Emotions Driven Videogame Interactive Music System

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Abstract. The indisputable capacity of music to generate emotions has dragged along a research tradition studying the effects of music as a means of communication, expression or emotional induction. The observation of the effects caused by the emotions that music arouses, the type of most recurring emotions and the reasons why people experience emotions are aspects that have been broken down, often without reaching definitive conclusions.

The challenge of being able to lay the scientific bases for the correct measurement and study of emotions, approached firstly from Psychology, also implies the correct choice of the measurement methods used, both over the physiological and cognitive human reactions.

By transporting these methodologies to the field of film music, some authors have demonstrated the specific effects of music on the emotions and perception of the audiovisual viewer and at the same time the effectiveness of the measurement systems. Recently, the measurement of emotions related to music in the interactive environment (video games) has been approached in different works, evidencing the influence of music on the gaming experience and immersion.

This work aims to take advantage of the measurement of the physiological response to emotional stimuli (specifically through one of the methods that best respond in real time to changes in emotion, the Galvanic Skin Response), as a triggering element of the changes generated in the interactive music selection system used in video games. This way, the music of the game can change depending on the physiological reactions of the player, instead of responding to the state of the game or other variables of the action itself, thus generating a personalized experience for each individual.

So far, this system has proved to be a valid alternative way to generate interactive experiences that take in consideration the unconscious individual emotional reactions and add them to the gaming experience equation.

Keywords: Music Emotions, Emotions Medition, Interactive Music System, Individualized Gaming Experience.

1 Introduction

This work is part of a doctoral thesis, in which some of its parts are in progress. It addresses the Measurement of Emotions and how this can be used as a means to generate an individualized gaming experience in video games.

As stated by Schtachter and Singer [1], emotions consist of a physiological component in addition to a cognitive response. These are also key elements in the measurement of musical emotions, as suggested by Juslin [2] or Dainow [3].

The measurement of emotions in music has been used by several authors. Khalfa [4] observes differences in respiratory rhythm between a "happy" song and a "sad" song. Dainow [3] documents the effects of music on Galvanic Skin Response (GSR) measurements and underlines the importance of Dual Analysis. Watanabe et. al [5] verified the influence that the tempo of the music has on the heart rate (HR). Elrich et al [6] proposed a looping system in which the brain's physiological response elicited by music is in turn reused to modify the music.

Taking into account the audiovisual element, Baumgartner et al. [7] verified that the images accompanied by music evoke cognitive responses of emotion and intense sensations. Thayer et al. [8], experimented with the visualization of a film with shocking scenes, and were able to measure alterations in the GSR and HR depending on whether the music accentuated those scenes or tried to minimize them. Koriat et al. [9] used films with dialogues after doing other previous desensitization processes (with and without music), using the measurement of cognitive experience. Thayer [10] observed the increase in stress due to particularly shocking images in a well-known documentary on occupational safety, depending on whether or not music was used, through HR and GSR.

Finally, in the most recent field of Videogames there have also been experiences with measuring emotions. Hébert et al. [11] verified the increase in the level of cortisol in the blood according to the use of music in a game. Ravaja et al. [12] used Dual Analysis with HR and electromyogram (EMG) to conclude that the interaction in the game with a real human player increases the emotional response. Cassidy & MacDonald [13] observed that the music known to the player creates a greater involvement of the player in the game. Williams [14] measured the effects that the use of Algorithmic Composition had on the subject in substitution of the original musical pieces in a video game. More recently, Granato [15] studied the design of a methodology for measuring emotions in video games, starting from physiological multi-analysis and suggesting the use of these systems for innovation in video games.

The present work wants to investigate whether it is possible to improve the individual game experience by integrating emotional physiological measurement into the Interactive Musical System (IMS), thus allowing the player's own emotions to determine the changes in mood reflected by the music. In this way, a loop is also generated between the music and the player's mood that can be used to create a more organic and immersive gaming experience. If compared to a conventional IMS, emotion driv-

en IMS involves the actual player's psycho-emotional state in the music selection process, which in turn also affects the player's emotional state (see Fig. 1).

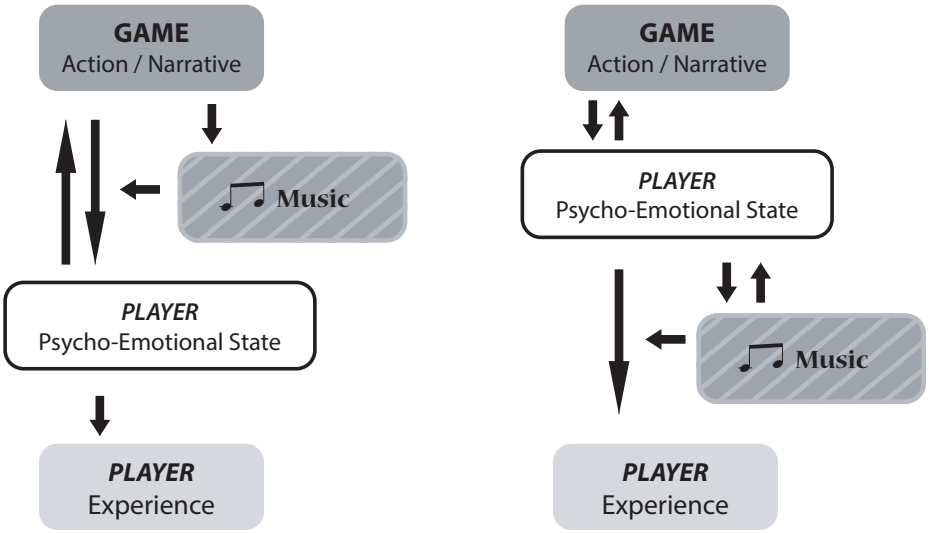

Fig. 1. Comparison of a conventional IMS (left) and the proposed emotion driven IMS (right).

2 Content and Methods

2.1 Interactive Music System (IMS) Design

The used IMS is conceived to work with a videogame level. It has an structure of 4 States that increase in intensity and stress level (E1_Calm, E2_Alert, E3_Danger, E4_Life_Or_Death). Four looped musical sequences of the same duration have been composed following a "compositive map" that allows smooth transitions between the sequences at any time. The music has been composed using musical characteristics that progressively generate more sensation of stress, found in scientific literature, such as the use of musical modes [16], harmonic tensions [16], [17], use of appoggiaturas and sequences [2] and Rythmic Roughness [16].

The IMS has two modes of use, depending on the trigger for changes in the State: Control_Mode (musical changes triggered by life level) and GRS_Mode (musical changes triggered by peaks in the GSR measurement).

2.2 GSR Emotion Sensor

Among the possible physiological meditions, GSR is selected due to its fast response and sensitivity. This brings the possibility of treating the data on real-time. An Arduino Nano is used with a GSR sensor attached to the player. Through UATTL Serial communication and the “Hairless Midi Serial” MIDI to serial bridge application, the Arduino sends MIDI messages that are received by the Middleware Wwise application, which manages the interactive music selection.

The Arduino code begins with a calibration period in which the player’s average GSR value is registered. Then it is compared with the captured values in a quiet and relaxed state and finally with an “aroused” state by listening to several examples of exciting music from different genres for 2 minutes. The average between the maximum increase detected in each of the calm and aroused periods is taken as "emotion_jump". During the game, when the increase in the GSR measurement is greater than this value, Arduino sends a State change message (to the next state when positive or to the previous state if it is negative) and causes a state change in Wwise, creating a transition between one sequence and the next.

2.3 Experimentation

An environment of experimentation with a real game (Wolfestein 3D) is proposed, using the original sound effects of the game, but not the music. Instead, the music from the Wwise output is added to the sound mix the player hears. Players are asked to follow the instructions to do the calibration, and then they are asked to play the game twice. In the first game the GSR Mode is activated (there are only musical changes if there is an “emotion jump”). In a second game, the Control mode is used (music changes are made based on the character's level of life).

Before starting the game, the level of experience as a player is asked. The games are recorded and the ascending and descending jumps of emotion, the duration of the games and the score obtained in the games are monitored. A mic records the spontaneous verbal expressions and also a final interview where the subject is asked about the emotional experience and the differences he has noticed between the games.

2.4 Population

For this experimentation, partly due to the limitations demanded by the COVID pandemic situation, 14 random subjects without exclusion criteria were interviewed. With ages between 10 and 65 years, 40% of them being females and with different gaming experience (from null to professional).

Although it is suggested to observe the behavior of groups selected with narrower criteria in future research, working with such a heterogeneous group has facilitated the observation of certain aspects of the functioning of the system in diverse population profiles.

3 Results

During the pilot tests, the calibration and the choice of the game had to be adjusted until a balance was found between playability, difficulty, and duration of the game. Once stabilized, the system has worked on all occasions, although the physiological response of the players has been uneven (as expected).

In general terms, the numeric measurements have increased between the Control game and the GSR game (number of jumps: 9.68%, duration of games: 2.49%, score: 30.42%). During the first game (Control Mode) 45% of the participants showed little physiological reactivity (low_response) with 1 or less emotion jumps, while 36% showed high-reactivity, experiencing between 7 and 19 emotion jumps (high_response).

During the final interview, some players admitted that they had no emotional reaction to the game for various reasons (no interest in video games, unchallenging game level, or even a conscious effort to control emotions). Most players recognized the effect that music causes on the experience of emotions, but were not able to differentiate one game from the other in this sense.

4 Discussion

While the important increment of the players' game scores in the second game could be explained by the advancement of the game's learning curve, emotion jumps and duration increases needed to be studied with more depth. Analyzing the two profiles according to the physiological response (low_response and high_response), there is a remarkable relationship between low responsiveness and low interest generated by the video game in the player.

All the players in the Low-response group who reported not having experience in video games experienced an increase of more than 80% in the number of GSR jumps in the second game, and for different reasons they felt more involved in the second game. In these cases, the control version offered the player more musical variety. This could suggest that music changes helped the players to get more into the game. The players in this group who reported having an important gaming experience didn't experience significant changes in the number of jumps between one game and the other. A particular case explained that due to his high level of knowledge of the game, and despite having a considerable gamer level, he did not experience any emotion during the game, but he did when he was the first in the Game score list (thus obtaining the only emotion jump of his game).

Highly responsive players had less physiological response in the second game, suggesting that the music changes generated by the action of the game may have acted as a "warning", preparing the player for a more tense action and attenuating the emotional reactions triggered by unexpected situations of the game.

5 Conclusions

The system seems to be successful in generating an adapted gaming experience, responding to the individual emotional characteristics of the player. This could be used as a way to introduce or reduce difficulty according to the objective and interest of the game.

To rule out the effect that player fatigue or the learning curve may have on the results, it is suggested to carry out other experiments by reversing the order of the Game Modalities and the type of game.

The GSR driven IMS seems to have a different effects depending on the type of physiological responsiveness of the player. While in players with low response the system would not help to motivate them, in players with high response it seems to put them in a situation of more physiological reaction. The system could be understood as an added feature in advanced stages of a game (where only devoted gamers can access) or in conjunction with an action-based IMS.

References

1. Schachter, S., Singer, J.: Cognitive, social, and physiological determinants of emotional state. Psychol. Rev. 69, 379–399 (1962).
2. Juslin, P. N.: Music and Emotion. Seven Questions, Seven Answers. In: Music and the Mind Essays in honour of John Sloboda, Oxford University Press, New York (2011).
3. Dainow, E.: Physical effects and motor responses to music. In: Journal of Research in Music Education, *25*(3), 211-221 (2010).
4. Khalfa, S., Roy, M., Rainville, P., Dalla Bella, S., & Peretz, I: Role of tempo entrainment in psychophysiological differentiation of happy and sad music. International Journal of Psychophysiology, 68(1), 17–26 (2008).
5. Watanabe, K., Ooishi, Y., & Kashino, M.: Heart rate responses induced by acoustic tempo and its interaction with basal heart rate. Scientific Reports, 7(February), 1–12. (2008).
6. Ehrlich, S., Guan, C., & Cheng, G.: A closed-loop brain-computer music interface for continuous affective interaction. Proceedings of the 2017 International Conference on Orange Technologies, ICOT 2017, 2018-Janua, 176–179 (2018).
7. Baumgartner, T., Lutz, K., Schmidt, C. & Jäncke, L.: The emotional power of music: How music enhances the feeling of affective pictures. Brain Research, 1075, 151-164 (2006).
8. Thayer, J. F., & Levenson, R. W.: Effects of music on psychophysiological responses to a stressful film. Psychomusicology: A Journal of Research in Music Cognition, 3(1), 44–52 (1983).
9. Koriat, A., Melkman, R., Averill, J. R., & Lazarus, R. S.: The self-control of emotional reactions to a stressful film 1. Journal of Personality, 40(4), 601-619 (1972).
10. Thayer, J. F., & Levenson, R. W.: Effects of music on psychophysiological responses to a stressful film. Psychomusicology: A Journal of Research in Music Cognition, 3(1), 44–52 (1983).

11. Hébert, S., Béland, R., Dionne-Fournelle, O., Crête, M., & Lupien, S. J.: Physiological stress response to video-game playing: the contribution of built-in music. Life Sciences, 76(20), 2371–2380 (2005).
12. Ravaja, Niklas, et al.: Spatial presence and emotions during video game playing: Does it matter with whom you play?. Presence: Teleoperators and virtual environments 15.4 381-392 (2006)
13. Cassidy, G., & MacDonald, R. A.: The effect of background music and background noise on the task performance of introverts and extraverts. Psychology of Music, 35(3), 517-537 (2007).
Williams, D.: Affectively Driven Algorithmic Composition (AAC). In: Emotion in Video Game Soundtracking (pp. 27-38). Springer, Cham (2018).
14. Granato, M.: Emotions Recognition in Video Game Players Using Physiological Information (2019).
15. Wallis, I., Ingalls, T., Campana, E., & Goodman, J.: A rule-based generative music system controlled by desired valence and arousal. In: Proceedings of 8th international sound and music computing conference (SMC) pp. 156-157 (2011).
16. Brookhart, C. E.: The effects of changes in harmonic tension upon listener response. Bulletin of the Council for Research in Music Education 6, 64-70 (1965).