

Regularization for seismic sources inversion from interferometric data

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Abstract

In this talk, we deal with the inverse wave source problem from interferometric measurements. Interferometric data are made of correlations of the wave field recorded at different receiver positions and frequencies. In some configurations, these correlations are stable with respect to phase shift due to some wave-speed uncertainties inside the medium. Hence, trying to recover sources from this data is of large interest. Some early works [2, 1] describe techniques of "interferometric migration", inspired by the classical Kirchhoff migration technique, to form an image of the source from this data. A re-focalization phenomenon is observed and the obtained image can be much better than the one obtained by the Kirchhoff method.

The full inversion problem from interferometric measurements is challenging as it reads as a large system of quadratic equations:

$$(Ax)_i \overline{(Ax)_j} = b_i \bar{b}_j, \quad \forall i, j \quad \text{s.t.} \quad E_{ij} = 1 \quad (1)$$

where A is the wave propagation linear operator, b is the data vector and E is a symmetric boolean matrix that select the cross-correlations to be considered. In the sense of least squares, the objective function becomes a non-convex 4th-order polynomial:

$$J(x) := \sum_{ij} E_{ij} |(Ax)_i \overline{(Ax)_j} - b_i \bar{b}_j|^2. \quad (2)$$

Nevertheless, in this work, we present simple conditions on E and b , based on graph theory, to ensure that the interferometric inversion problem is solvable. The presented results extend the stability estimates for interferometric recovery from [4, 3].

The minimization of this objective function combined with ℓ^1 -penalization, provides excellent reconstructions from data corrupted by a large phase uncertainty. In various numerical applications, we illustrate the robustness of this method.

References

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