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CHARACTER BELIEVABILITY ENHANCEMENT USING FACIAL EXPRESSION RECOGNITION TO IMPROVE THE PLAYERS IMMERSIVE EXPERIENCE

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Abstract. *Immersion is one of the gaming experience elements that gives the player the feeling of engrossment and makes the player more lenient towards any flaw within the game. While there are a lot of factors that affect player immersion, character believability is considered to be one of the most important within the RPG genre. RPG games tend to focus on the interaction between the player and the game characters at part of their experience. This study aims to improve the believability of the character in video games using Facial Expression Recognition (FER) in order to improve the player immersive experience. A modification for popular action RPG games has been designed and implemented. An empirical experiment (N = 52) was conducted in which the modification was tested and then was compared with the original version. A validation test was then applied to evaluating whether applying a facial expression recognition for the game adaptive model improved the player immersive experience or not.*
Keywords: Immersion, Character believability, Facial expression recognition, Player experience, NPC

1. **Introduction.** Video game is the most popular form of digital entertainment. To be profitable, a video game must offer a good gaming experience for its players. Gaming experience is influenced by many elements such as concentration, challenge, skills, control, clear goals, feedback, social interaction, and immersion [1]. Immersion in games refers to methods for making the game worlds feel real so the player can engross himself within the game. Game developers have done a good job utilizing the latest technology to make games with good graphical presentation, storyline, audio, world design, and characters to give the player an immersive experience. Characters in video games were given various roles in the game world that enhance the game world so that the player can feel as though they are interacting with another people [2]. Sadly, even with current game technology, Artificial Intelligence (AI) controlled characters often took action that often break the player's sense of immersion. This was caused by the different ways of decision making from the AI that control the characters and the players. The players often find more efficient way to play the games, while the AI is limited with the set of rules set by the developers. In most cases, the AI cannot keep up with the player and takes an action that is deemed inefficient by the players. Alternatively, the developers usually give the AI controlled characters have extra abilities to make up for their disparity with the player. However, this can sometimes impact the believability of the characters and break the game immersions. Thus, it is deemed necessary to look for an alternative way for this problem.

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Most AI controlled characters or Non-Player Characters (NPC) use the player action and the event that transpires around them for their decision making. However, taking the right action to satisfy the player with limited resource and little information is very difficult and varies from player to player. These limitations give an idea to emotion based adaptive game model as an attempt to tackle the main issue of player satisfaction directly [3]. Multiple studies have shown that interacting with the game often provokes player emotion manifested by facial expression [4]. Facial expression also indicates the emotions that are caused by their gaming experience at certain point of time. As facial expression relates to player gaming experience and improving player gaming experience is the goal, facial expression should be a suitable input for the adaptive game model.

The use of Facial Expression Recognition (FER) technology to improve gaming experience has been proposed in several literature, but only empirically evaluated by few. Several studies [4-6] used FER technology to adjust the difficulty in simple games, and improved the challenge and skills aspect from gaming experience in different genres. However, these studies evaluate their model using games that are designed to work with the FER system in mind. Currently, there are only few studies that evaluate FER technology in existing game. One of the studies [7] used FER with a framework that is implemented into NPC agents. This framework improves the dialogue aspect and enhances the player experience. All of these experiments were evaluated using questionnaires and reported that using FER technology in game significantly increases player experience.

This work attempts to provide novel contributions by 1) creating an FER based system that is capable of exchanging information with existing game engine; 2) exploring FER implementation practice within uncommon game genre (RPG); 3) exploring a way to improve the player experience by enhancing the believability aspect of game character. This study is organized as follows: Section 1 covers introduction of the study; Section 2 lists several literature and works related to the study; Section 3 elaborates design, development, and evaluation methodology used in the study; Section 4 discusses results of the study; Section 5 concludes the study and provides recommendation for future research.

2. Literature Review and Related Works.

2.1. Immersive gaming experience.

The main goal of video games is to give its player an experience that satisfies them. Research by Koster [8] has implemented the concept of flow channel into game design and suggested that players must be kept inside the flow channel to ensure optimal experience. In that case, a game must be able to keep the player immersed within the game world. To achieve this, the immersive element of the game should draw the players by affecting their senses through elements such as audio, visuals, and narrative [9]. Realistic representation of these elements can help player feel as if they are present at the actual real-world environment. The more realistically the real environment has been reproduced, the more the sense of presence in the environment becomes heightened, thus inducing the ultra-realistic feeling [10]. The game then became the most important part of the player's attention and their emotions are directly affected by the game. RPG games tend to focus on immersion as the main experience for its player.

2.2. Character believability.

Characters element within game helps in gaining the player's attention. Characters that are interesting and believable will attract a sense of empathy from their player, that is why fictional character is made to be as attractive as possible. The definitions of believable character are ambiguous and have been debated by many researchers. Research by Chowanda et al. [7] elaborated that the idea of believability does not necessarily come from a reliable character but one that provides the illusion of life, and thus permits the audience's suspension of disbelief. While Gomes et al. [11]

believed that believability is the identification, from the user or spectator, of an agent's goals, beliefs and personality. Believable characters will imply a very high degree of realism. According to research by Togelius et al. [2], a believable NPC can make many games become more engaging for players. In this case, it can be concluded that character believability influences the player's immersive experience. However, this can only be applied to game with certain genres. There are many games and NPC that are not designed to be believable, and there are also game genres completely devoid of NPCs (e.g., puzzle games).

2.3. **Affective adaptation in video games.** Affective games are games that are capable of recognizing player emotions, adapting game character behavior and gameplay to these emotions, and generating affectively realistic interactions among game characters. This research is proposed by Hudlicka [12] that has implemented affective computing concept into game design, since emotion plays a key role in user experience, both in entertainment and in serious games. To recognize the player emotions, input devices such as camera may be used. The result will be processed and interpreted by agents and provides an adaptation such as reward structure modification and realistic portrayal of in-game character emotions. A game can be with embedded FER system to automatically interprets current facial expression and make an adjustment as the game progress. In this case, the adjustment is focused on other characters in the game world called Non-Player Character (NPC). The system will send the player emotions data to the game, and the NPC AI will use this information to adapt their behavior and gameplay.

2.4. **Evaluating player experience.** There are numerous methods employed by various studies to evaluate player satisfaction. However, these methods are not suitable to be used in this study as they required the participants to experience the game directly. In the case of this study, character believability will be measured since it is affecting the player immersive experience. Believability is a subjective question and will vary from player to player. Research by Gomes et al. [11] has provided a method to measure believability using Likert scale questionnaire. Qualitative approaches are also used to find linear correlations between user data and Likert scale questionnaire results, while quantitative approaches attempt to quantify entertainment using performance metrics. Research by Andrade et al. [13] adopts Maguire's evaluation methods for human-centered design in a usability test [14]. The test includes satisfaction questionnaire and post-experience interview. Satisfaction questionnaire is used to collect subjective data using a certain Likert scale, and post-experience interview is conducted to obtain data not covered by the questionnaire.

2.5. **Related works.** There are only few studies that empirically evaluate the use of FER for adaptive game model. Chowanda et al. [7] have developed a modification for an RPG game, The Elder Scroll V: SKYRIM. They implemented a framework called ERiSA into two newly created characters and conducted experiment ($N >= 15$) in which the participant interacts with one of the two characters randomly. The framework is evaluated using the following questionaries: 1) Big Five Personality Inventory; 2) Quality of Relationships Inventory (QRI); 3) Social Relationship Index (SRI); 4) Ekman's six basic emotions; 5) The Game Engagement Questionnaire and The Immersive Experience Questionnaire. The study concluded that the framework significantly increases player experience. Other studies by Moniaga et al. [4-6] also utilized FER technology to improve the player experience and conducted experiments ($N >= 30$). These studies utilized different methods to evaluate their model. Moniaga et al. [4] evaluated the model using an immersion questionnaire, while Andrew et al. [5] used the player performance metric, and Akbar et al. [6] utilized game experience questionnaire. They reported that the model significantly increases player experience. While these studies have produced satisfying

result, there are currently no studies that evaluate FER model in terms of character believability.

3. **Methods.** This study consists of 3 main phases: design, development, and evaluation. In the design phase, modification for popular Action-Role Playing Game (ARPG) The Elder Scroll V: SKYRIM was designed. ARPG combines element from both action games and role-playing game in which the player takes the role of an important character in the story within the game world. Characters within the game usually are the main focuses because the game story revolves around them. The successful combination between a good story and interesting character will increase the player satisfaction. Furthermore, RPG games have gained an increase in popularity with many companies giving a massive budget to develop them. Thus, an empirical study to improve the player experience in this genre might contribute to similar game development in general. SKYRIM was selected to test the proposed model due to the following reasons: 1) SKYRIM is a very popular action-RPG game with many remastered and port to other platforms; 2) SKYRIM offers a unique world design consisting of wilderness, dungeons, caves, cities, towns, fortresses, and villages populated by NPCs that can be interacted within a number of ways; 3) SKYRIM releases the toolkit and engines that are used to develop the game and allows its player to freely modify the game.

In the development phase, the adaptive game model was made in the form of modification. The modification was developed using Creation Kit engine provided by Bethesda Game Studios, while the FER system was developed using the Unity game engine. The FER system utilizes AFFDEX SDK from Affectiva [15]. This SDK utilizes emotion facial action coding system to give a score within $[0, 100]$ to a certain expression, where 0 is missing expression and 100 is a fully present expression [16]. The FER system is built to recognize up to six type of emotions: anger, fear, joy, sadness, disgust, and neutral. When the game begins, FER system starts capturing and interpreting player face every second. Every 3 second, an adjustment is made based on the overall player's expression. If within this time the player is showing mixed emotion, or the system cannot detect any face, the parameter value will be set to neutral. These emotions also will determine the player's overall mood. If a negative emotion such as anger or sadness is displayed, a negative value will be assigned, while a positive emotion such as joy will assign a positive value. These values will determine a mood variable called valance, and the result can be either positive or negative, depending on which value is higher. The values of both valence and emotion accumulated in the first 3 seconds will determine their value for the next 3 seconds. The result will be written in a file and the game will read and use it as an input. Using Creation Kit, a custom follower type NPC called Lydia was created. Follower type NPC is essentially the player's companion in game, and they have the abilities to follow and help the players in many ways, like protecting players against other hostile NPC, carrying player's item, and giving context of the area. The proposed model (Figure 1) attempts to further improve the interaction between the player and Lydia by modeling the AI using HFSM (Hierarchical Finite State Machine). HFSM is a model that is capable of simulating simple sequential logic. The model consists of one or more pre-defined states that represent specific behavior. The model will hold the current state as active until it receives an information that it recognizes. This information comes from the event that occurs in the game world and from the FER system. HFSM itself is an improvement from FSM (Finite State Machine) to deal with ambiguity problem that occurs when transitioning between state by prioritizing transition using stacking approach [17].

In this model, Lydia will adapt her behavior from the information around the game world and the information from FER system. Low valence is not desired during the game, as they suggest that the player is unhappy with the current situation. For example, if

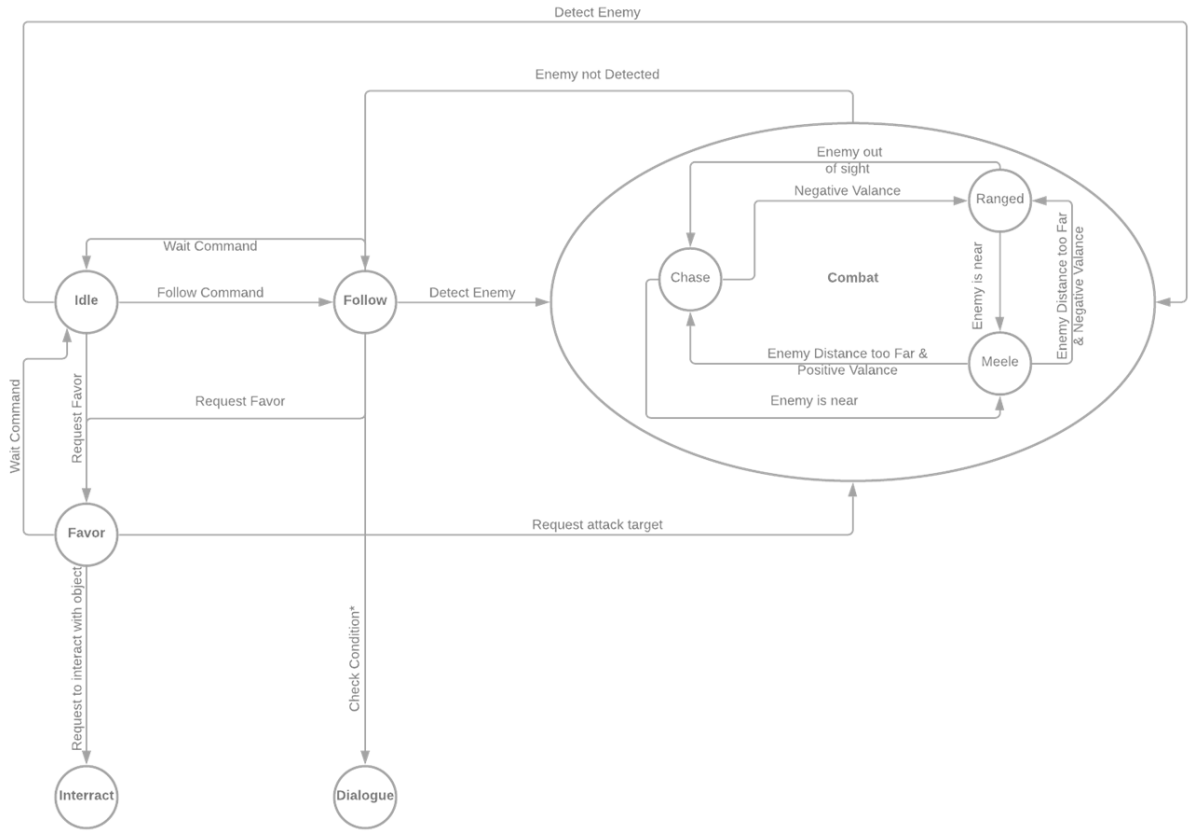

FIGURE 1. Chart showing the NPC decision process

Lydia detects that the players health is low and their valance is negative, she will assume that the player is in trouble. Her AI will transition to dialogue state and initiate a dialogue to offer a health potion to the player in order to make the current situation better for the player.

In the evaluation phase, the model was evaluated. Empirical experiment was conducted in which participants watch two videos showing interaction simulation between the characters in both version of the game. This method of evaluation is chosen for several reasons: 1) eliminating the skill requirement for the participants to experience the model; 2) enabling to choose participants from larger demography; 3) highlighting interaction that requires an extended play time. To preserve validity and avoid biases, every participant is required to: 1) Participant filled Demography Form; 2) Without informing the difference, participant is required to roll a random number $[1, 10]$ to determine which version the participant watches first; 3) Participant watches the version with the model first if odd number was rolled and the original version if even number was rolled; 4) Participant filled several questionnaire questions; 5) Participant watches the second version; 6) Participant filled the same questionnaire questions; 7) Participant answered interview questions.

The experiment goal is to evaluate player satisfaction for the suggested model by utilizing a usability test proposed by Andrade et al. [13]. The test was selected expecting to produce more accurate representation of player satisfaction. A questionnaire was filled by participants to evaluate both versions of the game NPC. The questionnaire is derived from character believability questionnaire [11] with nine questions extracted from the questionnaire (Table 1), with 4-point Likert scale scoring from 1 to 4 for the first eight questions and multiple choice for the last. Lastly, an interview was conducted to collect additional data.

TABLE 1. List of questions used to quantify character believability

Game component	Question
C1: Awareness	**Q1:** The character perceives the world around him/her.
C2: Behavior understandability	**Q2:** It is easy to understand what the characters is thinking.
C3: Personality	**Q3:** The character has a personality.
C4: Visual impact	**Q4:** The character's behavior draws my attention.
C5: Predictability	**Q5:** The character's behavior is predictable.
C6: Behavior coherence	**Q6:** The character's behavior is coherent.
C7: Change with experience	**Q7:** The character's behavior changes according to experience.
C8: Social	**Q8:** The character interacts socially with other characters.
C9: Emotional expressiveness	**Q9:** What emotions do you believe the character was mainly expressing?

4. **Result and Discussion.** The experiment involved 52 participants (age 18-35, 85.6% male, 71.2% have played RPG games before, 86.5% have played or watched other people play SKYRIM before). After conducting the experiment, the model evaluation data was obtained. To find the data distribution, test of normality was done using both Kolmogorov-Smirnov and Shapiro-Wilk and produced the following result (Figure 2).

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Model	.145	52	.008	.935	52	.007
Original	.134	52	.020	.949	52	.025

a. Lilliefors Significance Correction

FIGURE 2. Normality test result

Since the value of Sig. in both original and model version is less than 0.05, it can be concluded that the data distribution did not come from normal data distribution. Hence, Wilcoxon signed-rank test was selected to statistically compare the metrics in both versions. The test result reveals a statistically significant difference ($p < 0.05$) in all desirable believability component (Figure 3), except for Q5 which represents predictability. According to the research by Gomes, enhanced perception of the believability dimensions corresponds to a greater sense of believability, except for predictability [11]. Therefore,

Test Statistics[a]

	Q1_Model - Q1_Original	Q2_Model - Q2_Original	Q3_Model - Q3_Original	Q4_Model - Q4_Original	Q5_Model - Q5_Original	Q6_Model - Q6_Original	Q7_Model - Q7_Original	Q8_Model - Q8_Original
Z	-5.031[b]	-4.031[b]	-4.764[b]	-5.347[b]	-.479[c]	-4.209[b]	-4.127[b]	-4.911[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.632	.000	.000	.000

a. Wilcoxon Signed-Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

FIGURE 3. Wilcoxon singed-ranks test result

the proposed model can be concluded to statistically provide higher player satisfaction by enhancing the game character believability and thus improving the immersive experience.

For emotional expressiveness as recommended by Gomes et al. [11], we gave multiple choices from the six emotions to the participants to determine what emotions they do believe the characters were mainly expressing (Figure 4). The result indicates that most participants believed the original character emotion is more neutral when compared with the model version, which had more varying results.

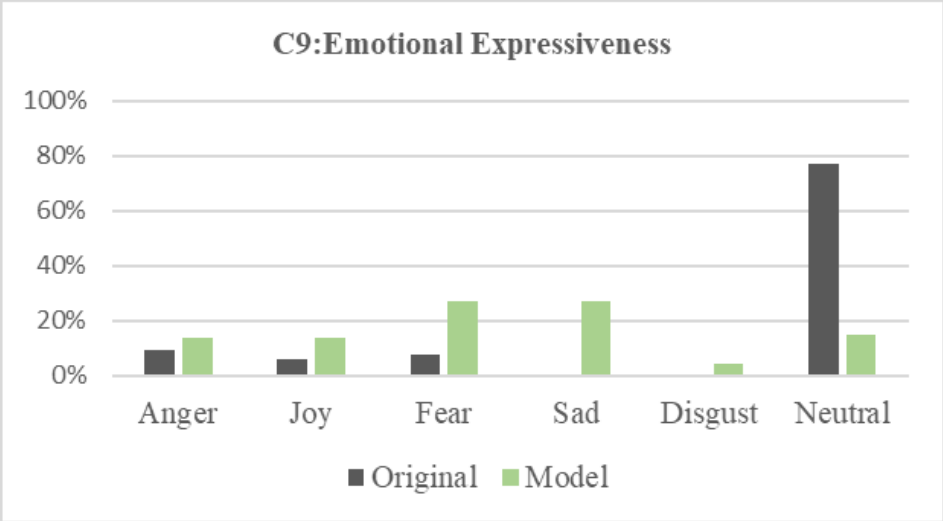

FIGURE 4. Bar chart representing satisfaction questionnaire result

The rest of the metrics were compared. According to the responses, 81% participants noticed valid difference between the 2 versions and when asked, 79% participants preferred the version with the proposed model, mostly due to the better experience it provides. A few that chose the original version cite that the model version character is more annoying.

5. **Conclusions and Future Works.** This study demonstrates on how FER can be used to provide input for emotion-based AI. A modification for famous video game The Elder Scroll V: SKYRIM was design and developed. Simulation for both the original version and the version with the proposed model were recorded and then used in an empirical experiment ($N = 52$). Both versions were evaluated using a usability test. Wilcoxon signed-rank test was applied and revealed a statistically significant improvement ($p < 0.05$) for metrics in the game version with the proposed model. Such improvement is supported with additional results from character believability questionnaires, and post-experience interview. This experiment can be concluded that the game, as an RPG, can improve its players immersive experience further by enhancing the character believability using FER system.

Future works for this study would be to test the proposed model by requiring the participants to play the game for an extended time. This would further solidify the current result and test some metric that could not be noticed in short period of time. Another future work is to improve the FER aspect by applying an FER system that can interpret a larger range of emotions/expressions with higher accuracy and efficiency. Combining FER with other biometric sensors such as microphone or electrocardiogram may also be done to enable system to interpret player emotion with higher level of confidence. Additionally, future experiments may apply the proposed model to another type of NPCs. Study of emotion based adaptive game model could be further extended by exploring its utilization in other game genres.

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