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A Facial Animation Based on Emotional Model for Characters in 3D Games

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***Abstract*—A believable virtual human should have both geometry shape, and autonomous emotion Based on previous researches on emotion models. In order to make player in games be capable of emotion expression, a suitable mathematical model should be first used to describe emotions. This paper presents a method to express character's facial animation and an emotional model d based on psychology theory and ortony,clore,collins (OCC) model .the architecture of a virtual character is presented and a formalization of a virtual character's motivation is proposed. In addition, a character could confirm the range of perception dynamically according to his appraises to other objects in the environment. The Demo showed that the emotion model can drive player to be more facial animation.**

Keywords-Facial Animation; emotion; virtual human; player character; 3D games

I. INTRODUCTION

Emotions are closely related to human and an important way for interpersonal communication [1]. The Player Characters is entirely graphic entity generated In Games, and is used to simulate behaviors and actions of human. Emotions influence how we think, adapt, learn, behave, and how humans communicate with others [2-4]. In addition, the Facial Animation of characters have been studied and modeled in computers in different purposes.

Psychologists and sociologists study human nature so that salient emotion expression may be captured. History reveals have carried a great amount of interest in understanding and controlling the motion of people. There has been extensive research on incorporating psychological models into the simulation of characters.

Because emotions are very complex and fuzzy [5], the impact of motivations and mood on emotions are synthetically considered, this paper is based on behavior models and other previous work and research [6]. Our goal is to present a model for studying the impact of the players' emotions in 3D games obtained on the evacuation efficiency and its dependence on local interactions. The starting point of the following discussion is the physically based FSM, which is generalized in order to present different states and behaviors.

Emotional simulation has been discussed by many authors. The project team of Oz had studied out the credibility of the agent, credibility means that the behavior and personality more realistic [7-8]. In order to make the computer be capable of emotion expression, a suitable mathematical model should be first used to describe human emotions. Liu Zhen etc presented a architecture of a virtual character is presented formalization of a virtual character's motivation Based on psychology theory and ortony,clore,collins (OCC) model [9]. Picard considered that emotions have impact on decision-making, intelligence, sociality, perception, memory, learning, and creativity. Torrens [10] introduced a novel approach to modeling urban crowds, based on individual and collective geospatial intelligence.

There is still considerable controversy in personality research over how many personality traits there are, but the OCEAN model is popular. Face to different situations, the players will show a different expression. The OCC model revealed by Ortony is used to expression basic emotion. The OCC model includes 22 basic emotions but ignore the detail of low level on implement.

In this paper, the Facial Animation of the player or no player character is attained as an emergent function of emotions. We generalized the emotion model in order to include different artificial intelligence as well as facial animation

II. CHARACTER'S VIEW

Virtual visual is belong to the felling area and used to simulate the human's eye perception. Its purpose is extracted from the visible objects in the environment of the character, and made available to the perception module for further processing. In order to determine whether other character is in range of character's view, we use the perception of information with movable character in virtual scenes. So, the character visual range is defined by Horizon fan.

According to the human's physiological features, we can approximate the character's visual field into a fan-shaped region. To determine whether other character is in the range of one's visible range is to determine whether the determine object is in the fan-shaped range (shown in figure 1). P_o is character player's location in 3D scene and P_t is other character's position at time t. $\overrightarrow{V_{view}}$ indication the character's current sight vector. The angle between character's views and the direction of two characters can be calculated by formulation (1):

$$\cos\theta = \frac{\overrightarrow{P_o \cdot P_t} \cdot \overrightarrow{V_{view}}}{\left|\overrightarrow{P_o P_t}\right| \cdot \left|\overrightarrow{V_{view}}\right|} \qquad (1)$$

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The formulation of the distances of tow characters is:

$$D_t = \left|\overrightarrow{P_0 P_t}\right| \qquad (2)$$

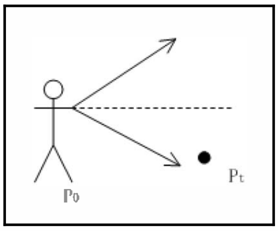

Figure1. Player's view range

III. EMOTION

Twenty-two kinds of emotions are included in OCC model. Nine emotions such as hope, gratitude, disappointment, like, fear-confirmed, admiration, happiness, fear and hate. Hope, gratitude, happy, like are positive emotion, while fear, fear-confirmed, and disappointment are negative emotion. Their intensities are in interval [0, 1]. 0 indicates no corresponding emotional; while 1 indicates that the emotional intensity is very strong. In order to establish the relationship between facial animation and emotional, we introduce the following definition formalized:

Definition 1: For the characters in the game, E is a set of basic emotions: $E = \{E_1, \ldots, E_n\}, i \in [1, N]$, E_i Is a basic emotion, eg : Happiness. N is the number of basic emotions. In this paper, we define $N = 9$. The detailed description of the nine emotions defined in the table 1:

TABLE I. DETAIL DESCRIPTION OF 9 EMOTIONS

emotion	name	description
E_1	hope	Expected things can happen
E_2	gratitude	Expect things successful complete
E_3	disappointment	Expect things did not occur
E_4	like	Favorite player in the same camp
E_5	fear-confirmed	the players of the opposing camps
E_6	admiration	According to own property, the respect of other character
E_7	happiness	To their advantage things happen
E_8	fear	See the emergence of the events or characters
E_9	hate	The emergence of undesirable events or characters

Definition 2: $wE_i(t)$ is weighting function of basic emotion E_i affect the role of facial animation at some certain time. The intensity is in interval [0, 1]. For example, $wE_1(t) = 0$ means the emotion of "hope" cannot afford the impact of the facial animation at the time t. if $wE_1(t) = 1$ means the emotion of "hope" significant role in the facial animation of characters. The formula of $wE_i(t)$ is:

$$wE_t = wE_0 \cdot \cos(D_t' \times \pi / 2) \qquad (3)$$

Where:

$$D_t = \begin{cases} 0, & D_t > \mathrm{R} \text{ and } \theta \notin A \\ \lambda D_t & D_t < \mathrm{R} \\ \dfrac{D_t}{e^{\alpha}}, & \mathrm{R} < D_t < 2\mathrm{R} \text{ and } \theta \in \mathrm{A} \end{cases} \qquad (4)$$

$$A \in \left[-\frac{\pi}{3}, \frac{\pi}{3}\right].$$

R is the radius of the character scope of activities.

θ is calculated by formulation (1).

D_t is calculated by formulation (2).

IV. FINITE STATE MACHINE (FSM)

The finite-state machine (FSM) is a mathematical model used to design computer programs and digital logic circuits. Finite-state machines can model a large number of problems, among which are electronic design automation, communication protocol design, parsing and other engineering applications. In biology and artificial intelligence research, state machines or hierarchies of state machines are sometimes used to describe neurological systems, and in linguistics they can be used to describe the grammars of natural languages.

Players could meet some NPCs or monsters who will communicate with others while they enter a special region in game scene. NPC means Non-player character that has his own activities regions. NPC would be interested in other players who enter into NPC's vision view. Then, NPC will speak with the player or give the players a task instruction. If NPC is hostile to players, the NPC would attack players or escape away immediately. In order to realize those NPC's behaviors, we need use some rules based-on artificial intelligence technology in games. Game artificial intelligence technology is to design a series of appropriate rules in games, to make NPC or players' smarter and richer changes. The game also while be more lively, challenging and a stronger sense of immersion. In this paper, the finite state machine is used to simulate motions of the characters applied to the facial animation.

First, in each cycle of execution of the game, we checked the current state of the virtual game character and determine the events accepted by the character. Second, we transferred the characters' current state to the next state while preserved the current state. The finite-state machine's formulation is defined by:

$$M = (E, TC, f, E_0, Z) \qquad (5)$$

$$E = \{E_1, \ldots, E_n\}, i \in (1, N) \qquad (6)$$

$$wE = \{wE_1, \ldots, wE_n\}, i \in (1, N) \qquad (7)$$

$$TC = \{TC_1, \ldots, TC_m\}, i \in (1, M) \qquad (8)$$

$$f : E \times TC -> E \qquad (9)$$

The basic transition condition TC is defined in table 2 in the game demo.

TABLE II. BASIC TRANSITION EVENTS

transition	*description*
TC1	Some get into the field of vision
TC2	The task is successful completed
TC3	The task has not started
TC4	Task is not completed
TC5	Friendly
TC6	Enemy
TC7	Character level difference is little , $\|\Delta Lv\| < 5$
TC8	Character level difference is moderate, $5 < \|\Delta Lv\| < 15$
TC9	Character level difference is large, $\|\Delta Lv\| > 15$

Where: $\Delta Lv = |Lv1 - Lv2|$.

The transition rules f are defined in table 3.

TABLE III. TRANSITION RULES

Source state	***TC***	***Target state***
E_0	TC1 & TC5	E_4
E_0	TC1& TC6&TC7	E_9
E_4	TC2	E_2
E_4	TC3 or TC4	E_3
E_9	TC6 & TC8	E_8
E_9	TC6& TC9	E_5
E_0	TC5 & TC9	E_6

V. APPLICATION IN GAMES

The most Application of artificial intelligence in the current game is in areas of combat system, the interaction between the characters and information tips. Especially, using of the role of emotions in the combat system can increase the authenticity of the virtual human. In this paper, we consider the combating of NPC, monster or player character is affected by some random value which is calculated by emotions through formulation (10).

$$P = f(PS, w_t, E_t, D_t) = PS, w_t \times \sin^a\left(\frac{D_t}{2R} \times \frac{\pi}{2}\right) \times \sin^b(E_t \times \pi) \qquad (10)$$

Where: PS is Physical strength of characters.

Normally, the numerical formula of combat of characters is calculated by formulation (11).

$$Hit = P \times k\Delta Lv \times \gamma S_t \qquad (11)$$

Where: $S_t = S_o \times e^{\frac{\sum_{1}^{N} wE_i \cdot E_i}{\varphi}}$

k , γ , φ is a adjust factor and $k, \varphi . \gamma \in [0,1]$,

Within a certain distance, two game character's final attack value is calculated as:

$$AH = (Hit / (Hit + D_t \times 0.35)) \times (Lv \times 1.9 / \Delta Lv) + (Lv + \Delta Lv) / 50 \qquad (12)$$

VI. DEMO AND RESULT

The system has been tested on a common education game and the system was tested on a computer with an Intel Pentium(R) 4 CPU 3.0GHz 1GB Ram and NVIDIA GeForece 6800 graphics card. The simulation was written in the C++ programming language and the rendering engine utilizes OpenGL.

In the demo, we test facial animation of player character, NPC and monster. The vision radius of player character is set to 50; the vision radius of monster is set to 20, and the vision radius of NPC is set to 30. All characters' initial value of physical strength is set to 20. The range of emotion is in [0, 1]. We assumed that the NPC and the player have friendly relations. On the contrary, the monster and the player have Enemy relations. The character's emotion was expressed by the facial animation and the dynamic action. The character's facial expression performance mouth opened and nervously when he is fear-confirmed, disappointment or hate; the action frequency is accelerated. If the character is happiness, hope, admiration or gratitude, he would performance mouth up and relieve; action was also more stretch. The character's pleased, fear expression are shown in Figure 2, 3.

Figure2. Player's pleased emotion

Figure3. Player's fear emotion

Figure4. Player's welcome animation

During emotionally experiment, when the friendly one enters character's vision view, the characters would performance like or happiness and played welcome action to express their own emotional state (figure 4). Oppositely, the hostile one gets into one's view region, the character would correspond different expression according to different attribute. The mainly emotion of monster or player is hear or hear-confirmed. They would attack with each other or run away. In the application of battle system in the game, the character's physical attack probability and attack value changes show in figure 5,6. Although the character's physical decline, but its emotional value is increased, the experimental data are accordance with the general laws of combat.

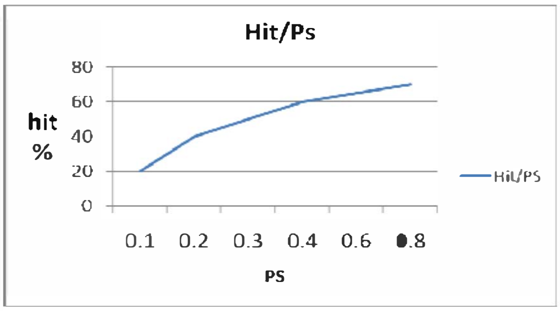

Figure 5 probabilities with physical change

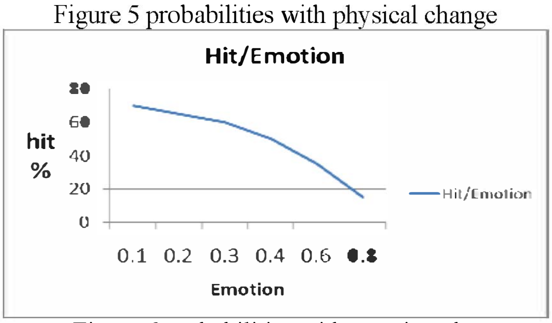

Figure 6 probabilities with emotion change

VII. CONCLUSION AND FUTURE WORK

Trough analyzing game character's states and events and using human's the principles of biological and Psychology, we create a simulation modeling of the virtual character's emotion. In order to make character more truth in 3D games, we used the virtual character's emotion, physical and other factors. For increasing flexible, real and interesting of character's behavior, the finite-state machine is considered to performance the facial animation of character. Also, we integrate the virtual character's emotion into the computational simulation of the behavior of characters fighting in game application. From the demo result, the given emotional modeling can impact on the facial animation and be applied to the game logic calculation effectively. This modeling also can provide a new method to improve the game interesting.

For future work, we are interesting in improving the facility to use the simulation by incorporating it in an editor. For that a user can control to alter the parameters of the model.

VIII. ACKNOWLEDGEMENTS

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REFERENCES

[1] Zhiliang Wang, Artificial Psychology, China Machine Press, Beijing, 2007.

[2] LIU Zhen, PAN Zhi-geng, "An Emotion Model of 3D Virtual Characters in Intelligent Virtual Environment", First International conference on affective computing and intelligent interaction, ACII2005, LNCS 3784, Springer Publisher, 2005, pp. 629-636.

[3] Helbing, D,; Farkas, I. and Vicsek, T. "Simulationg Dynamical Features of Escape Panic". Natrue, v.407, pp; 487-490. 2000.

[4] Musse, S. R., Thalmann,D.m"Hierarchical Model for Real Time Simulation of Virtual Human Crowds". IEEE Transactions on Visualization and Computer Graphics, vol. 7, n.2, pp 152-164. April-June, 2001.

[5] L.A. Zadeh. "Fuzzy Sets", Information and control, Vol.8,No.3, 1965, pp.338-353.

[6] J. Funge, X. Tu, D. Terzopoulos. "Cognitive Modeling: Knowledge, Reasoning and Planning for Intelligent Pedestrians", In Proceedings of ACM SIGGRAPH1999, Los Angeles, CA, August 1999, pp.29-38.

[7] Reilly W SN. Believable Social and Emotional Agents [D]. Pittsburgh, PA, USA: Carnegie-Mellon University, 1996.

[8] Nelson M, Mateas M. Search-based drama management in the interactive fiction anchor head [A]. In: Proceedings of Artificial Intelligence and Interactive Digital Entertainment (AIIDE 2005) [C], Marinadel Rey, California, USA: AAAI Press, 2005: 99-104.

[9] LIU Qiong, LIU Zhen, BIAN Yu-long. Simulation Model of Emotional Behavior for Virtual Characters in Cartoon Games. Journal of System Simulation.2011, 23(10):2151-2155.

[10] P.M. Torrens. "Behavioral Intelligence for Geospatial Agents in Urban Environments". Proceedings of the 2007 IEEE/WIC/ACM International Conference on Intelligent Agent Technology, 2007 Page(s):63 – 66.