Imaging for Neuroscience (last 3 CFU)

Homework 8-b

The aim of this homework is to perform image reconstruction using different array configurations from DOT data acquired in one adult human participating in an experiment evaluating the different activation pattern between texting on a mobile phone using the right hand and texting on a mobile phone using the left hand, while walking around.

The toolboxes required for this lab are: Homer2, iso2mesh

DATASET

S08_walking_texting.nirs: nirs data file of one subject. During the experiment, subjects were asked to either text on their mobile with their right hand (condition 1) or text on their mobile with their left hand (conditions 2) while walking around in a room.

MNI: folder containing the head volume mesh, the grey matter (GM) and scalp surface meshes, the cranial landmark coordinates and the 10-5 positions of the asymmetric MNI152 atlas

S08_walking_texting.jac: Jacobian matrix for the given array registered on the atlas. This file can be downloaded from here: https://www.dropbox.com/s/eiyau0xr8n0ul18/S08_walking_texting.jac?dl=0

vol2gm: matrix for the mapping from volumetric mesh to GM surface mesh

ANALYSIS TO BE PERFORMED

1) Plot the 3D array configuration (sources, detectors and channels).
2) Compute the source-detector distance for each channel and plot all distances with a histogram.
3) Identify “bad” channels as those channels with average intensity lower than 500 or higher than 1e10 or with signal-to-noise ratio (SNR) lower than 0. The output of this step should be a column vector with 0 for channels to be removed and 1 for channels to be kept. This vector should be placed in the SD.MeasListAct field.

   Plot the 3D array configuration highlighting the bad channels with a different color.

4) Pre-process the fNIRS data and compute the average optical density hemodynamic response across trials for each condition. Pre-processing should include:
    a. Conversion to optical density changes
    b. Motion correction performed with the wavelet motion correction technique using iqr=0.5
    c. Band-pass filtering with cut-off frequency 0.01 and 0.5 Hz
    d. Computation of the average optical density hemodynamic response for each channel and condition in a time range of -2 to 40 seconds from stimulus onset with the block average approach
5) Display the whole array sensitivity for the first wavelength on the volumetric GM mesh with all channels and, in a separate figure, by removing the "bad" channels as defined in step 3).
6) Reconstruct HbO and HbR images for both condition 1 and 2 mapped to the surface GM mesh. Use lambda1 = 0.1 for the regularization. Plot the reconstructed images for both HbO and HbR and for both conditions at the following time points: 0 s, 10 s and 18 s.
7) Reconstruct HbO and HbR images for both condition 1 and 2 mapped to the surface GM mesh removing from the array all channels with source-detector distance >= 30 mm. Use lambda1 = 0.1 for the regularization. Plot the reconstructed images for both HbO and HbR and for both conditions at the following time points: 0 s, 10 s and 18 s.
8) Compare the reconstructions obtained in points 6) and 7) and discuss if and why they are different and why one should be more accurate and less biased than the other.

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Submit your homework in the e-learning page of the course in the Homeworks section (there will be a separate submission folder for this and Prof. Bertoldo's homeworks). The submission MUST be completed one week before the day of the exam (for instance, if you want to do the exam on 6 September, you must upload the files by 29/8). You are required to do the homework in English (report, codes etc.). In a .zip folder (named Hwnumber_Name_Surname) you are required to turn in a copy of your own commented code(s), as well as:

1) a brief and complete presentation in power point/pdf of the performed analysis (methods, problems and issues, results, discussions, ...). Mandatory maximum 10 slides (excluding the first slide with title and your name)

2) A .mat file with the vectors/matrices generated at points 3 and 6 and 7 of the analysis (for point 6 and 7, only the reconstructed images at the selected time points)