Measurement of Welding Deformation Based on Stereo Imaging Technique

Masakazu Shibahara, Toshiki Yagi and Shinsuke Itoh
Graduate School of Engineering, Osaka Prefecture University
Sakai, Osaka, Japan

ABSTRACT

Due to the rapid improvement of digital cameras, especially the pixel resolution, digital image correlation (DIC) has been introduced to measure the deformation and strain of structures. Using digital cameras for the DIC technique is an easy and fast method for obtaining structural information, represented as all the pixel points in a photo. Because a wide range of structural deformation can be obtained with high accuracy, this method has the potential to be very useful. Currently, DIC can execute a measurement with high accuracy only when the out-of-plane displacement is small. When the out-of-plane displacement is large, the deformation causes the measurement error. Therefore, a stereo imaging method using two digital cameras is proposed in the present study. The proposed method can measure not only in-plane deformation but also out-of-plane deformation with high accuracy without calibration of the errors caused by the out-of-plane displacement. In this paper, the measurement accuracy of the proposed method for in-plane and out-of-plane deformation is discussed through the application of a bead-on-plate welding test. The proposed method can measure transverse shrinkage and angular distortion with high accuracy. In contrast to the vernier caliper and laser distance meter measurement methods, which can measure only a few points at a time, the proposed method using two digital cameras can measure the full field in a short time. These results confirm that the proposed method is more advantageous than other methods.

KEY WORDS: For library indexing and on-line searching, list up to 7 key words. Please separate the keywords with semicolons. Example: Wire; cable; rope; tension.

INTRODUCTION

In recent years, the pixel resolution of digital cameras has significantly improved camera performance, especially because of the huge increase in the number of pixels. Thus, application research of image processing technology, such as the image correlation method, has been actively undertaken for the measurement of structural deformation and stress. In these techniques, a base image is recorded before structural deformation, and the object image to be measured and inspected is recorded after deformation. The in-plane displacement distribution, strain distribution, and stress distribution throughout the entire camerarecorded region are calculated by determining the brightness correlation value of the two obtained images. This technique is simple, and the measurement points are the number of pixels in principle. Thus, with the tremendous amount of information generated, it is a promising technique. However, the measurement with high accuracy is, in principle, possible only when the out-of-plane deformation is small. When the out-of-plane displacement or out-of-plane deformation of a set test specimen is large, the distance from the fixed camera varies. As a result, the out-of-plane displacement or out-of-plane deformation itself may inadvertently measure as shrinkage or expansion. Thus, correction is necessary.

In this study, a measurement system using two cameras was established, and the stereo imaging technique based on the digital image correlation method was applied. Thus, we developed a technique in which the abovementioned errors due to out-of-plane displacement and out-of-