On uncertainty transfer in full-field identification methods,

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Résumé

As we have seen in the previous lecture, Digital Image Correlation (DIC) is based on an inverse method. Consequently, some of the measurement noise will be transferred from the camera sensor to the displacement measurement. Identification methods such as Finite Element Method Updating (FEMU), the Virtual Fields Methods (VFM) and others are also inverse methods. Consequently, they also transfer some of the noise from their input, i.e. the displacement field, to the output, i.e. the material parameters. However, typically, DIC also confers some correlation to this noise. In many cases, this correlation can be expressed clearly in the form of the covariance matrix. In this lecture we will see how to use this covariance matrix to our benefit to improve our identification strategy.
We will first discuss the trivial method, namely, FEMU on a real application (1). This will introduce the mathematical framework that will be used throughout the course and allow the discussion of techniques that are found in the majority of cases. It will discuss the concepts of residual fields, sensitivity fields, Hessian matrices and Tikhonov regularization. Moreover we will discuss how to merge multiple data sources that may or may not be full-field and or asynchronous in time.

Next we will move to a purely academic case of the identification of the average strain in a one dimensional displacement signal. This 1D case allows a detailed illustration of important concepts like the covariance matrix, the optimal extractor, and the implications of nested inverse methods.

Finally, the course will finish with a panorama of recent cases from the literature. Including the discussion on various alternative identification methods like, the VFM, Integrated-DIC, and others and discuss how they can be unified in a single general framework (2). Identification methods are often very sensitive to seemingly unimportant choices. Seeing how fellow researchers have addressed the many choices that are involved in full-field identification will hopefully inspire future identification campaigns.

(1) Neggers, J., Mathieu, F., Hild, F., & Roux, S. (2019). Simultaneous Full-Field Multi-Experiment Identification. *Mechanics of Materials*, *133*
(2) Roux, S., & Hild, F. (2020). Optimal procedure for the identification of constitutive parameters from experimentally measured displacement fields. *International Journal of Solids and Structures*, *184*, 14–23

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