A Review of Affective User-Centered Design for Video Games

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Abstract—**In recent years, there have been increasing interests in the field of Human Computer Interaction (HCI) towards gaming. Due to the competitive industry and high demand for novelty in today's world, gaming has now become a valuable and stimulating research setting for HCI researchers to study its interface and interaction design, input devices, graphical user interface, social communication and development processes. Video games have advanced technologically and visually, and seem to demand greater levels of engagement from their users. The degree of interaction designed into a game is vital to effectively generate a constructive or destructive player (user) experience. The success of the gaming industry has bred a desire to accurately understand and measure player responses to video gaming, thus making video games a perfect test-bed for HCI explorations. This paper will attempt to address and review the literature on affective user-centered design principles, elements and methodologies that are applicable in video games.**

Keywords - affective design; user-centered design; video games; affective gaming

I. INTRODUCTION

In recent years, video games have garnered much attention and there has been significant research progress in the human-computer interaction (HCI) field. Affective interface design plays an essential role in HCI because it influences emotional and mental communication as well as improves the interaction between users and product. Furthermore, the incredible advancement in gaming technologies over the years has focused primarily on the affective realism of the game environment, game character, complexity and performance of game simulation, and networking. Nevertheless, for video games to attain some degree of success in today's market, they must appeal to as many players as feasibly possible. Hence, designing games in a manner that provides the same user experience to all players, irrespective of player motivation, experience or skill is becoming the focus of modern game research [1]. This is where Hudlicka [2] pointed out that current affect plays "a key role in the user experience, both in entertainment and in serious games and that games are somewhat lacking in the affective realism". Therefore, there is a need for game designers to identify affective problems in the early stages of the game development process.

In today's era, the design of user experience is increasingly important in developing interactive systems [3], such as video games. Affective communication may be the key to aid game developers in improving user experience for players. According to [4], when approaching affect as interaction, never simplify complexity, but instead try to enhance or evolve it by changing the experiences of affect. If affect is not conveyed correctly during gameplay, then player suspension of disbelief may be negatively influenced, and may also ruin the gaming experience [5]. Therefore, understanding user affectiveness and their resulting output is essential for intelligent gaming interfaces that aim to create believable interactions [6]. Regrettably, user-centered design principles have not yet reached the same level of usage or awareness in game design and development as it has in other electronic applications [7]. Thus, for a better understanding of the differences and challenges brought forth in games, one must appreciate the relation of games with other software applications where user-centered design principles are present, such as in productivity-type of applications [7].

II. ADDRESSING AFFECTIVE USER-CENTERED DESIGN

According to [8], the former affective design approach leaned towards the more traditional human factors approach, whereas the latter shows a more significant shift in the approach of the design. Even so, the two methods are concerned with affect as well as emotion and they are valued as important aspects of use. It would appear that modernity does matter in affective design, especially in today's digital world. The practice of design usually seeks to fulfill a certain function. However, pure functionality may not affect certain late-modernist individuals through emotional achievement. Users tend to prefer pleasurable design without any apparent reason [8]. This may highlight the mindset gap between late-modernist and the new mentality that tend to adore and appreciate positive affect and emotion, exceeding the epitomes of the more traditional direction. Therefore, in such a case, a more modern aesthetic design and outlook does matter. According to [6], aesthetic feelings emerge from certain combinations of physical, perceptual and cognitive arousal. The aesthetic success is communicated through feelings. People like something because it gives them a good feeling, they like looking at it, it makes them think of something new or it inspires them. Ideally in the end, it brings people to a new state that feels better than the one they are in [6].

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In today's contemporary world, most designs can be regarded as unethical because they ignore real human needs. As such, design that addresses human needs and desires may help increase genuine and real value to the users. A potential candidate for this role is called "User-Centered Design" (UCD). Reference [9] asserted that UCD is a broad term to describe design processes in which end users influence how a design takes shape. The term "user-centered design" originated from Norman in the 1980s. Norman's work stressed the need to fully explore the users' needs and desires, as well as the intended uses of the product [10]. Users are the people who use the final product or artefact to accomplish a task or goal. There are a variety of ways in which users are involved in UCD but the important notion is that users are involved in one way or another.

From post literature, the terms "affective design" and "user-centered design" appear to have been coined by a few authors [8], [9]. However, the term *affective user-centered design* has yet to be defined. A possible definition of the term for affective user-centered design could be the integration of the terms used for affective design and user-centered design. If so, affective user-centered design (AUCD) can then be defined as an attempt to explore the emotional relationship and the affective properties of both interface and design while addressing the user's needs and desires.

III. Affective Gaming

Affective gaming has been receiving much attention lately as more gaming and HCI communities recognise the importance of emotion in game development [11]. Reference [11] coined the term of today's "affective gaming" which generally means adapting to the player's emotions by minimizing frustration and ensuring a challenging and enjoyable experience. The goal of affective gaming is capturing how a player is feeling at any given moment and integrating this personal representation of context into a game [12]. Reference [5] asserted that video games are dynamic entities, i.e. the games change according to how the player interacts with them. However these actions are not the only thing going on with the player during the gameplay. There are other unseen physiological responses taking place within the players and these are noticeable through various behavioural responses such as facial expressions, body postures, and gestures. These responses are useful in identifying the current state the player is in. This form of gameplay can also be referred to as "affective gaming", that is, where the player's current emotional state is used to influence the gameplay [5]. In other words, to achieve a state of affective gaming, both the player and video game have to be "responsive" to the affective signals of one another.

The current focus in affective gaming is on the sensing and recognition of the player's emotions, and on altering the game responses to these emotions by, for example, reducing frustration and inducing pleasurable game challenges [11]. Game researchers have emphasised the importance of affective game adaptation to the player's emotions to ensure engagement and to enhance effectiveness of "serious" games. This indirectly forces game developers to often "push" the limits on the hardware aspects in the game design in order to stay competitive and to meet the high expectations of the players who are, ultimately, the buyers. However, the need for affect differs greatly among people. According to [13], user populations are becoming more diverse and it is difficult to identify an ideal user.

IV. Affective Game Interfaces

The main focus of game research today is in designing games which provide the same user experience to all players, regardless of player motivation, experience or skill [1]. For video games to achieve some degree of success in today's market, they must appeal to as many players as feasibly possible [1], [13]. A player's emotion can be triggered in many ways during the gameplay. In affective gaming, games that respond to the user's emotional state may hold the key to creating a good game. Thus, in order to understand the importance and the impact of emotion generated by affective gaming, individual emotional differences must be taken into consideration during evaluation. It can help predict user preferences by determining what type of affective interfaces the user might enjoy [14]. Important aspects to consider for affective game interface are presented in Table I below.

TABLE I. Affective Game Interface Aspects

Aspects	Description	Authors
Challenge	Challenges which bring enjoyable experiences to the users. Competition, pacing difficulty, goal and rewards are important sources of challenges which satisfy users' needs for competence and motivate return play.	[7], [15], [16], [17], [18], [19]
Aesthetic and Visualisation	Games should be made appealing to draw users' attention. creativity and interactive game environment (*i.e. visual effects, sound, artificial intelligence, objects*) are important aesthetic features because they make routine game tasks more enjoyable and exciting, hence bringing a richer gaming experience to the users.	[5], [18], [20]
Narrative and Character	Narrative has the ability to bring users to a level of personal involvement by becoming emotionally involved in the trials of the game characters.	[7], [15], [20], [21], [22], [23]
Usability and Interface	Game interface (*i.e. menu layouts, typography, dialog design, controllers buttons, status bars, field of view*) should be easy-to-use and not confusing to users. Failure to design usable game interfaces can obstruct users' gameplay progress and experience.	[7], [15], [16], [22], [23], [24], [25], [26], [27]
Flow	Games that facilitate flow usually generate positive affect which make users feel deeply immersed in the games. Games should provide flexibility, efficiency and consistency that will not hinder the users' gameplay progress.	[7], [13], [15], [16], [19], [26], [28], [29], [30], [31]

V. AFFECTIVE EVALUATION

Video games in HCI require new ways of thinking and new tools for analysis which are specifically developed for application to games, rather than to generic interfaces [24]. A number of researchers have proposed various ways on how affective evaluation should be approached and they highlight several important evaluation issues that need to be taken note of. According to [32], to make a user's experience enjoyable in the gaming and entertainment application, some researchers are suggesting that the next leap in design philosophy should focus on affect.

There are many cases where user affect is important for successful completion of a task, avoiding (often disastrous) errors, achieving optimal performance or maintaining reasonable user stress levels. Hence, it is critical for designers to accurately evaluate the range of possible affective state that users may or should experience during interactions with the system. From there, the designer will understand the effects on the user, as well as on the task performance. This understanding will decide which affective consideration must be addressed, as in how and whether to adapt the system functionality to this state.

VI. METHODOLOGIES TO EVALUATE AUCD IN VIDEO GAMES

It appears that there are many affective evaluation approaches which have been conducted to measure affect and emotion. Traditionally, attempts to measure emotions have been done in the field of psychology and sociology. However, as the market share in personal computing escalates, computer science seems to lead in the field of measurement of emotions [33]. Presently, the instruments used for assessing affective concepts range from simple pen-and-paper rating scales to alluring high-tech apparatus that measure brainwaves and eye movements. The ability to measure user affect has become important for the intelligent interfaces that aim to either establish believable interactions or alter internal behaviour based on the user's affect. Evaluating and interpreting this measure presents a challenge because of many ambiguities related to the definition of affect, its communication, and subsequent interpretation [34]. Hence, methods and tools must develop the ability to be adaptive and sensitive towards shifting tasks, interests, communication as well as affect and emotions [8]. Despite the substantial progress made in the assessment methods and tools, several researchers [7], [11], [35] pointed out that to gain a more reliable assessment, co-existing use of multiple methods is required. Apparently, there are more methods yet to be discovered as any method found to be able to reliably measure emotional responses will provide significant insights to the association between independent affective responses, its related interactions, and consequential design attributes [33].

It seems that combining multiple methods and tools for affective evaluation will prove to be helpful in obtaining reliable data regarding emotion and affect. Measuring emotion and affect is difficult due to the subjective feeling involved in the users which may lead to biasness. But it is also important to gain user opinion and perception on the product, regardless. Therefore, to solve this problem, two types of methods should be employed: (i) non-invasive method, and (ii) user feedback method. By combining these two methods, HCI and game researchers are able to gain data of the players' emotions during affective state or reaction, both consciously and subconsciously.

A. Non-Invasive Methods

The main aim for most affective evaluation for gaming interface is to find a non-invasive and easily-carried-out method to help gain further understanding about the affective state of a person during an interface evaluation with users. As reference [36] pointed out, gamers dislike being interrupted while playing. Table II below presents a summary of non-invasive methods of AUCD evaluation for video games.

TABLE II. NON-INVASIVE METHODS

Non-Invasive Methods		
Methods	***Description***	***Authors***
Physical Measures	• The main advantage of body measurements is that it can be taken in parallel during interaction instead of interrupting the user or asking him after the task. • Cameras, sensors and microphones are commonly used for physical measures that reveal many signals relevant to emotional responses. • **Passive sensors** are usually readily incorporated into existing game controls (*i.e. gamepad pressure, Wii controller*) to detect user arousal and to indentify game-relevant user states such as engagement and boredom.	[11], [14], [33], [34], [37], [38], [39]
Physiological Measures	• Physiological measures can provide additional insight of the users' emotional state which occur within their body (*i.e. skin, blood pressure, pupil, heart, brain waves*) without relying on their cognitive judgement of their emotional state directly. • **Affective wearable** (*i.e. expression glasses, pressure-mouse, touch phone*) can measure physiological responses to help identify users' feelings and body responses towards video games. • **Affective feedback:** Users are not aware that their physiological state is being detected or recorded while playing video game as the intention is to capture their normal affective reactions. • **Biofeedback:** User controls their physiological responses in order to control the game world. • Two types of biofeedback measure: i. **Direct physiological control** works best with action games that requires quick reaction from the users. ii. **Indirect physiological control** are best used as a dramatic or aesthetic aspect in games that influence the environmental variable.	[5], [6], [7], [11], [12], [19], [33], [34], [40], [41]

TABLE II. CONTINUED

Non-Invasive Methods		
Methods	***Description***	***Authors***
Observation Measures	• Most interface evaluation are conducted by observing and recording the user interaction with the interface. • Two main categories: i. **Facial expression** instruments are used to capture certain emotional cues through patterns of the users' facial expression. ii. **Vocal expression** instruments are capable to quantify emotional effects in multiple vocal cues such as pitch changes, colour intensity, rate of speech, vocal clarity and its quality, and auditory articulation.	[20], [33], [38], [42]

However, some of these methods do raise a host of legitimate concerns pertaining to user discomfort because of a feeling of privacy invasion and loss of control. Reference [39] advised that it is important to keep in mind that some people do not feel comfortable with "parallel communication" of affect, especially with methods involving signals that people do not usually see. This highlights a limitation of the method due to the inability to accurately and reliably assess a limited set of basic emotions and not mixed emotions [33], [38].

B. User Feedback Methods

User feedback is of utmost important for any affective evaluation as a variety of information can be gathered on any aspect of the game to help make it more fun and inspiring to play. According to [26], various approaches have been used to obtain user interaction-games feedback with varying achievement. Verbal self-report instruments are commonly used to examine subjective feelings [33] such as being happy or being spirited as it is the conscious awareness of an emotional state.

Table III below presents a summary of approaches to elicit user feedback for AUCD assessment of video games. Note that these are methods commonly practiced and published. However, it must be noted that as with all approaches they have their respective applied advantages and disadvantages. The known limitations of these methods are its practicality of use in certain cultures, and sometimes being unreliable due to prejudices [14, 43]. These methods also fail to deliver adequate user data in terms of how a particular game is perceived, and do not provide critical, usable feedback for game designers to act upon. Thereby, they may not be deemed as being dependable approaches to measure affect alone [38]. They require other types of methods to support them.

C. Other Methods

There are other types of approaches and apparatuses that can also be applied to measure affect and emotion. Table IV below presents a summary of other methods of AUCD evaluation for video games.

TABLE III. USER FEEDBACK METHODS

User Feedback Methods		
Methods	***Description***	***Authors***
Classical Methods	• Also known as traditional methods (*i.e. interviews, questionnaires, focus groups, surveys*). • Classical methods are mainly conducted to gather information from users especially on their perception of games. • Classical methods are difficult to conduct due to the questions which are tricky to write in a way that yields high quality, actionable data. • When performed correctly, they offer important insights that will aid game designers to have better understanding on how users think about their games.	[14], [26], [33], [38], [43]
Usabilty Testing	• Usability testing is a great source of behavioural information about users. • Measurable usability criteria for video games usually address issues related to the effectiveness, efficiency, learnability and memorability as well as users' subjective satisfaction with them. • Usability testing is usually done with users along with experts through expert reviews. Experts can comment on usability issues while users can point out small problems related to tasks.	[10], [22], [26]
Playtest Methods	• Playtest method is a combination of survey and hands-on gameplay. • Playtest aims to offer game designers with valuable user feedback in a systematic manner using scientific methods on how the users perceive critical aspects of their games. • Playtest is one of the most common ways to uncover game design problems, but this method requires a playable prototype that only exists in the later stages of the development process.	[6], [22], [26]

TABLE IV. OTHER METHODS

Other Methods		
Methods	***Description***	***Authors***
Heuristics Evaluation	• Heuristic evaluation is potentially a useful assessment method for game prototypes as it does not make assumptions about tasks and about the purpose of an application. • The benefit of heuristic evaluation is that it helps practitioners and researchers to find important classes of problems that are not always found with user testing. • Heuristic evaluation can be used to evaluate most video games.	[5], [15], [22], [38]
Non-Verbal Self-Report Instruments	• There are researchers and practitioners who have developed instruments that combine non-verbal and verbal self report together. • Example: *Self-assesment Manikin (SAM: Lang, 1985); Product Emotion Measurement instrument (PrEmo: Desmet, 2003)* • Non-Verbal Self Report instruments can measure distinct and mixed emotions without requiring users to verbalise their emotions.	[22], [26], [33], [38]

VII. SUMMARY

This paper has reviewed the literature on affective user-centered design elements, principles and methodologies that are applicable in video games. There is a need to have a deeper understanding of what the roles of emotions are, and the affected processes as the design of user experience becomes increasingly important in the development of video games. The enhancement of game interface design is dependent on how well the emotional affect can be identified through sensing and recognising a player's emotions, and subsequently be able to tailor the game responses to those emotions. However, despite the substantial progress already made in assessment methods and tools, we foresee more work in the future in affective user-centered design employing more mixed-methodologies and multi-disciplinary approaches to gain a more reliable assessment.

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