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Towards a new Vision of Emotions: Empathy

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Abstract

The synthesis of emotions receives a great interest in many domains. When the concept of emotions is included in a human-machine interaction, the interactivity is a lot improved: it is more entertaining for the user and the machine shows better adaptation to a social environment. In decision making and learning process also, the inclusion of emotions as a new parameter opens a way to a new heuristic process and agent's behaviors. Emotion models have been broadly studied in the past years and many models and implementations are now available. The next step in the study of emotions is also the understanding of their meaning as a mean of communication. In order to achieve such communication we need to be able to project our self in another state of mind and emotions, this is called empathy. We introduce in this paper the new ideas brought through the concept of empathy in order to find new domains of contribution.

1. Introduction

According to Albert Mehrabian [16], 55% of a message in the face-to-face communication is expressed by the body language, 38% by the tone and 7% only by the words. Even if this rule has to be understood under the initial conditions of his experiments [16], we can still understand that the emotions take an important part in the communication, especially in the non-verbal communication.

Many systems require research on the emotions, such as robotized agents, dialogues agents and also the Embodied Conversational Agents (which are usually virtual 3D agents used as attendants for virtual sales or expositions like houses). But these kinds of interactions are nowadays interesting also to the space industry to analyze and assist people especially for long missions [11].

If we compare the different uses of emotions in the human-robot interaction field, we can describe three sub-domains: the expression of emotions, the reading of the emotions and the synthesis of the emotions. We are here focusing on the synthesis of the emotions which leads to the process of the emotional information.

In the human decision making process, emotions play an important role especially on the social relationships. It is a noble goal for human-robot interaction to give a heart to a robot, to allow a

machine to feel emotions and interact with things in the world depending on those emotions. Interacting with emotions, a machine can integrate in a social environment a lot more efficiently, because people will start to like it (with the affective meaning of “like”). Therefore we need to simulate the emotions process, synthesize the emotions to provide the result in an artificial being.

The computing of emotions is a broad research area and a lot of research has been yet made. We made here a survey on the different systems that aim to synthesize the emotional process, the different computational models of emotions.

Because emotions are on the basis of communication, we need also to explore the role of emotions in this communication. Every communication implies a protocol, a way that allows a message to transit from an agent A to an agent B. Empathy allows the understanding of emotions. Also, by empathy, new emotions are learnt and understood by an agent, which may be able to reproduce the emotions according to similar conditions. Empathy can be therefore seen as a process of emotions, that influences future expressions of emotions and behavior.

This work aims to present and compare those models and their purpose of application in order to show the different ways on which a research contribution can be done.

The rest of the document will be organized as follows. Section 2 presents the related works on the fields of psychology and Section 3 shows some computer science solutions for emotion synthesis. Section 4 introduces the notion of empathy. We will conclude in Section 5.

2. Theoretical Models of Emotions

An emotional system is first based on a theoretical model that describes how emotions are processed by humans or animals. Several different models have been used already for the computation of emotions. Those models can be either psychological or physiological [5]. Some models are based on animal behaviors (ethological basis for computing emotions) and others on human behaviors. The theoretical models are usually issued by research in psychology e.g. Paul Ekman’s basic emotions [8]. I will additionally give a particular attention to the Ortony, Clore and Collins (OCC) model [19] which has been often preferred to as the referent emotional model over all others.

Paul Ekman described the fundamental emotions [8], basic emotions called sometimes the Big Six. The emotions that should be recognized by any human being are biologically universal. These emotions are: happiness, sadness, anger, fear, surprise and disgust. Although Ekman has extended them to fifteen [9], many research work stick to those six emotions, and sometimes even more limited for those who need to overlap with the OCC model [27].

2.1 Ortony, Clore and Collins

We can have a look a little bit deeper in the OCC model because of its wide use. Many researchers inspired their models from the OCC model but apply also some variation depending

on their purpose of application (determining the emotions they need to express). The OCC model is a cognitive model that allows the expression of 22 emotions depending on categories that are the reactions to consequences of events, actions of agents, and aspect of objects. The model based on given knowledge (goals, standards, attitudes) computes also intensity variables such as attractiveness of an object, worthiness of an action, or desirability of an event. The OCC model is described in Figure 1 [1].

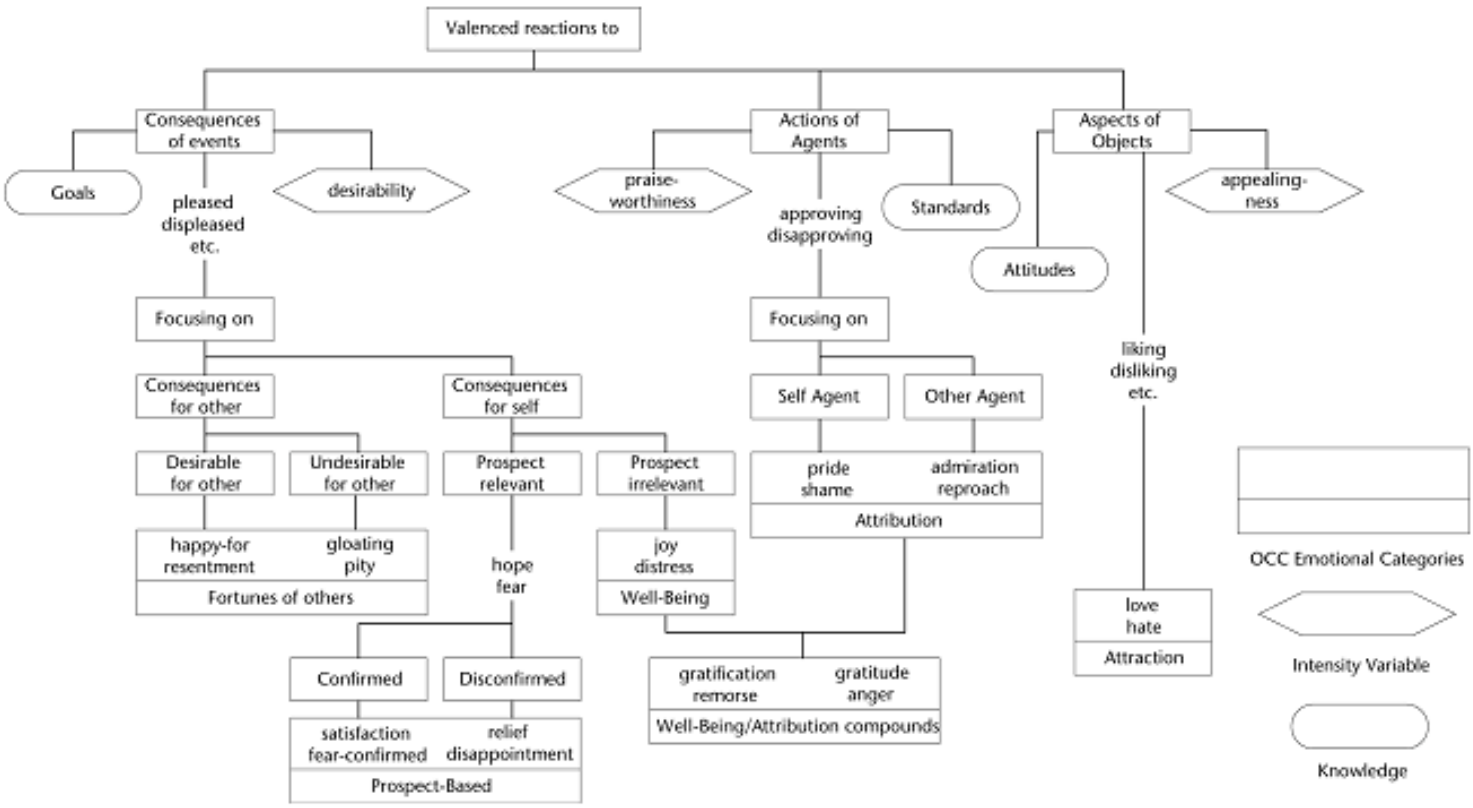

Figure 1: The OCC model.

Implementing the OCC model can be accomplished by following five steps [1]:

1. Classify the consequence of an event, the action of an agent, or the aspect of an object. Depending on the knowledge basis of the model, this step allows the system to know on which category to reason.
2. Evaluate the intensity of the variable of reaction of the category chosen (desirability, attractiveness…).
3. Interact depending on the intensity on a certain category (e.g. it can be just counting the positive or negative values given by a set of rules).

4. Find for the resulting emotion an expressional emotion (determined by the needs of the system. Figure 2 shows a possible table of correspondence of Paul Ekman's basic emotions to the OCC resulting emotions [27]).
5. Express the emotion (it can be done for the system by making a decision).

OCC Emotions		Paul Ekman's Basic Emotions
Happy-for Gloating Joy Pride Admiration Gratitude	Love Hope Satisfaction Relief Gratification	Happiness
Resentment Remorse Pity	Distress Shame	Sadness
Anger Reproach	Hate	Anger
Fear	Fear-confirmed	Fear
N/A		Surprise
N/A		Disgust

Table 1: Correspondence between OCC emotions and Paul Ekman's emotion

The Table 1 allows to highlight the OCC model has some imperfections and does not allow the expressions of all kind of emotions.

2.2 Swagerman and Frijda

Swagerman together with Frijda developed a computer model of emotions [29]. This model is based on the attraction by a system to a certain state of the environment. Therefore different goals might be produced to create a state of the environment that would be preferred by the system. Depending on the achievement of the goals, actually on the difficulties in the achievement, the system will produce emotions such as irritation, frustration, anger but also satisfaction. When the main goal is life, such system can even feel fear, and relief of the fear.

Figure 2 describes the model designed by Frijda [30]. We can observe that the role of the urgency, difficulty and seriousness appraisal as a relevant activation signal to trigger a behavior. This approach is strongly related to the notion of goal achievement and here is the novel idea brought by the model. Goals are motivations for emotions, and the distance to a goal (in a multidimensional matter, such as relevance, context, urgency, difficulty) modulates an emotion.

Such system implemented in the Swagerman's Artificial Concern REalization System ACRES show extreme mood swings because the model does not include any notion of inertia and the emotional state is just switching from one state to another without transition. Also there is no process of a current emotional state, no memory of the current state either that would allow a blending of the emotions, or at least the consideration of the current emotion to process the following.

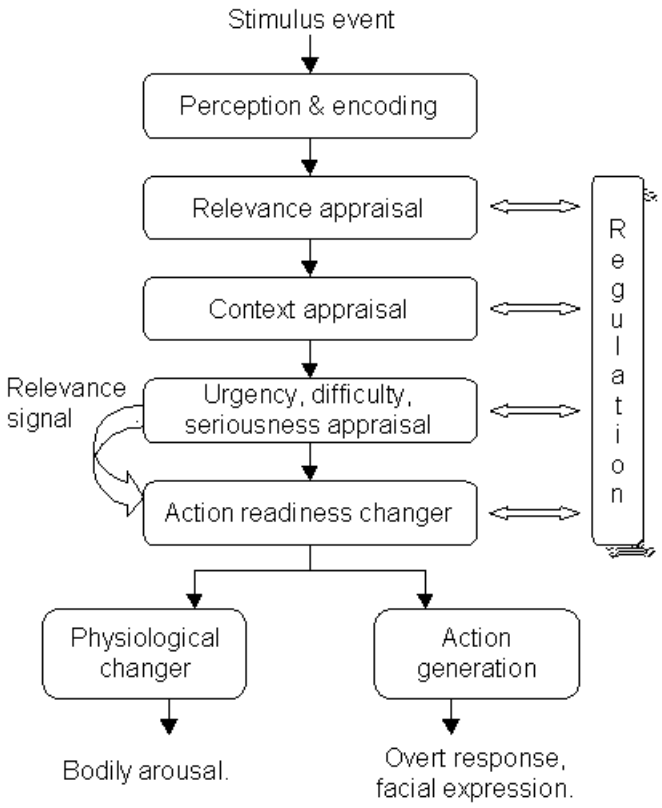

Figure 2: Frijda's model of emotions

2.3 Roseman

Solomon in [4] introduced a theory based on appraisals which are processes that elicits the emotions. The emotions are not raw feelings but the result of processes and judgments. Roseman in [24] extended the theory identifying more accurate appraisals of the emotions. By statistically analysis the appraisals describes by 182 subjects, Roseman suggested the appraisals of unexpectedness, situational state, motivational state, probability, control potential, problem source, and agency causes a large number of emotions.

Depending on a nature of an event, the relation of the event with the agent and with the agent's situation, different emotions can be expressed. The figure 3 shows 17 emotions that are elicited. The polarity of the emotions depends on the consistency of the agent's wishes (whether the event is as wanted, or as improving things, or on the contrary unwanted and making things worse). Surprise seems to be a particular emotion that is induced by only the unexpectedness character of an event, which could be of any nature. Surprise has basically no polarity and could be positive or not.

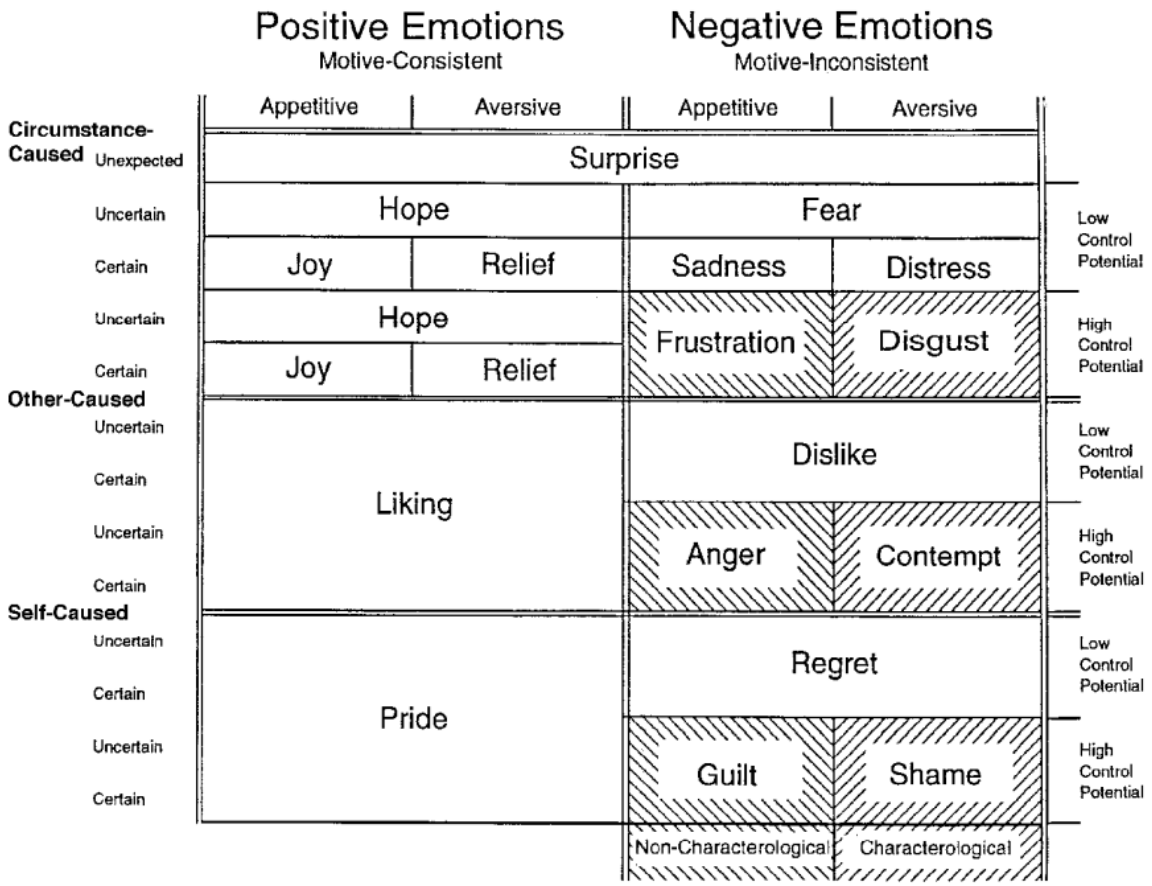

Figure 3: Roseman's structure of emotions

This model is powerful in the way it details the appraisal determinants of emotions, on which criteria can be influenced an emotion. One more time we can insist on the multidimensional nature of emotions elicitation. This model consider the orientation of the event more than does the OCC one: whether the event is caused by circumstances, others, or one's self. A novel approach is also the control potential appraisal, determined by the power of the agent on the event and situation (can the agent do or not something to change the current situation).

Because the theory states that emotions are answers to determined conditions, this model does not clearly specify any process of the current mood and/or memory of the previously felt emotions. This aspect is just stated in the probability appraisal (is it certain or uncertain to happen this way). In addition, no emotional inertia and continuous valence in intensity and time is suggested in the model: for example, it is not a repetitive action in time or a strong action that changes “dislike” to “anger”.

2.4 LeDoux

LeDoux’s emotional brain defends a Darwinian approach of emotions as process to optimize the survival [14]. He states that emotions are part of a complex neural system which allowed us to survive. The learning process is made through experience and the emotional answers are processed into the brain’s neural basis. The brain basically answers to some stimuli (that the brain has detected), which have to be evaluated to evaluate an emotional answer. The amygdala has a major role in the detection of the stimuli. There is actually situation pattern of the brain state that brought first the emotion, like fear in presence of a snake, which is then quickly recognized in the amygdale. The emotion felt then allows the subject to respond in an adaptive manner in the environment.

The brain first react to a new situation and evaluate it, it is the cognitive approach, conscious. But when such a pattern of a situation is recognized again (through the amygdala), the adapted behavior and emotional response will be expressed in anticipation of the cognition.

This approach does not state about the emotions and the explanation of the specific emotions but introduces the idea of a situational pattern that once recognized, is more susceptible to activate emotional states that have been already felt before. Through the example of the snake, LeDoux has shown off also that a baby monkey, natively, does not fear a snake. But the little monkey has learnt to fear snakes through his mother’s experience, who were having already the fear of snakes.

This also introduces the emotions as a strong communication process for survival. It implies the notion of emotions recognition and empathy to make this communication efficient.

3. Implementations of the models

Several systems have implemented a computational model of emotions:

- The robot head designed in [27] is a typical example of the use of the OCC model in the expression of emotions. Although the project focuses on the mechanical aspects the expression of emotions, they used both OCC models and Paul Ekman’s basic emotions to choose the set of emotions they wish to express.

- BORIS and OpEd by M.G. Dyer in 1987. BORIS is natural language understanding program and focuses on understanding the emotional states of characters from a text story. It is based on the cognitive appraisal theory of Solomon. BORIS uses a symbolic representation of emotions as five-slot frames: goal situation, expectation, direction,

polarity of arousal and strength of the emotion [7]. OpEd is an extended version of BORIS that includes beliefs.

- The Artificial Concern Realization System (ACRES), by Fridja and Swagerman in 1987 [29] implements their theory of emotion stimulation. This implies the notions of pleasure and allows the agent to respond emotionally when he is concerned. The system is a dialogue agent that can be annoyed by the user, and also fears of being killed by displaying appropriate messages.

- Affective Reasoner started in 1992 by Clark Elliott [10] is a multi agent system based on the OCC model. Each agent has a goal, preferences, principle guiding behavior, and moods. Each agent can influence other agents' emotional state. Moods and personalities affect agents' emotional states. Agents' behaviors are corresponding to specific emotions. The system includes multimedia input and output (text-to-speech, speech recognition, cartoon-style facial expressions). The project helps to improve human-computer interaction, to test appraisal theories of emotion, and to develop more believable characters in computer games.

- The OZ project at the Carnegie Mellon University, closed in 2002. The project intended to develop tools for "highly interactive drama" and virtual worlds [11, 12]. Emotions are included as part of agents architecture, using the OCC model to cause emotional actions of the agents by threshold mechanisms. The most advanced demonstration of Oz shows creatures, the Woggles, which have individual personalities, show emotions and social behaviors, and react to their environment taking in account an extra user-controlled Woggle.

- Cognitive Systems for Cognitive Assistants (CoSy), use emotions as part of the cognition and learning of a robot [26]. This European project aims to give the knowledge to the robot on how and why it performed some task. The research is based on a scenario approach: The Explorer, is concerned with spatial exploration (find a way in a building), the PlayMate will manipulate of 3D structures (copy a given structure), and the Philosopher wants the robot to reason (understand a task, explain a task, describe his process).

- The Kismet robot by Cynthia Breazeal [3] is able of multimodal social interactions. She used the OCC model to implement the emotional behavior of Kismet. She implemented emotion drives to activate behaviors based on a threshold approach.

All these applications are inspired by the previously described computational models. They all differ in their purpose of application and thus the way they translate in variables and computer process the input of the psychologically based models. In addition they offer adapted simplifications of the models that made them fit the experiences situation. We can notice that in order to make a contribution, the tools used are certainly important, but the domain of application, the purpose of such system synthesizing emotions is capital, and brings the real contribution.

4. Empathy

The synthesis of the emotions is quite well advanced. The issues in the synthesis tend to concern the set of emotions that can be felt, and those are more or less extended by modifying

the current main computational models of emotion, and especially by combining the different approaches proposed in the psychological and medical literature.

4.1 Definition

Another approach would be not to focus on the emotions process itself, but on the utility of emotions. It has been shown in the previous section that emotions make a strong mean of communication. Like any mean of communication, there is a message sent (by the emotions) and the message received. The reception of such message is made through empathy. We will get interested by empathy in this section.

Empathy has been started to be studied quite recently and its definition has not been fixed yet because it is first a psychological concept and it is also related to philosophy. Kohut [28] defines the empathy as "*the capacity to think and feel oneself into the inner life of another person.*" There are two main view of empathy. It can be seen as a cognitive process, allowing taking another's perspective (inference on another's feelings, Ickes, 1993), and it can be seen as an affective phenomenon (feeling with or feeling for another, Batson et al. 1997). Both views are of course not incompatible and empathy certainly assumes both roles.

There are no formal models of empathy yet studied and the research in the human-machine interaction is still at the early steps but we can pull out two directions in reasoning from the two points of views we cited:

- The cognitive aspect, by taking another's perspective is directly relation to the retrieval process (we look for the causes that make another's precise state of mind).
- The affective aspect, by feeling for and with another is related to the anticipation process, and we join here previously commented LeDoux's point of view on the role of the amygdale in the emotional process, and why the baby monkey learns the fear of snake through his mother.

We can notice also the work of Mark H. Davis [6] who designed a questionnaire to measure empathy in order to show differences in empathy depending on sex. The questionnaire measures four characteristics of people: fantasy, perspective-taking, empathic concern and personal distress. It will be good to remember this approach in order to validate the empathy simulated by a system.

It will be good in a future work to describe the role of each emotion in a social interaction. By empathy an agent understands a message, and each emotion transmits a specific message. We have no time and space here to describe the message transmitted through each emotion here but R. J. R. Blair describes in his work [2] how a specific empathized emotion brings a very specific message (such as anger which express a rupture in some social law, and requires from the interlocutor to readapt her behavior). By empathizing another's emotion, an interlocutor understands the message expressed through this emotion.

4.2 Applications

In computer science the investigations on empathy are very recent and only a few works has been led toward that direction.

It is interesting to know that some works aim to make the human user empathize with the artificial system (for example see [20], here is described a system that allows kids to empathize with virtual agent in order to demonstrate the negative effects of bullying).

Another project deserves to be mentioned: Empathy by the Universita degli Studi di Bari [25] describes a reprocess of the currently felt emotion to set the mood and smooth the expression a new felt emotion. It consists in adding the current emotional state in the inputs and influences the decision on the new emotion felt. This actually includes the notion of inertia and memory of an emotion, but it is not yet empathy.

We will focus in this part on four works that implement artificial empathy:

- Some medical treatments need the patients to be constantly watched using devices for a long term such as cardio meters. The acceptance of the system is vital for the patient, but it is quite constraining to bear them, especially for a long term interaction between the patient and the device. R. Picard [21] offered to embed empathy in such monitoring system through a human-machine interaction as a (simple) dialogue system. The empathetic system has been strongly preferred by the patients, which shows the pertinent interest of the study of empathy in human-machine interaction.
- Delay time due to computation usually raises the user's frustration. R. Picard [22] proposed a system that responds to user's frustration by interaction. The interaction is made through dialogues (small questions/answers) and induces support when the user answers with frustration. The user is playing a very slow and annoying game, with long delay times. In parallel, the computer asks the user his emotional state through multiple answers questions, and displays some supportive messages depending on the user's answer. Results have shown that the users play the annoying game for a longer time when the computer shows empathy to her situation than when the computer does not. One more time this show the interest of empathy in collaboration between human and computers.
- In a computer version of the game of blackjack, a virtual player has been programmed as an agent with empathy. The agent interacts with the users as a player of course, but also by displaying messages and emotions through facial expressions. The agent is able to feel empathy towards the other user's situation but also his own situation. This means the agent is happy when the player wins but also when he wins himself. The set of emotions is limited to happy, sad and neutral (no expression). The messages can be supportive and complaining to the user but also self oriented. S. Brave et al. in [18] studied the likability, caring, trustworthiness, dominance, positive and support feelings of the agent, described by the users in the four possible situations. Results have shown in most of the cases that the agent induced measured feelings to the users when it was displaying empathy to the user

and even more when it was also self oriented. This studied demonstrates once more the positive effect of empathy in human-machine interaction.

- In a simple treasures hunt game McQuiggan and Lester [15] programmed an agent that cooperates with the user. The agent is able of facial and body expression as well as text expression. Depending on the user's behavior the agent will display supporting or irritating behavior related to the treasures hunt. For example if the user takes time to find a treasure, the agent will blame the user, and even more if he is looking twice in the same place. If the user displays high skills to discover treasures, the agent will display happiness, compliments and support. If the time is limited, the agent will pressure the user. The study has demonstrated the interest of such agent in the video game area. Such character can influence the user and make the experience of the video game more entertaining.

All those works are centered on the human-computer direct interaction and the improvement of the interaction using empathy is evident. None of those works have been yet deeply understanding the user's motivations and feelings but mainly answering to the user's emotional state. Therefore we have in the study of empathy in its full definition a strong contribution that can be made. Also the fields of application are now quite limited but it makes no doubt that a lot more can be found soon (e.g. as personal advising, problem explanation or individualized interaction).

5. Validation and conclusion

We have described more the OCC model which is the most popular but just cited the others and given an overview of the current implementations. In this work we have also described three of the most influent computational model of emotions and added a totally new approach of the emotions through empathy.

We described the main computational models of emotions with their pros and cons, and the current implementations in computer science. There might be no best model to describe the emotions but a combination of those models brings the best answer when applied to a real situation. The best contribution that can be made in the synthesis of emotions should first come with one "on-field" application (the purpose) and the adaptation of the chosen model to the situation.

Empathy is a quite new field of research in the human machine interaction. This approach of emotions will bring a new view of programming emotions because it partly answers the question "why emotions?". Indeed, the emotions are not only a motor to express behaviors, but also a mean of expression. Through emotions are expressed the reasons that induced a specific behavior, and empathy allows to understand, learn, and answer to the emotions. It seems that there is still a huge work to do to be able to define and to understand empathetic process, as well as simulating them. Such work would benefit both psychology and artificial intelligence fields.

We have found there a new field of interest in the study of emotions. Because emotions and empathy cannot be dissociated, a research in empathy should contribute a lot in the synthesis

of emotions. Maybe the approach by empathy is completing the definition emotions which stayed until now far from the real meaning of emotions. In another point of view we can imagine that the first studies conducted on emotions have always been implying empathy, but mainly from the user. We might have here the field that will bring the next generation of human-machine interactions. The study of empathy will certainly provide the solution for new adaptive and individualized interactions between human and machines. In other words, it may lead to a real collaboration between human and machines.

References

[1] Bartneck, C. (2002). *Integrating the OCC Model of Emotions in Embodied Characters.*

[2] Blair R.J.R (2005) *Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations*.

[3] Breazeal, C.L. (2002) *Sociable Machines: Expressive Social Exchange Between Humans and Robots*. Ph.D. Thesis, MIT

[4] Calhoun, C. & Solomon, RC. (1984).*What is an emotion?*

[5] Damasio, A. R. (1994). *Descartes'error: emotion, reason, and the human brain.* New York: G.P. Putnam's Sons.

[6] Davis, M. H.(1980). *A Multidimensional Approach to Individual Differences in Empathy*, JSAS.

[7] Dyer, M.G., Harley, S., Johnson, P.N., Lehnert, W., Yang, C.J., (1983). *BORIS -- An experiment in in-depth understanding of narratives.*

[8] Ekman, P. (1999). *Basic Emotions*.

[9] Ekman, P. & Friesen, W. V (1969). *The repertoire of nonverbal behavior: Categories, origins, usage, and encoding.*

[10] Eliott, C. (1992). *The Affective Reasoner: A Process Model of Emotions in a Multi-Agent System*, The Institute for the Learning Sciences Technical Report #32, PhD Thesis, Northwestern University.

[11] European Space Agency, (26 March 2007) *Tools for Psychological Support during Exploration Missions to Mars and Moon*, ESTEC, Noordwijk,The Netherlands.

[12] Kelso, M., Weyhrauch, P., and Bates, J. *Dramatic Presence.* In PRESENCE: The Journal of Teleoperators and Virtual Environments, Vol 2, No 1, MIT Press

[13] *Overview of the Oz project*: http://www.cs.cmu.edu/afs/cs/project/oz/web/overview2.html

[14] Ledoux, J. (1996). *The emotional brain. In Human Emotions*, Jenkins, J.M., Oatley, K., Stein, N.L.

[15] McQuiggan, W. & Lester, J. C.(2007). *Modeling and evaluating empathy in embodied companion agents.*

[16] Mehrabian, A. (1981). *Silent messages: Implicit communication of emotions and attitudes* (2nd ed.). Wadsworth, Belmont, California.

[17] Mehrabian, A. See references 286 and 305 in Silent Messages.

[18] Nass, C., Brave, C. Hutchinson, K. (2005). *Computers that care: investigating the effects of orientation of emotions exhibited by an embodied computer agent.*

[19] Ortony, A., Clore, G., & Collins, A. (1988). *The Cognitive Structure of Emotions*. Cambridge University Press.

[20] Paiva, A., Dias, J. (2005) *Feeling and Reasoning: A Computational Model for Emotional Characters.*

[21] Picard, R. W. & Liu, K. K. (2005) *Embedded Empathy in Continuous, Interactive Health Assessment.*

[22] Picard, R. W., Klein, J. & Moon, Y. (2002). *This computer responds to user frustration: Theory, design, and results.*

[24] Roseman, I.J.; Antoniou, A.A. & Jose, P.A. (1996). *Appraisal determinants of emotions: Constructing a more accurate and comprehensive theory*.

[25] Semeraro et al (>2003) *Empathy: A Computational Framework for Emotion Generation.*

[26] Sloman, A. (2001) *Beyond shallow models of emotion*. Cognitive Processing: International Quarterly of Cognitive Science 2, 1, 177-198.

[27] Song, H. & Kwon, D. S. (2007). *Design of a Robot Head with Arm-type Antennae for Emotional Expression*, International Conference on Control, Automation and Systems, Seoul.

[28] Stepansky, P. E , Kohut, H. & Goldberg. A. *How Does Analysis Cure?* University of Chicago Press.

[29] Swagerman, J. (1987). *The Artificial Concern REalization System ACRES: A computer model of emotion.* University of Amsterdam: Doctoral dissertation.

[30] Swagerman, J. & Frijda, N. (1987). *Can computers feel? Theory and design of an emotional system.* Cognition and Emotion, 1(3):235-257.