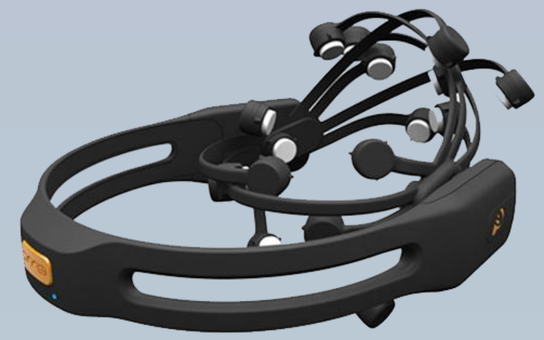
Evaluating HCI using the Microsoft Kinect augmented with Non-invasive BCI



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Project Overview

Natural User Interaction technologies allow for engagement with computing devices without the tether of mouse or keyboard; Brain computer interfaces (BCI) and the Microsoft Kinect are examples of new devices that support this type of user experience. This project investigated whether BCI can augment the gameplay experience provided by the Microsoft Kinect.

To accomplish this goal a set of three computer game puzzles were devised that use a combination of three input techniques provided by the hardware. The Microsoft Kinect provides both speech recognition and skeletal tracking support, while the Emotiv EPOC provides a simple EEG reading (Figure 2). The EPOC data can be used to determine the state of concentration or relaxation as demonstrated in other BCI based research. [1] [2]

Experiment Design

The experiment was designed with three stages.

- Calibration stage.
- Completion of the three different puzzles.
- A short questionnaire

The calibration stage (screenshot, Figure 1) required participants relax for 20 seconds and then concentrate for the same period. This determined an approximate rescaling factor to make the game playable by every user.

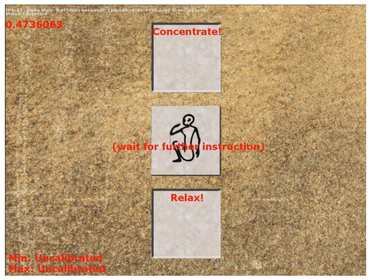

Figure 1. *Calibration Stage.*

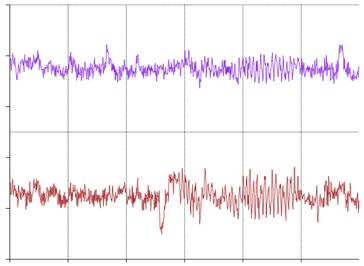

Figure 2. *Alpha waves EEG data.*

The three puzzles included a Tile Puzzle, a Street Puzzle, and a River Puzzle. Figure 3 shows the initial appearance of the Tile Puzzle, the aim of this task was to rearrange the tiles into the correct pattern, however there are no visual cues to suggest the correct pattern. Figure 4 shows the result of the participant relaxing; a hidden image is shown. Through hand gesture and voice commands the puzzle could be solved.

Experiment Design Cont.

The second puzzle used the centre of the hips to position the player while following a thief and changed speed based on the relaxation/concentration state.

The third puzzle required user gestures to grab objects from a moving river. BCI inputs were used to control the perceived rate of time using concentration and relaxation.

The questionnaire was used after these puzzles to establish relevant background information about participants and their thoughts about the experience of using the hardware.

Due to licensing a pair of networked laptops were used to pass the Emotiv EPOC data to the game. Within the puzzles subsequently detected relaxation or concentration states would modify the gameplay state. This was indicated to the participants using the bar seen in Figure 3 and 4 on the left hand side.

Figure 3. *Tile Puzzle with the image hidden.*

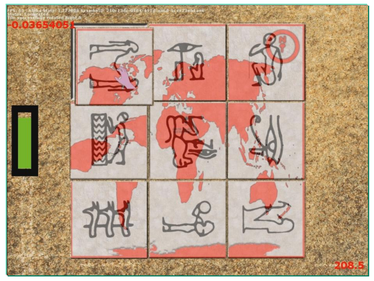

Figure 4. *Tile Puzzle with the hidden image visible.*

Results

There were 15 participants who took part in the experiments. All participants had previous exposure to a variety of game systems and exposure to at least one motion input technology. Some observations from the experiment follow.

- Participants found the BCI difficult to use particularly the changing between mental states, and were highly mixed in their opinion of the improvement to entertainment. The majority felt it added a lot to the challenge and aided replay-ability. (Figure 5)
- The Kinect was found to be generally easy to use for the physical input, but complexities with voice input meant it was rated poorly.
- The interest in BCI being brought into the gaming market was higher than the combination of inputs; however, both were reasonable levels of interest.

Results Cont.

There were a number of issues with the input technologies discovered during testing and from experimentation during design.

- There a level of complexity in setting up and reliably controlling the BCI input. There is a dependence on a good calibration step.
- Muscle movement provided a huge contamination of the EEG data. A likely cause for the data seen in Figure 6.
- Often unreliable or slow speech recognition and jittery input detract from the playability with the Kinect.

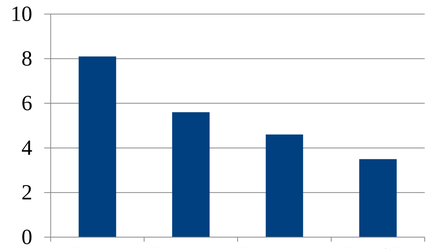

Figure 5. *Average Participant Ratings*

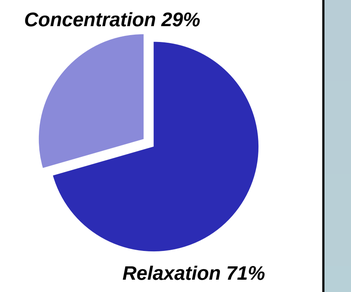

Figure 6. *Average BCI State*

Future Work

Areas for future work in this field include:

- Testing with alternate strategies for calibration, use of BCI data in gameplay, and the amount of time participants are exposed to gameplay.
- Comparing the results against other similar types of hardware.
- Exploration of applications in fields other than games development.

Conclusion

The knowledge gathered by this initial trial will act as baseline data for subsequent experiments with the Microsoft Kinect and Emotiv EPOC. The results and approach to the experiment can be applied to other similar projects that incorporate the use of BCI, speech and/or gesture recognition. The response from participants who took part in this study was one of interest in BCI for gaming technologies. Given these results there may be a potential future for BCI augmentation of Microsoft Kinect gaming systems.

I would like to acknowledge Dr. Sean Fitzgibbon for his support and advice throughout this project.

References

[1] Bos, D.P.-O., Reuderink, B., van de Laar, .B., Gürkök, H., Mühl, C., Poel, M., Heylen, D., Nijholt, A. 2010, *Human-Computer Interaction for BCI Games: Usability and User Experience*.
[2] Van de Laar, B., Bos, D. O., Reuderink, B., and Heylen, D. 2008, *Actual and Imagined Movement in BCI Gaming.*