Imaging for Neuroscience (last 3 CFU)

Homework 2-b

The aim of this homework is to decide the best motion correction technique for the available data and to perform image reconstruction 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 seated.

The toolboxes required for this homework are: Homer2, iso2mesh

DATASET

S07_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 comfortably seated on a chair.

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

S07_texting.jac: Jacobian matrix for the given array registered on the atlas. This file can be downloaded from here: https://www.dropbox.com/s/7guwkrj52781b08/S07_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
    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) Concerning motion correction (4b), decide which is the best motion correction technique for this type of data by looking at the type, amount and distribution of motion artifacts. Discuss and justify your choice.
6) Test all motion correction approaches on the data and establish whether your choice based on theory (the one at point 5) did provide good qualitative results.
7) 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).
8) 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. Discuss the differences in activation (e.g., same or different spatial pattern, same or different intensity of activation, which task is more engaging, etc.) between the two conditions at the different time points.

======

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 8 of the analysis (for point 8, only the reconstructed images at the selected time points)