**Forward Preparation**

See ‘D:\Depth electrode github example\Rat\_055\Forward Preparation on harddrive or ‘eit-nas/shared/Mayo Depth electrode github example\Rat\_055\Forward Preparation on eit-nas for example of output from various steps

Instructions for installing PEITs can be found here

https://github.com/EIT-team/PEITS/wiki/Installing-PEITS

1. **Find cortical electrode positions**

Overview

Finds the coordinates of the electrode arrays on the surface of the mesh. It requires the centre position of a couple of electrodes in the first row in order to get the correct angle at which they were placed on the brain. The rest of the electrodes are found by assuming a fixed distance along the surface of the mesh according to the electrode design.

Code/files required

1. generate\_array\_cortical1.m
2. generate\_array\_cortical2.m
3. put\_cortical\_pos\_together.m
4. Mesh\_rods\_ratXX.mat
5. dubs3\_2.m, paint\_electrodes.m (from supersolver branch github)
6. electrode\_nodes\_cortex (extra useful for visualizing in vtk)

Input required

In generate\_array\_cortical1.m and generate\_array\_cortical2.m

1. Line 1 – change to point to correct mesh and mesh location
2. Line 2-5 – put in coordinates of electrode array
   * For cortical 1, the first entry of act\_pos should be electrode 1 (see cortical1.pdf). The second and third would be any of 2,3,4 or 5
   * For cortical 2, the first entry of act\_pos should be electrode 1 (see cortical2.pdf). The second and third would and of 2,3, or 4

Output

1. cortical\_pos1.mat (from generate\_array\_cortical1.mat)
   * position of all electrodes on first array
2. cortical\_pos2.mat (from generate\_array\_cortical2.mat)
   * position of all electrodes on second array
3. Run put\_coordinates\_together.m to concatenate the files.
4. Get out pos\_cortex.mat: position of cortical electrodes with numbering according to recording and injecting maps (pos2 followed by pos1)

Notes

1. If you don’t have central position of electrode 1 change coordinated accordingly by adding in lines 27 and 28
2. If you don’t have position of first electrode then you have to use another electrode as reference and first compute the expected location of this first reference electrode before proceeding. See lines 65-72
3. The more anterior array electrode2 has been defined to be the first one for the forward solver therefore it is put in first when concatenating (slightly confusing as when recording this was the 33-64 channels, this has been accounted for in recording\_map.mat so is all handled).
4. **Find depth electrode positions**

Code/files required

1. electrodes\_for depth\_RatXX\_3mm.txt

Notes

1. Read this into matlab and save as ‘pos\_depth.mat’
2. **Map injection protocol**

Overview

Map the depth protocol and cortical protocol used in experiments to the electrode assignment used in forward solution. Probes on anterior depth probe are in positions 1-16, probes on posterior depth probe are 17-32 (N.B. these are mirrored as probes were facing eachother in experiments). Electrodes on more anterior cortical array are 1-20, and electrodes on posterior placed cortical electrode are 21-47

Code/files required

1. map\_protocol\_depth.m
2. injection\_map\_depth.mat
3. map\_protocol\_cortex.m
4. injection\_map\_cortex.mat
5. Protocol\_depth from experiments
6. Protocol\_cortex from experiments

Input

1. Change files to load in correct protocol\_depth and protocol\_cortex from experiments

Output

1. Prot\_map for depth and cortical protocols

Notes

1. If you change the way the positions of electrodes are defined or the electrodes themselves the map needs to be changed
2. The cortical protocol has 32 added as the depth electrodes have been assigned in position 1-32 and cortical after.
3. **Find electrode nodes for depth protocol for forward solver**

Overview

Finds nodes for depth electrodes when using shunted protocol. The nodes from all the connected electrode contacts need to be assigned to the same electrode. This means that the forward solver actually only sees 26 electrodes in the depth for each protocol line. The prot\_map also needs to also be adjusted accordingly. This is all dealt with in this code. As the shunted electrodes vary between the protocols the same nodes cannot be used for every protocol. Therefore, the forward solver has to be solved separately for each protocol line.

Code/files required

1. electrode\_nodes\_for\_FS\_shunted\_protocol.m
2. removeisolatednode.m
3. dubs3\_2.m
4. Mesh\_rods\_ratXX.mat
5. Protocol\_depth\_mapped.mat
6. Pos\_depth.mat
7. Pos\_cortex.mat

Input

1. Change lines 1-8 to point to correct files
2. Change line 15 to correct name of Mesh

Ouput

1. electrode\_nodes\_mesh\_RatXX\_prtN
   * These are the nodes required for forward solver for each protocol (note you can see which ones are injecting in depth as they are 4 x the length of other electrodes)
2. prtN\_inj\_idx.mat
   * This is the protocol for each injection pair once the shunting in the forward has been accounted for (inj\_fwd2)
   * It also has the indices of where electrodes need to be reinstated later such that the normal numbering can be recovered (elec\_idx)
3. electrode\_nodes.vtk
   * so you can check nodes are assigned properly
4. pos\_prtN.mat
   * position of electrodes for each protocol

Notes

1. This is coded for the electrode configuration used and the four shunt injection. If this changes the code needs to be adapted
2. The figure at the end with waitforbuttonpress is a good check to make sure the nodes for injecting electrodes have been assigned properly
3. **Find electrode nodes for cortical protocol for forward solver**

Overview

This finds the nodes for the 32 depth electrodes and the 47 cortical electrodes. This is identical to the normal way the forward solver is run (with no shunting). These are required when running the forward solution for the cortical protocol.

Code/files required

1. electrode\_node\_for\_FS\_cortical\_depth.m
2. removeisolatednode.m
3. dubs3\_2.m
4. Mesh\_rods\_ratXX.mat
5. Pos\_depth.mat
6. Pos\_cortex.mat

Input

1. Lines 1- 8 – change to point to correct files
2. Line 11 – change to correct naming

Output

1. electrode\_nodes\_mesh\_RatXX\_cortex
   * These are the nodes required for forward solver for all depth and cortical electrodes
2. electrode\_nodes\_mesh\_RatXX\_cortex.vtk
   * vtk for checking
3. **Prepare files for depth protocol forward solution**

Overview

Converts mesh to .dgf format for forward solver. Also creates parameter file, protocol files, position files and electrode diameter files in format required for forward solver

Code/files required

1. prepare\_forward\_shunted.m
2. removeisolatednode.m
3. dune\_exporter.m
4. Mesh\_rods\_RatXX.mat
5. pos\_prtN.mat
6. prtN\_inj\_idx.mat

Input required

1. Line 1 – 7 – change so that code is pointing to correct files

Output

1. mesh\_RatXX.dgf
   * mesh in correct format for forward solver
2. electrode\_positions\_mesh\_RatXX\_prtN
   * coordinates of electrode positions for each protocol in correct format for forward solver (final position in each file is reference electrode)
3. electrode\_diameters\_mesh\_RatXX
   * diameter of all electrodes (this is not actually used as we use the node assignment approach but forward solver complains if it can’t see it so generate anyways)
4. protocol\_mesh\_RatXX\_prtN
   * protocol for forward solver for each protocol line. All measurements taken with respect to reference electrode 74
5. param\_mesh\_RatXX
   * Parameter file for forward solver.
   * Make sure line 6 says ‘electrode.use\_node\_assignment:true’ and line 18 says ‘fem.assign\_conductivities:false’

Notes

1. Transfer all the files output in addition to the electrode\_nodes\_mesh\_RatXX\_prtN from step 4 into the ‘PEITS\_root/PEITS/data’ on workstation
2. **Prepare files for cortical protocol forward solution**

Overview

Converts mesh to .dgf format for forward solver. Also creates parameter file, protocol files, position files and electrode diameter files in format required for forward solver. This is in normal format that is used by other people (i.e run forward for whole protocol)

Code/Files required

1. prepare\_forward.m
2. removeisolatednode.m
3. dune\_exporter.m
4. Mesh\_rods\_RatXX.mat
5. Pos\_cortex.mat
6. Pos\_depth.mat
7. Protocol\_cortex\_mapped.mat

Input

1. Lines 1 -15 – change to point to correct files

Output

1. mesh\_ratXX\_cortex.dgf
   * mesh in correct format for forward
2. electrode\_positions\_mesh\_RatXX\_cortex
   * position of all depth and cortical electrodes and reference electrode
3. electrode\_diameters\_mesh\_RatXX\_cortex
   * diameter of all electrodes
4. protocol\_mesh\_RatXX\_cortex
   * full protocol for forward solver. All measurements taken with respect to reference electrode 79
5. param\_mesh\_RatXX\_cortex
   * parameter file for forward

Notes

1. Transfer all the files output in addition to the electrode\_nodes\_mesh\_RatXX\_cortex from step 5 into the ‘PEITS\_root/PEITS/data’ on workstation