Electric impedance tomography with resistor networks

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Electric impedance tomography consists in finding the conductivity inside a body from electrical measurements taken at its surface. This is a severely ill-posed problem: any numerical inversion scheme requires some form of regularization. We present inversion schemes that address the instability of the problem by adaptive parametrization of the unknown conductivity. Specifically, we consider finite volume grids of size determined by the measurement precision, but where the node locations are determined as part of the problem. A finite volume discretization can be thought of as a resistor network, where the resistors are essentially averages of the conductivity over grid cells. We show that the model reduction problem of finding the smallest resistor network (of fixed topology) that can predict meaningful measurements of the Dirichlet-to-Neumann map is uniquely solvable for a broad class of measurements. To determine the unknown conductivity, we use the resistor networks to define a nonlinear mapping of the data, that behaves as an approximate inverse of the forward map. Then, we propose an efficient Newton-type iteration for finding the conductivity, using this map. We also show how to incorporate a priori information about the conductivity in the inversion scheme.