Problem-specific optical methods with application in biomechanics

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ABSTRACT

The non-contact full-field capabilities of optical methods make their use particularly suitable for shape and deformation measurements for biomedical applications. Currently, in fact, optical methods are successfully used to map the regional varying material properties of biological structures thus allowing to gain an important insight into the mechanics of healthy and diseased tissues and organs. Nevertheless, the full potential of optical methods is still limited by the inherent complexity in terms of shape and material composition/distribution of most biological structures. To perform an accurate inverse mechanical characterization, in fact, it is of foremost importance to test the biological structure in its native shape under reproduced physiological load/boundary conditions. This requirement introduces a series of challenges that fail to be treated with traditional approaches and push towards the development of specially-designed measurement methods.

A first problem occurs whenever the measurement involves largely deformed images such as those obtained from two angled-views of complex-shaped parts (e.g. in lower limbs studies) or from an inadequate temporal sampling of fast- or slow-evolving phenomena (e.g. in growth and remodeling studies) over a large range of deformation. A further frequent issue is represented by the need to get time-resolved information over the full 360° surface of complex-shaped parts and/or to process sets of images obtained from different video-systems at different time and under different experimental conditions.

This talk aims to give an overview on problem-specific experimental protocols based on Fringe Projection (FP) and Digital Image Correlation (DIC) that have been recently developed to collect dense sets of 3D shape and deformation data on complex biological parts. Illustrative examples of application to the in-vitro testing of natural and synthetic structures of biomedical interest are given presenting experimental data collected with standard stereo-DIC, hybrid DIC-FP methods, multi-camera and panoramic DIC systems.