing is applied to the general thermal images with low resolution. To display the temperature distribution of a target, the thermal contrast-based technique for the signal processing is typically applied. Many kinds of the signal processing have been suggested for obtaining quantitative results and improving the precision. [2]

4. RESULTS

Infrared thermography are used to measured defect and temperature change according to the halogen lamp heating amount of the steel plate FBH. It was confirmed thermography image of defect FBH respectively different diameter and depth. We were able to confirmation the defect and defect size via Line Profile at the defect position. The diameter of the defect can be calculated by calculating the diameter per Pixel of 14, 16, 18, 20mm, it were able to confirmation that the diameter of the calculated defect matched more than 80% compared with the diameter of the actual defect.

Table 1 Temperature distribution results of steel plate specimen with FBH measured by IR camera.

Heating amount	Thermography image	Heating amount	Thermography image	Line profile
10%		70%		
40%		100%		

5. CONCLUSIONS

In this study, the steel plate specimen with FBH was heated with the controlled heating amount and the sizes of FBHs were measured by infrared thermography. Finally, some meaningful results were concluded as follows;
1) When the heating amount was too small or too large, FBH couldn't be distinguished from the defect free area and when the heating amount was between 40% and 70%, FBHs were clearly distinguished.
2) It seems that the optimal temperature range for detecting defect can be predicted through the testing for correlation of heating amount and measuring distance.
3) It is confirmed that this results can be used for the reference of the exact size measurement of an object.

ACKNOWLEDGMENT

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIP) (No. 2012-0668)

REFERENCES

[1] C. S. Ro, K. S. Kim and H. S. Chang, "Method for Measuring Weld Temperature Using an Infrared Thermal Imaging Camera." Journal of the Korean Society for Nondestructive Testing, Vol. 34, No. 4, pp. 299-304, (2014)
[2] K. W. Yun, H. C. Jung, S. W. Seon, S. J. Jung, W. J. Kang and K. S. Kim, "New application method of Infrared Thermography through Halogen Lamp design." Journal of Mechanical Science and Technology, pp. 1887-1890, (2012)