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Publishable summary report

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PP	Restricted to other program participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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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
BCI2000-	BCI software package, http://www.bci2000.org/
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 will improve 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 12 month stage, all activities are advancing according to the outline schedule set out in the Description of Work (DoW). Although the majority of work during this first reporting period has focussed on methodological and organizational work, significant progress has been made in signal processing, user interface, application interface, and initial integration activities.

In the course of the first months of the BRAIN project, the project manager Dr Volosyak at **Uni-HB** developed the web based infrastructure to support the project management activities as discussed during the project kickoff meeting. 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.

The project partner **TMSi** has started the development of a new measurement system consisting of two main parts; the sensors and the amplifier system according to the project plan (the measurement part will be completely renewed in comparison to the commercially available BCI amplifiers). The novel sensors that only use plain water and can give a clean and undisturbed EEG signal for at least several hours were developed. In combination with this prototype of a water-based EEG electrode **TMSi** started with development of the new, small, convenient, and wireless measurement system to reach the goals of lightweight BCI system that does not need significant preparation and clean-up time.

In order to be viable as consumer interaction devices, Steady-State Visual Evoked Potential (SSVEP) based BCIs need to increase their usability along three main criteria, namely shorter setup and calibration procedures, safety, and higher information throughput. The first two criteria have been initially addressed by **PHILIPS, UW** and **Uni-HB** during this reporting period, as foreseen in the DoW, because of their higher importance in achieving a usable BCI that does not require expert assistance. Increasing the communication throughput constitutes our underlying objective that can be achieved by leveraging on the results of the research aiming at shortening the calibration and increasing the safety. Rapid calibration to detect the SSVEP at a given frequency is achieved through a training phase which consists in presenting the subject with a short sequence of visual stimuli oscillating at the trained frequency interspersed with break periods. A set of coefficients is then obtained to linearly combine the signals recorded from several electrodes into a single signal that has maximum power at the trained frequency. The topographical representation of these coefficients on the scalp confirms the fact that the relevant activity originates in the region that is closer to the primary visual cortex. In the initial demonstrator, (to be presented during the first annual project review in Brussels) the calibration lasts for app. 60 seconds per stimulation frequency. To ensure the safety of the current SSVEP based BCI, stimulation frequencies above 30 Hz are used (in order to diminish the risk for photo-induced epileptic seizure). Complete description of the algorithm can be found in [Garcia Molina, et al. 2009].

During this reporting period **UU** and **TID** developed the initial prototype of the BRAIN Intuitive Graphical User Interface (IGUI) and the Universal Application Interface (UAI). The purpose of the IGUI is to decode packets which have been classified by BCI2000 to represent the intention of the user, in controlling their environment. BCI2000 applies signal processing to the recorded electroencephalogram (EEG) to provide classification and a 4-way choice. The interface between IGUI and BCI2000 is by User Datagram Protocol (UDP) over a network connection. The purpose of the UAI is to provide 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. The UAI system relies on the UPnP standard for device abstraction at the protocol level.

The involvement of end users in both **CEDAR** Foundation smart home supported housing and the lab at **TID** resulted in the identification of BRAIN user requirements. The participants with the CEDAR Foundation are people living with complex physical disability. TID has utilized people without disabilities to inform design. The main goal within the BRAIN project is to construct and to apply the user centric design methodology, and the concept of the 'Lead User' to ensure that the key beneficiary of the results of the BCI product i.e. the person with disabilities is involved from the beginning in the whole development process. During the current reporting period several reports on the methods used to engage with users and the results of these consultations were produced, along side use case scenarios. In addition the preliminary phase of the SSVEP evaluation has been planned and described with an initial lab evaluation having been completed.

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. A press release to reflect upon the BRAIN project was prepared by University of Ulster after the consortium meeting on 10th March 2009. Photographs from the meeting were also used for the public website. Ethics Manager Dr McCullagh subsequently provided a radio interview to Radio Ulster on 16th March 2009. BRAIN's results and research in ERD/ERS based BCIs were presented in a tutorial session at the IEEE/BiOCAS 2008 conference in Baltimore/US. The SSVEP research resulted in two papers. The first paper was presented at the EUSIPCO 2009 conference while an extended version will be published in the special issue NEUROMATH of the German Journal "Biomedizinische Technik". A presentation on BCI was presented at EMBEC 2008 (Antwerp, Belgium) as part of a workshop on Brain discovery techniques. The presentation indicated the technical challenges that successful uptake of BCI and hence inclusion for disadvantaged citizens would need to address. The work on SSVEP has also been presented at NEUROMATH 2009 on 13th March 2009. The NEUROMATH workshop focuses on algorithmic methods for describing brain activity and connectivity, this year NEUROMATH emphasizes BCI technology; in particular the selection of the BCI modality. In addition a tutorial session on EEG processing for BCIs was proposed for presentation at EUSIPCO 09. Meanwhile three new papers are submitted for review to the major international conferences in area of human-computer interaction CHI 2010 and IUJI 2010.

Within the scope of the predecessor FP6 funded Marie-Curie TOK project BrainRobot at the **Uni-HB** the high impact research study with more then 106 subjects from volunteered visitors to the booth of Institute of Automation was carried out at the international exhibition CeBIT 2008. It is foreseen to participate in CeBIT2010 next year for conducting research and presenting progress of the BRAIN project.