Affective Gaming: a GSR Based Approach

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Abstract: - Affective computing is described as computing influenced by emotions, the idea behind affective gaming is to establish a correlation between a player emotional state and gameplay satisfaction by allowing a computer game to successfully detect and adapt to the player emotional state based on Biofeedback. This paper describes a preliminary study aimed at investigating whether GSR can be used to acquire information regarding the affective state of a player while playing a first person shooter game. The results indicate that the amplitude and frequency of phasic events is modulated by the level of difficulty of the game. These results support the possible role of affective computing in the context of game play and suggest that game play can be customised to the user's emotional state.

Key-Words: - Affective computing, affective gaming, autonomic computing, decision support systems, first person shooter gaming, galvanic skin response.

1 Introduction

Can a computer game be considered an information system in the classical sense? Probably not – but clearly games provide players with a range of decision making opportunities that need to be rendered in real-time and have potentially realistic consequences – at least for our avatars! Gaming provides us with an opportunity to examine how people respond to challenges with various amounts of information at their disposal. How are our decisions affected by our mental state is a very relevant question. Do we perform as well when bored as opposed to highly aroused? This paper presents a preliminary study which provides a platform for addressing such questions. A basic first-person shooter (FPS) game has been developed that provides levels which are designed to provide varying degrees of stimulation to the player. The arousal state of the player is recorded using their galvanic skin response (GSR), recorded during game play. To find out if increasing the player's level of excitement over a certain amount of time will enhance the gaming experience resulting in a better more pleasant gaming experience. Further, by examining the score, a rough estimate of the role of arousal level has on performance can be acquired. By manipulating the arousal level of the player, one can acquire quantitative information regarding the role of affective state (arousal level in this case) and performance. This is the essence of 'affective gaming.' The Affective Gaming concept was first introduced by Wehrenberg, Charles through using Biofeedback to control a game based on relaxation level, it was the earliest research for correlating a game with biofeedback and after years of research the project was first implemented in 1984 for apple II computers, and the test results proved that human arousal level can actually be measured through GSR and used to control a game [1]. Since that time other researchers have been done to prove that biofeedback can be used as a control mechanism for gaming, yet game designers did not consider the concept hence no further research was done into its implementation and commerciality, until recently when game designers realised that the process of player engagement require more than the conventional conscious control instructions, As a result the idea of correlating biofeedback in game technology was brought back to life in the Game Developers Conference by incorporating biofeedback as a secondary control mechanism alongside the conventional conscious control mechanisms, in order to autonomously vary game engagement, making game engagement unique for each individual without producing different version of the game and without prompting the player with a test in the beginning to try to understand his personality or assess his gameplay ability, as it is hard for human beings to judge themselves [2].

Jahng and colleagues published a study that examined the consistency of ANS responses with film clips that induce sadness and disgust emotions [3]. In this study, twelve college students were selected (6 males and 6 females) where both ECG and EDA data was recorded prior to the start of the experiment for 1 min and during the experiment for 2-4 minutes, afterwards each subject was given a self-assessment form to rate the amount of sadness or disgust they felt, the result of the self-assessment form was consistent with the data recorded for both EDA, ECG and the emotional response intended from the film clips showing emotion-specific physiological patterns. In another study by Jang and colleagues aiming to examine brain function and skin conductance responses influenced by fear emotion using audio-visual films [4]. In this study, 13 college students were selected where ECG and EDA data was recorded for 1 minute prior to the experiment and for 2 minute during the experiment, and the result showed again consistency between the result obtained from ECG, EDA and the emotional response intended by the film clips in this case the fear emotion. As a result of these two researches mentioned formerly it is proven that Electro dermal response can validly model change in emotions.

A study by Mandryk and Atkins was designed to evaluate the user (player) emotional state during interaction with play technologies [5]. In order to reach a model for modelling physiological signals into arousal and valence and then transform arousal and valence into five emotional states relevant to computer game play which are boredom, challenge, excitement, frustration and fun mainly to reach a method for quantifying emotional states during a play experience. For this experiment 24 participant were chosen 12 to generate the emotional model while the other 12 to validate it, the participant played a game under 3 conditions, the first was against a computer, the second against a co-located friend and the third against a co-located stranger the reason behind these 3 different conditions as the user states.

> "We were not interested in whether there was a difference between playing against a friend, a stranger, or a computer. We have observed many groups of people playing with interactive technologies, and we know that these three play conditions yield very different play experiences; rather, we were interested in whether our model of emotion could detect the differences between the conditions. [5]"

During that experiment both audio and video were captured to record the users' facial expressions and use of controller. As the user states "Using GSR as an example, a global minimum and maximum GSR were obtained for each participant using all three conditions and the rest period" these values where used to normalise values obtained under each of the three conditions following the formula present in equation 1.

$$\text{Normalized GSR}(i) = \left(\frac{\text{GSR}(i) - \text{GSR}_{\min}}{\text{GSR}_{\max} - \text{GSR}_{\min}}\right) \times 100. \quad (1)$$

The authors state that the difference in physiological data between individuals is very large and normalisation was a vital step in order to perform group analysis over the test results. The twelve subject whom were not used in calculating the model where used to test it where the mean modelled emotions from those twelve subjects, and the reported emotions were analysed with a Friedman test, the outcome of

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the analysis was consistent with predictions based on the model derived from the results of the first twelve subject proving that the emotion of a person can be quantified and measured during interaction with entertainment technologies, not only revealing the variance between different emotions but revealing the variance within each emotion, showing that entertainment technologies can induce changes in a players emotions and arousal level.

2 Problem Formulation

This section will detail the sequence of tasks and actions that will be carried out in order to allow a computer game to monitor a player emotional state, and take certain actions according to the players' autonomously monitored biofeedback, to establish that by keeping the players within certain levels of arousal during the gaming experience results in a better more pleasant gaming experience, test subjects are expected to be of different age groups and gender, and each will have different personality and mental abilities, hence all variations between individuals must be identified, so that if a difference in behaviour exist it can be contributed to a specific factor.

The experiment will proceeds as follows, 9 subjects will be chosen, each 3 will belong to a different age group for example 3 subjects will be above eighteen, the other 8 subjects are under eighteen and the final 3 subjects are above 20, almost half of the test subjects will be females and one third of the test subjects will be left handed, each subject will test the game twice, the first time they will test the game GSR biofeedback will be recorded however the game will make no adjustment to the gameplay based on variation in SCL, afterwards the test sample will be given a questionnaire assessing their level of enjoyment while playing the game with respect to graphics and sound effects and any other factors the test subjects might point out, not only that but the questionnaire will also asses the predictability of the game events and whether the test subjects felt that some parts were too repetitive or not, which will help identify certain points along the gameplay experience where SCL is expected to be relatively low. The second time the subjects are going to test the game the GSR biofeedback will be used as a secondary control mechanism where the game will make adjustment to itself based on the rise and decline of the player SCL values with respect to time, so if the player show rise in SCL for a certain amount of time among the counter measures might be reducing the game difficulty or slowing the game pace, and on the contrary if the player show decline in SCL for a certain amount of time the counter measures might include increasing the game difficulty, showing a hint or carrying out a random event from a list of random events.

At the moment, we have worked with 2 subjects in a preliminary test of our system. The subjects were informed that they would be participating in an experiment where they would have their GSR tested while playing a custom developed computer game. The experiment was conducted in a quite laboratory, with the subjects sitting on a large comfortable chair, the computer game was projected onto a screen 2 meters from the subject, and the subjects interacted with the game using a standard PC keyboard. The subjects were fitted with headphones to minimise any ambient noise and the room lighting was reduced to enhance display contrast. Each subject played the game for 20 minutes, at which time they were debriefed. All subjects were told they could leave at anytime during the course of the experiment.

The GSR was recorded using finger electrodes placed on the left hand (index and middle finger, proximal joints) using a Vilistus 4-channel DSU. The data was acquired at 128 Hz, and stored for subsequent data processing. The subjects were instructed to sit in the chair – and their GSR was recorded for 2 minutes prior to the start of the game in order to ensure the signal was being properly acquired and also to acquire data that would serve as a control for the remainder of the experiment. As a preliminary experiment, the goal was to determine if the game could elicit a stress response from the subject during various phases of the game. Stress would be induced as a function of the level of play difficulty. The timing between play and recording time was fully synchronised in order to map the GSR response to the play level. The game was divided into two basic levels: difficult and non-difficult. The recordings for each class were pooled together except at the boundaries when the level switched from difficult to non-difficult and vice versa. For these segments, data within 1 minute from either end were removed to reduce noise induced by these transitions. When this experiment was completed, the subjects were queried regarding how they felt about the game – whether they perceived any particular sections more difficult than the other – and these points were recorded and noted as points of interest during the analysis phase.

In the next experiment, the difficulty level was randomly set such that the play was interleaved and balanced between play levels. The principal task here was to acquire the score from the player during low and challenging play periods in order to see if there was any difference that could be attributed to level of difficulty. Care was taken to ensure that practise effects were minimised, so a fully balanced skill level paradigm was implemented. Scores were acquired while the player was engaged in low and high difficulty level and the results are reported in the next section.

3 Problem Solution

The first result acquired from this study was that the game did induce feelings of stress at the same time points, as reported by all subjects deployed in this study. The players' GSR was recorded during play and the GSR data was pooled according to difficult/non-difficult regions and the data was analysed according to several features: Phasic responses were investigated with respect to the frequency and amplitude of the responses throughout the two phases of the game. The results indicate that during the stressful periods (increased level of play difficulty), the skin conductance level increased and the frequency of spontaneous GSRs increased somewhat (from 0.5 to 2.3 per minute on average). It was clearly evident from the GSR which phase of the game the player was involved in within 60 seconds of recording inspection. The result of the GSR recording is also to be deployed to alter the difficulty level of the game. The goal with this approach to gaming is to provide subjects with a balance between basic and advanced play – such that the player feels comfortable with the level of difficulty – as measured using GSR. This is accomplished by providing the results of the GSR back to the game - whereby the game logic uses the value of the affective state of the player to adjust the difficulty level according to a player-centric requirement. Further, we wished to determine if level of arousal had any effect on the players' score – a reflection of player performance. The results indicated that player's score consistently higher when aroused (by increasing the difficulty level of the game).

4 Conclusion

This preliminary study provides data that demonstrates that GSR can be used to acquire some aspects of the affective state of a player engaged in playing a computer game. The results from this study provide quantitative information regarding the changes in SCL as a function of difficulty level of a first-person shooter game. These results are encouraging, as GSR data is easy to collect – a sensor could be placed on a mouse or game controller which in turn could record GSR levels in real time, transmitting the data via Bluetooth or WiFi to a remote computer for data analysis. The GSR data was treated as a binary switch – that indicates whether or not the player is undergoing stress during game play. This is the essence of a burgeoning interface for gaming – instead of basic I/O devices that acquire motoric input from the player – we are able to acquire cognitive effects of the game – as is related via the responses of the autonomic nervous system. This is the basis of what has been termed 'cognitive gaming.' Its aim is to enhance the quality of the experience a player acquires during game play. Further, the player can tailor the game to meet their needs – as opposed to taking it or leaving it as most games are

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designed. That is, a player can adjust the difficulty level without having to resort to menu options – possibly saving and re-loading the game. Instead, the game adjusts at possibly many levels to the affective state of the player.

Further, this study demonstrates that the affective state of the player can influence performance. In this study, the increased difficulty level actually increased the score – a seemingly counter-intuitive result. This may simply reflect the increased engagement of the player which in turn my enhance their overall sensitivity to audio-visual stimuli and enhanced their reaction times. Unfortunately, this study does not allow us to make clear conclusions in this regard. One should generate a level of arousal that is independent of the game and then ask the player to engage in both low and high level of difficulty to see how the scores vary with difficulty level. This task will be performed during the next stage of this work.

Another issue to be addressed is how easily and how accurately can the affective state be acquired – without burdening the player with a myriad of electrodes? To this end, a comprehensive analysis of the various biosignal sensors (EEG, ECG, BVP, EMG, GSR, etc) must be investigated in terms of their sensitivity and specificity with respect to acquiring data regarding the affective/cognitive state of the player. This analysis is constrained in that the analysis should be performed in real-time – perhaps a GPU could be dedicated towards this end as they are capable of performing large number of FLOPS in parallel? The issue then becomes one of testing the sensitivity of these biosignals under controlled scenarios that reflect what is to be expected from typical game play. The move towards cognitive gaming will take time – in the meantime gamers will continue their activities. Existing games will provide a more significant challenge as they were not designed with cognitive play in mind. Newly developed games should take into account the possibility that the cognition of the player – especially their affective states is an important input into the system. A cognitive/affective engine should be developed that would provide the necessary functionality to allow seamless integration of biosignal based affective estimation into the game at the appropriate level. This works serves as the very foundation of that strategy.

References:

[1] Wehrenberg, C. C. (1995). *Will ball.* Solozone.

[2] Game Developers Conference 2011: In The Trenches. (2011). *Game Developers Conference.*

[3] Jahng, H. E., Lee, Y. C., Chung, M. A., Chung, S. C., & Sohn, J. H. (2008). Reliability of ANS responses induced by sadness and disgust induce by audio-visual film clips. *Journal of Psychophysiology*, 271.

[4] Jang, H. E., Suk, W. J., Lee, C. Y., & Sohn, H. J. (2008). Brain function and EDA response while seeing fearful film clips. *Journal of Psychophysiology*.

[5] Mandryk, R. L., & Atkins, M. S. (2007). A fuzzy physiological approach for continuously modeling emotion during interaction with play technologies. *Human-Computer Studies*.

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