Development of an Affect-Sensitive Game Agent

Jonathan Jason C. King Li and Tricia Angela A. Monsod
Ateneo Laboratory for the Learning Sciences, Department of Information Systems and Computer Science, Ateneo de Manila University

Introduction

Brain-computer Interfaces (BCIs), a communication link between the brain of a user and a computer, have found their way into the gaming industry. This was a continuation of a previously conducted thesis that developed a prototype of an affect-sensitive game. It addressed several questions, most prominently concerning the proper utilization of the OCZ Neural-Impulse Actuator in order to create affective elements that contribute to the development of an affect-sensitive game. After creating a stable plot for the game, the researchers explored the possibilities of designing a BCI-dependent or affect-sensitive agent that changed accordingly in accordance to the user's brain waves. Table 1 describes the version history of the game in terms of feature implementations.

Feature	Version 1	Version 2	Version 3
Arousal Formula	Arousal = Beta/ Alpha	Arousal = Beta / Alpha	Arousal = ΣBeta >=ΣAlpha
Power Implementations	Eco-empathy: Incremental	Grow: Moving Target	Telekinesis: Moving Target; slows down upon reaching green area
	Ghost: Low Arousal		
	Combustion: Middle-High Arousal		Pyro: Middle-High Arousal
Glowing Interactive Objects	Eco-empathy: Not Implemented	Grow: Not Implemented	Telekinesis: Glows Green
	Ghost: Not Implemented		Ghost: Glows Blue
	Combustion: Not Implemented		Pyro: Glows Red
Arousal Meter Behavior	Erratic		Accelerative – Incremental
Arousal Cursor Staring Point	Eco-empathy: Not Implemented	Grow: Not Implemented	Telekinesis: Not Implemented
	Ghost: Not Implemented		Ghost: High End (right)
	Combustion: Not Implemented		Pyro: Low End (left)
Agent	Not Implemented		Text-based; Professor persona
Story	Isolated Mini-Stages	Partial Story with cutscenes	Complete Story with implemented cutscenes through the agent

Table 1: Previous Versions of School of Thought

Methodology

Instruments

To develop the affect-sensitive game, the researchers made use of the OCZ Neural-Impulse Actuator (NIA) and headset. It is a noninvasive device that requires minimal set-up time. The headset consists of three diamond shaped conductor plates that will be bound to the forehead by a rubber headband, as shown in Figure 1. This is connected to the NIA device, which is then connected by USB to a computer. The computer must be properly grounded to lessen electromagnetic interference.

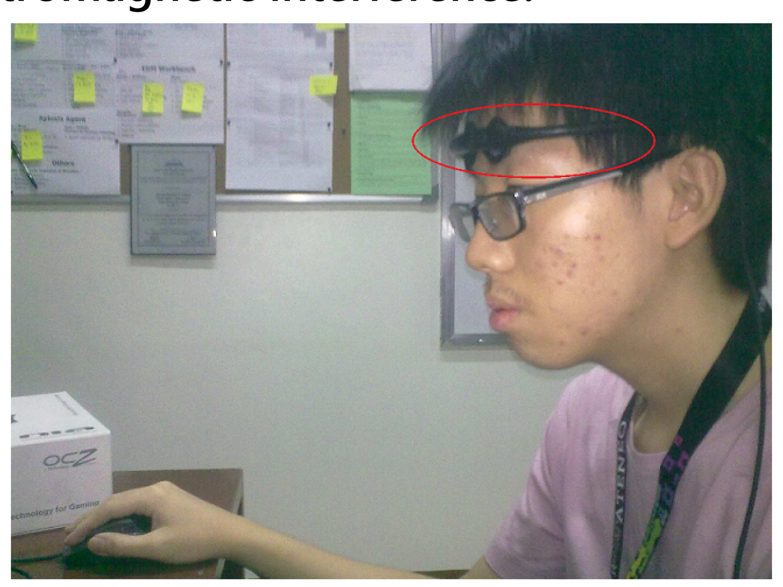

Figure 1: Test subject wearing the NIA headset on his forehead

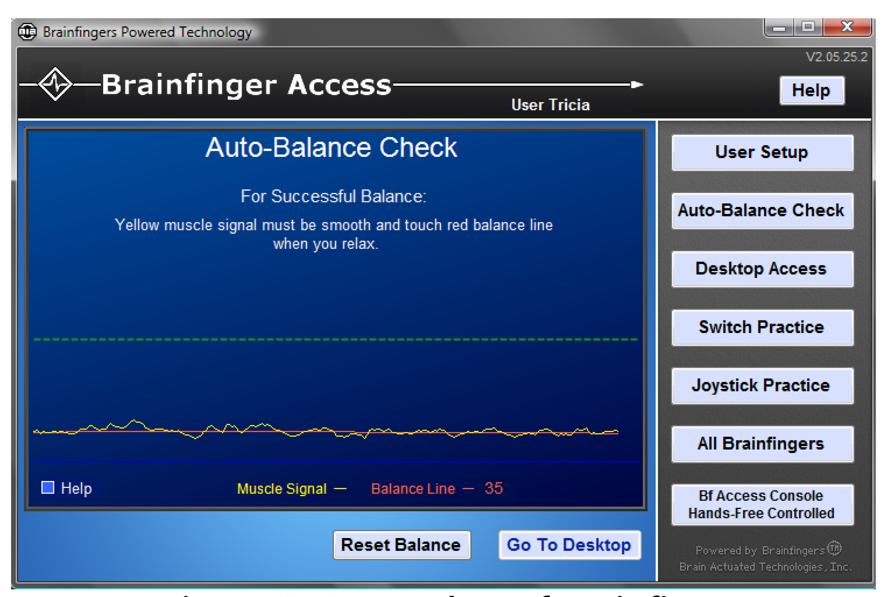

Figure 2: Screenshot of Brainfingers

The data collected from the NIA is passed through to the Brainfingers Access Software, which computes for several Brainfingers that span the controllable frequency range of the user's forehead signal. These Brainfingers are responsive to user's eye movements, alpha and beta brainwaves as well as facial muscle activity [3]. Figure 2 shows a screenshot of the software. Software version 2.0.5.25.2 nia 1.0 is the particular version of Brainfingers software used by the researchers that allows the writing of Brainfingers data to a shared memory space. This allows programs to access the shared memory space and get date in real time. In this case, the program would be the affect-sensitive game.

Arousal Implementation

Previous research has shown that arousal can be expressed through "excitation presented [with] a higher beta power and coherence in the parietal lobe, plus lower alpha activity" [1], which they also refer to as the "beta-alpha ratio" [1]. To exhibit this, the researchers have come to estimate arousal as a condition where

$$\Sigma \text{ Beta} >= \Sigma \text{ Alpha}$$

that causes players to sustain arousal and meet their goals much more freely. This condition also allows players to adjust their excitement accordingly to any shifts in their own arousal [6].

Agent Implementation

The agent is found in-game with an objective to aid the player in learning the new technology. Like the game, it is also affect-sensitive, reading the player's brain signals, and is only active when the player moves to a new stage to narrate the story, when the player is having a hard time accomplishing an affect-sensitive task exhibiting a state opposite to the required state, and after when the player has accomplished said task. To ensure minimal distractions for the player, the agent at this point is purely text-based.

Game Design

School of Thought is basically a story-driven game that revolves around a titular character gifted with three powers (pyro, ghost and telekinesis) that has been kidnapped for experimentation with the goal of escaping the castle while utilizing their powers to get past obstacles. Figure 3 shows a screenshot of the game interface.

The active power is denoted by an icon, cycled through using muscle tension picked up by the OCZ-NIA. The arousal meter gauges how much brain activity the player has, doubling as feedback to assist players in knowing how near or far they are from reaching the goal of certain tasks. The supplementary arousal orb changes colors within a red-blue spectrum, signalling arousal and non-arousal respectively.

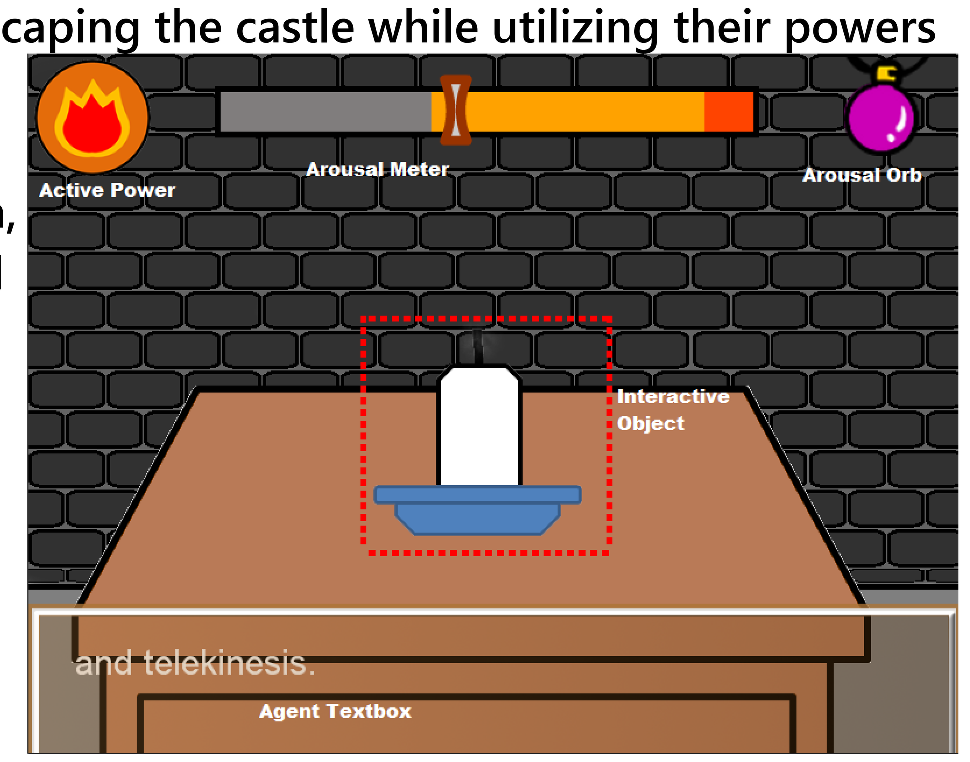

Figure 3: Game Interface

Interactive objects are those which can be manipulated on by the three powers. The agent textbox is allotted for the text-based agent for narration and motivational dialogue purposes.

Results

Alpha and Beta Testing

Both streams of testings gathered 10 participants each (7 males, 3 females and 6 males, 4 females respectively). The dynamic change towards the beta test included the addition of extreme opposites in agent motivational dialogue to account for the different brain activites of the different participants.

Figure 4 displays a summary of findings, generating the average rating of particular components of the game concept and the use of Brainfingers as a means of control. Observations and comments by the players were taken into account in making the discussions that are not found in the surveys.

Component	Alpha Average Rating	Beta Average Rating
Agent Helpfulness	3.20/5	4.40/5
User Interface	4.10/5	4.30/5
Music	3.80/5	3.80/5
Art Assets	3.50/5	3.50/5
Replayability	3.80/5	4.30/5
Recommend	4.30/5	4.90/5
Overall	3.78/5	4.20/5

Game Concept: Likert scale: 1 – strong disagreement, 3 – neutral, 5 – strong agreement

Component	Alpha Average Rating	Beta Average Rating
Overall use of Brainfingers	3.80/5	2.80/5
Using muscle signal to change powers	4.20/5	4.20/5
Using Pyro power	3.60/5	3.70/5
Using Ghost power	3.80/5	2.90/5
Using Telekinesis	3.20/5	2.20/5
Overall	3.72/5	3.16/5

Use of Brainfingers: Likert scale: 1 – too hard, 3 – just right, 5 – too easy

Figure 4: Results of Alpha and Beta Tests

Discussions

Elements of a Good Affect-Sensitive Game

Aside from the classical elements of any game such as plot and aesthetics, the novel modality should be taken into consideration. Since the modality is new, the learning curve is already steep, therefore the challenge of the game should be tempered with assistance from the game itself. Based on observations made on how players interact with the game, there is a tendency to seek ways by which a player could be creative with their powers in-game by providing more challenge to the game despite the natural difficulties presented by the BCI to avoid repetitiveness of the game. In the end this typical fact is reaffirmed despite having a novel modality.

Parameters of Human Control

The OCZ-NIA has an advantage in its simplicity since it can be easily worn and taken off when need be. Aside from keeping the controls as intuitive as possible, directions should note to players that they are free to experiment on ways to fulfill mental tasks such as the use of physical movements or even experiment with different mental states as the player deems fit.

Affect-Sensitive Agent Implementation

Based from the observations made during testing, there seems to be a tendency for the players to ignore the helper agent when it senses that the player is having a hard time. Therefore, crucial instructions should not be written by the agent since it has to remain in the player's margins of attention. Helper agents, affect-sensitive or not, should stay unseen when not needed, to preserve the player's attention to the game, but should be present and trustworthy when needed.

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