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Inverse problems

Foreword

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Inverse problems are concerned with the exploitation of observed data and assumed physical models for estimating physical quantities that are "hidden" (e.g. finding flaws inside a structure using the measured response of the flawed system to a given probing excitation). The "hidden" quantities are often (finite- or infinite-dimensional) parameters of the physical model describing the system under examination.

Inverse problems arise in all branches of physics and engineering. Understanding their fundamental properties and solving them numerically is facilitated by the well-developed mathematical theory of ill-posed problems, initiated about fifty years ago. Moreover, the considerable advances accomplished over roughly the same period of time in physical modelling, solution algorithms and computational platforms have considerably broadened the scope and complexity of the applications of inversion methodologies. Hence, in addition to defining a very active and multidisciplinary research area, to which several international journals are devoted, the concepts and methods of inversion now also feature prominently among the tools available to engineers.

In the field of solid mechanics, within which this special issue is set, inverse problems typically arise in medical and seismic imaging, non-destructive material characterization, and structural health monitoring. This issue presents a snapshot of recent research carried out on these (and related) topics, in the form of eleven articles written by contributors from several countries (Brazil, Canada, Chile, France, Greece, Italy, Turkey, USA). While this set of articles certainly does not cover exhaustively the field, it touches upon many aspects, such as:

- Mathematical analysis of identifiability (Morassi and Rosset);
- Exploitation of full-field data (Santhanam et al., Leiderman et al., Massard et al., Sinkus et al., Yuan and Guzina);
- Wave-based inversion (Askan et al., Bonnet, Borcea et al., Yuan and Guzina);
- Imaging of heterogeneous media (Santhanam et al., Askan et al., Borcea et al., Leiderman et al., Massard et al., Sinkus et al.);
- Non-iterative identification approaches (Yuan and Guzina, Bonnet);
- Algorithmic and numerical issues (Askan et al., Gutiérrez and Mura);
- Medical-oriented research (Santhanam et al., Leiderman et al., Sinkus et al., Yuan and Guzina);
- Applications in geophysics (Askan et al.);
- Bayesian approach (Massard et al.);
- Uncertainty modelling in structures (Louf et al.).

I wish to thank all the authors of the above-mentioned articles for their contributions to this issue, and express the hope that this selection will prove helpful for furthering the research in inverse problems in solid mechanics and for providing a useful starting point to newcomers in this field.

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