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Full-field displacement measurement using digital image correlation method for a laser scanning confocal microscopic image

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Summary

Recently, in order to reduce the size of electronic products, manufacturers have begun to embed many electronic devices in printed circuit boards. Stress and strain around embedded devices affect the functionality of the devices and can cause the failure of electronic products. We applied a digital image correlation technique to measuring displacement and strain in such products. In order to improve the accuracy of measurement, a method for image correction is proposed for digital image correlation with a laser scanning confocal microscopic image. The scan lines of a laser scanning confocal microscope have sub-pixel error in their position in the scanning direction, which is called drift distortion. Drift distortion decreases the accuracy of the measured displacement using the digital image correlation method. The correction method proposed here removes both drift distortion and spatial distortion. Drift distortion is removed using a pair of images, each of which has a different scanning direction. Spatial distortion removal is performed using a methodology that employs a series of in-plane rigid body motions and a generated distortion map. Experimental results involving rigid body motion indicate that, after the correction of drift and spatial distortions, (i) the standard deviation of the measured displacements was 0.03 pixels, and (ii) the measured displacement fields are unbiased and agree closely with those obtained using an optical microscope. The proposed correction method effectively removes the distortions of obtained images and improves the accuracy of the digital image correlation method using a laser scanning confocal microscope. Finally, we applied the developed measuring system to evaluate a strain field in the cross-section of a print circuit board during a thermal cycle test. The measured strain in a micro-region accurately correlated to the macroscopic warpage measured by a laser displacement meter.