Emotional Character Animation System Using Cognitive Emotional Theory

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Abstract

In computer graphics, most animations of characters have been created using the traditional and often highly labor intensive key-framing technique. Recently, character animation is demanded increasingly automated techniques for animation according to interaction with the user or environment of the user. In this paper, we will propose a new method which can animate characters automatically with user interactions. The character's behavior is determined as a result of understanding the emotional condition of the user. Psychology and cognitive AI provide some ideas about how to approach this problem. Our study is based mostly on the theories of Ortony, Clore and Collins, which were designed to be implemented computationally. In our system, we can make 22 emotion types and some more behavior features and we apply to some characters

Keywords:
Character animation, User interaction, Emotions, Cognitive emotional theory, Computer graphics

1. Introduction

Increasing of computing power marks a broad emerging trend in advanced computer graphics. Specially, the technique of 2-D or 3D animation is important field of computer graphic technique. In computer graphics, most animations of characters can be generated with key-framing, motion capture, or dynamic simulation. The key-framing is traditional method and it is often highly labor intensive way. The traditional approach is to employ skilled artists and animators. The talents of the most highly skilled human animators may still equal or surpass what might be attainable by computers. And the other approaches require a tradeoff between the level of control given to the animator and the automatic nature of the process. Recent work in character animation has developed toward autonomous, self-animating, emotional characters for use in VR and interactive games. There are many approaches to developing an autonomous character animations, for example, behavioral animation, and action-selection of animals based on ethology etc. Reynolds[1] was one of the first to investigate behavioral control. Reynolds' boids are able to perceive the distance to other boids within a spherical neighborhood. Tu & Terzopoulos[2] have created a virtual marine world inhabited by artificial fishes which can swim dynamically in simulated water through the motor control of internal muscle.Faced with the difficult task designing lifelike synthetic agents for entertainment applications, several researchers have drawn inspiration from biology. For example, Blumberg[4] has developed a behavioral control mechanism inspired by findings in ethology which is used to control a synthetic dog. The Oz's project[3] at Carnegie Mellon University has proposed "interactive drama". Reilly proposes the inclusion of emotional agents wherein the personalities of the actors can be designed by expressing their emotions. That is similar to our study, however their system is largely rule-based and is unclear how extensible their architecture.

This paper proposes that can animate characters automatically with user interaction. The character's behavior is determined as a result of understanding the emotional condition of the user. Psychology and cognitive AI provide some ideas about how to approach this problem. Our study is based mostly on the theories of Ortony, Clore and Collins, which were designed to be implemented computationally. We propose the new emotional model that based on the theories of them, have emotion types with intensities and directions.

2. Emotional Theory

In this section, we explain the cognitive emotional theory which can be basis of our character animations. There are many studies about emotions in psychology. Emotions have many facets. They involve feelings and experience, they involve cognition and conceptualization. Some psychologists suggest that cognition makes to emotions. They think that emotions arise as a result of certain kinds of cognitions and explore what these cognitions might be.

We choose as a basis for our study the emotions theories of Ortony, Clore and Collins[6]. One reason for choosing these models is that they were designed to be implemented computationally and another is that they are reasonably simple to understand. Their cognitive emotion model studied at the level of emotional clusters, called emotion type, where the emotions within each cluster share similar cause. The groups of emotions that we identify have two important characteristics. First, emotions in the same group have eliciting conditions that are structurally related. The second is that each distinct emotion type represented in them is best thought of as representing a family of closely related emotions.

In describing the overall structure of emotion types, we begin with the some assumptions. The assumption is that there are three major aspects of the world or interaction in the world, upon which user can focus, namely, events, agents, or objects (Figure 1). When one focuses on events one does so because one is interested in their consequences, when one focuses on agents, one does so because of their actions, when one focuses on objects, one is interested in certain aspects or imputed properties of them qua objects.

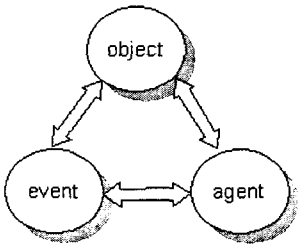

Figure 1 : Three aspects of the world

Events are things that happen, considered independently of any beliefs they may have about actual or possible cause. They are judged to be either pleasing or displeasing according to the agent's goal.

Objects are with each other they exist, it means the with each other different individuals with the qualification which is equal. Objects can be liked or disliked according to an agent's attitudes.

Agents can be nonhuman animate begins, inanimate objects or abstractions, such as institutions and even situations. Agent's actions can be approved of or disapproved of according to a set of standards. Standards represent both moral beliefs of right and wrong as well as personal beliefs about level of performance.

This model proposes that emotions are the results of three types of subjective appraisals. First is that the appraisal of the pleasingness of the events with respect to the agent's goals. Second is that the appraisal of the approval of the actions of the agent or another agent with respects to a set of standards for behavior. And the last is that the appraisal of the liking of objects with respect to the attitudes of the agent. These give rise to a number of emotions, hope, fear, anger, gratitude, joy and distress and so on.

An emotion type is a distinct kind of emotions that can be realized in a variety of recognizably related forms. Figure 2 shows the 22 kinds of emotion types. There are three main branches correspond to the three ways of reacting to the world. Each branch is associated with broad class of affective reactions. Whether or not these affective reactions are experienced as emotions depends upon how intense they are, which is one of the reasons why it is important to know what factors affect the intensity of what emotions.

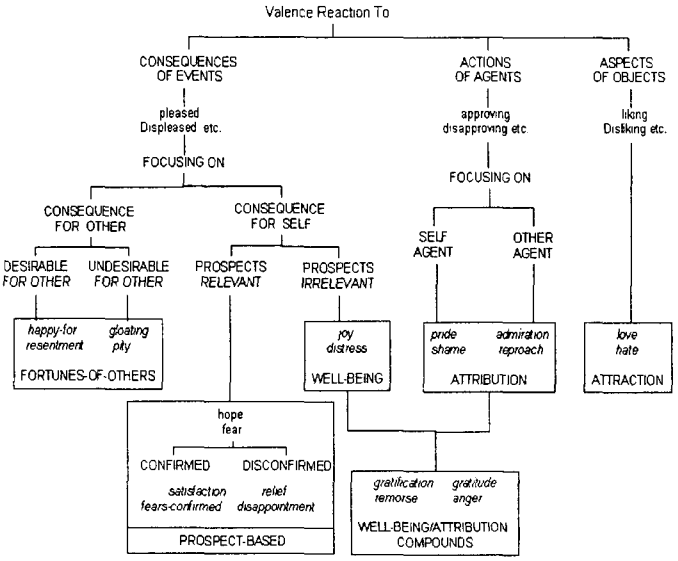

Figure2 : Global structure of emotion types (Ortony, 1988)

The general class of affective reactions those of being pleased and displeased (See most left side branch of Figure 2). And other affective reactions are also used for make emotions. For example, emotion types of "love" and "hate" can be described as follow. When attends to any object, this can give rise to an emotional response. Attending to a liked object and appealing object gives rise to "love", attending to a disliked object and unappealing object gives rise to "hate". Figure 3) The intensities of these emotions are based primarily on the level of like(or dislike) and appealing(or unappealing).

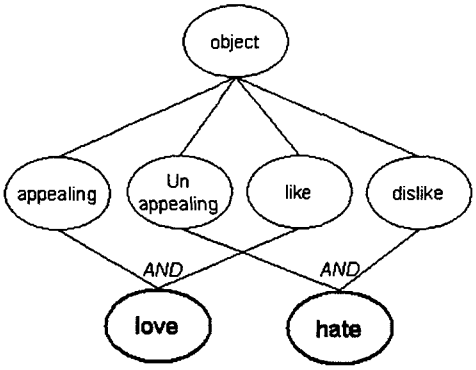

Figure 3 : Emotion types of "love" and "hate"

3. Emotional Model

In constructing the emotional character model for animation, we built the emotional model(based on Section 2) first, and then make the character animation.

The system that we provide first of all is an emotional model. The emotional model determines emotional type of what is and their mapping behavior features. So the character behavior is automatically determined according to an emotional model. Figure 4 shows the emotional model architecture.

The first thing to notice in Figure 4 is the user input. This input is used to decide when a character animate emotionally. Also it can be used to emotional rule's parameters. And other structural elements are explained as follows.

Emotional Rule This is the rule of emotion generation. Basic rules have emotion type, intensity and direction. If an agent has a goal success and the goal has importance A, then the emotional type is "joy" with intensity A.

Emotion Types Emotion types represent sets of

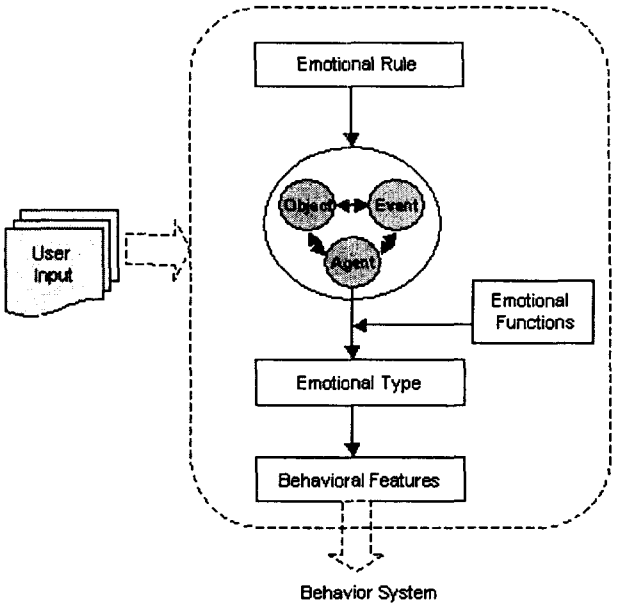

Figure 4 : Emotional Model System Flow

the emotions that are similar in hoe they affect the behavior character. Appraisal parameters to express emotion types of each case are as follows (Table 1).

Emotions Type	Appraisal parameters					
happy-for	event	other	desirable	pleased		
gloating	event	other	undesirable	pleased		
resentment	event	other	desirable	pleased		
pity	event	other	undesirable	displeased		
hope	event	self	desirable	pleased	prospect	unconfirmed
fear	event	self	undesirable	displeased	prospect	confirmed
satisfaction	event	self	desirable	pleased	prospect	confirmed
relief	event	self	undesirable	pleased	prospect	dis-confirmed
fears-confirmed	event	self	undesirable	displeased	prospect	unconfirmed
disappointment	event	self	desirable	displeased	prospect	dis-confirmed
joy	event	self	desirable	pleased	well being	
distress	event	self	undesirable	displeased	well being	
pride	agent	self	praiseworthy	approving		
admiration	agent	other	praiseworthy	approving		
shame	agent	self	blameworthy	disapproving		
reproach	agent	other	blameworthy	disapproving		
gratification	agent	event	pride + joy			
gratitude	agent	event	admiration + joy			
remorse	agent	event	shame + distress			
anger	agent	event	reproach + distress			
love	object	liking	appealing			
Hate	object	dis-liking	unappealing			

Table 1 : Appraisal parameters of emotion types

Emotional Functions We define two kinds of emotional functions, which are combinational functions and decay functions. Combination functions are used to combine the intensities of the emotion and decay functions are decay emotions in over time.

Behavioral Features The emotion types by emotional functions are mapped into behavioral features. They are intermediate process between emotional model and animation system.

The controlling of a character animation based on cognitive emotional model is determined according to the process stated below :

First, the character gets the information of others (usually user input or other characters). This information may be about agent or object or event.

Second, there are constructed 22 types of emotion by emotional rule and inputs.

Third, the emotional type of the character changes by emotional functions and there is a resulting changes.

And last, resulting changes are mapped behavioral features. The output of emotional model is used to input of character animation system.

Next, we explain the character animation system.

4. Character animation system

Animation has historically been produced in two ways. The first is by artists creating a succession of cartoon frames, which are then combined into a film. A second method is by using physical models which are positioned, the image recorded, then the model is moved, the next image is recorded, and this process is continued.

We use physical model for animation. A major part of animation is motion control. A low-level system requires the animator to precisely specify each detail of motion, whereas a high-level system would allow them to use more general or abstract methods. For example, to move a simple rigid object such as a cube, requires six degrees of freedom per frame. A more complex object will have more degrees of freedom, for example a bird might have over twenty degrees of freedom. Now think about animating an entire flock of birds. Now control hierarchy is required, so that high level control constructs can be specified which are then mapped into more detailed control constructs.

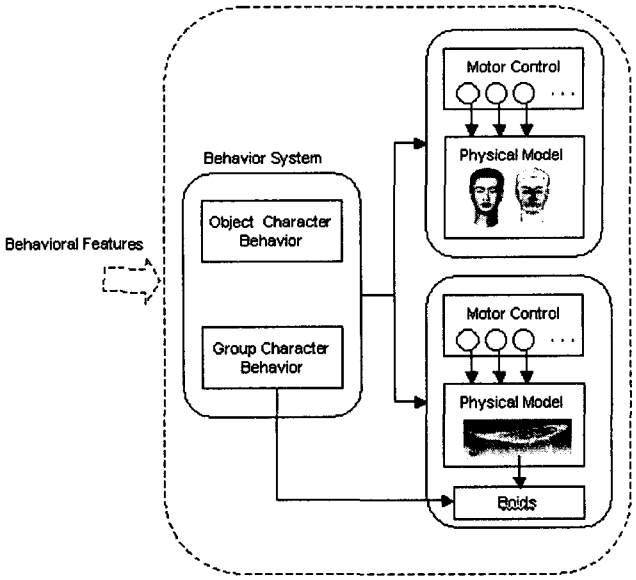

Figure 5 : Character animation system

Usually, design animation architecture composes three levels. These three levels are physical level , motor level and behavior level. So, our system has three level for each is physical model, motor control and behavior system. They use the behavioral features which is outputs of emotional model. These are connecting parameters between emotional model and animation system.

Each physical model has subdivided motor control. For example, physical model of fish have several motors, such as jump up, jump down, swim left, swim right etc. Behavior system is divided two methods, one is the object character animation (like human face), and another is group character animation (like fish or birds). For behavior based group animation, structure and operation method of action selection[5] are used and base class for behavior template for group behavior modules are designed. Four group behavior modules, which are 'collision avoidance for static obstacle and moving object', 'velocity matching', 'group centering', and 'cruise distance maintenance'.

5. Experiment

We applied the emotional character model to two kinds of computer graphics animation. One is fish model and other is human facial model.

Human facial animation is created by synthesizing basic muscles and edited muscles. In constructing the facial

animation system, we built on the work of Shim and Byun[7]. First, we make a 3D facial model for arbitrary input 2D image. In order to make a 3D facial model, we use 39 feature points for parts of eyes, eyebrows, mouth and nose. This feature points are selected manually for input images and 3D modeling is processed automatically. Figure 6 represents the example of 3D facial modeling for 2D input image. For facial synthesis, we use a muscle-based model with 26 basic muscles. The muscles of the face are commonly known as the muscles of facial expression[8]. Some facial muscles also perform other important functions, such as moving cheeks and lips.

For facial animation, we use user input which is about user's mood. User input are related emotion types and we can use 5 emotion types, 6 behavioral features, and 8 motor controls (Table 2). Figure 7 shows some experimental results of expression animation using our emotional character model. They are emotion types of distress, anger, resentment and behavior features of sad, anger, surprise in order. If an user increase the value of the 'anger' parameter, then anger behavior feature is active for motor controls of 'up the eyebrows', 'pout lips'and 'down lips' with each intensity.

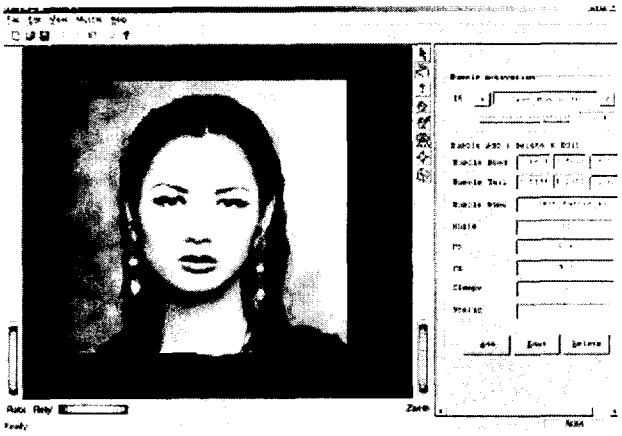

Figure 6 : Human Facial Animation System

Emotion Type	Behavioral Features	Motor controll
resentment	Disgust	down the eyebrows
fear	Fear	up the eyebrows
joy	Happiness	open the mouth
distress	Sad	open the eyes
anger	Anger	close the eyes
	Surprise	pout lips
		down lips
		up lips

Table 2 : Parameters for facial emotional model

Figure 7 : Results of Facial Animation

Next our implementation is fish animation, likewise facial animation. It has 9 emotion types, 8 behaviors, and 4 motor controls (Table 3). Because fish is not elaborate model, it has a few motor controls. Figure 8 shows the physical fish model and Figure 9 shows the result.

Emotion type	Behaviors	Motor controll
hope	avoiding obstacle	Swim left
satisfaction	avoiding enemy	Swim right
relief	attacking	jump up
fear	feeding	jump down
joy	mating	
distress	swimming	
love	running away	
hate	schooling	
anger		

Table 3 : Parameters for fish emotional model

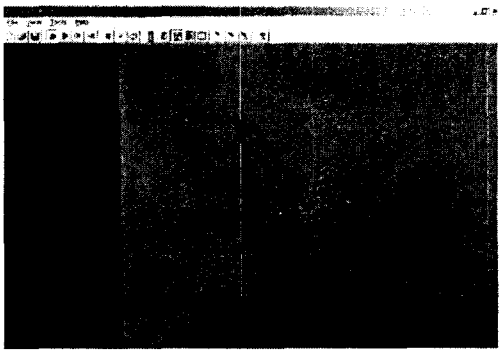

Figure 8 : Fish model

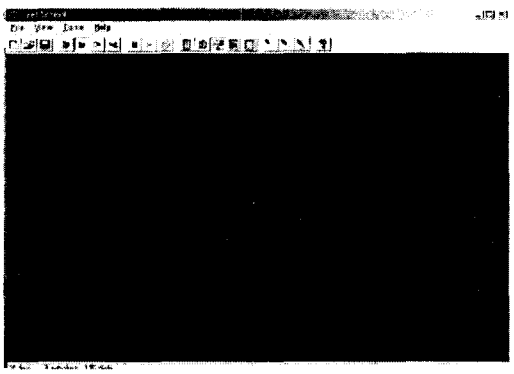

Figure 9: Results of Fish Animation

6. Conclusion

The emotional character model which we have proposed is a simplified mechanism for making human emotion. The focus of this study is cognitive emotional model. This is based on the theories of Ortony, Clore and Collins, but we do suggest the existence of relatively mapping structure between emotional model and character animation system.

Following the results, we synthesize the facial animation for any person' s face, and consider the real face expression and synthetic face. And we implement the sea world by simple fish. All of them use emotional model with user interaction.

We are planning to achieve behavior determination for all emotion types for various character model. Consequently, interactive animation software could be constructed with flexibility. We will be also able to achieve behavior determination along some story line.

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