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Project Title: BCIs with Rapid Automated Interfaces for Nonexperts

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Publishable summary report

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Project website: http://www.brain-project.org/
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Title: Project management and resources report

Author(s): All BRAIN consortium partners

Reviewer(s): Project Manager Dr. Ivan Volosyak, University of Bremen

Keywords:

List of abbreviations:

- BCI- Brain-Computer Interface
- EEG- Electroencephalogram
- SSVEP- Steady-state visual evoked potential
- P300- 300ms potential of an ‘Oddball’ event related potential paradigm
- ERD/ERS- Event related desynchronization/Event related synchronization
- IGUI- Intelligent Graphical User Interface
- UAI- Universal Application Interface
- UPnP- Universal Plug and Play interface
- UDP- User Datagram Protocol
- XML- eXtensible Markup Language
Publishable summary of results

EU-project BRAIN (ICT-2007-224156) “BCIs with Rapid Automated Interfaces for Nonexperts” is developing Brain-Computer Interfaces (BCIs) into practical assistive tools to enhance inclusion for a range of different users with disabilities. Many of these individuals would otherwise have little or no opportunity to interact with loved ones, carers, home appliances and assistive devices, or personal computer and internet technologies. BRAIN is improving BCI reliability, flexibility, usability, and accessibility while minimizing dependence on outside help. Scientific and technical improvements target to all four components of a BCI system - signal acquisition, operating protocol, signal translation, and application. The BRAIN consortium consists of seven partners - three academic: University of Bremen (Uni-HB), University of Ulster (UU), University of Warsaw (UW); three industrial: Philips Electronics Nederland (PHILIPS), Telefonica (TID), Twente Medical Systems International (TMSi) and the disability expert CEDAR Foundation (CEDAR). The BRAIN consortium brings together the partners with different background to create structures which allow project members to generate knowledge in close collaboration.

At the 24 month stage, all activities are advancing according to the outline schedule set out in the Description of Work (DoW). Significant progress has been made in signal processing, user interface, application interface, and initial integration activities.

During this reporting period PHILIPS and Uni-HB constantly improved the web based infrastructure to support the project management activities. All required information interchange such as minutes of the meetings, technical contributions to deliverables, conference talks, and relevant publications is communicated within the BRAIN consortium via internal SVN based repository and project WiKi. Knowledge generated within the project has and will continue to be made available to the general public through the public part of the BRAIN website. UU developed further prototypes of the BRAIN Intuitive Graphical User Interface (IGUI) and collaborated with TID on further development of the Universal Application Interface (UAI) and applications. The IGUI handles the interaction between the BCI systems, the UAI and the end users. It has been integrated and tested with two forms of SSVEP BCI system and amendments have been made to support ERD/ERS. The user experience with the IGUI has been studied and this investigation will form the basis for further IGUI customizations to enhance usability and support of the final BCI system within BRAIN (P300). The UAI provides an easy way for integrating applications into the BRAIN system so they can be BCI controlled via the IGUI. Applications are implemented as OSGi bundles for easy installation and management. This work at TID has been advanced with concentration now on a multi-media server that recognises devices connected and disconnected to the network without the need for configuration. UU has also been involved in advancing the control of smart home devices integrating an MTek X10 protocol controller with the UAI server. UU has performed testing and evaluation of the technical components in a laboratory environment prior to evaluation with the CEDAR tenants, in a community setting. User involvement has enhanced further technical development and will continue to influence IGUI interaction and applications. Cedar Foundation continues to lead on work package “Evaluation and User Feedback”. The general approach of working closely with the lead user in tandem to recruited participants has continued. During this period work finalized the testing of the SSVEP signal processing in partnership with collaborators from PHILIPS and UU. In addition to this, the CEDAR participants have been involved in the screening and testing requirements for a second paradigm of BCI, the ERD/ERS. This work is progressing well, with a focus on the potential of ‘imagined movement’ to support access and control of the BCI system. Input from Uni-HB and UU has enabled regular testing with CEDAR participants delivering feedback from the home environment. Parallel to this work CEDAR
Foundation has supported the efforts of UU collaborating on usability studies of the IGUI. Furthermore, CEDAR has made significant effort to connect regionally with ‘key players’ in the delivery of services to people who have the potential to be beneficiaries of the BRAIN system in the future. To this end workshops have been facilitated with the Regional Brain Injury Unit, Regional School for young people with a complex physical disability, and the Speech and Language Therapist who administrates the regional communication advice centre. CEDAR links directly into other work packages to support a range of dissemination activities. During previous reporting period, Uni-HB programmed the first prototype of software module (BCI wizard) to individualize an SSVEP based BCI by determining the optimal frequencies and corresponding threshold values for the individual user. This year, the software was further developed to calibrate all relevant parameters in a sensorimotor driven scenario. UW presented the first prototype of an ERD/ERS signal processing tool that automatically determines the relevant signal parameters, i.e. adjusting the individual frequency-bands, selection of optimal linear combination of available channels, selection of relevant and not redundant set of features for asynchronous motor-imagery classification. Concurrently, Uni-HB designed a training application that serves as a feedback-driven user interface to improve the subject’s performance working with UW’s online classifier tool and to prepare for a designated use of the IGUI. In parallel to the work on the ERD/ERS scenario, PHILIPS refines the formerly invented SSVEP signal processing tools. The second prototype of advanced SSVEP signal processing tools entails several stimuli sharing the same frequency but phase-shifted. During this reporting period, PHILIPS focused on the development of a dry electrode set and improving the prototype that was demonstrated in the first year project review. After initial tests with capacitive electrodes, the galvanic solution has been chosen. Encouraging results have been obtained in monitoring alpha activity. Further tests include the measurement of SSVEPs. Instead of using different frequencies to use the SSVEP the emphasis has now been on using the same stimulation frequency but different phases. This has brought a considerable improvement in time necessary for the calibration and the user comfort. TMSi developed the first prototype of new electrodes which require just tap water instead of electrolytic gel, promising results with these electrodes were achieved during an online BCI experiment with healthy subjects. The BRAIN project has a strong dissemination emphasis to help establish BCIs as effective communication tools within the assistive device communities, different research communities, key industry partners, policy makers, and different disabled populations. The dissemination activities of the BRAIN consortium included a large number of publications (4 journal papers, over 16 peer-reviewed publications), the presence of BRAIN in several international conferences. Tutorial lectures on BCIs were given at two international conferences: EUSIPCO 2010 and ISSPA 2010. The BRAIN website was also updated to highlight the unique contributions of BRAIN to the state-of-the-art. These are: The BCI wizard, the integration of user needs in the system design, the universal interface, high-frequency based SSVEP, and the electrodes that use water instead of conductive gel. For the complete list of dissemination activities please refer to the dissemination and exploitation plan (DUEP), which is continuously updated throughout BRAIN’s duration and available online on the BRAIN website. Within the scope of the BRAIN project the high impact research study with more than 86 subjects from volunteered visitors to the BRAIN booth was carried out at the international exhibition Hannover Messe in April 2010. In this study two sets of SSVEP stimuli: one in the medium frequency range (13, 14, 15 and 16 Hz) and another in the high frequency range (34, 36, 38, 40 Hz) were compared with respect to BCI performance, personal preferences, and different subject factors such as age or gender. High frequency SSVEPs (above 30 Hz) diminish user fatigue and risk of photosensitive epileptic seizures. It is foreseen to participate in CeBIT2011 next year for conducting research and presenting progress of the BRAIN project.