Exploring BCI paradigms for augmented reality applications

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1   Introduction

In recent years, promising new techniques have arisen in BCI leading to faster and more accurate recognition of brain signals that require little training, like SIGFRIED[1]. Also multiple commercial portable EEG devices are being developed and perfected, like the Emotiv headset[2]. All this in the context of the recent arrival of augmented reality devices like Google goggles[3] and immersive virtual reality devices that could also be adapted to augmented reality like the Oculus[4], that will lead to new paradigms and requirements on human machine interaction.

BCI is a promising answer to these new challenges but current implementations of the different techniques in the field are dispersed around specific applications and not on a general GUI or set of principles to employ a BCI implementation as a continuous and fluid input device. The exploration on how to combine different techniques in BCI along with their optimization on the context of a general user interface, might lead to new insights about how to integrate and perfect this technology and expand its applications beyond healthcare systems. In addition, most BCI implementations are focused solely around employing one input device (like the EEG) and not around the potential of combining different input devices that might provide more information to the BCI technique itself along serving other functions, like an eye-tracker.

2   Research proposal

The research would consist of exploring three complementary aspects concerning the creation of a fluid user interface centered on BCI based on EEG and with immediate applications to AR.

1. Exploring the SIGFRIED[5] technique and its possible optimization and complementarity with other techniques to achieve an interaction speed below a second per input. Considering that the input speed is the most important challenge in the creation of fluid human machine interactions. SIGFRIED would be the central technique for two reasons; first that it requires almost no training and so provides a base to start interactions without an immediate concern for specific action classification which can be introduced later to refine the accuracy of the interactions; and second that it appears to have a fast pattern recognition speed compared to other techniques, which is essential to achieve our purpose.

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[1] Brain–computer interfaces (BCIs): Detection instead of classification. G. Schalk et all. 2007.

[2] http://www.emotiv.com/

3 http://bits.blogs.nytimes.com/2012/04/04/google-begins-testing-its-augmented-reality-glasses/

4 http://www.oculusvr.com/

5 Known implementations of SIGFRIED employ the BCI2000 software.

(BCI2000 main page) http://www.bci2000.org/BCI2000/Home.html

(SIGFRIED package page) http://www.bci2000.org/wiki/index.php/Contributions:SigfriedSigProc#Methodology_Concept

2. Exploring how the employment of an eye-tracker can help delimit the context of action and attention during interactions without interfering with the brain signals, since visual-cues are a natural complementary action to any interaction. With the idea that by diminishing the possible set of actions that can be selected at any time and by specifying the current context of action by eye-tracking, it would be possible to develop a set of general and abstract input commands mapped to arbitrary actions based on local contexts. Like the versatile outcome of a right click of the mouse on different software applications.

3. Exploring how the employment of other BCI techniques based on signal classification, unconscious triggers like selection with the PC300 algorithm, varied sensory inputs, and deliberate actions like motor imagery and the beta wave manipulation through concentration, might be employed and combined to achieve a fluid concatenation of actions on a general purpose graphical user interface, also through the design of graphical controls adapted to this techniques.

3 Experimental setups ideas

On a flat screen (the main idea would be to completely replace the mouse, and maybe more, with the EEG and eye-tracker):

1. Creation and manipulation of panels (windows).
2. Realizing actions on panels that have different action sets and options.
3. Exploring the design and implementation of different graphical user interface tools and controls better adapted to each BCI technique aiming for a fluid interaction.

Applications on augmented reality (would require oculus device and cameras):

1. Extracting information from a text book.
2. Managing diagrams and information objects in space.
3. Selecting an image from the environment and looking up for its information, employing google goggles software technology[6], this information then should allow for other types of interactions.

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[6] http://www.google.com/mobile/goggles/#text