Integrating the OCC Model of Emotions in Embodied Characters

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Abstract

The OCC (Ortony, Clore, & Collins, 1988) model has established itself as the standard model for emotion synthesis. A large number of studies employed the OCC model to generate emotions for their embodied characters. Many developers of such characters believe that the OCC model will be all they ever need to equip their character with emotions. This paper points out what the OCC model is able to do for an embodied emotional character and what it does not. Missing features include a history function, a personality designer and the interaction of the emotional categories.

1 Introduction

Emotions are an essential part of the believability of embodied characters that interact with humans (Elliott, 1992; Koda, 1996; O'Reilly, 1996). Characters need an emotion model to synthesize emotions and express them. Ultimately they also need to be able to sense the emotional state of the user, but this aspect is not in the focus of this paper.

The emotion model should enable the character to argue about emotions the way humans do. An event that upsets humans, for example the loss of money, should also upset the character. The emotion model must be able to evaluate all situations that the character might encounter and must also provide a structure for variables influencing the intensity of an emotion. Such an emotion model enables the character to show the right emotion with the right intensity at the right time, which is necessary for the convincingness of its emotional expressions (Bartneck, 2001).

Emotions are particularly important for conversational embodied characters, because they are an essential part of the self-revelation feature of messages. The messages of human communication consist of four features: facts, relationship, appeal and self-revelation (Schulz, 1981). The inability of a conversational character to reveal its emotional state would possibly be interpreted by the user as missing sympathy. It would sound strange if the character, for example, opened the front door of the house for the user to enter and spoke with an absolute monotonous voice: ”Welcome home”.

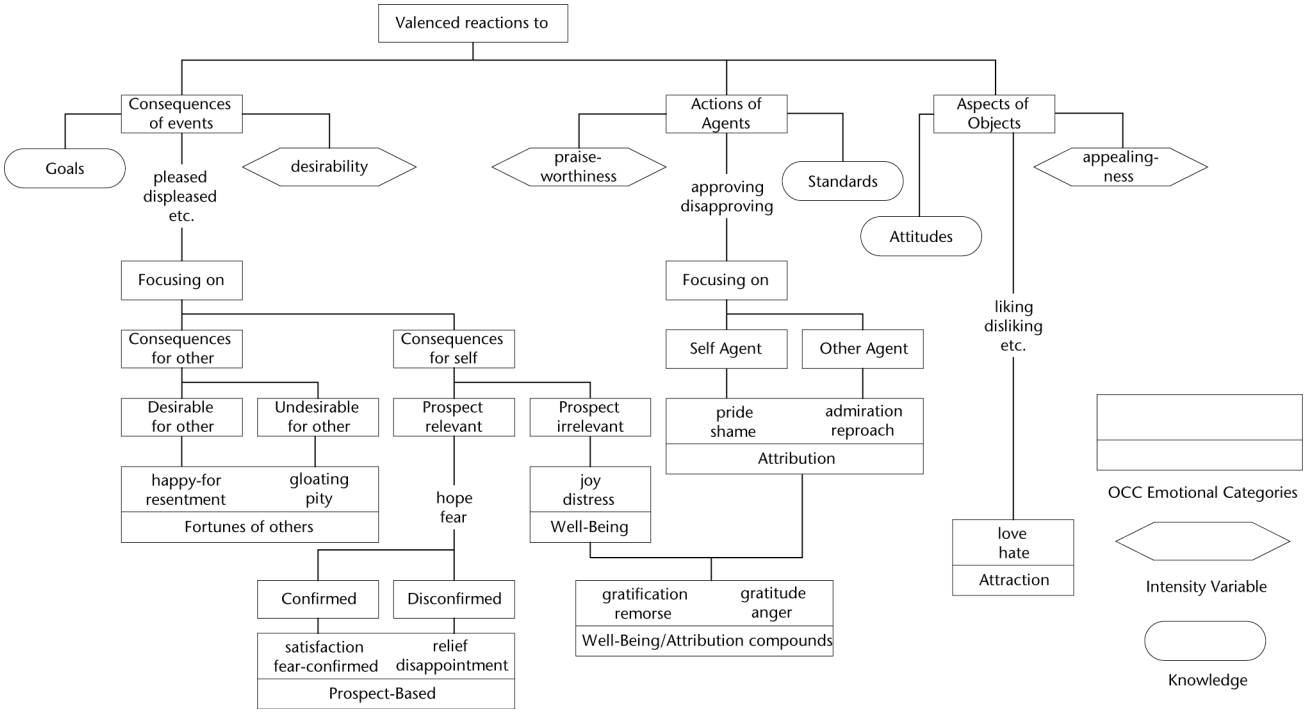

Figure 1: The original OCC model.

Several emotion models are available (Roseman, Antoniou, & Jose, 1996; Sloman, 1999). However, Ortony, Clore and Collins (1988) developed a computational emotion model, that is often referred to as the OCC model, which has established itself as the standard model for emotion synthesis. A large number of studies employed the OCC model to generate emotions (Elliott, 1992; Koda, 1996; O'Reilly, 1996; Studdard, 1995). This model specifies 22 emotion categories based on valenced reactions to situations constructed either as being goal relevant events, as acts of an accountable agent (including itself), or as attractive or unattractive objects (see Figure 1). It also offers a structure for the variables, such as likelihood of an event or the familiarity of an object, which determines the intensity of the emotion types. It contains a sufficient level of complexity and detail to cover most situations an emotional interface character might have to deal with.

When confronted with the complexity of the OCC model many developers of characters believe that this model will be all they ever need to add emotions to their character. Only during the development process the missing features of the model become apparent. These missing features are often underestimated and have the potential to turn the character into an unconvincing clown. This paper points out what the OCC model is able to do for an embodied emotional character and what it does not. You may consider this paper as a short guide to using the OCC model for character development.

2 The five phases of emotion processing

The OCC model is complex and this paper discusses its features in terms of the process that characters follow from the initial categorization of an event to the resulting behaviour of the character. The process can be split into five phases:

1. Classification In the classification phase the character evaluates an event, action or object, resulting in information on what emotional categories are affected.

2. Quantification In the quantification phase, the character calculates the intensities of the affected emotional categories.

3. Interaction The classification and quantification define the emotional value of a certain event, action or object. This emotional value will interact with the current emotional categories of the character.

4. Mapping The OCC model distinguishes 22 emotional categories. These need to be mapped to a possibly lower number of different emotional expressions.

5. Expression The emotional state can be expressed directly through facial expression and can influence the behavior of the character.

2.1 Classification

In the classification phase an event, action or object is evaluated by the character, which results in information on what emotional categories are affected. This categorization requires the character to know the relation of a particular object, for example, to its attitudes. Depending on this evaluation either the “love” or “hate” emotional category will be affected by the object.

Consider this example: a character likes bananas and the user gives him a whole bunch. The character will evaluate the consequences of the event for the user, which results in pity, since the user has a whole bunch of bananas less. It will also evaluate the consequences of the event for itself, which results in satisfaction because it received a bunch of bananas. Next, it evaluates the action of the user, which results in admiration and finally the aspect of the object, which results in love.

To do this classification the character needs knowledge. First, it needs to know its relationship to the user, which was assumed to be good. Hence, pity is triggered and not resentment. Moreover, it needs to know what this event means to the user. Otherwise the character’s happy-for category might be triggered (User Model). Second, it needs to have a goal “staying alive” to which the bananas contribute (Goals). Third, it needs to know what to expect from the user. Only knowing that the user does not have to hand out bananas every other minute the character will feel admiration (Standards). Last, it needs to know that it likes bananas (Attitudes).

The standards, goals and attitudes of the character that the OCC model requires need to be specified, organized and stored by the designer of the character. A new character knows even less than a newborn baby, since it does not even have instincts. One way to store this knowledge could be an exhaustive table in which all possible events, actions and objects that the character might encounter are listed together with information on which emotional categories they affect and how their intensity may be calculated. This approach is well suited for characters that act in a limited world. However, it would be rather difficult, for example, to create such an exhaustive list for all the events, actions and objects that the character might encounter at the home of the user. With an increasing number of events, actions and objects, it becomes necessary to define abstractions. The bananas could be abstracted to food, to which also bread and coconuts belong. The categorization for the event of receiving food will be the same for all types of food. Only their intensity might be different, since a certain food could be more nutritious or tasty.

This world model is not only necessary for the emotion model, but also for other components of the character. If, for example, the character uses the popular Belief, Desires and Intention (BDI) architecture (Bratman, 1988), then the desires correspond to the goals of the emotion model. The structure of the goals is shared knowledge. So are the standards and attitudes. The complexity of the OCC model has a direct influence on the size of the required world model.

As mentioned above, the OCC model distinguishes 22 emotional categories (see Figure 1). This rather cumbersome and to some degree arbitrary model appears to be too complex for the development of believable characters (Ortony, 2003). The OCC model was created to model human emotions. However, it is not necessary to model a precise human emotion system to develop a believable character. A “Black Box” approach (Wehrle, 1998) appears to be sufficient. The purpose of this approach is to produce outcomes or decisions that are similar to those resulting from humans, disregarding both the processes whereby these outcomes are attained as well as the structures involved. Such a “Black Box” approach is more

suitable, particularly since the sensory, motoric and cognitive abilities of artificial characters are still far behind the ones of humans. The characters emotion system should be in balance with its abilities. Several reason speak for a simplification of the OCC model.

First, only those emotional categories of the OCC model should be used that the character can actually use. If a character uses the emotional model only to change its facial expression then its emotion categories should be limited to the ones it can express. Elliot (1992) implemented all 22 emotional categories in his agents because they were able to communicate each and every one to each other. This is of course only possible for character-character interaction in a virtual world. It would be impossible for characters that interact with humans, since characters are not able to express 22 different emotional categories on their face. Ekman (1972) proposed six basic emotions that can be communicated efficiently and across cultures through facial expressions.

Second, some emotional categories of the OCC model appear to be very closely related to others, such as gratitude and gratification, even thought the conditions that trigger them are different. Gratification results from a praiseworthy action the character did itself and gratitude from an action another character did. It is not clear if such a fine grained distinction has any practical advantages for the believability of characters.

Last, if the character does not have a user model then it will by definition not be able to evaluate the consequences of an event for the user. In this case, the "fortunes of others" emotional categories would need to be excluded.

Ortony acknowledged that the OCC model might be too complex for the development of believable characters (Ortony, 2003). He proposed to use five positive categories (joy, hope, relief, pride, gratitude and love) and five negative categories (distress, fear, disappointment remorse, anger and hate). Interestingly, he excluded the emotional categories that require a user model. These ten emotional categories might still be too much for a character that only uses facial expressions. Several studies simplified the emotional model even further to allow a one-to-one mapping of the emotion model to the expressions of the character (Bartneck, 2002; Koda, 1996).

2.2 Quantification

The intensity of an emotional category is defined separately for events, actions and objects. The intensity of the emotional categories resulting from an event is defined as the desirability and for actions and objects praiseworthiness and appealingness respectively (see Figure 1).

One of the variables that is necessary to calculate desirability is the hierarchy of the character's goals. A certain goal, such as downloading a certain music album from the internet, would have several sub goals, such as download a specific song of that album. The completed goal of downloading of a whole album will evoke a higher desirability than the completed goal of downloading of a certain song, because it is positioned higher in the hierarchy. However, events might also happen outside of the character's current goal structure. The character needs to be able to evaluate such events as well.

Besides the goal hierarchy, the emotion model also needs to keep a history of events, actions and objects. If the user, for example, gives the character one banana after the other in a short interval then the desirability of each of these events must decrease over time. The character needs to be less and less enthusiastic about each new banana. This history function is not described in the original OCC model, but plays an important role for the believability of the character.

The history function has another important advantage. According to the OCC model, the likelihood of an event needs to be considered to calculate its desirability. The history function can help calculating this likelihood. Lets use the banana example again: The first time the character receives a banana, it will use its default likelihood to calculate the desirability of the event. When the character receives the next banana, it will look at the history and calculate how often it received a banana in the last moments. The more often it received a banana in the past the higher is the likelihood of this event and hence the lower is its desirability. After a certain period of not receiving any bananas the likelihood will fall back to its original default value. This value should not be decreased below its default value, because otherwise the character might experience an overdose of desirability the next time it receives a banana. Another benefit of the history function is the possibility to monitor the progress the character makes trying to achieve a certain goal. According to the OCC model, the effort and realization of an event needs to be considered to calculate its desirability. The history function can keep track of what the character has done and hence be the base for the calculation of effort and realization.

2.3 Interaction

The OCC model does not describe another important aspect of an emotion model: the interaction of the different emotional categories. Lets assume that the character was not able to download a certain song from the internet and is therefore angry. Next, the user gives it a banana. This event should not suddenly make it happy, but make it less angry. The emotional value of a certain event interacts with the current emotional state of the character. Little is known how this interaction might work, but a very simple approach could be to counter effect of the positive and negative categories.

2.4 Mapping

If the emotion model has more categories than the character has abilities to express them, the emotional categories need to be mapped to the available expressions. If the character, for example, uses only facial expression then it may focus on the six basic emotions of happiness, sadness, anger, disgust, fear and surprise (Ekman et al., 1972).

Interestingly, there is only one positive facial expression to which all 11 positive OCC categories need to be mapped to: the smile. Ekman (1985) identified several different types of smiles but their mapping to the positive OCC categories remains unclear. The 11 negative OCC categories need to be mapped to four negative expressions: Anger, Sadness, Disgust and Fear. The facial ex-

pression of surprise cannot be linked to any OCC categories, since surprise is not considered to be an emotion in the OCC model.
Even though the character might only be able to show six emotional expressions on its face, the user might very well be able to distinguish between the expression of love and pride with the help of context information. Each expression appears in a certain context that provides further information to the viewer. The user might interpret the smile of a mother next to her son receiving an academic degree as pride, but exactly the same smile towards her husband as love.

2.5 Expression

The emotional state of the character is defined through values for each of its emotional categories. This emotional state needs to be expressed through all available channels. A conversational embodied character, for example, needs to express its emotional state through its speech and facial expressions. It would be unconvincing if the character would smile, but speak with a monotonous voice. However, the systematic manipulation of speech to express emotions remains a challenge for the research community. Emotional facial expressions are understood better, but a fundamental questions remains. Shall the character only express the most dominant emotional category, or shall it express every category at the same time and hence show a blend of emotions. The blending of emotional expression requires a sophisticated face, such as Baldi from the CSLU Toolkit. Cartoon like characters, such as eMuu (Bartneck, 2002) or Koda's Poker Playing Agent (Koda, 1996) are not able to show blends and therefore they can only express the most dominant emotional category.

Another important issue that needs to be considered when designing the facial expression of the character is that they need to be convincing and distinct at low intensity levels. Most events that a character encounters will not trigger an ecstatic state of happiness. The evaluation of a certain event should be roughly the same as could be expected of a human and most events that humans encounter in everyday life do unfortunately not result in ecstasy. If the character managed to download a complete album of music it still did not save the world from global warming. Hence, it should only show an appropriate level of happiness.

Not only the face of the character is influenced by the emotional state of the character, but also its actions. It would be unbelievable if the character showed an angry expression on its face, but acted cooperatively. The mapping of the emotional state should be based on strong theoretical foundations. Such theoretical foundations might not be available for every action that a character might be able to execute and thus force the developer of the character to invent these mappings. This procedure has the intrinsic disadvantage that the developer might introduce an uncontrolled bias based on his or her own experiences and opinions. The mapping should be evaluated through a serious of user tests, similar to the ones described in Section 3.

Besides the actions of the character, the emotional state may also influence the attention and evaluation of events, actions and objects. In stress situations, for example, humans tend to focus their attention on the problem up to the point of "tunnel vision". Ortony (2003) categorized the behavioural changes of the character through its emotional state in self-regulation (such as calming down), other-modulation (punish the other to feel better) and problem solving (try to avoid repetition). The latter will require the history function mentioned above. The emotional state of the character might even create new goals, such as calming down, which would result in actions like meditation.

3 The personality of the character

Consistency is an important factor for the believability of a character (Ortony, 2003). This consistency can be described as the personality of the character. If bananas make the character happy now then it should continue to do so in the future.

The OCC model is designed to model humans in general. Usually developers of characters intend to create a "neutral" character that behaves like a "normal" human. Users that interact with the character might perceive this "neutral" character quite differently. They will perceive a certain personality and therefore it appears to be a good idea to actively design this perceived personality instead of trying to achieve just a "neutral" character. Iterative design cycles of character design and evaluation would help to create an appropriate character. Several personality tests and theoretical frameworks are available to measure the perceived personality of the character, such as the five factor model of personality (McCrae, 1987).

4 Conclusions

The OCC model provides a good starting point to equip an embodied character with an emotion model, but it falls short on suggestions on what to do with the emotional state. The mapping of the character's emotional state to its behaviour remains the responsibility of the developer of the character. Great care should be taken to base this mapping on a solid theoretical framework and to evaluate the mapping through a serious of user tests.

The OCC model needs to be extended with a history function, an emotion interaction function and personality designer. The history function will help to calculate the likelihood, realization and effort of events. The interaction function will mix the emotional values of events, actions and objects with the current emotional state of the character. The personality designer will enable the designer of the character to systematically vary the parameters of the character, such as its standards and attitudes. Through a serious of iterative design cycles of character design and personality testing, the optimal personality for the role the character should be derived.

Overall, it appears beneficial to simplify the OCC model to a level that corresponds with the abilities of the character, such as its ability to express the emotions. Such a simplified emotion model will dramatically reduce the development effort since the necessary world model is reduced. This model needs to be entered by hand and resembles an often largely underestimated work package. The world model should be shared with the other components of the character. The goal structure, for example,

forms a central component that need to be accessed by many other components.

On the one hand the OCC model should be simplified to match the abilities of the character, but on the other hand it requires the addition of a history function, an interaction function and a personality designer. The overall complexity of the system might therefore stay the same.

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