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Multi-frequency MUSIC for electrical impedance tomography

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Abstract: Electrical impedance tomography is an imaging modality that recovers information on the conductivity distribution inside a body from electrostatic measurements on its boundary. This is a nonlinear severely ill-posed inverse problem.
Some years ago the MUltiple SIgnal Classification (MUSIC) algorithm from signal processing has been suggested as a means for detecting small focal inhomogeneities and anomalies in an otherwise known conductivity distribution from electrostatic measurements, and also a rigorous justification of the method for this particular application has been provided. The basic assumption of this analysis is that voltage measurements generated by sufficiently many linearly independent spatially distributed boundary currents are available.
When this is not the case for whatever practical reasons one may alternatively consider to leave the quasi-stationary regime and apply AC currents of different, somewhat larger, frequencies to generate linearly independent boundary excitations. For example, this was suggested by Scholz [1] for the so-called TransScan TS2000, a commercial device for mammography screenings that only generates a single spatial boundary current distribution, but can operate at various frequencies up to the kHz regime.
We discuss the potential and the limitations of a MUSIC-type reconstruction method for this setting in dimension two: While the position of a single obstacle will always be detected with sufficiently many different driving frequencies, the identification of multiple obstacles may fail for certain exceptional geometrical configurations. We will also show that, generically, the given measurements allow the determination of the conductivities and permittivities of the conductivity inhomogeneities to facilitate their classification. Finally, we provide arguments to support the claim that it should also be possible to extract shape information from these data.
This talk is based on joint work with Martin Hanke (Universität Mainz, Germany).

[1] B. Scholz, Towards virtual electrical breast biopsy: Space frequency MUSIC for transadmittance data, *IEEE Trans. Med. Imaging* **21** (2002), pp. 588–595.