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STRAIN RECONSTRUCTION FROM STEREO DIC MEASUREMENTS BASED ON SPACE-TIME DIFFUSE APPROXIMATION

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Full-field measurements are nowdays widely used during mechanical experiments, in particular thanks to digital image correlation. Their richness offers new possibilities in terms of identification of material behaviour. When it comes to the qualitative understanding of damage as well as to some identification strategies, the required quantity might be the strain, whereas only the displacement is most often measured. This implies a numerical differentiation step, either explicit or not, which requires the estimation of the gradient of noisy data.

Special attention is to be paid to this step in order to control reconstruction error and several aproaches have been proposed [1]. In this framework, we are studying approximation methods, where the two points to adress are the choice of the approximation basis and the choice of a local or global formulation. It appeared in previous studies [2] that either the approximation basis or the formulation is to be local in order to yield relevant strain fields, and a diffuse approximation scheme is therefore proposed [3], first for $2D$ DIC data. The proposed reconstruction tool actually helped improving the understanding of damage in $3D$ composites [4]. Then, in order to improve the spatial resolution, the reconstruction tool has been extented to $3D$ filtering for space-time filtering purposes [5].

In the case of $3D$-DIC (understood as DIC on $3D$ surfaces), the stereocorrelation softwares usually propose reconstruction tools to compute the strain field from the measured displacement field (e.g. [6]) but their use is limited to the options proposed and the insight on the methods is often limited. We therefore wish to adapt our diffuse approximation tools to the case of $3D$ DIC, for two purposes: the understanding of the reconstruction step and the use of the efficient $2D$ and $3D$ tools previously developed. As a consequence our reconstruction strategy of the tangent strain tensor has the following keypoints:

1. in order to keep the reconstruction on a regular grid of data points, the derivatives

are estimated with respect to the CCD-plane coordinates (and not the real world coordinates);

2. the gradient of the position of the data points is estimated in order to get both a local basis and the jacobian matrix of the CCD plane-realworld transformation;

3. the gradient of the displacement is estimated, then turned in the local basis and finally combined with the jacobian matrix in order to get the real world tangent strain tensor, in either small or large deformation.

Once the method is presented, it is studied in terms of reconstruction accuracy and choice of the reconstruction parameters. The direct adaptation of the previous tools allows to perform a space-time filtering of the $3D$ DIC data, leading to an improved spatial resolution of the strain field. It is then first applied to torsion tests on $3D$ carbon/epoxy composites, in order to detect local non-linearities, through an approach coupling DIC with other measurements such as acoustic emission. A second example is then proposed, dedicated to the study of the motion of the human face during *in vivo* tests.

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