Technical University of Denmark

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Stahlhut, Carsten; Stopczynski, Arkadiusz; Petersen, Michael Kai; Larsen, Jakob Eg; Hansen, Lars Kai

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Carsten Stahlhut, Arkadiusz Stopczynski, Michael Kai Petersen,
Jakob Eg Larsen, and Lars Kai Hansen

Technical University of Denmark, DTU Informatics, Denmark

THIS demonstration will provide live-interaction with a smartphone brain scanner consisting of a low-cost wireless 14-channel EEG headset (Emotiv Epoc) and a mobile device. With our system it is possible to perform real-time functional brain imaging on a smartphone device, including stimulus delivery, data acquisition, logging, brain state decoding, and 3D visualization of the cortical EEG sources. Implementation of the smartphone brain scanner is based on the Qt framework and benefits from the cross-platform support of multiple hardware platforms (smartphones, tablet devices, netbooks and PCs) that are based on Linux operating systems. Thus our system runs on multiple platforms, including Maemo/MeeGo based smartphones, Android-based smartphones and tablet devices.

I. Technology

In our current online pipeline raw electroencephalography (EEG) data is acquired at a sampling rate of 128Hz with wireless transmission to the mobile device. All subsequent processing is carried out directly on the mobile device using custom-made software implemented in Qt [1-2]. Source localization is implemented locally on the smartphone with a 3D brain model consisting of 1,028 vertices and 2,048 triangles stored in the mobile application. The current source activity is reconstructed by a Bayesian formulation of the inverse methods minimum norm (MN) [3] and low resolution brain electro-magnetic tomography (LORETA) [4]. Source reconstruction is performed on 16 samples window, resulting in a snapshots update rate of 8 Hz. Given the source activations of the 16 samples window, a spectrogram can be calculated using fast Fourier transform performed on all vertices resulting in a spectrogram from 0 to 64 Hz with a 1 Hz resolution. Hereby, visualization of the source activation for specific frequency bands can easily be selected for example neurofeedback experiments. The brain activity is rendered using ranges of RGB color values, providing a performance of approximately 30 fps and fluent touch-based interaction with the 3D model.

In the current configuration of the system there is a delay of 150ms from the signal is read on the EEG headset until it is visualized on the screen. The delay depends on the complexity of potential pre-processing steps, such as temporal filter type and filter order. The system design benefits from the possibility of being able to integrate with multiple hardware platforms that are based on Linux operating systems.

II. User experience

The BMBI participants will be able to see and interact with the smartphone brain scanner such as touch based gesture interaction with real-time source activity superimposed on a 3D model of the cortical surface – this is demonstrated in a video at http://milab.imm.dtu.dk/eeg. Furthermore, this demonstration session will provide the user with an experience in neuro-feedback. By selecting specific brain regions the users will be able to test how well they can control the activity in these regions. Our low-cost EEG system setup will allow multiple users to be able to test the equipment simultaneously. This should ensure a continuous substitution of users and thus minimize possible waiting time. Finally, the possibility of applying multiple hardware platforms will be demonstrated.

References

[1] A. Stopczynski, J. E. Larsen, C. Stahlhut, M. K. Petersen, and L. K. Hansen, A smartphone interface for a wireless EEG headset with real-time 3D reconstruction. Proceedings of the Affective Computing and Intelligent Interaction, Springer, 2011.

[2] J. E. Larsen, A. Stopczynski, C. Stahlhut, M. K. Petersen, and L. K. Hansen, A Cross-Platform Smartphone Brain Scanner, CHI 2012 Workshop on Personal Informatics in Practice: Improving Quality of Life Through Data, 2012, pp.1-4.

[3] M. Hämäläinen, R. Hari, R. J. Ilmoniemi, J. Knuutila, and O. V. Lounasmaa, Magnetoencephalography-theory, instrumentation, and applications to noninvasive studies of the working human brain. Reviews of Modern Physics, 1993, 65, 413-497.

[4] R. D. Pascual-Marqui, C. M. Michel, and D. Lehmann Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. Int J. Psychophysiol., 1994, 18, 49-65.

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C. Stahlhut, A. Stopczynski, M. K. Petersen, J. E. Larsen, and L. K. Hansen are with the Technical University of Denmark, DTU Informatics, DK-2820 Kgs. Lyngby, Denmark (corresponding author to provide phone: (+45) 4525-3894; e-mail: cs@ imm.dtu.dk).