Computing the realistic head model: the detailed algorithm

In this document we describe the computation of the realistic head model associated to a subject MRI, i.e., the **lead field** matrix needed to compute any inverse solution using the theoretical coordinates of the electrodes on the sphere, that is, when no sensor position indicator is available.

Note: For all computations we use **MRI files in Analyze Format** and the Right Hand Oriented System with X increasing from back to front, Y from right to left and Z from bottom to top (Cz).

Input Data: The **MRI** of the subject and the name of the **electrodes** as in the 10/20 or 10/10 system.

Main Output:

Jlea or Flea: **lead field matrix** for vector or scalar fields associated to the configuration determined by the **electrodes** and the **solution points**.

Additional Outputs:

Segmented MRI file in the original coordinate system.
Segmented MRI file in the RHOS.
Original MRI file in the RHOS.
MRI file containing the gray matter in the RHOS.
SPI file containing the solution points in the RHOS

Detailed algorithm:

1) If the input MRI file is isotropic go to (2) else resample it to make it **isotropic** (MRICRO).

2) Segment the image (*myfinalsegmentation.m*) to detect:
   a) External surface (31)
   b) Brain surface (12)
   c) Gray matter (11)
   d) White matter (21)

3) Using the original image and the segmented image select 5 landmarks[1] (*landmarksvol.m*):

[1] The most important aspect here is the plane determined by Inion, Nasion and CZ. Note that the landmarks do not need to be really related with the anatomy but to correctly determine the central plane dividing both hemispheres. That insures that Right and Left are both correctly identified in the theoretical and the real model. In other words, the midline of both models are, at least, coplanar. Violating this point is one of the main sources of bad localization results.

   a) Nasion (36). Pixel around the Nasion belonging to the “main plane”, that is the plane dividing the two hemispheres.
   b) Inion (37). Pixel near the Inion contained in the main plane.
   c) Vertex or Cz (40). Pixel near the head vertex contained in the main plane.
   d) Right (39) and Left (38) near-auriculars determining an horizontal line.

4) Using the segmented image (landmarksvol.m) select the solution points (13).

5) Preprocess the segmented file to obtain (*analyze_prepro.m*):
   a) Best fitting sphere (center and radious).
   b) Delete isolated points (*del_isopixels.m*).
   c) Auxiliary files in the RHOS (*create_rhos_files.m*).

6) Using the input electrode names determine the theoretical locations on the sphere (*from_list_2_xyz.m*).

7) Using the segmented image in the RHOS compute the lead field for J or F or both (*DoMRI2SphMRI.m*).

For an example see the document: head_model_appendix1.pdf