Simple FEMs aren't as good as we thought:

*experiences developing EIDORS v3.3*

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What is EIDORS?

Open Source Collaborative software for algorithms

Goal: Software community

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Web Site: eidors.org

EIDORS: Electrical Impedance Tomography and Diffuse Optical Tomography Reconstruction Software

EIDORS: Download

Released Versions
- Download latest released version
  eidors-v3.3rc1.zip
- Download All Versions
  EIDORS download

Developer (latest) Version
- Browse Developer Versions
  Browse CVS
- Read only access to Developer Version
  Read-only, worldwide access is available via CVS using Anonymous C:
cvs -d:pserver:anonymous@eidors3d.cvs.sf.net:/cvsroot/eidors
- Access Developer Version
  Read-write, access is available via CVS for registered developers. To
Features

• Interfaces to FEM generation tools:
• New algorithms (and faster old ones):
  – Electrode movement solver
  – Kalman filter and Temporal solvers
  – Dual model solvers
  – Total Variation PDIPM
  – Iterative CGLS
  – Better caching and memory use
• Data repository
• Improved graphics and extensive tutorials
Contributed EIT Data:

Authors:  Inéz Frerichs, Peter A. Dargaville, Taras Dudykevych, Peter C. Rimensberger

Date:  2003

Brief Description: The measurements were performed in the same pig after induction of acute lung injury with surfactant (p1130122.get). Both measurements were acquired at a rate of 13 scans/s, and data was acquired during an incremental and decremental PEEP trial (stepwise increase).


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Format: Data are in *get files encoded in a zip file

Methods: Pig torso. Single plane of 16 Electrodes numbered clockwise, with electrode #1 at the

Data: Data (zip format)

Fig. 3 Tracings of local relative impedance change (right top, dark thick lines) during the PEEP manoeuvre in four regions of interest in the right

Electrical impedance tomography

Regions of interest

Acute lung injury
Dual Models Tutorial
Dual Model Examples

Corresponding Meshes

Coarse Model

Fine Model

Reconstruction onto a pixel grid

2½ D reconstruction
FEM problems

- EIT generally uses simple first-order tetrahedral models
- We’re pretty relaxed about it
Why so relaxed??

Difference imaging – simulate a moving ball

Each element is filled with fraction of target

Reconstructions are fine
What’s the problem?

Correct simulation: remesh at each target

Geometry changes with targets

Difference imaging with changing FEM shows the model accuracy effects
What’s the problem?

Images are awful

2000 elements

Unless you use fine FEMS

10000 elements
It’s worse in 3D

Numerical instability??
Problem: saline tanks have less noise

2D 2k elems

3D 178k elems

Tank IIRC Korea EIT system
Discussion

EIDORS v3.3

- Use dual models (esp. for static imaging)
- Please contribute data

FEM Meshes

- Simple FEMs are trickier than we thought
- Recommend: 10k elems for 2D
- 1M elems for 3D