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METROLOGICAL QUALIFICATION OF COMMON FILTERING METHODS FOR PROCESSING DIC MAPS

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ABSTRACT

In the present work, seven methods used to “denoise” or “filter” Digital Images Correlation (DIC) maps are compared for 2D DIC. These approaches can be classified in: common image filters (Gaussian and Median filter), frequency filter (Lowpass Butterworth and Holoborodko), local polynomial fitting (Savitzky-Golay filter and cubic splines) and Finite Element mapping. The proposed methodology to compare the enhancement of these methods is based on the star pattern test cases proposed in the DIC Challenge 2.0 [1]. Depending on the filter, significant enhancement of the displacement and strain maps are obtained

Keywords: digital images correlation, digital filters, metrology.

INTRODUCTION

In the last few years the Digital Images Correlation (DIC) community has been active to better understand and quantify the metrological aspects of DIC measurements. In particular, a first DIC challenges have been proposed. The second “DIC challenge 2.0” [1] concerning 2D DIC enables to better understand and quantify the tradeoff between spatial resolution and measurement resolution when using DIC.

While it is very usefull to better understand the functioning of DIC, full field measurements are often used in order to characterise or identify some material properties from heterogeneous tests. To that end some approaches require displacement fields whereas others needs strains. And, it is well known that the measurements errors may biased the identification results [2]. Certain approaches aim at decreasing the noise sensibility internally, however, optimal methods do not exist in the general case of nonlinear constitutive laws. So, practitioner commonly try to enhance full field measurements with “filters” prior to their use in inverse methods. It is indeed clear that spatial filtering of DIC results will influence the tradeoff between spatial resolution and measurement resolution. However, the effect of different filters onto this tradeoff is not straightforward to quantify.

METROLOGICAL QUALIFICATION OF THE FOLKI-D SOFTWARE

Firstly, the FOLKI-D DIC code [3] is metrologically qualified using this methodology defined in the DIC Challenge 2.0. This software proves to behave in a very similar way to other codes with affine subset shape functions. Figure 1 compares the measurement resolution versus the spatial resolution for several DIC software with respect to the FOLKI-D software. For both displacement and strain computation the FOLKI-D software has performances very similar to the ones of software using a similar approach.

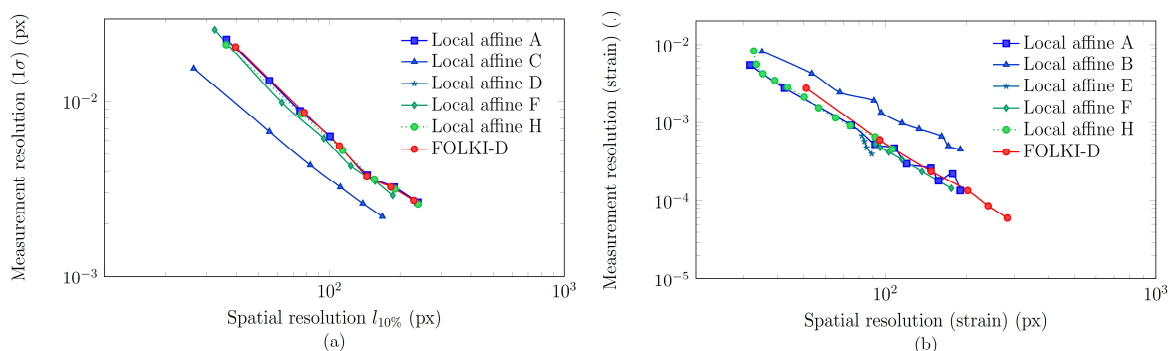


Fig. 1 – Measurement resolution vs spatial resolution for several local DIC software with affine grey levels interpolation with the FOLKI-D software - (a) displacements - (b) strain.

METROLOGICAL QUALIFICATION OF THE FILTERS

Then, the same framework has been used to investigate the effects of some filtering approaches onto DIC results. While there are many approaches in the literature, the present work focuses onto seven filtering methods. These approaches can be classified in: common image filters (Gaussian and Median filter), frequency filter (Lowpass Butterworth and Holoborodko), local polynomial fitting (Savitzky-Golay filter and cubic splines) and Finite Element mapping. They are believed to be representatives of filtering techniques used in most applications.

Here, only the results obtained with the most enhancing methods are compared with those of other codes from the DIC Challenge 2.0 in Figure 2. It can be seen that depending on the type of filters used a significant improvement in the metrological efficiency can be obtained.

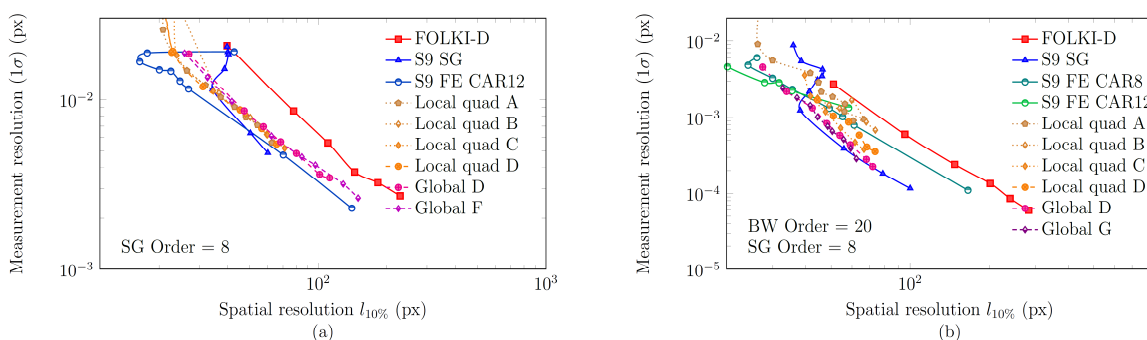


Fig. 2 – Comparison of the enhanced measurement resolution vs. spatial resolution with results from the DIC Challenge 2.0 - (a) - for displacements - (b) - for strain. The Savitzky-Golay filter and differentiator are denoted (SG), the FE mapping is denoted (FE), other results come from [1].

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