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Facial Expression Recognition on Games to Improve Player Experience Satisfaction

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ABSTRACT
Player Experience has been known to be the most important keys for the success of game. There are a lot of methods for improving player experience and one of them is by using Facial Expression Recognition. This paper aims to improve player experience by using Facial Expression Recognition with a balancing game. The player's emotion will be captured real time and game balancing will work with the emotion value. 2 games were developed one with basic game and the other one with FER. There are 30 respondents that will play both games. The result shows that there is no significant difference between the basic games and the enchanted games using Facial Expression Recognition and Game Balancing.

Keywords: Player experience, Game Technology, Facial Expression Recognition

1. INTRODUCTION

Games is one of the entertainment facilities in the world. The interesting part about game is that human will still challenge the game voluntary even when they are affected by negative emotion such as frustration, fear, sadness [1]. Players emotion play an important role in the development of games. Players can interact with non-playable characters (NPC) or we can call it a game object so that players can feel emotional experience. This emotional experience that attracts someone to play games. Only with this emotional experience that games can be said to be fun or boring. Non-playable character (NPC) in a game is one of game object that is made to be able to interact according to the movements we do. Usually in a game will be given a choice of words or emotions by characters that we play so that non-playable characters (NPC) will responding according to that. But because of this choice it makes limited interaction in a game with non-playable characters. This non-playable character is very important in a game. Only when we can improve the quality of this non-playable character so that we can increase the experience that we will get in a game. Experience is something that we feel inside our life. Experience is something that can make humans to learn because with experience humans can judge things that happened and can learn from it. Experience is also very important in a game, only with an interesting experience is new one can be interested in developing in the game.

Therefore not a few games are made so that people can feel the experience which makes them want to keep playing. Facial expressions are one of the most powerful, natural and universal signals for humans to convey their emotional states and desires [2]. There are six basic emotions that show that humans

feeling certain basic emotions regardless of cultural differences. The basics emotion are anger, joy, sadness, surprise, fear, and disgust. Facial expression recognition (FER) systems are divided into two main categories, the first is static image facials expression recognition
where the feature representation is only encoded from a spatial information of an image. The second is dynamic sequence facial expression recognition where in dynamic sequence FER considers the temporal relationship between adjacent frames on facial expression recognition input. We can use facial expression recognition to develop a non-playable character through the emotions felt by players so that the games we have can be more interesting and have variety more so that it is not static and makes the game better and not bored. By improving it we can increase the experience felt by the player.

2. RELATED WORKS

2.1 Human Facial Expression.

In previous studies, Humans can give facial expressions intentionally or unintentionally. this depends on the nervous mechanism of each individual. Expression that is intentionally is usually caused by thoughts that make us express accordingly with what you feel. And with this expression we get use it as data that can be used for many things. One of them is by using facial expression recognition we can get data on human facial expressions and the data can be managed for needs such as emotion recognition in robots orartificial intelligence. If facial expressions (including displaying emotions) are adaptations social, then they are produced into signals, especially with the aim of social. Whether or not emotions are related to most facial expressions, or even any facial expression, is a very important matter in emotional psychology [3]. In 2011 there is a research about facial expression of emotion and perception of the uncanny valley in virtual characters. The result shows that Data from this study imply that animated, high-fidelity, humanlike, talking-head, virtual characters are rated by users as uncanny (less familiar and human-like) but significantly more so when movement, and therefore emotional expressivity, is limited in the upper face. More important, the magnitude of this increased uncanniness varies depending on which emotion is being communicated. Under these conditions, the emotions fear, sadness, disgust, and surprise, evoke a strong sense of the uncanny but, despite aberrant upper facial movement, uncanniness is less noticeable for the emotions anger and happiness [4]. There was a research about violent video game players and non-players differ on facial expression recognition aggressive behavior which shows that chronic exposure to violent video game playing might affect the recognition of fearful and disgusted faces, but not the recognition of angry, happy, or sad faces [5]. With the different type of game, it will bring a different emotion towards the player. emotion recognition of players through facial expression recognition can be used in many ways. For example, in interactive and multiplayer games, emotions of players can be transferred to the players' avatars on the screen. Or in educational games, recognizing players' emotions can help the system how to behave in better manner. For example, if the player is sleepy, the system may wake him/her up; or if the player is happy after doing something well, the system may cheer him/her up and so on. Thus, facial expressions recognition of players is applied, intelligent game systems can become more interactive, vivid and attractive [6].

2.2 Facial Expression Recognition.

In previous studies, Facial Expression Recognition is a system that can automatically recognize facial expressions using photos or videos. To analyze facial expressions and engagement from the received face image, it is necessary to crop only the face region through face detection. Deep learning is the state-of-the-art technique in the detection field and pre-trained models have shown

excellent detection performance in many fields [7].This system is widely used in various fields such as Health, facial expression recognition is used to measure pain and even in the world of games, facial expression recognition can also be used to develop games. A facial expression is usually considered as the deformations of facial components and their spatial relations, or changes in the pigmentation of the face [8]. Facial expression recognition has 3 steps, namely face detection, facial expression detection, and expression classification to an emotional state [9]. Emotion detection is an analysis based on facial landmark position nose, eyebrows). In the video, the change in position is also analyzed, in order to identify contractions in facial muscles [10].

Photos or videos that function as input to facial expression recognition algorithms varies from surveillance cameras to cameras that are placed close to advertising screens on stores as well as social media and streaming services or devices personal [9]. Even though facial expression recognition can analyze emotions based on facial expressions. but facial expressions individuals are different and can even give mixed expressions such as sad and happy or even no emotion at all. too much ambiguous emotions such as when someone is being sarcastic. Therefore, even though facial expression recognition can analyze emotions from face expression, but the accuracy given is not 100% accurate even though most of it the accuracy is quite high. In 2017 there was a study with the title Real Time Facial Expression Recognition Using Webcam and SDK Affectiva. This study aims to create a system that will use 3 phases on the recognition process to work fast and stable in real-time. Result shows that by using the Affectiva SDK, the average total detection rate is 84.27%. but if the subject doesn't have a head that move above 15 degrees it can get a value of 100%.

But if subject look to the left or right or the head is moving then face detection will be failed along with its emotion detection [11]. Quantitative methods have the potential to represent true player experiences in the game and are able to continuously capture a more diverse body of information [12]. In 2012 there was a research entitled A feasibility study in using facial expressions analysis to evaluate player experiences. This research uses facial expression to analyze the experience felt by players when playing games. The results show that of all the graphs that have been obtained from the data owned, automatically recorded facial expression useful for getting player data when playing games and the data can be used to conclude the experience felt by the player. In the end of the session when participants were asked if they were aware that they being recorded or feeling disturbed by the presence of a camera, participants are not aware of it and the presence of the camera does not interfere about the experience experienced by them but there are also participants who feel the presence of the camera and answer like they are more adapting their expression and restrain themselves when they are angry or frustrated. With using facial expressions, they can capture rich representations and sustained from real-life player responses in play situations authentic, making it possible to analyze experiences smoother gameplay. Using a computer analysis method automatically, it also solves the privacy issues by the play tester who uncomfortable having their videos seen by others. This is an app essential for game companies that need to develop game analytics tools visuals for analyzing online games [13]. In 2017 there is a research about enchanting student models in

game-based learning with facial expression recognition. The result shows that by augmenting gameplay data with facial expression data,

affect-enhanced student models significantly outperformed models using only gameplay features. Additionally, the models using the more granular action unit data significantly outperformed models using the composite emotions [14]. In 2016 there is a research about an effective facial expression

recognition approach for intelligent game systems. The result shows that since the proposed method is very simple, fast and obtain high accurate even with smaller resolution (e.g., 48 × 48 pixels), so it is suitable for real time systems such as data-driven animation, intelligent game applications and intelligent human-machine interface systems [15]. In 2020 there is a research about non-contact emotion recognition combining heart rate and facial expression for interactive gaming environments. The research of emotional recognition during games can maintain user's
involvement and enhance their gaming experience. For this purpose, automatic emotion recognition for game users is mandatory to maintain his/her involvement without interrupting his/her gaming process [16].

2.3. Non-Playable Character.

In previous studies, NPC role in a game is important because NPC can made to be a companion or ally of the player or to be enemy or become a third party who has a specific purpose. With NPC there is many interactions that can be made that are diverse and creative. Player of course will have a lot of interaction with NPC. Therefore, by making NPC to be able to interact according to the player's emotions is a positive thing that can increase the experience of players. NPC can also be controlled by artificial intelligence in a game and usually NPCs are only used as a tool so that the story can continue or to make plots. Although intelligence is a basic element for making NPCs, emotions can increase the credibility of NPCs [17]. When players interact with NPCs in the game, the real and nuanced emotional responses displayed by these characters undoubtedly add more vividness and realism to the game. Emotion expressions similar to those of humans make players feel as if they are in a real and vibrant game world, establishing deep emotional bonds with the characters. With the continuous progress of game technology, emotion simulation has become an important means to enhance the gaming experience [18].

2.4 Dynamic Balancing System.

In previous studies, Facial expression recognitionis used to get expressions from players in
real-time when players play games. After that, dynamic balancing system will automatically adjust game difficulty based on of players' expressions when playing games [1]. In this study there are 2 groups that play 2 test games, namely 2D games: Alien fighter and 3D game: Rushing Escape. Each group will play the game 2 times, one with a dynamic balancing system that has been installed on the system and one without it. The results show in both games that there are no negative effect variables on player experience from baseline and enchanted games. Besides that, there is a statistically significant difference in the five experience categories players in both game groups. In 2D games, only 1 of 2 variables (Q2) in the Competency category which has statistical differences between baseline and enchanted games. While in 3D games there is no significant difference statistically significant in this category. In the future, the variable other dynamic counterbalances (e.g., Enemy Strike Points, Enemy Lives) can be explored. Finally, his research can be extended to settings a serious game where the speed of learning depends on the individual controlled by a dynamic balance system. This dynamic balancing can used as a system that helps non-playable characters to develop. In this study, dynamic balancing is used and not using difficulty adjustment, this is because dynamic difficulty adjustment changes the parameters, scenarios, and behavior of the game. Meanwhile, what researchers want to achieve is a system that can helps NPCs to develop and researchers don't focus on making a game becomes easier or more difficult but to improve the experience felt by the player. Dynamic balancing will help researchers so that researcherscan get developmental data based on response from players.

2.5 Player Experience.

In previous studies, Games User Research (GUR) focuses on measuring, analyzing, and understand the player experience to optimize game design.

Therefore, GUR experts aim to understand how game design choices are made experienced by players and how this can lead to a response of certain emotional states [19]. Player will be motivated to play certain games to fulfill the desire to regulate moods, regulate oneself, or satisfy oneself. and players a 'good' experience is the result of satisfaction from it [19]. Player experience is one of the things whose value cannot be measured using numbers or we can say as a qualitative thing. Each person also has different differences such as differences in genre interest in games. Therefore, to increase player experience, it is necessary to be functional and psychosocial level of measurement to enable game research community to gain new insight into what constitutes a player positive experience [19]. Physiological measurements are able to capture player experiences continuously in real-time. In addition, physiological data represent the real life experiences of the player [20]. Collecting, detecting and analyzing player experiences are non-trivial tasks. This is because direct measurement methods are often disruptive and laborious, and affective states are complicated, derived concepts. Traditional approaches are often qualitative and includes collecting subjective data from direct observations, interviews and

think-aloud protocols [21]. Still many other things that can affect how to improve the player experience such as game design, the attractiveness of a character in the game, design characters in the game, so to increase the player experience you can done in many ways that already exist or even do not exist for now. With the development of player experience, the game will also develop, because with the development of better player experience, it certainly brings the game to develop in a positive direction.

2.6 Affective Game.

Affective gaming refers to the new generation of games in which the players' behavior directly affects the game objectives and gameplay. The emotional state and actions of a player can be recognized and used in order to alter the game play plot and offer an increased user experience feeling [22]. Affective games are a sub-field of affective computing that tries to learn how to design responsive video games to the emotions expressed by players, as well as provoking they want [23]. To achieve that goal research is needed on how to measure and detect human emotions using computers, and how to adapt video games to emotions felt until it finally provoked them to the players [23]. Although developers usually focus their efforts to improve the graphics quality of video games, in recent years very difficult to stand out in this, thus forcing them to find new ways to gain interest in their game. This is where Affective games work, assessing player emotions and adjusting gameplay with them as well as trigger the right emotions into the player to improve their overall satisfaction [23]. While Affective Computing topic has been around for more than two decades, implementing Affective Computing is still considered as in the infancy state. The ultimate goal of the game is to make players satisfy when, and after playing the game. The game designers are competing to create a game that offers the best game player experiences [24]. To study human emotions, affective states need to be evoked in laboratory environments, using elicitation methods such as images, audio, videos and, recently, virtual reality (VR) [25].

Develop toward ped online personalization method provides an effective basis for converging to an appropriate affective state for the individual human player. Affective games are made to help find a suitable method for measure the affective state of the player.

3. METHODOLOGY

In this study, we proposed a facial expression recognition using python to connect on unity. Facial expression recognition can detect and give value for 7 emotion. Emotion will be obtain using the camera. The result from facial expression recognition will passed into a new file and unity will read that file that contains emotion value. In this study game will be made using Unity using its library and assets store. NPC will increase or decrease their hit point depending on the emotions felt by the player. If the player is having trouble and the emotions start to be negative, then the AI game will work to help player by decreasing 1 hp from the NPC and increasing the player hit point by 1. The AI will only work every 10 seconds, and vice versa if the player's emotions are positive and players get bored because it's too easy then the game AI will work with increase the enemy's hit point by 1 and decreasing players hit point by 1. With the help of the AI, players will be able to feel play more comfortably to improve the experience feel when playing.

3.1 Dataset.

We used a dataset in unity store, we only need to download the dataset or template. This section we are making a simple game using the template and asset from the unity store, and modify it according the setting we want. And we use python with the dataset from edureka for the facial expression recognition.

3.2 Game Balancing.

After the game and facial expression is ready, by using the emotion value, we will decide the value of negative and positive, we set value happy is positive and neutral is neutral and the others is negative. Then the dynamic balancing game will work according to the emotion value. There is 4 variable that we will using dynamic balancing.

The first variable is the player and enemy Hit Points. When the emotion value is negative then we will make game AI that help players with increase the hit point and reduce the enemy hit point using the formula:

$$HP = CHP + 1 \quad (1)$$
$$EHP = EHP - 1 \quad (2)$$

Where:
HP = Hit Point

CHP = Current Hit Point
EHP = Enemy Hit Point

When the value is positive then we will make game AI that reduce the Hit Point using the formula:

$$HP = CHP - 1 \quad (3)$$
$$EHP = EHP + 1 \quad (4)$$

Where:
HP = Hit Point
CHP = Current Hit Point EHP = Enemy Hit Point

The second variable is Moving Speed. When the value is negative then we will make game AI that help players with increase the player moving speed using the formula:

$$MS = MS+2 \quad (5)$$

Where:
MS = Moving Speed

When the value is positive then we will make game AI that decrease the player moving speedusing the formula:

$$MS = MS\text{-}2 \quad (6)$$

Where:
MS = Moving Speed

The third variable is player vulnerable. When thevalue is negative then we will make game AI thathelp players with increase the player vulnerable using the formula:

$$PV = PV * 2 \quad (7)$$

Where:
PV = Player Vulnerable

When the value is positive then we will make game AI that decrease the player vulnerable usingthe formula:

$$PV = PV / 2 \quad (8)$$

Where:

$$PV = PV / 2 \quad (8)$$

PV = Player Vulnerable

The fourth variable is enemy damage. When the value is negative then we will make game AI thathelp players with increase the player damage using the formula:

$$PD = PD + 1 \quad (9)$$

where
PD = Player Damage

When the value is positive then we will make game AI that decrease the player damage usingthe formula:

$$PD = PD - 1 \quad (10)$$

where
PD = Player Damage

3.3 Questionnaire.

After all the data already collected then after that an evaluation will be carried out and calculations to determine whether using the facial expression recognition can improve player satisfaction or we can say that they got a better experience. Player will be given a questionnaire that evaluate player experience when playing. The type of data that weuse in this study is quantitative data. Quantitative data is a type of data that can be measured or calculated directly, usually quantitative data is data that uses numbers or usually data in the form of numbers. This data is obtained from the questionnaire given to the respondent

after they play the game. Due to the data that will be taken in the form of individual subjective perceptions, this method will be used Likert scale. Evaluation will be carried out using System Usability Scale (SUS) and Game Experience Questionnaire (GEQ).

4. RESULT AND DISCUSSION

Table 1 shows the result of ShapiroWilk test to check data normality.

TABLE 1. Test of normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Game_Basic	.146	30	.105	.955	30	.226
Game_FER	.079	30	.200*	.984	30	.922

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The data is normally distributed, because theP-Value is more than 0.05.

Table 2 shows the result of Paired Sample T-Test

TABLE 2. Paired Samples T-Test

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Q1_basic - Q1_FER	.100	1.398	.255	-.422	.622	.392	29	.349	.698
Pair 2	Q2_basic - Q2_FER	-.633	1.752	.320	-1.287	.021	-1.981	29	.029	.057
Pair 3	Q3_Basic - Q3_FER	.100	.960	.175	-.258	.458	.571	29	.286	.573
Pair 4	Q4_Basic - Q4_FER	-.700	1.393	.254	-1.220	-.180	-2.752	29	.005	.010
Pair 5	Q5_Basic - Q5_FER	.100	1.242	.227	-.364	.564	.441	29	.331	.662
Pair 6	Q7_Basic - Q7_FER	.267	1.202	.219	-.182	.715	1.216	29	.117	.234
Pair 7	Q8_Basic - Q8_FER	-.167	1.262	.230	-.638	.304	-.724	29	.238	.475
Pair 8	Q9_Basic - Q9_FER	.267	.868	.159	-.058	.591	1.682	29	.052	.103
Pair 9	Q10_Basic - Q10_FER	-.533	1.167	.213	-.969	-.098	-2.504	29	.009	.018
Pair 10	Q12_Basic - Q12_FER	-.233	1.135	.207	-.657	.191	-1.126	29	.135	.269
Pair 11	Q13_Basic - Q13_FER	-.367	1.273	.232	-.842	.109	-1.578	29	.063	.125
Pair 12	Q14_Basic - Q14_FER	-.533	1.042	.190	-.922	-.144	-2.804	29	.004	.009
Pair 13	Q15_Basic - Q15_FER	-.400	1.248	.228	-.866	.066	-1.755	29	.045	.090
Pair 14	Q16_Basic - Q16_FER	-.633	1.245	.227	-1.098	-.168	-2.786	29	.005	.009
Pair 15	Q17_Basic - Q17_FER	-.167	1.085	.198	-.572	.239	-.841	29	.204	.407
Pair 16	Q18_Basic - Q18_FER	-.633	1.497	.273	-1.192	-.074	-2.318	29	.014	.028
Pair 17	Q19_Basic - Q19_FER	-.667	1.213	.221	-1.120	-.214	-3.010	29	.003	.005
Pair 18	Q20_Basic - Q20_FER	-.433	1.305	.238	-.921	.054	-1.819	29	.040	.079

The results obtained show that H0 is accepted and Ha rejected. Because the value of Sig. (2-tailed) > of 0.05 and it can be concluded that no there is a significant difference between the use of basic games and FER games. Based on the data analysisthat has been collected from 30 respondents, conclusions can be obtained that can be obtained through research results the use of Facial Expression Recognition to increase satisfaction player is the FER system used has a weakness because most of the changes are static values so for next research it can be developed by making changes to the dynamic value.

5. CONCLUSIONS

This paper explains how using balancing system with facial expression recognition can improve the player experience in the game. We proposed a facial expression recognition with game balancing to help the game Artificial Intelligence to improve the player experience by changing a little bit of game variables using the game balancing based on the player current emotion. The results were statistically

analyzed using a paired sample T-Test method. The result shows that there is no significant difference between the basic games and the enchanted games using Facial Expression Recognition and Game Balancing. For the future work, Other Dynamic balancing point like (Enemy Damage, Enemy Shield, Enemy Spawn Rate, etc.) can be used and more types of games like (FPS-based Game, Horror Game, Visual Novel Game, etc.) can be explored too.

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