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A DOMAIN DECOMPOSITION APPROACH FOR DIGITAL IMAGE CORRELATION BASED IDENTIFICATION OF LOCAL ELASTIC PARAMETERS

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The robust and low-cost identification of local material parameters in heterogeneous continua is a key step for accurately feeding advanced modeling and simulations of complex microstructures. Classical testing procedures that rely as much as possible on homogeneous mechanical fields only give access to averaged quantities at the scale of the specimen. A way to experimentally obtain more local information is to capture the heterogeneous kinematics (typically the heterogeneous displacement field) by the use of Digital Image Correlation. Image based techniques are very appealing due to three features: (1) they do cover a wide variety of scales (nano tomography, AFM, SEM, microscopy, digital cameras), making them useful at almost all engineering scales (2) they are "non-contact" measurement techniques, and sensitive bodies can be observed *in-situ* with minimal perturbations (3) they strongly take advantage of the heterogeneity of the displacement. This makes them the perfect tool for studying heterogeneous structures. The challenge is then to design a relevant inversion technique to recover the local material parameters from this enriched information.

Several identification methods have been developed including the finite element updating method (FEMU), the virtual fields method (VFM), the constitutive equation gap method (CEGM) [2], the equilibrium gap method and the reciprocity gap method (RGM) (see [1] for a review). We focus here on the CEGM [4] which, unlike other methods, considers the constitutive equation in a weak manner as a guiding norm for the identification.

First, we will discuss about the local identification of elastic parameters. We propose a technique to uncouple the solution process into a global optimization over a specific stress space so called the "solution stress space", followed by a local estimation of the material parameters in a strong manner at any point of interest in the domain. The proposed '"constitutive compatibility technique", leads to two major advantages: (1) a drastic reduction in the computation cost by transforming the global coupled functional into a global functional depending only on stresses followed by direct local constitutive identification (2) an ability to easily determine points where the identified parameters are non-unique. We develop the concept of constitutively compatible stress fields to finally introduce the formulation of the constitutive stress compatibility method (CCM) for the case of isotropic materials. The method is validated by errors and convergence analysis.

Second, we introduce a domain decomposition technique in the CCM framework [3]. While plenty of work has been carried out on domain decomposition for forward problems, there is at our best knowledge no literature related to the development of domain decomposition technique specifically designed for DIC-based inverse problems. To address this, this article describes the development of the domain decomposition CCM for more computationally efficient identification in the case of larger problems.

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