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# Analyzing Artificial Emotion in Game Characters Using Soft Computing

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***Abstract*—** This paper describes a simulation model for analyzing artificial emotion injected to design the game characters. Most of the game storyboard is interactive in nature and the virtual characters of the game are equipped with an individual personality and dynamic emotion value which is similar to real life emotion and behavior. The uncertainty in real expression, mood and behavior is also exhibited in game paradigm and this is focused in the present paper through a fuzzy logic based agent and storyboard. Subsequently, a pheromone distribution or labeling is presented mimicking the behavior of social insects.

***Keywords*—** Artificial Emotion, Fuzzy logic, Game character, Pheromone label

## I. Introduction

Gaming is a highly relevant application area for intelligent Agents and synthetic characters. Nowadays, computer games invade our life bringing us a set of new experiences, driving us into fantastic adventures. Although purely fictional, characters in such games have a personality, likes and dislikes, emotion and moods that pulls us into the story and make us feel live. The primary argument for using emotions in games is that they define humans, and are therefore a key factor in providing realism and believability in computer games. Computer games are a highly interdisciplinary field of research. Apart from computer science and AI, areas such as psychology, sociology, education, graphics' design and arts are inspired and motivated by computer games and it characters [9]. Characters that display emotion are critical to a rich and believable simulated environment, especially when those characters interact with real people possessing real emotions. Traditionally, animators have painstakingly created these behaviors for pre-rendered animations. This approach, however, is not possible when we wish to use autonomous, interactive characters that possess their own unique personalities and moods. Truly interactive characters must generate their behavior autonomously through techniques based upon *Artificial Emotion (AE)* [10]. In this paper, this AE is analyzed in a typical game storyboard using soft agents (the agents driven by soft computing techniques) simulation. The proposed simulation may assist largely in virtual character modeling of game and finally believability of those characters will be more prone to real life.

The rest of the paper is organized as follows: Section II explored the utility of AE in computer game. Section III described the essential definition of AE and proposed simulation using soft computing based agents. Here, we have adopted Fuzzy logic and synthetic pheromone labels to define the simulation. Section IV briefly describes the conclusion and further avenues of research in this direction.

## II. Utility of Artificial Emotion in Computer Game

While designing game characters, it has been observed that the action and dynamism of them are not only controlled by external stimuli but also their own individual emotion, personality mood and attitude [1]. Darwin laid pioneering foundation of fundamental theory of emotion (comprising anger, contempt, disgust, fear, joy, sadness and surprise) through the analysis of their expression in human faces. Ekman's study revealed that some emotions are not culturally determined [2]. The OCC model (named as Ortony, Clore, & Collins 1988) has been widely used to associate intensity values with different types of emotions such as joy/distress, hope/fear, disappointment, pride/shame, admiration/reproach, happy-for/resentment and gloating/pity [3]. The stimuli behind OCC theory are evaluated with respect to goal or intention of actors. The psychological research in personality is also dominated by dimensional representation e.g. five factor model [4]. All these models inspired the research in believable virtual agents and their character in computer game or in interactive story telling system [5] [6]. Fundamental to the AE-based behavior system is the notion that emotions comprise three layers of behavior. At the top level is what we call as momentary emotions; these are the behaviors, that we display briefly in reaction to events. For example, momentary emotions occur, when we smile or laugh at a joke or when we are surprised to see an old friend unexpectedly. At the next level there are different types of moods. Moods are prolonged emotional states caused by the cumulative effect of momentary emotions. Underlying both of these layers and

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always present is our personality; this is the behavior, which we generally display when no momentary emotion or mood overrides [8]. Artificial emotion produces two fundamental components as output: gestures and actions. Actions are a general category and are dependent upon the context of the situation in which the character exists. A simulation's control system uses AE to select and/or modify an action. When selecting an action, AE indicates what actions are appropriate to the character's personality and current mood. Hence, for example, a timid character is unlikely to do anything aggressive. When modifying an action, AE can help to determine how an action is carried out [11]**.** An outgoing, extroverted character might perform an action enthusiastically, although this probably wouldn't be the case for an extreme introvert. Our primary use of AE in this proposal, however, is in driving gestures, namely hand, body, and facial gestures.

## III. Proposed Simulation and Results

Prior to start the actual simulation, we have envisaged certain standard parameters already accomplished by some prominent researchers regarding personality models. Each of them are consisting of a set of dimensions, where every dimension is a specific property of the personality. For example the OCEAN model [4], which has five, dimensions (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism). Generalizing from these theories, we assume that a personality has n dimensions, where each dimension is represented by a value in the interval [0, 1]. A value of 0 corresponds to an absence of the dimension in the personality; a value of 1 corresponds to a maximum presence of the dimension in the personality. In this context, the personality p of an individual can be represented by the following vector:

$$P^T = [\alpha_1 \ldots\ldots \alpha_n], \forall i \quad [1,n]: \; _i \quad [0,1] \quad \alpha$$

Considering these basic parameters, the following storyboard has been fabricated to represent simulation of artificial emotion. A stranger or traveler was searching for a lost city in a wild, remote jungle. Suddenly, he found the entrance to the city and walks in. It's still inhabited. The inhabitants' (tribal mob) body language changes when they see him, reacting to his sudden intrusion. Some become fearful, backing away and curling into a non-threatening posture. Others do the opposite; standing upright, shoulders back, chest out, and fists clenched, seem to be trouble. The traveler stood motionless for a time, until a very jovial character smiles broadly at him, laughs, and then comes over to greet him, telling the other inhabitants to do likewise. The inhabitants' interactive behavior, and more importantly their individual behavior, creates a living world for us to explore and within which to entertain ourselves. This environment would be socially oriented; the stranger's decisions and actions would be based upon the personalities and moods of the characters that he encounters. Essentially, the characters' decisions and actions would be interactively based upon real time; nothing would be pre-scripted (unless the designer of that experience wished it typical way, as in interactive theatre).

In this storyboard we assume the gesture and emotion in inhabitant's body language after arrival of the stranger traveler can be modeled as set of X from the followings:

$x_1$ = simple surprise or suspicion
$x_2$ = simple fearful negation
$x_3$ = takes some time to react
$x_4$ = looks into the eye of seniors members of the group what they are thinking
$x_5$ = showing an introvert personality but curious
$x_6$ = joyful and jovial acceptance.

In this point for the given scenario our expectation from the tribal mob's response can also be represented by the possibility distribution: $r_0 = (0.9, 0.1, 0.7, 0.3, 1, 0.6)$

From this distribution it is expected that as stranger in storyboard we expect a positive answer from the tribal mob. Suppose that the following message $M_1$ has been received by the stranger (We call it $AE_1$):

$$M_1 = 0.1/x + 0.8/x + 0.4/x_3 + 0.1/x_5$$

This message although relative strong, unambiguous and crisp and it is not consistent with the stranger's expectations. We can measure the consistency is:

$S(M_1, r_0) = \max [0.1, 0.1, 0.4, 0.1] = .4$ (we incorporate standard fuzzy belief measure for communication: which is

$$r(M) = \max [\min (\mu_M (x), r (x)])$$

$$x \in X$$

Because, the message is contrary and expression is opposite to young mans expectations. Let us assume that the stranger introduces certain biased distortion by himself (this is interactive and self motivated emotion of stranger). Hence, new distorted and biased message:

$$M_1 = 0.4 / x_1 + 0.9 / x_2 + 0.7 / x_3 + 0.4 / x_5$$

Based on this message the stranger modifies his expectations according to $r_1(x) = \min [(r_0{}^6 (x), \mu_M (x)]$ for each $x \in X$ or

$$r_1 = 0.4 / x_1 + 0.25 / x_2 + 0.7 / x_3 + 0.25 / x_5$$

The stranger has thus greatly diminished his expectation of a simple surprise or suspicion, some what increased his expectation of a simple fearful negation and with some time given up all hope of the possibility of joyful and jovial acceptance.

At present scene of storyboard he puts back a question to the mob and receives an expression of emotion as ($AE_2$):

$$M_2 = 0.9 / x_2 + 0.4 / x_5$$

This message is stronger clearer and less general than the first reaction. It's consistency with stranger's new expectations is: $s(M_2, r_1) = 0.25$. Let us now suppose that the response, which the stranger will have to choose from the storyboard as the game model, would also demonstrate the stranger's emotion level. The response emotion set is y:

$y_1$ = happy agreed
$y_2$ = Frustrated
$y_3$ = Great surprise
$y_4$ = anger
$y_5$ = consolidated patience

$y_6$ = impatience
$y_7$ = adhered to

We form a fuzzy relation $R \in Y \times X$ represent the degree which the strangers emotion to respond to the given emoti with a response having the attribute y. The relation can l given by:

Table 1 Fuzzy Relation Matrix of Emotion Exchange Between Stranger and mob

| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ |
|---|---|---|---|---|---|---|
| $y_1$ | .9 | 0 | .2 | 0 | 0 | 1 |
| $y_2$ | 0 | .9 | .1 | .2 | .1 | 0 |
| $y_3$ | .1 | .9 | .2 | .9 | 1 | .3 |
| $y_4$ | 0 | .5 | 0 | .6 | .7 | 0 |
| $y_5$ | .1 | 0 | .9 | 0 | 0 | .5 |
| $y_6$ | 0 | .3 | .2 | .3 | .4 | 0 |
| $y_7$ | .9 | 0 | .9 | .3 | 0 | 1 |

Using Fuzzy equation $A = R \circ M$ (from Table 1) [where R is the fuzzy relation and ° represents fuzzy operator on the message M], we calculate the artificial emotion value that should be injected in expression of storyboard stranger receives from the tribal mob in the forest:

$$A = R \circ M_2^{'} = \frac{0.9}{y_2} + \frac{0.9}{y_3} + \frac{0.7}{y_4} + \frac{0.4}{y_6}$$

Therefore, the AE level of stranger to be exhibited is great deal of frustration and surprise, a large degree of anger and some impatience. This labeled AE has to be demonstrated on the gesture, behavior and body language of the storyboard character.

The scaling of artificial emotion is done on the basis of fuzzy operator °, over the message set M. The choice of fuzzy set is appropriate to tackle the uncertainty and mixed mood representation in the character of the storyboard.

The labeling of artificial emotion can be accomplished by well-defined digital pheromone distribution according to different emotional traits of the storyboard characters. The term pheromone is referred to a chemical mark up deposited by the ant or other social insects to identify food source in best-optimized fashion [7]. Digital pheromones are scalar

Table 2. Relation between Emotion and Digital Pheromone in Storyboard. High - 1, Low - 0, Medium - 0.5

| | Emotions/ Dispositions for Tribal Mob $AE_1 + AE_2 + \ldots\ldots + AE_n$ | | | | | |
|---|---|---|---|---|---|---|
| | surprise or suspicion (1,-1) | fearful negation (1,-1) | Time Occupancy (1,-1) | Others Feeling (1,-1) | introvert but curious (1,-1) | joyful and jovial acceptance (1,-1) |
| Pheromone Labels *Stranger* | *Dampened* | *Anger* | *Patience* | *Don't Know* | *Adherence* | *Happy* |
| Acceptance | Medium | High | Low | ------- | ------ | ------- |
| Rejection but no harm | | High | | Medium | High | ------ |
| Frustrated | High | High | ------- | Low | Low | ------ |
| Astonished with fear | High | High | -------- | High | -------- | Low |
| Tolerance | Low | -------- | High | High | Medium | High |

UPDATE

variables that agents deposit at their current location in the environment and those they can sense. Agents respond to the local concentrations of these variables typically climbing or descending local gradients. Their movements in turn change the deposit patterns. This feedback loop, together with processes of evaporation and propagation in the environment, can support complex patterns of interaction and coordination among the proposed soft agents. The agent in this model has demonstrated the scope value of distribution of emotion experienced from story board each in [-1, 1], describing the agent's response to six kinds of information. Based on the storyboard narration we have identified 5 types of pheromone labels (e.g. Acceptance, Rejection, Frustration, Astonished with fear, Tolerance) reciprocated as the strangers emotion level after the response given by the tribal mob. Each emotion has been mapped with this triggered pheromone fuzzy linguistic value called as high medium and low (Refer the Table 2). From perspective an appraisal model will obtain emotional information. This information is then used to update the mood and emotional state. There may be desired change in emotion as per the given input expression. The emotion information vector (suppose denoted by a) or it may be called as emotion influence. This actually contains the desired change of intensity for each of emotional value (assuming m emotions). This is denoted by:

$$a^T = [\delta_1 \ldots\ldots \delta_m], \forall i \in [1, m] : \delta_i \in [0,1] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The emotional state swings ups and downs and being updated on the gesture and facial expressions of game characters. The present model considers a heuristics function τ (p, $\omega_{t,,}$ a). It actually calculates the change and updates of emotional state based on the character's personality p, the current emotional state history ωt and the emotion inertia a. Basically, the heuristics function τ which represents the intensity of pheromone in ant colony system [7]. The generalized pheromone update rule is:

$$\tau_{ij}(t) \leftarrow (1-\rho).\tau_{ij}(t) + \quad . \rho_{ij}(t) \quad \ldots\ldots\ldots\ldots (2) \Delta$$

Where i, j is the edge belonging to traversal of most balanced emotion path for the entire scene (climax), ρ is the parameter governing pheromone decay. $\Delta\tau_{ij}(t)$ is change of emotional state based on the expression of other character of the story(here it refers to the change of emotion for stranger).Hence, finally the expression of emotion state and mood update can be written as :

$$\Delta\tau_{ij}(t+1) = \Delta\tau_{ij}(t) + \tau(p, \omega_{t,,} a) + [\rho.\tau_{ij}(t), \varpi_t] \quad \text{..... (3)}$$

The term $[\rho.\tau_{ij}(t), \varpi_t]$ represents the decay of emotion as per current emotion history. For example, the strangers fear emotion could be diminished by the mobs joyful or jovial expressions.

**Application Examples**

The character modeling of the storyboard has interpreted through this simulation[1] as shown in Figure 1a and 1b describing the facial artificial emotion injected in stranger (Red circles shown). The utility is comprised of facial animation of game character using automata based on personality, mood and emotional state as mentioned the proposed model. This artificial emotion is evolved during the role-play of tribal mob with the stranger.

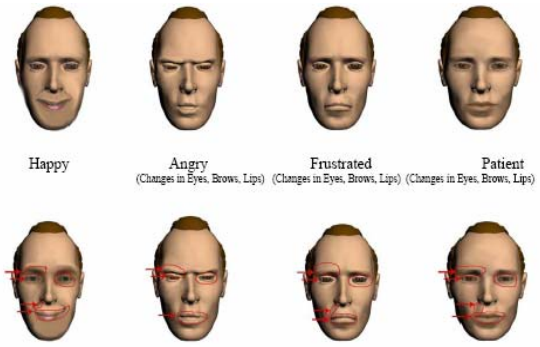


Figure 1a and 1b Emotion in Stranger

## IV. Conclusion

In this paper, we have described a simulation of artificial emotion in game characters using fuzzy logic and ant colony based digital pheromone label. The work also integrates an example in terms of forming a strategic game storyboard character. The future work is likely to explore the simulation and role of artificial emotion in developing strategy for similar game characters. This would like to envisage the designing of game character and game-bots, their strategy of actions more live, believable and comprehensive.

[1] Simulation is done through Maya Script language using 2.53 GHz Pentium 4 processor with 1 GB of RAM running the standard Windows XP Professional operating system.

## References

[1] Mark Ingebretsen, "Toward More Human Video Game Characters", IEEE Intelligent Systems, 1541-1672/08, July - August 2008, pp. 4-7.
[2] P. Ekman, "Facial Expressions and Emotion", American Psychologist, 48(4), 1993, pp. 384-392.
[3] A. Ortony, G. Clore, and A. Collins, "The Cognitive Structure of Emotions", Cambridge University Press, Cambridge, 1988.
[4] R. McCrae and O. John, "An Introduction to the Five- Factor Model and its Applications", Journal of Personality, 60(2), Janaury1992, pp. 175-215.
[5] D. Livingstone, "Turing's Test and Believable AI in Games", CiE 4(1), 2006.
[6] C.Thurau,, T. Paczian and C. Bauckhage, "Is Bayesian Imitation Learning the Route to Believable Game bots?", In: Proc. GAME-ON North America. 2005, pp. 3–9.
[7] Marco Dorigo, Mauro Birattari, and Thomas St¨utzle, "Ant Colony Optimization: Artificial Ants as Computational Intelligence Technique", IEEE Computational Intelligence Magazine, November 2006, pp. 28-39.
[8] David Milam, Magy Seif El-Nasr, and Ron Wakkary, "Looking at the Interactive Narrative Experience through the Eyes of the Participants", International Conference on Interactive Storytelling, 2008, pp. 2-11.
[9] Magy Seif El-Nasr and Athanasios V. Vasilakos, "International Journal on Computer Science, Special Issue on Computational Art", 2008. (Introduction to special edition for the journal).
[10] Jackeline Spinola de Freitas and and João Queiroz, "Artificial Emotions: Are We Ready for Them?", Lecture Notes in Computer Science, Springer Berlin/ Heidelberg, Volume 4648, 2007, pp. 223-232.
[11] Seungwon Oh and Minsoo Hahn, "Proposal of an Artificial Emotion Expression System Based on External Stimulus and Emotional Elements", Lecture Notes in Computer Science, Springer Berlin/ Heidelberg Volume 5208, 2008, pp. 526-527.

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