

# Tobi hybrid BCI: principle of a new assistive method

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**Abstract.** This work presents the concept of a hybrid BCI (hBCI) which allows a modular design through defined interfaces. It defines an integrated system where a BCI is defined as one assistive device among others for the entry of control commands.

**Keywords:** Brain-Computer Interface, Modular Architecture, Electroencephalogram, Assistive Device, Hybrid BCI

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## 1. Introduction

Persons having severe disabilities for various reasons can use a wide range of assistive devices (ADs) for managing their daily needs as well as using them for communication and entertainment purposes. The set of ADs ranges from simple switches connected to a remote controller over more complex sensors (e.g., mouth mouse) attached to a computer up to very sensitive eye tracking systems. Although these systems work relatively well when being adjusted individually to each person, there are situations where these systems do not work properly, e.g., in the case of rapid fatigue of residual muscles. In such a case, a Brain-Computer Interface (BCI) might be a good option, using brain signals for the control without the necessity of any movements. The large scale integrated project TOBI (Tools for Brain-Computer Interaction) aims to develop a hybrid BCI (hBCI) which combines existing input devices with a BCI (Millán et al. 2010). That is, the BCI should be available if the user wishes to extend the types of inputs available to an assistive technology system, but the user can choose not to use the BCI. The hBCI will be able to decide which input channels offer the most reliable signal(s), and switch between input channels or fuse weighted combinations of them to improve information transfer rate, usability, reliability, and in general the performance of the system.

## 2. Material and Methods

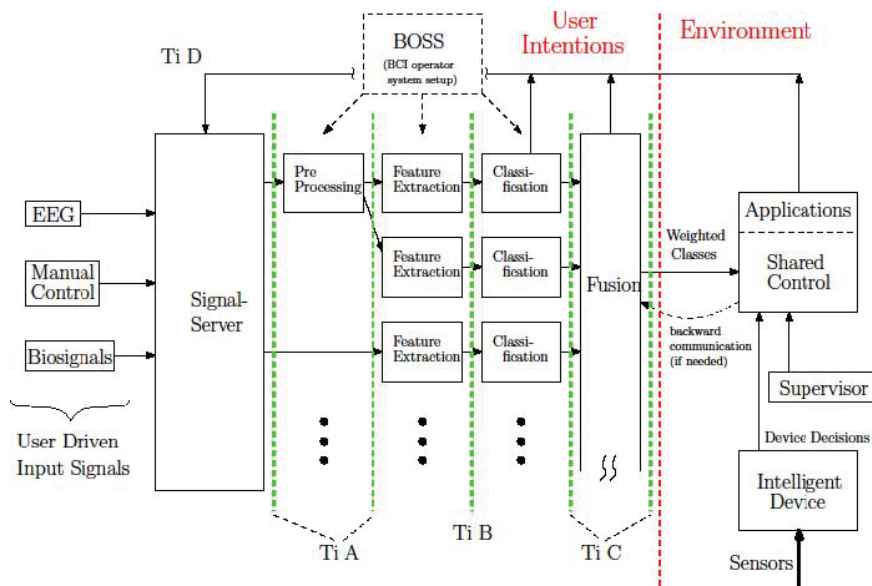
The TOBI hBCI is meant to allow a universal combination of different control-strategies, such as BCI-, manual-, sensory- and additional biosignal-control (e.g., EMG, ...). While the user will be allowed to switch between different input sources intentionally, TOBI is developing methods to make this automatically happen via some sort of surveillance of the performance. The hBCI should also be aware of the environment to be able to sort out wrong or pointless commands. The main components to achieve these goals are the *fusion* and the *shared control* blocks (cf. Figure 1). These blocks provide the integration of several modules but also the communication with the environment to allow targetoriented tasks or to prevent the users from performing unintended actions.

The design of the hBCI is very modular to ensure a maximum of flexibility. All modules of the hBCI are connected through well defined interfaces (called TiA – TiD) facilitating the possibility to exchange such modules in an easy way. Communication between those modules is possible by using network connections for distributed systems or also local mechanisms like shared memory.

### 3. Results

In Figure 1 the concept of the hBCI can be seen. One of the main components is the signal server which allows biosignal (e.g., g.USBamp, g.tec, Graz, Austria) as well as assistive device signal acquisition (integrated mouse, buttons). Different clients can connect to this server through interface TiA. Between interfaces TiA and TiC mainly BCI modules like preprocessing, feature extraction, and classification can be incorporated, as well as other processing modules (e.g., from assistive devices). The fusion module decides which of the control signals provided by the signal processing pipes are finally used for application control. Then, the application, which can have sensors, is driven with the support of the shared control module, which finally creates the control signal out of the fusion and sensor signals. Last, through interface TiD, information from the application can be sent to the signal server. A BCI operator system setup (BOSS) takes care of the different connections and the application flow.

Working prototypes have been developed following the principles described above. Libraries implementing the signal server and the interfaces TiA and TiC are available, and modules implementing the functionalities described above are now part of the TOBI repository.



**Figure 1.** Design of the TOBI hBCI system. The figure shows the different modules, signals, and interfaces that altogether form the new hBCI.

### 4. Discussion

The idea of the TOBI hBCI is twofold: (i) Implementing a BCI platform which enables BCI researchers to connect different modules to realize a working system, no matter which platforms and programming languages they use. This should ease collaborations, quicken BCI development in the future and generate better systems. (ii) Providing such an hBCI system which integrates common ADs as well as different types of BCIs, mental state monitoring and adaptation, users will be able to use their “assistive system” throughout the whole day with high accuracy and BCI systems will become real assistive devices.

#### Acknowledgements

This work is supported by the European ICT Programme Project FP7-224631.

#### References

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