Towards Affective Trajectories in Games with Physiological Signals

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Abstract
Playing a game is an emotional journey that goes well beyond positive and negative valences. A well-designed game puts players on affective trajectories. Recent advances in and the falling price of sensor hardware provide new opportunities for designers to experiment with assessment of players' states and progress in their games. PhysSigTK is a toolkit that aims to make low-cost hardware more accessible for that purpose.

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Affective Trajectory; Physiological Signals; Game Design; Engagement; Physiological Sensors.

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Introduction
Game designers intend their players to experience a whole range of emotions. The experience of gaming, even in the case of non-serious games for entertainment, is not merely to create a feeling of happiness in players, but rather to enable them to follow affective trajectories that can go from very negative states such as frustration to positive ones once challenges are overcome. However, ending in positive states is certainly not a necessity and potential and intended trajectories are dependent on the game

Figure 1: Wild Divine Iom, Empatica E4, and NeuroSky MindWave.

as well as on the type of player[1]. New developments of low-cost sensor hardware make it possible for designers to experiment with affective signals from players in order to account for this affective journeys not only in conceptual, but also in practical terms, as well as interactively.

Affective Trajectories

The intricacies of gameplay experience are hard to capture as they vary between different types of games, types of players, and the dynamic context of the current state of the game. One pathway to relate the affective trajectory that players experience to measurable quantities is to use conscious evaluation by players after or during gameplay. Continuation desire [1] is one such metric connected to 18 causes for the player's desire to continue the game. The causes include extrinsic and intrinsic objectives and ranges of activities (interfacing, socializing, solving, sensing, experiencing the story and characters, exploring, experimenting, creating and destroying), accomplishments (achievement, progression and completion), and finally affective experience (positive, negative and absorption). The identified categories, however, might not be applicable to all games and the range of affect that is considered is limited. In the case of horror games, at specific moments, this approach might yield inconsistent results. An extension of continuation desire for survival horror games [2] considered affective experience as a combination of a physiological and mental responses, integrating engagement, involvement, and immersion in a conceptual model of a scary mood. Another conceptual model proposes "incorporation" [3] for analyzing players' moment-by-moment engagement and immersion in video gameplay, proposing six categories of involvement, including tactical, spatial, affective, narrative, shared, and performative Involvement. Furthermore, examples of tested questionnaire measures that relate to engagement in games are the Game Engagement Questionnaire [4] or work on assessing immersion [5].

While those measures provide valuable approaches towards experience trajectories that are independent from specific game content, physiological signals in combination with in-game interactive behavior can provide a context-aware method of assessing the affective aspects of experience in particular. A game designer can define the relevant aspects of affective trajectories specific to a game, testing for different types and intensities of involvement using both signals and pro-active in-game metrics, such as the choices presented to the player. However, this approach requires, on the one hand, the careful consideration of design features so that the players' progress in a game can be related to changes in engagement and their physiological states. On the other hand, a range of measurement devices needs to be available to game designers so that they can evaluate the suitability of a particular device.

PhysSigTK: A Toolkit

Physiological sensors open up information channels from the player that game designers can exploit to assess factors such as engagement in games [6]. Sensors allow experimentation, from covert assessment

[1] For a game designer's approach to a particular affective trajectory in a particular type of game, learning games, see work on "the Sophia engine" by Erin Hoffman (as of now not yet published in academic contexts).

of experience [7] to biofeedback control in games [8]. However, such experimentation with affective gaming is still mostly constrained to research settings [9]-[11]. Most research efforts are focused on recognizing discrete emotion events in laboratory settings, rather than enabling game designers to experiment with available real-time signals. PhysSigTK aims to enable designers to experiment with and evaluate devices to see how far they can go beyond laboratory settings.

For the following devices, see Fig.1, the toolkit enables access in Unity, cross-platform on Mac OS, Windows, and Linux where technically possible. The Wild Divine Iom includes 3 sensors that fit onto the fingertips of the player, measuring skin conductance and hear-rate variability. The Empatica E3/E4 (as well as the not yet released, more low-cost, Embrace) are wrist-worn devices measuring electrodermal activity, blood volume, temperature, and movement. The e-Health sensor is based on the Arduino platform, requires self-assembly, and supports different sensors. The Mindwave by NeuroSky is a low-cost EEG sensor and includes a heart rate sensor for the ear.

Biography of the Author

Stefan Rank is an Assistant Professor at Drexel University's Digital Media and Game Design & Production Programs. Previously, Rank conducted research at the Austrian Research Institute for Artificial Intelligence (AI) and the University and Medical University of Vienna. Rank's gaming and digital technology career is heavily steeped in research on Artificial Intelligence and various cognitive sciences. He was involved in several European research projects in the last years, most recently in Cyberemotions and a network on Interactive Storytelling. His work in those multi-national and multi-disciplinary projects focused on interactive characters and affective human-computer interaction. He also serves as the portal editor for the Humaine Association for the Advancement of Affective Computing. Rank specializes in development and application of computational affective behavior models for users and synthetic characters, intelligent software agents, game design, interactive narrative and human-computer interaction.

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