

Principles and Techniques of Digital Image Correlation

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The capabilities and applications of digital methods in experimental mechanics have evolved substantially over the past decade, facilitated in part by a rapid growth in available computing power. An experimental method that has benefited from this period of intense growth in computer-based analysis is Digital Image Correlation (DIC), which has emerged as a leading technique for surface deformation measurements of materials and solid structures. DIC is a non-contact optical correlation method used to measure full-field displacements on the surface of an object by tracking a random pattern on the sample surface. The surface deformation is obtained by optimizing a cross-correlation or a least-squares function in order to determine the matching accuracy between the local grayscale intensity values in an image of the undeformed specimen and in the subsequent images of the deformed specimen. The technique is a fast, robust, highly scalable, and accurate method for determining both the surface profile of a three-dimensional object and the displacements (Lagrangian strains) on the surface of the object. The DIC method has no inherent length scale or time scale, and substantial progress has been made in improving the spatial and temporal limits of DIC to view deformations at small length scales and/or high speeds as better microscopy and high speed photography instrumentation has become available. This tutorial will cover the basic principles and theory behind the DIC technique and practical considerations for its application at various length and time scales, including special considerations for its use with high-speed imaging and microscopy (optical and electron). Possible sources of error will be discussed, including poor tracking pattern quality, lens distortions and complex testing environments. Tracking (speckle) pattern application and evaluation at various length scales will be discussed, and particular attention will be paid to the application and development of tracking patterns for fields of view applicable in optical and electron imaging.