Emotionally Adapted Games – An Example of a First Person Shooter

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Abstract. This paper discusses a specific customization technology – Psychological Customization - which enables the customization of information presented on a computer-based system in real-time and its application to manipulating emotions when playing computer games. The possibilities of customizing different elements of games to manipulate emotions are presented and a definition of emotionally adaptive games is given. A psychophysiologically adaptive game is discussed as an example of emotionally adapted games.

Keywords: Customization, adaptive systems, psychological effects, emotion, games, emotionally adapted games, psychophysiological measurement, Psychological Customization.

1 Introduction

Emotions or emotion-related variables (e.g., competitiveness) play a critical role in gaming behavior [1, 2]. People seek, and are eager to pay for, games that elicit positive emotional experiences and enjoyment; however, an enjoyable game may not elicit only positive emotions but possibly also negative ones (e.g., anger, fear). Thus, one of the major goals for video game designers is to elicit optimal emotional responses or response patterns.

It is possible to build systems which either automatically or semi-automatically adapt games to create optimal emotional responses and response patterns. Such customization systems entail the manipulation of the game per player to elicit specific emotional responses or to create desired response patterns. We propose a system called Psychological Customization to be used in the adaptation of games for manipulating emotional states of players.

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Psychological Customization entails the customization of *transient* (i.e. short-term) *user experiences* (i.e. psychological effects) when interacting with media- and communication technologies. Experience-based customization entails the automatic or semi-automatic adaptation of information per user, task and context in an intelligent way with information technology. A subset of Psychological Customization is to vary the form of information (modality for instance) per user profile, task and context, which may systematically manipulate (approach, avoid, modify intensity, frequency and duration, create combinations, create links to behavior) different psychological effects. Psychological effects can be considered transient states, such as emotion, mood, types of cognition, learning, flow, presence, involvement and enjoyment. [e.g. 3, 13]

Psychological Customization works on the principle of target experiences which can be set by using the system either by providers of a service or by users. Target experiences are different types of transient psychological states that have varying durations, frequencies, intensities, combinations, and motivational and action tendencies as well as a linked stimulus class which facilitates a particular state. The system is set up to either approach or avoid a certain target experience within the other parameters of customization such as altering the intensity, duration or frequency of a certain effect or creating simultaneous combinations or links to probable behavior of different target experiences. [3]

Psychological Customization can infer customer needs via user models and various feedback loops observing customer behavior and responses. Psychological Customization also provides different adaptations of presenting information to different customers based on the customer interacting with the configuration settings of the product or service.

The basic functioning of the system is based on a classic control theory model, the biocybernetic loop. It defines two kinds of control loops in complex and adaptive systems that can be established: negative (avoid an undesirable standard) and positive (approach a desirable standard) loops of feedback [e.g. 4, 5]. Target experiences are then controlled by this type of reasoning in the system based on real-time feedback from user responses and/or based on ready-made design-rule databases.

Emotion. Although various definitions of emotions have been proposed, the most general definition is that emotions are biologically based action dispositions that have an important role in the determination of behavior [e.g., 6]. It is generally agreed that emotions comprise three components: subjective experience (e.g., feeling joyous), expressive behavior (e.g., smiling), and physiological activation [e.g., sympathetic arousal, 7].

There are two main competing views of emotions. Proponents of the basic distinct emotions argue that emotions, such as anger, fear, sadness, happiness, disgust, and surprise, are present from birth, have distinct adaptive value, and differ in important aspects, such as appraisal, antecedent events, behavioral response, physiology, etc. [8]. In contrast, according to a dimensional theory of emotion, emotions are fundamentally similar in most respects, differing only in terms of one or more dimensions. Proponents of the dimensional view have suggested that all emotions can be located in a two-dimensional space, as coordinates of valence and arousal [or bodily activation; e.g., 6, 9]. The valence dimension reflects the degree to which an affective experience is negative (unpleasant) or positive (pleasant). The arousal dimension indicates the level of activation associated with the emotional experience, and ranges from very excited or energized at one extreme to very calm or sleepy at the other.

Other theorists have, however, suggested that the two main, orthogonal dimensions of emotional experience are negative activation (NA) and positive activation (PA) that represent a 45° rotation of the valence and arousal axes [10]. The NA axis extends from highly arousing negative emotion (e.g., fear) on one end to low-arousal positive emotion (e.g., pleasant relaxation) on the other, while the PA axis extends from highly arousing positive emotion (e.g., joy) to low-arousal negative emotion (e.g., depressed affect). The self-report NA and PA dimensions have been suggested to represent the subjective components of the BIS and BAS, respectively [e.g., 10, 11].

We adopt the latter definition of emotion. On the NA axis we call the high arousal negative emotion anxiety and stress while the low arousal emotion can be termed as pleasant relaxation. On the PA axis we see the high arousal emotion as joy and the low arousal emotion as depression.

In our studies we have successfully used both psychophysiological measurements and self-report to index emotional processes, also when playing computer games. In computer games, there is a dynamic flow of events and action, games potentially eliciting a multitude of different emotions varying across time. A serious limitation of prior game studies is that they have used tonic, rather than phasic, psychophysiological measures. Tonic measures (e.g., the mean physiological value during the game minus pre-game baseline) do not enable the examination of the varying emotions elicited by different instantaneous game events. Given that psychophysiological measurements can be performed continuously with a high temporal resolution, it is possible to quantify phasic responses to instantaneous game events (e.g., by comparing the local pre-event baseline to physiological activity immediately following event onset). [12]

It is then evident that psychophysiological measurement of emotional states when playing a computer game is both feasible and fruitful in providing an account of some aspects of the moment-to-moment experience of the user [13]. Naturally, psychophysiology could be extended to function as a feedback loop into the gaming engine making real-time adaptation of the game relative to the emotional state or mood of the user a possibility.

2 Emotionally Adapted Games

Emotionally adapted gaming can be seen as based on gaming templates which are parts of the meta-narrative of the game. Hence, a basic approach to an element to be adapted inside a game is a psychologically validated template which creates a particular psychological effect. A broad view of templates may be that the whole game consists of a database of psychologically validated templates that are dynamically presented by the gaming engine in sequences during gameplay. A limited view entails that a smaller collection of templates is used. The element of psychological evaluation means that the selected psychological influence (such an emotional response) of the template on a particular type of user is sufficiently predictable. These psychologically evaluated templates may consist of i) manipulating the substance of a game, such as story line (initiating events, new characters etc.) and manipulating the situations specifically related to the character of the player (such as putting the character into sudden and dangerous situations inside the game) and ii) manipulating the form or way of presentation of the game (such as visual elements, shapes, colors, types of objects, sound effects, background music, level of interactivity and feedback etc.). The difficulty level of the game may also be continuously automatically be adjusted, thereby keeping the skills and challenges in balance, which results in a maintenance of an optimal emotional experience and possibly also a flow-state. [14]

Why and when then to manipulate emotion in gaming on the basis of avoiding or approaching a specific emotional state? First, there are the transient basic emotional effects of games that are dependent of the phase of the game or some specific events. These are emotions such as happiness, satisfaction, sadness, dissatisfaction, anger, aggression, fear and anxiousness. These emotions are the basis of narrative experiences, i.e. being afraid of the enemy in a shooting game, feeling aggression and wishing to destroy the enemy and feeling satisfaction, even happiness, when the enemy has been destroyed. Emotional regulation systems in these instances most naturally may focus on manipulating the event structures, such as characters, their roles, events that take place and other features of the narrative gaming experience. [14]

Second, there are possibilities for emotional management, especially in the case of managing arousal, alertness and excitation. Also, one may wish to manage negative emotions, such as sadness, dissatisfaction, disappointment, anger, aggression, fear and anxiousness. The case for managing these emotions is twofold. On the one hand, one may see that these emotions could be eliminated altogether in the gaming experience. This can happen via either eliminating, if possible, the emergence of such an emotion in the game. For example, one can make a deliberately happy game with level-playing monkeys in a far away island throwing barrels at obstacles and gathering points. This would include minimum negative emotions. Or, in a game where negative emotion is a basic part of the game, one may wish to limit the intensity, duration or frequency of the emotions via manipulating gaming events and gaming elements so that sadness or fear are at their minimum levels, or that gaming events do not lead to sadness at all. [14]

Similarly, managing level of arousal or the intensity, duration and frequency of select negative emotions may be quite feasible in the case of children as a form of parental control. On the other hand, one may wish to maximize arousal, alertness and excitation, perhaps even anger, fear and aggression for hardcore gamers.

Third, there are possibilities related to the avoidance of certain types of emotions that are typically indicative of a poor gaming experience. Inactivity, idleness, passivity, tiredness, boredom, dullness, helplessness as well as a totally neutral experience may be indicating that there is some fundamental problem in the user-game interaction. This could be due to poor gaming skills of the user vs. the difficult challenges of the game or some other factors, such as the user is stuck in an adventure game for too long and can not proceed without finding a magic key to enter the next level or so. When a gaming engine detects these emotions in the user, it may adapt its behavior to offer the user more choices of selecting the difficulty level of the game or offer the user some clues as to how to go forward in the game. The game can also adapt its level of difficulty to the player's skill level. [e.g. 14]

Fourth, it is also possible to create different combinations of emotional states (satisfied and angry) or emotional states and other psychological states (pleasant relaxation and efficient information processing) or emotional states and behavior (using specific motivational and action tendencies). [3]

All of these possibilities may be relevant. However, the elimination or minimization of certain emotions may be specifically feasible in the case of indicated overly poor gaming experience in which the game may adapt its behavior to assist the user. It should be noted that events in games may change quickly and produce complex situations and hence complex emotions that may change rapidly. Consequently, one should better integrate these approaches into the genre or type of the game, such as driving simulator, first person shooter, sports game such as golf, or an adventure game, or a level-playing game for children. [14]

3 Example: Psychophysiologically Adaptive First-Person Shooter Game

We will now present a basic system schematic of an emotionally adapted game in Figure 1. The process of a typical gaming engine is depicted on the left-hand side of the diagram. The engine continuously monitors user input, which is typically collected using a keyboard, a joystick, or other game controllers. This input data is then processed and transferred to the layer that handles the game's internal logical state, and the user input may influence the game state. After the logical state of the game is defined the system alters the actions of the synthetic agents in the game world. For example, these include the actions of computer-controlled non-player characters. The complexity of this AI layer varies greatly depending on the game. Based on the game state and the determined actions of the synthetic agents, the physics engine determines the kinetic movements of different objects within the world. Finally, the game world is synthesized for the player by rendering the graphical elements and producing and controlling the audio elements within the game. [see 14]

The proposed emotional regulation can be implemented as a middleware system that runs parallel to the actual game engine. The input processing layer of the game engine can receive a data flow of captured and pre-processed sensor data. The real-time signal processing may consist of different forms of amplifying, filtering and feature selection on the psychophysiological signals. This data flow may directly influence the state of the game world, or it can be used by the emotional regulation sub-module of the emotion feedback engine. This module consists of the rules of emotional balancing for different player profile types and gamer-related explicitly set preferences controlled by the "emotion knob". In addition, it contains a collection of design rules for narrative constructions and game object presentation within the game world. The emotional regulation module also receives input from the game engine's logical layer to make selections related to desired emotional balance and narrative structures within the game. [14]

The outputs of emotional regulation engine may then be applied to various different levels of the actions of the game engine: i) the logical state of the world may be re-directed, ii) the actions of the synthetic agents may be controlled, iii) the kinetics of the game may be altered and iv) the rendering of the game world may be changed. First two options are more relevant to high-level and story-related structures of the game, whereas the last two are more directly related to the selection of presentation of objects within the virtual environment. [e.g. 14]

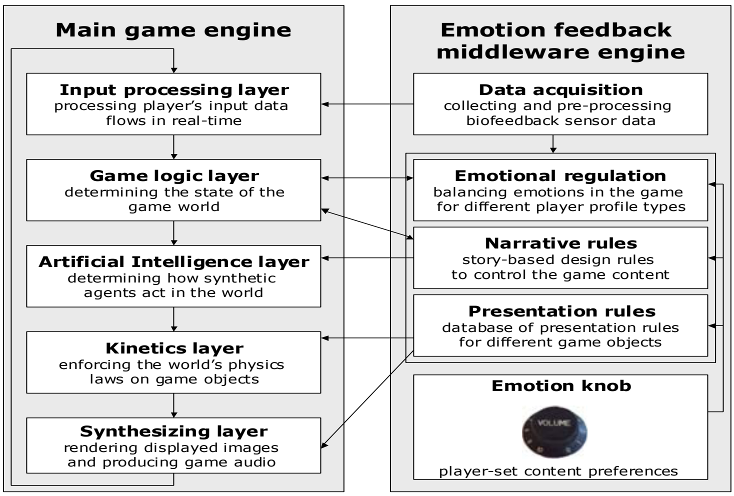

Fig. 1. Emotional adaptation system design for games. Adapted from [14].

With our system design for games it is possible for the game designer as well for the user to set desired emotional targets to be approached or avoided. The system uses both positive and negative feedback loops to determine the ideal adaptations case-by-case for game play for various emotional effects to be realized and managed.

Indeed, to implement and evaluate some of the ideas presented, we have explored novel technical solutions and tested different kinds of psychophysiological adaptations that can be implemented. EMOShooter is a prototype platform for psychophysiologically adaptive 3D first-person shooter (FPS) gaming. It is built on top of open-source graphics engine (OGRE 3D) and physics engine (ODE). In this experimental platform we have the possibility to modify practically any game world element, player avatar, avatar outlook, or control parameter.

EMOShooter is a simple psychophysiologically adaptive game and hence a part of our emotionally adapted games definition. The system uses psychophysiological signals to influence the ease of use of the controls of the game hence affecting game play difficulty and game play experience. The system does not have target experiences systematically implemented at this moment nor does it have an emotion knob to tune the system. However, the EMOShooter game is a valuable example of one type of emotionally adapted games in demonstrating one feasible link between real-time emotional state measurement with psychophysiology and the game play.

The goal of the EMOShooter game is to kill cube-like enemies either with sniper or machine gun. We have been testing various adaptation patterns with EMOShooter by primarily EDA and respiration as psychophysiological signals in our adaptive feedback system regards how these signals can be meaningfully connected to the actual game play via adapting game controls.

Adaptation of game controls includes changes in rate of fire, recoil, movement speed and shaking. If a player is aroused this will be reflected in EDA and respiration signals which in turn will make rate of fire and movement slower and will make the aim shaky. Hence, for a highly aroused player the game becomes more difficult. For a mildly aroused or calm player the controls become more efficient and easy to use hence facilitating performance at game play. Game events are mostly arousing. The amount of cubes to shoot, their approach and firing on the user, the amount of health left after being hit and the sound effects all are geared to drive up arousal in the game. The player's task is to be calm as indexed by psychophysiological signals to be able to operate the controls more efficiently.

In our tests of the game we have collected also EMG data to infer the valence dimension of emotion during game play. In addition to the psychophysiological signals we have collected data from the players using behavioral game logging, video capture, interviews and questionnaires. During our tests we noticed that proper calibration and base lining of the psychophysiological signals is very important for the adaptations to work. We also noticed that having robust stimuli in the game is crucial for the adaptations to work because in many cases the stimulus functioned as a trigger in adaptation. The psychophysiological signals used are calibrated by using dynamic range (basically a variation of dynamic signal normalization algorithm), which has a memory buffer of a few seconds (depending on signal). Dynamic range is easy to use and effective calibration mechanism, and relative change seems to be more practical than absolute values in this kind of gaming.

According to our early analysis, there are three key issues in designing psychophysiologically adaptive games i) understanding the meaningful emotionally adaptive gaming patterns, ii) implementation of adaptation algorithms and signal processing, and iii) purposeful use of sensors in the game context [15].

The design patterns used in emotionally adaptive gaming must be meaningful and enjoyable for the player, and the utilization of signals must also obey the overall goal of the game. In order to achieve the goal player should find the right rhythm or balance of playing the game and control of psychophysiological responses and signals.

Signals should be analyzed as close to real-time as possible in psychophysiologically adaptive gaming in order to keep the feedback loop in pace with the game adaptations and game events. We have used time-series analysis with short sample windows. In practice, ECG, EEG and EMG always require extensive data processing, but EDA and respiration can be almost used as such to create the adaptation signal. This implies that not all psychophysiological signals are equally open to be used as real-time inputs into an adaptive game at least in this stage of signal processing hardware and software development.

Usability of psychophysiological recording devices remains quite poor. Respiration, HR [heart rate] and EDA are probably the easiest to implement. Also in case of emotional adaptation the design of the game may include the physical design of the sensors, e.g. "Detective hat" for EEG sensors or "Sniper-gloves" for EDA sensors. Hence, the sensors could be designed as part of the game story rather than presented as cumbersome and invasive laboratory-originated equipment.

In future versions of EMOShooter we may also employ the system design of emotionally adapted games including setting of explicit experiential targets and their parameters for gaming sessions and the emotion control knob.

4 Discussion

Gaming, as we have presented it in this article, is perhaps one of the most promising application areas of Psychological Customization. We see that both casual and hardcore gamers could benefit from the use of our system and entirely new types of games can be created. Psychological Customization would enable game designers to use our tools both when developing the game and testing it with users in a rapid manner as well as part of the final product. From the user's point of view, using various types of control knobs of emotion or other experiences enables them to customize and have more control over their gaming experiences.

Good games are composed of delicate synthesis of the components creating a pleasant game balance and challenge for players. Introducing emotional adaptation increases the complexity of game design tasks involved. However, regards the economics of game development our system would not induce a dramatic cost. The system automatically establishes gaming patterns and structures which would fill a target experience and its parameters. Our system could be a modular toolset that can be adapted to various types of gaming platforms and gaming engines. The emotional tuning knob could be integrated into existing game controls including sliders for level of graphic violence in the game, for instance. Of course, development work is needed to create an easy-to-use game adaptation interface for users to set their preferences for game play.

There are several challenges for Psychological Customization systems in games. We see three main areas which are critical: i) measurement of experience, ii) quality of reasoning in an adaptive system and iii) acceptability by users.

The measurement of experience in the first place is a key challenge. However, we have presented an approach to concentrate on those aspects of experience, such as emotion, which are perhaps better defined than experiential states in general. Despite this focus, there is still disagreement in theorizing, operationalizing and measuring emotions.

The quality of reasoning in an adaptive system is often a bottle-neck in performance. If a closed system is produced with fixed design-rules it would inevitably encounter situations, stimuli and users which would challenge the systems fixed rules and produce errors in adaptations. While there are several deep and sophisticated technical and mathematical approaches to this problem including different ways of machine learning and reasoning (which are beyond the scope of this article), we propose a higher-level solution possibility. Our answer is to rely on the co-evolutionary potential of our system design with changing user models and emergent design-rules. Of course, this approach needs working algorithms and techniques to form the necessary metadata and other data structures to be processed by the system.

User acceptance of invasive psychophysiological measurement as input to the game is critical. Hardcore gamers may be more suspect to accept new peripheral devices linking them to game than gaming novices or casual gamers. However, the culture of connecting one's body to a game is already evolving. Think of Wii as an example with a controller tied to one's wrist, constantly touching the skin. It would not be unimaginable to think of psychophysiological sensors embedded in similar controls as people are more used to "semi-invasive" gaming controls beyond the use of a mouse and keyboard. The solution here could be to design sensors as embedded into essential existing or new types of gaming peripherals. A driving wheel with EDA and ECG sensors or driving gloves with similar sensors with added blood pressure, muscle tension and finger movement sensors could be used as easily acceptable controls of a driving simulator, for example.

In our tests of the psychophysiologically adaptive game as a first prototype of emotionally adapted games we have been able to produce meaningful gaming patterns and game adaptations. We argue that our approach to emotionally adapted games is novel and creates new opportunities for designing games. We feel that our approach may result in a new type of enabling technological platform focused on the customization of gaming experiences. This new enabling technology platform can facilitate the development new types of games but can also be used with existing types of games and gaming platforms.

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