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. TOBI will deliver short-term BCI assistive prototypes for each of the application areas by the first year that will be tested and evaluated by the second year. Then, we will build upon the work done for the achievement of these short-term milestones to create more advanced technology based on novel hybrid architectures, adaptive principles, as well as EEG hardware and common implementation platforms. This final BCI assistive technology will be tested and evaluated in real life situations by a large number of end-users. Finally, TOBI will devote substantial efforts to create awareness of TOBI results among the key players. For this we will organize a series of annual workshops.

The short-term BCI prototypes include a zoomable document browser and a text entry (WP1, Communication & Control), a FES orthosis for maintaining elbow posture and an assistive mobility robot (WP2, Motor Substitution), a photo browser (WP3, Entertainment), and a BCI tool endowed with rehabilitative principles (WP4, Motor Recovery). The objective for this first year is to demonstrate these prototypes, either completely (zoomable document browser and a text entry, WP1, FES orthosis, WP2, and photo browser, WP3) or partially (assistive mobility, WP2, and rehabilitation BCI, WP4). It is worth mentioning that, as part of the demonstration, we run life demos during the 6-month review and others are scheduled for the first year review and the associated public workshop. Figures 1 and 2 show demonstrations of the text entry prototype, where a subject delivers mental commands to QualiWORLD AT software in order to write sentences, and of the FES neuroprosthesis, where a BCI drives the FES system to allow a subject execute grasping patterns and open the hand.

In the early part of the year, and as reported in the 6-month review, the objectives spun around setting up the necessary infrastructure, both technical and human, to undertake the work in TOBI as a whole and in each of its workpackages. In this respect, a critical element to undertake work with patients in order to validate our BCI tools is the early definition of user requirements, inclusion and exclusion criteria, and evaluation metrics. From the technical standpoint, apart from achieving the different milestones specific to each workpackage, there are three main objectives. The first is defining our approach to the hybrid BCI architecture and multimodal fusion. The second one is establishing our roadmap for a common implementation architecture (standardization). This standardization effort also comprises our approach to IPR. In this respect, our strategy —which is supported by the Advisory Board— is to let IPR holders decide whether to disclose their source code, while keeping the overall architecture an open standard. The third objective is setting up the common EEG system —which requires developing the necessary software and additional hardware to operate the EEG system.

Figure 1: Life demonstration of the text entry prototype developed in WP1. A subject uses our non-invasive BCI to write sentences using a commercial AT software. The BCI is based on motor imagery and the software is QualiWORLD.

Figure 2: Life demonstration of the FES neuroprosthesis prototype developed in WP2. A first subject uses another motor imagery BCI to drive a FES system that allows a second subject execute grasping patterns and open the hand.

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