BCIforReal: An application-Oriented Approach to BCI Out of the Laboratory

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In principle, brain-computer interfaces (BCIs) hold the promise for being the ultimate intelligent interfaces – what could surpass an interface that is able to interpret your thoughts and preferences, in real time, and behave accordingly? In practice, it is still not quite clear if and how BCIs can contribute to or replace existing interaction paradigms. In the last 10-20 years BCI research focused on providing patients who lost their ability to communicate through the usual channels (speech) with ways of communication that are directly based on brain signals. While a lot of progress has been made, very few patients actually use BCI in their daily life. Moreover, it is not clear whether BCI has any advantage for non-clinical applications and for able-bodied individuals.

Beyond the medical realm, our focus is on non-invasive BCI – the overwhelming majority of research projects utilize electroencephalogram (EEG), but we also see functional near infrared spectroscopy (fNIRS) being increasingly explored. Both methods suffer from low spatial resolution and low signal to noise ratio, which result in daunting limitations on the type and accuracy of information that can be extracted from them; unlike neuroscientific studies, in which the data from multiple subjects and multiple repetitions can be averaged and analyzed offline, BCI applications require the system to extract information from a single trial (or a small number of trials) over a short period of time, online. These requirements severely constrain the type of phenomena that can be used by BCI. As a result, most BCIs that are intended for explicit control are still based on a limited number of techniques that have been around us since the 1990s (or earlier): P300, steady state evoked potential (SSVEP), and motor imagery.

As a result, increasing attention is directed towards applications where the BCI is used for functionality other than explicit control. Rather, we are now considering a wide range of applications and devices that can respond and adapt to our emotional and cognitive state. Such paradigms have been typically referred to as passive BCIs [2]. In such applications it is important to understand BCI in the context of natural human behavior and find a match between BCI technologies, with all their current limitations, and the specific application requirements.

From a basic research perspective it is essential to distinguish between information extracted from the brain and other types of information picked up by the brain sensors. This is especially important given the proliferation of low cost consumer EEG devices, such as the Emotiv EPOC[1] or the Muse device[2] . These devices allow non scientists to believe they are developing or using a BCI, where in many case they are engaged in artifact-based interactions, which can lead to undesired 'hype' on the one hand or frustration on the other hand. This important thread is addressed by one of the workshop papers discussing community outreach activities through brain 'hackathons'.

From a practical point of view, however, we believe there is no reason to limit ourselves to 'pure' brain interactions. In practice, there are clear advantages to fusing multiple sources of (physiological) information in conjunction with brain signals. This theme is also addressed by several of the workshop papers. However, this also raises an important question: if we fuse multiple sensors, what is the unique contribution of the information coming from the brain? is there any information that we can extract today, using non-invasive techniques such as EEG, which we absolutely cannot extract from any other source of information? we suggest that this is an important question for developers of BCI applications, since brain recording is most often the most cumbersome and least friendly source of information. For example, while cognitive load can be measured by EEG, in order to demonstrate its utility in the real world we suggest that developers need also to 'prove' that it cannot be measured as accurately by any combination of other sensors, which are typically easier to use – such as eye tracking, face tracking, autonomous nervous system signals, voice, and 'body language'. This question is typically ignored, and we suggest that it needs to be addressed before BCI can be successful outside the laboratory.

For our workshop we have received twelve submissions. After having been reviewed by at least two independent referees, eight of them were accepted as proceeding papers. The papers cover a wide range of application areas: driving, head mounted display imaging, text annotation and neurofeedback. Besides the presenters of the eight papers, we are happy to host two distinguished invited speakers. Prof. Dr. Benjamin Blankertz from the Technical University of Berlin will discuss "Applications of BCI Technology Be-

[1] https://www.emotiv.com/epoc/
[2] http://www.choosemuse.com/

yond Communication And Control", and we refer the readers to a recent review of the exciting projects taking place at his research group [1]. Importantly, we are also happy to host a representative of one of the target user groups of BCI – Dr. Chris McClernon, International Program Officer at the European Office of Aerospace Research and Development, who will give a talk on the goals of his prospective neuro-ergonomics program.

As should be evident from the above, we believe it is now imperative for the BCI communinty and the human computer interface (HCI) community to join forces and address the challenges of BCI together. The long term challenge of 'BCI4Real' is still many years ahead of us, and requires not only inputs from the neurosciences, but also inputs from both the intelligent systems and HCI research communities. Thus, the intelligent user interfaces (IUI) community is especially welcome to join us in this exciting endeavor of taking BCI out of the laboratory, and we are happy to have this workshop as part of the IUI annual conference.

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