Rotational electrical impedance tomography using electrodes with limited surface coverage provides window for multimodal sensing — article supplementary

Mari Lehti-Polojärvi[1*], Olli Koskela[1*], Aku Seppänen[2], Edite Figueiras[3] and Jari Hyttinen[1]

[*] equal contribution

[1] BioMediTech Institute and Faculty of Biomedical Sciences and Engineering, Tampere University of Technology, Tampere, Finland

[2] Department of Applied Physics, University of Eastern Finland, Kuopio, Finland

[3] International Iberian Nanotechnology Laboratory, Braga, Portugal

E-mail: `mari.lehti@tut.fi`, `olli.koskela@tut.fi`

Abstract. This document briefly describes the files included in the supplementary material of the article. The files are functional codes used to create the numerical simulations and the conductivity reconstructions in the article. Also an example usecase is included.

Files have been implemented with Mathworks MATLAB R2014a or newer and EIDORS version 3.8 with Netgen.

1. Before running the files

These supplementary codes assumes that user has downloaded and unzipped EIDORS from the website (http://eidors3d.sourceforge.net/). This code has been implemented using EIDROS 3.8 with Netgen (http://prdownloads.sf.net/eidors3d/eidors-v3.8-ng.zip). Also user is required to have started EIDORS before running the example file `MAIN.m`. Starting of EIDORS is done by running `startup.m` from YOUR PATH TO EIDORS\eidors-v3.8-ng\eidors\.

2. MATLAB code files

- `MAIN.m` (script)
  Example usecase of the included functions.
- `RotationalEITmeasurement.m` (function)
  Function simulates the rotational data acqusition. Computes EIDORS forward problem for the given geometry and conductivity distribution in all rotational positions.
- `rotational_inv_solve_diff_GN_one_step.m` (function)
  Computes the inverse problem using in rotational case.
- `CreateMesh.m` (function)
  Function creates EIDORS structure and mesh for a given number of electrodes and their positions.
- `CreateRotationMatrix.m` (function)
  Creates rotational mapping matrix M for counterclockwise rotation direction
- `CreateRotationMatrixCW.m` (function)
  Creates rotational mapping matrix M for clockwise rotation direction. Rotations are in opposite directions in forward and inverse problems. Hence if forward problem rotation is clockwise, rotational mapping M is to be constructed counterclockwise.
- `EightElectrodesAllCombinations.m` (function)
  Returns the EIDORS data structure for simulation and measurement patterns. Returned structure includes all possible patterns of simulation and measurement.
- `ElemNodesPolarRotation.m` (function)
  Computes rotation of node coordinates for a given angle. This function is used in RotationalEITmeasurement for rotation of the conductivity distribution inside the mesh, and in CreateRotationMatrix for construction of mapping matrix M.
- `AddTwoComponentNoise.m` (function)
  Includes additive noise to given measurement data. Noise is composed of two components: the first is proportional to the largest measured amplitude and the second component is proportional to each measurement separately.

3. Tip's for the user: how to start working with your own configuration

This section presents some of the parameters in MAIN.m file and the purpose is to provide the user some tips of how to start modifying the code towards his or her own preference.

- `electrode positions`
  List of electrodes and their positions. The number of resulting electrodes is the number of given positions (in degrees) in this list. Electrodes are numbered in the same order as listed. Position refers to center of the electrode.
- `diam`
  Diameter of the numerical phantom or with real data inner diameter of the measurement tank.
- `elect size`
  Tangential width of the electrodes in the same units as diam.
- `max mesh elem size*`
  Sets the maximum element sizes for the finite element mesh. Can be controlled separately for the inner part (the (semi-)solid sample), aqueous rim between the sample and the electrodes, and elements touching the electrodes.
- `outerlayer width percent`
  Width of the aqueous layer in per cents of the radius of the sample.
- `thetas`
  Rotational measurement positions in counterclockwise order and in degrees.