Quantification of resolution and spatial resolution in local and global DIC

P. Lava[1a], L. Wittevrongel[1], D. Debruyne[1] and F. Pierron[2]

[1]Department of Materials Engineering, University of Leuven, Gebroeders De Smetstraat 1, B-9000 Gent, Belgium, [2]University of Southampton, Southampton SO17 1BJ, UK

[a]pascal.lava@kuleuven.be

Abstract. Optical full-field measurement methods such as Digital Image Correlation (DIC) are currently extensively applied to study the deformation characteristics of a wide range of materials. The measured displacement and strain fields, however, should always be interpreted in view of the obtained resolution (noise floor) and spatial resolution. Indeed, local (or subset-based) approaches heavily rely on the adopted regularization settings (subset size, step and strain smoothing kernel) whereas global algorithms are influenced by the applied mesh to a large extent. In this contribution, the aim is to present a methodology to objectively compare both approaches in terms of resolution and spatial resolution. Finally, a comparison will be made to a novel adaptive global DIC approach that is less dependent on the initial user input.

Introduction

Digital Image Correlation (DIC) is gradually becoming a standard tool in experimental mechanics, for both industry and academia. Results of the measurement technique, however, are mostly used qualitatively (detect hotspots, check boundary conditions, visualize some deformation phenomena), but there are still only very few examples of quantitative use of such measurements (to validate models or identify constitutive behaviour etc.) This is due to the fact that current implementations of DIC are highly dependent on the initial user input. Indeed, a subdivision of DIC algorithms is usually made in terms of local [1] and global [2] DIC. Local DIC, or subset-based DIC, heavily relies on the adopted subset, step and eventual strain smoothing kernel [3,4]. Global DIC, on the other hand, is highly influenced by the mesh density.

Generally, for both methods a trade-off between resolution (noise-floor) and spatial resolution must be made. Indeed, as indicated in Fig. 1, a higher subset size , e.g. will largely decrease the noise-floor of a strain measurement since more smoothing is adopted, at the expect however of a decreased spatial resolution. The example shown is the result of an uni-axial tensile test on a 5-harness satin weave carbon/PPS thermoplastic composite where specific stress concentrations occur at the cross-over points (where warp and weft yarns are interlacing) [5]. Equivalently, larger element sizes will have an equivalent effect. It is, however, not clear yet how both methodologies can be mutually compared in terms of resolution vs. spatial resolution performance. Simply considering the same element and subset dimensions is much too drastic since the nodal values of the element are interconnected by its neighbouring elements.

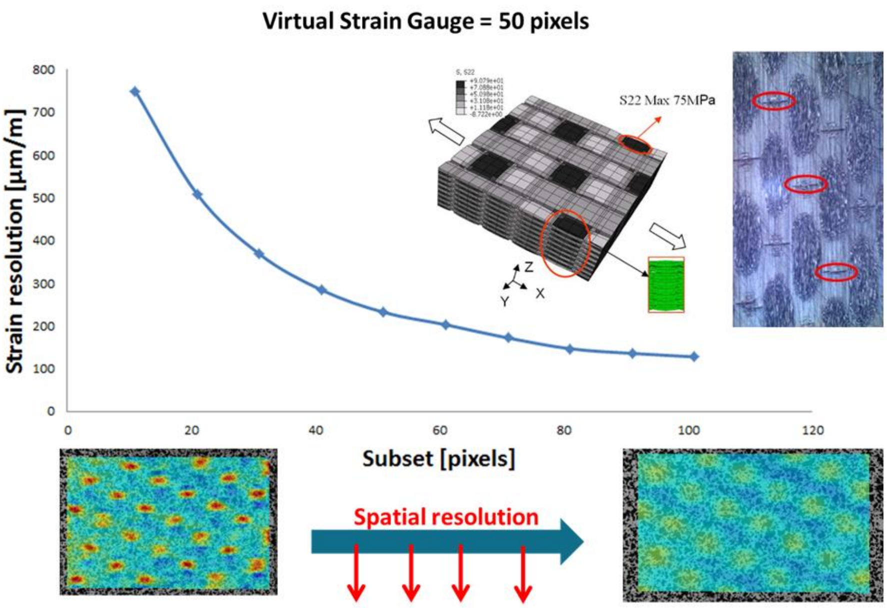

Fig. 1: Impact of subset size on strain noise floor and spatial resolution.

In this contribution a more honest comparison will be performed based on the reconstruction of a sinusoidal wave at various frequencies. A comparison will be made to a novel adaptive global DIC approach [6]. It is important to stress that the algorithmic comparison is pure, since all the compared methodologies are implemented on the same platform, relying on identical interpolators and image processing. Only the correlation part differs.

The purpose of this presentation is to make people aware that DIC data must be treated with care and additionally to invoke a discussion on global and local DIC methodologies. Results are still preliminary and accordingly cannot yet be published in this abstract.

References

[1] M. A. Sutton, J.J. Orteu, and H.W. Schreier : *Image correlation for shape, motion and deformation measurements*, Edited by Springer, New York (2009).
[2] G Besnard, F. Hild, and S. Roux: Experimental Mechanics 46 (2006), p. 789-803.
[3] P. Lava, S. Cooreman and D. Debruyne: Opt. Lasers. Eng. 48 (2010), p. 457-468.
[4] M. Bornert et al.: Experimental Mechanics 49 (2009), p. 353-370.
[5] P. Lava et al: Opt. Lasers. Eng. 51 (2013), p. 576-584.
[6] L. Wittevronge. P. Lava, S.V. Lomov, and D. Debruyne: Experimental Mechanics (2014), DOI 10.1007/s11340{014{9946{3,