THEORY AND DEVELOPMENT OF A CAMERA-BASED NONCONTACT VIBRATION MEASUREMENT SYSTEM

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ABSTRACT

Dramatic advancement in technologies for high-speed high-resolution digital cameras in recent years enables the development of camera-based full-field noncontact measurement systems for vibration testing of flexible multibody systems undergoing large rigid-body motion and elastic/plastic deformations. A few of such systems exist in today’s metrology market, but they are inconvenient for use and prohibitively expensive. Most seriously, they are not really appropriate for structural vibration testing because their measurement accuracy is low due to several technical reasons, including inappropriate setting of cameras and experimental setup because of user’s innocence of video-grammetry, non-precise corner detection and other problems of image processing techniques, and inaccurate modeling and calibration of cameras. This thesis develops and puts together a complete set of necessary techniques for the development of a camera-based noncontact full-field vibration measurement system using inexpensive off-the-shelf digital cameras. An optimal combination of appropriate methods for corner detection, camera calibration, lens distortion modeling, and measurement applications is proposed and numerically and experimentally verified. Moreover, we derive/improve some image processing methods and 3D reconstruction algorithms to improve vibration measurement accuracy.