Fading regularization method: A tool for processing incomplete experimental data in mechanics

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Abstract

The limits of the current experimental setup generate several difficulties, such as measurements carried out only on a part of the sample and possibly incomplete or noisy boundary conditions. The difficulties give rise to identification problems which can be considered as inverse problems.

The fading regularization method was previously introduced to solve Cauchy problems associated with the Laplace equation [1] or the Lamé equation [2]. This inverse method is based on the idea of looking, among all solutions of the equilibrium equation, for those that fits the best the boundary conditions available on a part of the boundary. The resolution of the inverse problem is reduced to a sequence (fixed point algorithm) of constraint optimization problems. The solution thus computed does not depend on a regularization coefficient, verifies the equilibrium equation and is stable with respect to the noise on the data since these are recomputed to be compatible. This method is, in particular, able to deblur the given noisy data and can be implemented by using the finite elements method (FEM).

We present the extension of the combination of the fading regularization method with the FEM to identification problems from partial full-field measurements. The measurements are only available on a central zone of the specimen. With our algorithm, we reconstruct the field, solution of the equilibrium equation, in the whole domain and the boundary conditions inaccessible to measurements. The technique naturally gives rise, in the central zone where the measurements are available, to a residual composed of both the measurements noise and of the eventual equilibrium gaps. The method is validated with synthetic data but is also applied to experimental situations using displacement fields obtained by Digital Images Correlation. The application to these measurements highlights the performance and the robustness, with respect to noisy data, of the method.

References

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