Some recent advances in digital image correlation

Bing Pan

Institute of Solid Mechanics, Beihang University, Beijing, 100191, China
Email: panb@buaa.edu.cn

ABSTRACT

Digital image correlation techniques have been widely accepted as a versatile and powerful tool for full-field surface motion and deformation measurements of solid materials, components and structures. These outstanding advantages of DIC techniques (e.g., simple and inexpensive experimental setup, easy implementation, wide applicability with adjustable spatial and temporal resolutions, and strong robustness against ambient vibrations) not only have led to the dominance of DIC techniques in the experimental mechanics community over other competing interferometric optical techniques, but also engender their prevalence in new areas of application, such as material science, biomechanics, civil engineering, geotechnical engineering, and aerospace engineering.

In this talk, we report the following important advances recently made in digital image correlation (DIC), which have enabled more accurate, more convenient and better DIC measurements to be made. First, we developed a fast, robust and accurate DIC algorithm without redundant calculations, which combines a robust reliability-guided displacement tracking strategy with an efficient and accurate inverse-compositional Gauss-Newton algorithm. This advanced DIC algorithm outperforms existing one based on the classic Newton-Raphson algorithm in terms of efficiency, accuracy and noise-proof performance. Second, we comprehensively investigated the error sources involved in single-camera 2D-DIC and stereo-DIC systems due to imperfect and unstable imaging, and presented a novel reference sample compensation method for accurate DIC measurements. Based on the thorough understanding of these error sources, we established three kinds of single-camera video extensometer, which can deliver real-time, accurate strain measurement in material testing. In addition, we developed a novel mirror-assisted panoramic DIC system for full-surface 360-deg profile reconstruction and deformation measurement in material testing. Third, we reviewed existing single-camera stereo-DIC techniques, and proposed a novel and elegant color stereo-DIC technique using a single color 3CCD or CMOS camera. Typical applications of the newly-developed color stereo-DIC are also demonstrated.