The Future of Brain-Computer Interface for Games and Interaction Design

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ABSTRACT
In this paper we discuss the potential application areas and uses of modern Brain-Computer Interface technology such as the EPOC. We divide the discussing into two subgroups namely, Game design and Interaction design and hence discuss the future of these research areas in regards to such technology.

Author Keywords
BCI, EPOC, game design, interaction design

INTRODUCTION
The concept of Brain-Computer Interface (BCI) is a relatively new field of research and it is not until recent years that equipment has made it possible to use the signals produced in the human brain as an actual vehicle for computer interaction. In this paper, we look at what has already been done in the field of BCI applications and then propose ideas on how to further extend that research and knowledge. Here, we focus mainly on the use of the BCI tools EPOC, developed by Emotiv.

The paper is divided into two main topics; EPOC for Game design and EPOC for Interaction Design. We choose this separation because even though Interaction design might incorporate gaming and game design, it also represents a cluster of different research areas with very different purposes than those of game design.

EPOC FOR GAME DESIGN
Many games and applications today use biofeedback to help people to deal with emotional problems such as anxiety, phobia and post-traumatic stress. Since these types of disorders are all highly related to the brain, it is rather likely that Brain-Computer Interface (BCI) technologies, such as the EPOC, could be very effective at detecting and communicating emotions to such an application.

Studies performed by Matt (2003) show that feedback regarding physiological arousal levels can help people to manage their feeling of anxiety as seen in Relax to Win (Matt, 2003) where a game was created to help children who suffered from anxiety problems. By controlling stress levels, players relax more and thus perform better in the game. The level of the relaxation has been measured using ECG and GSR which have a lag time between the emotion and physical representation. We would like to introduce the EPOC to this type of game concept and upgrade the interaction between the player and the game. Since the EPOC is connected directly to the brain it does not have the lag times that some of the other sensory technologies have. With the EPOC we can detect early signs of tension and help change behavior before spiral arousal/tension has developed fully.

Using BCI as a tool to enhance interaction between the player and the game is an exciting concept. By feeding the game with EPOC sensory information regarding emotions and brain activity, we can modify the game play to drastically increase the game immersion, allowing people to play the game on a whole new level. Our suggestion is not to exclude other interaction devices or sensors, but to use the BCI equipment to supplement and enrich the interaction experience, much in the same manner as Froment et.al. (2009). Here, participants play the game of Unreal Tournament while being connected to EKG, GSR and body temperature sensors. By feeding the game with this real time emotion information, the game is manipulated with effects such as screen blur and off-aim. The idea of the game is then to reward the player on successfully resolve the emotional issues. These types of concepts can enhance emotional self-control as the users are playing against themselves.

Introducing the wireless EPOC, we might be able to substituting multiple sensors, thus giving the player more freedom to interact with the game. Another aspect of the EPOC is that it can communicate many other things than just emotions and brain activity, such as facial expression and head orientation, all of which can make the interaction richer and more immersive. Also, in the game Brainball, Hjelm et al. (2003) prove the potential usefulness of BCI in gaming by giving advantage to the most relaxed player.

EPOC FOR INTERACTION DESIGN
Computers are oblivious to its users' emotional states. In order to create believable artificial intelligence, such as HAL in Kubrick's Space Odyssey, it has to recognize, interpret and communicate back emotions (Picard, 1997). By feeding emotional information back to the computer, we can make it interact with user more naturally, recognizing the emotional state of the user and exhibiting sympathy and emotional intelligence which Picard (1997) states as a part of artificial intelligence. Using EPOC, we can directly

communicate emotions, subtle facial expressions and brain activity directly to the computer making it aware of the complete emotional state of the person it is interacting with. The ability to communicate emotions is trait of intelligent beings and as such by using BCI we make our computers intelligent. In this manner, we can make computer pick up on emotional trends and act accordingly, learning and communicating with the user.

Using BCI as a tool to enrich interaction by communicating emotions makes for an interesting future. The potential benefits of communicating emotional states is clearly shown in FantasyA and SenToy (Höök, 2003) where a physical doll is used to express emotions back to the game by a set of body gestures. Players enjoyed this type of game interaction because they could communicate their feelings to the doll, which is the game avatar itself. The difficulty players had was the built–in indirect control mechanism between doll and the avatar. Using EPOC, we remove this indirect control variable and put more direct control of the avatar by using emotion and facial expression recognition. Players can then directly communicate their emotions to the game, making it less "laggy" and frustrating. The stance of Pervasive Computing is to create context-aware applications that can adapt to information collected from the environment. Pervasive Gaming, however, deals with personalized aspects of how players are feeling at any given moment. As gaming moves more and more towards pervasiveness, we believe that the EPOC can communicate the player state as well as the environmental state to the application, thus enriches every application that uses this kind of pervasive interaction.

The EPOC is a rather non-invasive technology with no other discomfort to the user than that of wearing it on the head. As technology moves forward, so will this device and the possible feeling of discomfort will most likely be reduced. Brain-Computer Interface is an interesting field with great potential and it is very exciting to be a part of such a young and blossoming field of research.

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