Regularization by means of the total variation primal dual interior point method applied to the electrical resistance tomography

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Abstract: - Classical electrical resistance tomography (ERT) is an imaging modality in which the internal conductivity distribution is reconstructed based on the known injected currents and measured voltages on the surface of the object. We propose in this paper an application of the ERT to specify defects in modern materials, such as carbon fiber honeycombs. In this paper we introduce the surface and the contact conductivities vector $\boldsymbol{\sigma}$. As the testing of large structures requires good stability of the inverse problem, we introduce effective regularization known as Total Variation primal dual interior point method (PD – IPM). We minimize

$$\Psi(\boldsymbol{\sigma}) = \frac{1}{2}\left\|h(\boldsymbol{\sigma}) - \boldsymbol{d}\right\|^2 + \alpha TV(\boldsymbol{\sigma})$$

where $$TV_\beta = \sum_{all\ edges} \int \left|\mathrm{grad}\,\boldsymbol{\sigma}\right| d\Gamma = \sum \sqrt{\left\|\boldsymbol{L\sigma}\right\|^2 + \beta}.$$

Introducing to $\boldsymbol{\sigma}$ a dual variable $\boldsymbol{x}$, the iteration process is updated by solving the following mutual system recovering $\boldsymbol{\sigma}$

$$\begin{bmatrix} J^T J & \alpha L^T \\ \overline{F} L & -E \end{bmatrix} \begin{bmatrix} \delta\boldsymbol{\sigma} \\ \delta\boldsymbol{x} \end{bmatrix} = -\begin{bmatrix} J^T\left(h(\boldsymbol{\sigma}) - \boldsymbol{d}\right) + \alpha L^T \boldsymbol{x} \\ L\boldsymbol{\sigma} - E\boldsymbol{x} \end{bmatrix}$$

The details will be given during the poster presentation.

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