Play Experience Enhancement Using Emotional Feedback

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Abstract

Abstract less than or equal to 1 page one page stating what the thesis is about highlight the contributions of the thesis

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List of Abbreviations

TT	Thought Technology
GSR	Galvanic Skin Response
EMG	Electromyography
HR	Heart Rate
BVP	Blood Volume Pulse
EDA	Electrodermal Activity
HCI	Human Computer Interaction
AV	Arousal/Valence
NPC	Non-Player Character
Mod	Modification

Chapter 1

Introduction

Since computers are playing a significant role in our daily life, the need for a more friendly and natural communication interface between human and computer has continiously increased. Making computers capabale of perceiving the situation in terms of most human specific factors and responding dependent to this perception is of major steps to acquire this goal. If computers could recognize the situation the same way as human does, they would be much more natural to communicate. Emotions are of important and mysterious human attributes that have a great effect on people's day to day behavior. Researchs from neuroscience, psychology, and cognitive science, suggests that emotion plays critical roles in rational and intelligent behavior [16]. Apparently, emotion interacts with thinking in ways that are nonobvious but important for intelligent functioning [16]. Scientists have amassed evidence that emotional skills are a basic component of intelligence, especially for learning preferences and adapting to what is important [13, 8] People used to express their emotions through facial expressions, body movement, gestures and tone of voice and expect others understand and answer to their affective state. But sometimes there is a distinction between inner emotional experiences and the outward emotional expressions [15]. Some emotions can be hard to recognise by humans, and inner emotional experiences may not be expressed outwardly [9]. Recent extensive investigations of physiological signals for emotion detection have been providing encouraging results where affective states are directly related to change in inner bodily signals [9]. However whether we can use physiological patterns to recognise distinct emotions is still a question [16, 4].

Although the study of affective computing has increased considerably during the last years, few have applied their research to play technologies [21]. Emotional component of human computer interaction in video games is surprisingly important. Game players frequently turn to the console in their search for an emotional experience [18]. There are numerous benefits such technology could bring video game experience, like: The ability to generate game content dynamically with respect to the affective state of the player, the ability to communicate the affective state of the game player to third parties and adoption of new game mechanics based on the affective state of the player [21]. This work concentrates on developing a real-time emotion recognition system for play technologies which can quantify player instant emotional state during a play experience The rest of the paper is organized as follows: in Section 2 we outline different emotion recognition theories with an overview of physiology sensors. In Section 3 we demonstrate some implementation details of the system. We then describe the experimental setup in Section 4 before giving our results in Section 5. Finally, we give conclusions in Section 6.

Chapter 2

Emotion and Play Technologies

Using emotional responses to increase the level of users interaction with a real-time play technology requires an effective technique to identifying specific emotion states within an emotional space. Major existing emotion models in the psychology literture includes: basic emotion theory [6, 7] , dimensional emotion theory [10, 19] and models from appraisal theory (e.g., [17]) [23]

Basic emotion theory identifes anger, disgust, fear, happiness, sadness, and surprise [14] as the consice set of primary emotions. These are actually the least six universal categories researchers agreed upon [22]. It also claims these primary emotions are distinguishable from each other and other affective phenomena [5]. On the other hand dimensional emotion theory argues that all emotional states reside in a two-dimensional space, defined by arousal and valence.

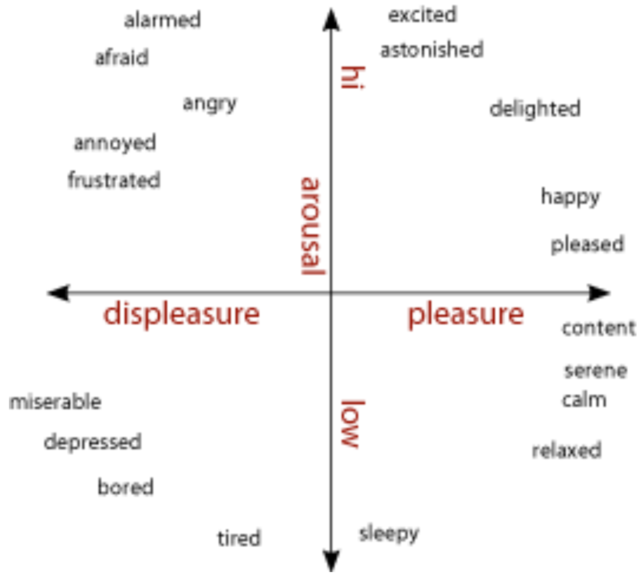
While there are various opinions on identifying emotional states, classifcation into discrete emotions [5], or locating emotions along multiple axes [20, 10], both had limited success in using physiology to identify emotional states [3].

Lang used a 2-D space defined by arousal and valence (pleasure) (AV space) to classify emotions [10]. Valence can be described as a subjective feeling of pleasantness or unpleasantness while arousal is the subjective state feeling activated or deactivated [1]. Using an arousal-valence space to create the Affect Grid, Russell believed that arousal and valence are cognitive dimentions of individual emotion states. Affect is a broad definition that includes feelings, moods, sentiments etc. and is commonly used to define the concept of emotion [15]. Russell's circumplex model has two "axes" that might be labeled as displeasure/pleasure (horizontal axis) and low/high arousal (vertical axis) It is not easy to map affective states into distinctive emotional states, However these models can provide a mapping between predefined states and the level of arousal and valence [22], Figure 2.1.

Both mentioned models for identifying emotions convey some practical issues in emotion measurement. In a HCI context, the stimuli for potential emotions may vary less than in human-human interaction (e.g., participant verbal expressions and body language) [23] and also the combination of evoked emotions [14]. However with help of physiological signals and the fuzzy logic in the model we are going to use, such issues with our dimentional emotion models would be minimized. Though it is anticipated to observe different range of evoked emotions while interacting with play technologies compared to interacting with other humans in

[1] Photo credit: http://imagine-it.org/gamessurvey/

Figure 2.1: Russell's circumplex model with two axes of arousal and valence [1].



daily life. [23]. However our dimensional emotion models suffers some other problems. One problems is that arousal and valence are not independent and one can impact the other [12]. Continuously capturing emotional experiences in this applied setting is of its other halmarks. Subjective measures based on dimensional emotion theory, such as the Affect Grid [20] and the Self-Assessment Manikin [2], allow for quick assessments of user emotional experiences but they may aggregate responses over the course of many events [23]. This work uses Mandryk et al. version of AV space [12].

2.1 What is Emotion?

2.2 Play Technologies and Emotion

2.3 Emotion and Physiological Signals

2.4 Adaptive Play Technologies

Chapter 3

Customizing Play Experience in Real-Time

3.1 Adaptive Game Design

3.1.1 Player

3.1.2 NPCs

3.1.3 Environment

3.2 Phisiological Signals

3.2.1 Heart Rate

3.2.2 Galvanic Skin Response

3.2.3 Facial Electromyography

3.3 Real-Time Affect Engine

3.3.1 Fuzzy Logic for Space Transformation

3.3.2 Physiological Signals to Arousal and Valence

Chapter 4

Implementation and Integration

4.1 Recognising Emotion

Heart rate (HR), blood pressure, respiration, electrodermal activity (EDA) and galvanic skin response (GSR), as well as facial EMG (Electromyography) are of physiological variables correlated with various emotions most. Interpreting physiological measures into emotion state can be deficult, due to noisy and inaccurate signals, however recent on-going studies in this area by Mandryk and Atkins [12] presented a method to continuously identifying emotional states of the user while playing a computer game. Using the dimentional emotion model and the fuzzy logic, based on a set of physiologcial measures, in its first phase, their fuzzy model transforms GSR, HR, facial EMG (for fowning and smiling) into arousal and valence variables. In the second phase another fuzzy logic model is used to transform arousal and valence variables into five basic emotion states including: boredom, challenge, excitement, frustration and fun. Their study successfully revealed self-reported emotion states for fun, boredom and excitement are following the trends generated by their fuzzy transformation. The advantage of continiously and quantitatively assessing user's emotional state during an entire play by their fuzzy logic model is what makes their model perfect to be in incorporated with real-time play technologies. Therefore exposeing user's emotional state as a new class of uncontious inputs to the play technology.

4.2 Affect Engine

This project has developed a real-time emotion detection system which can continiously detect and recognise user's emotional state. The system uses Blood Volume Pulse (BVP), Galvanic Skin Response (GSR) and Electromyography (EMG; for frowning and smiling), to classify human affective states in 2-dimensional valence/arousal space, Figure 2. The system has three modules, Figure 4: The Blood Volume Pulse (BVP) signal is a relative measure of the amount of blood owing in a vessel. From BVP we calculated heart rate and heart rate variability. The heart rate is known to re ect emotional activity and has been used to differentiate between both negative and positive emotions as well as different arousal levels [11] The Galvanic Skin Response (GSR) sensor to measure the skin's conductance (between two electrodes and is a function of sweat gland activity and the skin's pore size). As a person becomes more or less stressed, the skin's conductance increases or decreases proportionally [15].

The sensor module includes a Thought Technology ProComp Infinity encoder [11] connected to PC with a USB cable. SensorLib is the basic module which receives and filters raw physiological inputs. Then filtered signals are fuzzified by the use of 22 fuzzy rules in the first phase of transformation. Then generated arousal and valence values are transformed into emotion values using another 67 fuzzy rules in the second pass [12]. Appliactions such as games can easily integrate the system where emotion recognition can offer adaptive control to maintain user interest and engagement. Once connected via sensors to the emotion recognition system, the affective state of the user can be captured continuously and in real-time and it can be monitored on a displayed 2-dimenstional graph of valance and arousal, Figure 1.

4.3 Inegration With Valve Source Engine

4.3.1 Level Design

4.3.2 The Director

Chapter 5

Experimentation

5 to 10 pages talk about the experimentation adequacy, efficiency, productiveness, effectiveness (choose your criteria, state them clearly and justify them) be careful that you are using a fair measure, and that you are actually measuring what you claim to be measuring if comparing with previous techniques those techniques must be described in Chapter 2 be honest in evaluation admit weaknesses

Chapter 6

Discussion

5 to 10 pages talk for the discussion State what you've done and what you've found Summarize contributions (achievements and impact) Outline open issues/directions for future work

References

[1] Lisa Feldman Barrett. Discrete emotions or dimensions? the role of valence focus and arousal focus. *Cognition & Emotion*, 12(4):579–599, 1998.

[2] Margaret M Bradley and Peter J Lang. Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry*, 25(1):49–59, 1994.

[3] John T Cacioppo, Gary G Berntson, Jeff T Larsen, Kirsten M Poehlmann, Tiffany A Ito, et al. The psychophysiology of emotion. *Handbook of emotions*, 2:173–191, 2000.

[4] John T Cacioppo, Louis G Tassinary, et al. Inferring psychological significance from physiological signals. *American Psychologist*, 45(1):16–28, 1990.

[5] Tim Dalgleish, Michael J Power, and John Wiley. *Handbook of cognition and emotion*. Wiley Online Library, 1999.

[6] Paul Ekman. An argument for basic emotions. *Cognition & Emotion*, 6(3-4):169–200, 1992.

[7] Paul Ekman et al. Are there basic emotions. *Psychological review*, 99(3):550–553, 1992.

[8] Daniel Goleman. *Emotional intelligence: ; why it can matter more than IQ*. Bantam, 2006.

[9] Christian Martyn Jones and Tommy Troen. Biometric valence and arousal recognition. In *Proceedings of the 19th Australasian conference on Computer-Human Interaction: Entertaining User Interfaces*, pages 191–194. ACM, 2007.

[10] Peter J Lang. The emotion probe. *American psychologist*, 50(5):372–385, 1995.

[11] Thought Technology Ltd. Procomp Infinity Hardware Manual. http://www.thoughttechnology.com/manual.htm/, 2013. [Online; accessed 20-April-2013].

[12] Regan L Mandryk and M Stella Atkins. A fuzzy physiological approach for continuously modeling emotion during interaction with play technologies. *International Journal of Human-Computer Studies*, 65(4):329–347, 2007.

[13] John D Mayer and Peter Salovey. The intelligence of emotional intelligence. *Intelligence*, 17(4):433–442, 1993.

[14] Christian Peter and Antje Herbon. Emotion representation and physiology assignments in digital systems. *Interacting with Computers*, 18(2):139–170, 2006.

[15] Rosalind W Picard. Affective computing: challenges. *International Journal of Human-Computer Studies*, 59(1):55–64, 2003.

[16] Rosalind W. Picard, Elias Vyzas, and Jennifer Healey. Toward machine emotional intelligence: Analysis of affective physiological state. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, 23(10):1175–1191, 2001.

[17] Ira J Roseman. A model of appraisal in the emotion system: Integrating theory, research, and applications. 2001.

[18] Richard Rouse III and Steve Ogden. *Game design: Theory and practice.* Jones & Bartlett Publishers, 2010.

[19] James A Russell. A circumplex model of affect. *Journal of personality and social psychology*, 39(6):1161–1178, 1980.

[20] James A Russell, Anna Weiss, and Gerald A Mendelsohn. Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social psychology*, 57(3):493–502, 1989.

[21] Jonathan Sykes and Simon Brown. Affective gaming: measuring emotion through the gamepad. In *CHI'03 extended abstracts on Human factors in computing systems*, pages 732–733. ACM, 2003.

[22] Nelson Zagalo, Anthony Barker, and Vasco Branco. Story reaction structures to emotion detection. In *Proceedings of the 1st ACM workshop on Story representation, mechanism and context*, pages 33–38. ACM, 2004.

[23] Tao Zhang, David B Kaber, Biwen Zhu, Manida Swangnetr, Prithima Mosaly, and Lashanda Hodge. Service robot feature design effects on user perceptions and emotional responses. *Intelligent Service Robotics*, 3(2):73–88, 2010.

Appendix A

Fuzzy Functions

put fuzzy functions here