nirsLAB: A Problem Solving Environment for fNIRS Neuroimaging Data Analysis

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Access to well-configured computing environments is a necessary factor for accelerating the development of applications derived from data-intensive sensing platforms. In the field of neuroimaging, publicly available resources that support processing of EEG [1], MEG [2] and fMRI [3] measures, among other types of data-intensive platforms, already are well developed. In recent years commercial devices supporting high-density NIRS data have become available, but development of well-configured computing environments that support data processing by non-domain experts has been lagging. Several publicly available platforms have been developed, including Homer 2 [4], NIRS-SPM [5], NAP [6], NILAB and NAVI [7], but each has strengths and weaknesses. Motivating the configuration of resources available in the nirsLAB platform described here was consideration of the need for: 1) improved resources to facilitate editing of data and event-timing information; 2) the capacity to process data collected at a larger number of measurement wavelengths, and to restrict processing to specified subsets of the available wavelengths; 3) improved visualization tools; 4) access to additional utilities that support application development.

Key functionalities of nirsLAB include sensor registration for arbitrary arrays; data- and event-editing tools; artifact correction tools; parameter estimation from up to 8 wavelengths of input (instantaneous, or canonical event-related responses); display resources, including block-averaging and movies, onto planar, scalp and cortical surfaces; anatomical structure identification; Level-1 and Level-2 GLM-based statistical parametric mapping; data-export utilities; recording of data-processing history; and inter-subject comparisons for hyperscanning studies. Also available are utilities for reformatting data, in support of inter-platform compatibility, and for performing batch processing of multiple data sets. User-specified parameter values can be assigned either through keyboard entry or graphically. Access to other utilities for use of machine learning algorithms [8] and 3D image recovery are under development.

As examples of nirsLAB applications, results of analyses performed on data from a hyperscanning experiment, four-wavelength measurements, and an optical-source comparison experiment are presented in this report.

[1] http://sccn.ucsd.edu/eeglab/
[2] http://www.sourcesignal.com/
[3] http://www.fil.ion.ucl.ac.uk/spm/
[4] http://www.nmr.mgh.harvard.edu/PMI/resources/homer2/home.htm
[5] http://bisp.kaist.ac.kr/NIRS-SPM.html
[6] http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0024322
[7] http://www.nitrc.org/projects/fnirs_downstate
[8] http://bbci.de/toolbox/