GRACE - Generic Robotic Architecture To Create Emotions

Thi Haï Ha Dang, Sabine Letellier-Zarshenas, Dominique Duhaut

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THI-HAI-HA DANG
VALORIA – South Brittany University, IFI - Francophone Institute for Informatics, dthha@ifi.edu.vn, Hanoi - Vietnam

SABINE LETELLIER-ZARSHENAS
VALORIA – South Brittany University, sabine.letellier@univ-ubs.fr Vannes – France

DOMINIQUE DUHAUT
VALORIA – South Brittany University, dominique.duhaut@univ-ubs.fr Vannes - France

Abstract: In this paper, we present a model of emotions that we proposed in EmotiRob project. We make a comparison of recent models of emotions and show that our model is generic in basing on the theories of emotions of Ortony et al., Lazarus, Scherer and then the personality theory of Meyers-Brigg and Meyers.

1. Introduction

Nowadays, an increasingly number of scientists conduct their research to the design of emotions in computational agents (including "softbots" as well as embodied robots) that must perform unanticipated tasks in unpredictable environments. This tendency comes from the rapid development of human-machine applications in our everyday life. Conversational agents, embodied agents, and then robot assistants, robot servants or companion robot become more and more popular. A main demand for this kind of things is having human-characteristics like personality traits and/or emotional behaviour.

In the same tendency, our project EmotiRob [1][2] aims at designing a robot companion for impaired children or for children having to undergo lengthy hospital stays. In fact, the experiments previously conducted on elderly people staying in pensioners' homes with the Paro [3] seal designed by T. Shibata (AIST, Japan) have clearly shown that robot companions can bring some moral

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and psychological comfort to fragile people. We used Paro to carry out two experiments with disabled children. The experiments showed that the kind of psychological comfort provided by the robots depends on the quality of the affective bridge built between them and the children. It seems obvious that the link could be significantly enhanced if robots were able to understand human speech and to react emotionally in return.

So, beside the actual design and making of a robot, our project involves also the construction of a corpus of child speech within the particular context ; a linguistic study of the corpus with a view to applying the results to natural language processing techniques (particularly in natural language understanding); and studies on perception and emotions modelling. In this paper, we would like to mention our works on emotions modelling.

Section 2 of this paper gives an overview on some physiologic theories on which we base our model. Recent works on computational modelling of emotions are presented in section 3. We describe, in section 4, GRACE – our generic model of emotions with its justification. The last section is reserved for our future work and conclusions.

2. Characteristics of emotional processes

In this section, we will mention some physiologic theories that influents the construction of our model of emotions: the theory of Ortony & al on **event appraisal**, the theory of Lazarus about **appraisal** and **coping**, and thirdly the theory of Scherer about **emotional processes**. The section then ends with the theory of Meyers-Brigg and Meyers on **personality** which is important for us to conceive the model.

2.1. *Theory of Ortony & al. (1988)*

For Ortony, Clore and Collins [4], emotions are valenced reactions to events, agents or objects. These events, agents or objects are **appraised** according to an individual's goals, standards and attitudes.

The positive aspect of this theory is that it is very close to a computational approach. This theory is basic for most of models of emotions thanks to its generic evaluation criterions on emotions.

2.2. *Theory of Lazarus (1991)*

According to Lazarus [5], there are two processes that allow individual to stabilize his relation with environment: cognitive evaluation (**appraisal**) and adaptation (**coping**).

Lazarus defined cognitive evaluation as an adaptive process serving to conserve or to modify the relation between agent (its beliefs, its goals) and the world (its constraints, its modifications) in the way to maintain balances. For him, when a situation is evaluated as stressful, individual has to adapt: that is the role of the two **copings**:

- ***Problem-focused*** **coping** will try to solve the problem (classical approach), but can also avoid it by denying the problem to minimize the effect.
- ***Emotion-focused*** **coping** differs from avoidant strategies as it refers to efforts aimed at regulating the emotional response to the problem. The strategy is no longer to solve the problem, but its consequence in the body.

2.3. *Theory of Scherer*

For Scherer [6] five subsystems functionally defined are involved with emotional processes:

- An **information-processing subsystem** evaluates the stimulus through perception, memory, forecast and evaluation of available information.
- A **supporting subsystem** adjusts the internal condition through control of neuroendocrine, somatic and autonomous states.
- A **leading subsystem** plans, prepares actions and selects between competitive motives.
- An **acting subsystem** controls motor expression and visible behavior.
- A **monitor subsystem** finally controls the attention which is assigned to the present states and passes the resulting feedback on to the other subsystems.

2.4. *MBTI of Meyers-Brigg and Meyers*

Another study that affects our work is The Myers-Briggs Type Indicator [7] - a self-report instrument that helps to identify an individual's strengths and personality preferences. According to the authors, the **Personality type** is evaluated in responding four questions: where you focus your attention, the way you take in information, the way you make decisions and how you deal with the outer world. This four questions permit to characterize a personality trait on four categories: attitude (**Extraversion (E) or Introversion (I)**), perception (**Sensing (S) or Intuition (N)**), decisions (**Thinking (T) or Feeling (F)**) and structure (**Judging (J) or Perceiving (P)**).

We would like to integrate personality in our model of emotions because personality is incontestable, it characterizes an individual, it influences the way one perceives, thinks, acts and even the way one changes in his everyday life.

3. Related works

We have made a comparison of recent computational models of emotions to find out if there exists a generic model that we could customize for our project.[*] From 2000 up to now, many researchers interested in modeling emotions like El-Nasr et al with their ***FLAME*** (2000) [8]**,** Bui et al with ***ParleE*** (2002) [9], robot ***Kismet*** of C. Breazeal (2002) [11], model ***Greta*** of Pelachaud et al (2003) [12], Gratch and Marsela with their model ***EMA*** (2004) [13], Carole Adam with the model ***GALAAD*** (2005) [14] and ***PLEIAD*** (2007) [15], etc. In fact, these models have all implemented **event appraisal** following the theories of Ortony et al and Lazarus. But the strategy of **coping** is applied only in ***FLAME, EMA, GALAAD*** and ***PLEIAD***. Generally, **personality** has not much attention. Only ***Greta*** and ***ParleE*** implemented personality traits in their models to take into account the relationship between personality and emotions.

Table 1: Synthesis of comparison of different models of emotions

No	Name of model	appraisal	coping	personality
1	***FLAME***[8]	Yes	Yes	No
2	***ParleE*** [9]	Yes	Not mentioned	Rousseau's model[10]
3	Robot ***Kismet*** [11]	Yes	Not mentioned	No
4	***Greta*** [12]	Yes	Not mentioned	Personality trait
5	***EMA***[13]	Yes	Yes	No
6	***GALAAD***[14]	Yes	Yes	no
7	***PLEIAD***[15]	Yes	Yes	No

In conclusion, we find that there is no consensus on computational model of emotions. There is no model of emotions that not only has characteristics of **event appraisal, coping** but also contains a complete **personality** influence. That is the reason why we propose here a generic model of emotions which gives a global view on emotional processes so that one could customize to adapt to any particular computational approach.

[*] A complete comparison can be found in [1][16]

4. GRACE – Generic computational model of emotions

4.1. *GRACE – Generic Robotic Architecture to Create Emotions*

Definition of emotion: an emotion is the process that characterises the human body's response to a stimulus or event.

By *stimulus or event* we mean: external changes in the environment of the body, absence of external changes in the environment although one expected, and internal body changes.

By *human body response* we mean: physiological changes inside the body, external expressions of the body and also … no change.

Based on this definition we propose the following model in Fig.1:

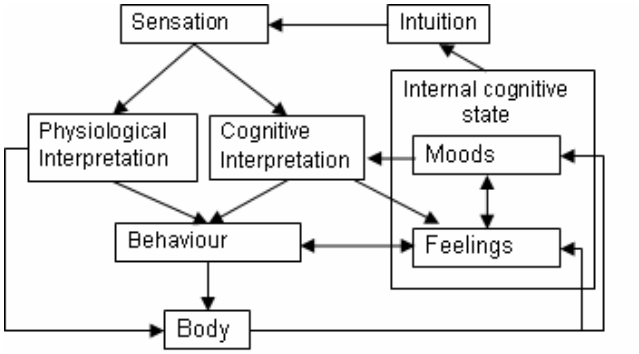

Figure 1: GRACE - Generic Robotic Architecture to Create Emotions

In this model *Sensation* is the basic starting point. The sensation is generated by an event, something which really exists or not, but which generates a physiological change in the body and/or by sending subjective information (from *Intuition*) to the sense-organs: touch, hear, see … This sensation will be processed in two ways. First, the *Physiological Interpretation* will directly interpret this initial signal into a body reaction (the heart races …) and will also alert the module *Behaviour*. On the other hand, the *Cognitive Interpretation* will interpret the signals received from *Sensation* into cognitive information about the environment situation.

The *Behaviour* will then calculate the response from the information coming for the perceptions based on the *Internal Cognitive State*. This response is sent to the *Body* where the physical reaction will take place.

4.2. *Integration of characteristics of emotions processes in GRACE*

So, how are integrated the theories on **event appraisal, coping, personality** or the **theory of Scherer** that we presented above?

4.2.1. *Event appraisal*

In fact, the theory of Ortony et al gives us the idea of when a sensation can take place and then how this sensation can be treated in interior. When an event takes place (an external change or internal change), this event will be captured by *Sensation* module and then given to *Interpretation* level for further processing. The interior analysis of this event takes into account the relation of the current goals and interests which is coming from the theory of Ortony et al about **event appraisal**.

4.2.2. *Coping*

In our model, we tend to resolve the strategy of **coping** in the internal analysis. Generally speaking, the strategy of **coping** influents the information processing rules from *Interpretation* level and *Internal Cognitive States* up to *Behaviour* decision-making. The result of this influence is the behaviour (or action) that will be expressed by the *Body*.

4.2.3. *Five subsystems of emotions*

Secondly, to compare our model with the **theory of Scherer** above, we have:

- The first subsystem (**information-processing subsystem**) is the process evaluating information from module *Sensation* to *Interpretation* level then finally to module *Behaviour*.
- The **supporting subsystem** will be implemented in the modules *Psychological Interpretation* and *Body* to adjust the internal condition.
- **Leading subsystem** will be implemented in module *Behaviour*.
- The **acting subsystem** is integrated in module *Body*.
- **Monitor subsystem** will be developed in module *Internal Cognitive States*.

4.2.4. *MBTI for personality*

The MBTI proposes four categories to build personality. Our model completely covers these four categories.

The first one is the *attitude* splited in **Extraversion** (E) or **Introversion** (I). In the generic model this particular feature is integrated in the *Mood* and

Behaviour modules. Secondly, *perception* category of the MBTI is completely covered by the generic architecture. The **Sensing** is constructed with the two *Interpretation* modules and the **Intuition** by the *Intuition* module. Then, the third category is *decisions*: **Thinking** (T) or **Feeling** (F). We cover these two approaches by the way that the *Behaviour* module of the generic model is coded. Last category of MBTI - **Judging** (J) or **Perceiving** (P) can be coded at the *Interpretation* level. In fact, it is a level of interest for the sensation that will be used. For instance, a sensation directly concerning a person will be more interesting for someone who is **Perceiving**.

5. Conclusion

We have proposed a generic model to build a computational architecture to express emotions and personality. Many researches proposed models of emotions but few of them did include personality. Therefore, our proposition is open for discussion.

In the mean time, we have already made a first instance of GRACE in a main computer with a scenario to justify the pertinence of the generic model. We work with a recording of the children history « Three little pigs ». This recording is cut it into chunks; then, we have GRACE analyze the chunks, calculate three emotional states (happiness, sadness, fear) and present them in graphic form. The next step is to embed GRACE in the EmotiRob robot for real-time experiments with children.

The originality of this work is to include a psychological approach in the software architecture for a robot. We are currently testing an instance of this architecture in the EmotiRob project.

Acknowledgment

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