Electrical impedance tomography

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MODELLING WITH 2.5D APPROXIMATIONS

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Abstract text: a. Introduction

In EIT, the 2.5D approximation is a method of reducing a 3D forward modelling problem to a 2D problem. We show that (a) the 2D modelling errors can be important, particularly for half-space like configurations (breast and prostate imaging, for example), and (b) that due to stimulus pattern sensitivity, the finite limit in the z-direction was only relevant out to a dipole spacing beyond the electrodes, at which point truncation errors were negligible. Presented in this work, is a new 2.5D forward solver appropriate for use with the new EIDORS iterative Gauss-Newton solver. We show efficient implementations of adjoint and FEM system matrix-derivative methods.

b. Objectives

We aim to identify what model parameters lead to measurement error when a 2D model is incorrectly selected for a 3D problem. We propose the 2.5D forward solver as a suitable solution for some scenarios.

c. Methods

Many 2D and 3D half-space models were generated. Electrodes were placed uniformly along the top surface in a colinear array. The model generation was parametrized for: number of electrodes, boundary distance, mesh density, electrode diameter, and electrode contact impedance. An analytic model was also constructed. Convergence was observed or the parameter was determined to not contribute significantly to measurement error.

A 2.5D forward solver was constructed which utilized the 2D model geometry, but constructed a Fourier Transform in the z-direction. The forward problem was then solved as multiple two-dimensional forward problems and numerically integrated to construct the inverse Fourier Transform.

d. Results

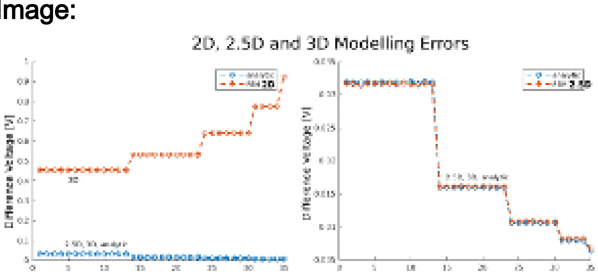
Both the 2D & 3D models solutions converged with boundaries x * 3 d, y * 2 d, and (for 3D) z * 2 d, for array length d, where the electrode array in the x-direction. 2D measurements always had significant errors with respect to the 3D solutions. Other parameters did not contribute significantly to forward modelling errors.

The 2.5D forward solver was found to give correct results. Further algebraic manipulations should lead to computational efficiencies.

e. Conclusion

Two-dimensional modelling errors can contribute to significant reconstruction errors. The 2.5D forward solver is an important tool for EIT and can contribute to better quality reconstructions.

Image:



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