1 Publishable Summary

TOBI will develop practical technology for brain-computer interaction; i.e., non-invasive BCI prototypes combined with other assistive technologies (AT) that will have a real impact in improving the quality of life of disabled people. These non-invasive BCI are based on electroencephalogram (EEG) signals. TOBI seeks to develop BCI assistive technology endowed with adaptive capabilities that augment those other AT they are combined with. In such a hybrid approach users can fuse brain interaction and muscle-based interaction or can switch between different channels naturally (based on monitoring of physiological parameters or mental states).

In TOBI we have identified 4 application areas where BCI assistive technology can effectively support people with motor disabilities, namely:

- Communication & Control,
- Motor Substitution,
- Entertainment, and
- Motor Recovery.

For each of these application areas the project will develop a number of BCI prototypes. In particular, the prototypes developed during the first year of the project include:

- a zoomable document browser and a text entry system (Communication & Control),
- a FES orthosis for maintaining elbow posture (Motor Substitution),
- an assistive mobility robot for telepresence (Motor Substitution),
- a photo browser (Entertainment),
- a system for creative artistic expression, brain painting (Entertainment) and
- a BCI tool endowed with rehabilitative principles (Motor Recovery).

These initial BCI assistive prototypes were demonstrated in the lab as well as during different public live demos. In particular, TOBI participated at the *ICT Exhibition 2010* held in Brussels on September 27-29, 2010. Our exhibit presented live demos of six prototypes. Visitors were also allowed to interact with the demos. In the first three demos, people controlled software for communication (text entry and web browser) and two physical devices for motor substitution (FES neuroprosthesis and assistive telepresence robot) by using their spontaneous brain activity. The next two prototypes exploited natural brain responses to items appearing in the computer for entertainment (photo browser and brain painting). The last demo was a new commercial wireless helmet made of dry electrodes that visitors could wear to visualise immediately their brain state. Figures 1 and 2 show two of our ICT demonstrations: brain painting, where a subject composes a piece of art through a P300-based BCI, and of the telepresence robot, where the subject can drives the robot to different targets using spontaneous brain activity, respectively. Figure 3 gives a snapshot of our ICT stand while two demos were running in the presence of media and public (the BCI subjects are occluded by visitors).

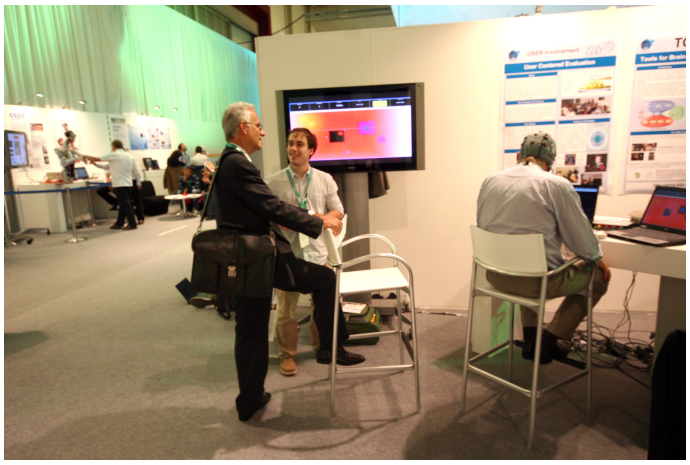

Figure 1: Live demonstration of brain painting at the ICT Exhibition 2010. A subject composes a piece of art through a P300-based BCI.



Figure 2: Live demonstration of the assistive telepresence robot at the ICT Exhibition 2010. The subject uses our non-invasive BCI to mentally drive the robot to different targets. The BCI user, back to the robot, is wearing a white cap. The second demo, running in parallel, is at the left side of our exhibit.

The main objective for the second year of the project has been the testing of the initial BCI prototypes with end-users. This evaluation is being carried out in clinics and assistive technology centers. First results with a rather large number of end-users (no less than 2 for each



Figure 3: Snapshot of our ICT stand while two demos were running in the presence of media and public (the BCI subjects are occluded by visitors).

prototype across 8 different places) show promising results as performance has been, on average, quite good. More importantly, feedback from end users, as well as from AT professionals and therapists, indicates they like the prototypes although it is necessary to improve them in different ways for the short and long-term daily use.

Another major objective is the development of the hybrid BCI prototype (hBCI) and the design of a common implementation platform. This platform is intended to serve as a reference for standardization of BCI implementations. Importantly, this is achieved by defining the interfaces between the BCI and the controlled device, and between the internal modules of a BCI; thus, it can be incorporated into new and existing BCI implementations without a major redesign. The first version of the common implementation platform is ready and dissemination has started. Also, we have implemented the main interfaces necessary for the hBCI and a first version can be downloaded at http://www.tobi-project.org/download.

Finally, the third objective has been the selection of a new industrial partner to reinforce one (or more) of the application areas. We received 18 proposals in response to our Call for New Industrial Partner. The new member of the TOBI consortium is the company Medel, Hamburg, who will contribute to our application areas 'Motor Substitution' and 'Motor Recovery'. They will help in the development of the TOBI industrial strategy to bring our results in the field of BCI technology to the market. Medel will join the project in January 2011.

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tools for brain-computer interaction