ICTA'07, April 12-14, Hammamet, Tunisia

EMASPEL (Emotional Multi-Agents System for Peer to peer E-Learning)

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Abstract

Intelligent Tutoring System (ITS) must enrich learner-tutor interactions with more personalized communications based either on cognitive and affective behavior. This provides flexible tutoring process during learning process, context-sensitive help and explanation. In this context we propose a multi-agent system with agents that manage both cognitive and affective model of the learner, that are able to express emotions through emotional embodied conversational agents (EECA) and to recognize the learner's facial expression through emotional agents in peer-to-peer e-learning environments.

1. Introduction

In an Educational Context to interact most effectively, it is often useful for us to try to gain insight into "invisible" human emotions and thoughts by interpreting these non-verbal signals. Teachers use these non-verbal signals to make judgments about the state of others to improve the accuracy and effectiveness of their interactions with students. Furthermore and according to Goleman, D 1995 "The extent to which emotional upsets can interfere with mental life is no news to teachers. Students who are anxious, angry, or depressed don't learn. People who are caught in these states do not take in information efficiently or deal with it well"[1]. In this approach, one privileges at the same time the contributions of a social intelligence to the shared knowledge between virtual communities. Moreover, the evolutionary and the emergence of services on demand within "peer to peer" communities becomes a strategic stake and consequently integration in the dialogue of another form of communication that the texts or the speech such as the emotions. Consequently, the question arises of knowing if one can dynamically build the protocols of "peer to peer" exchanges starting from the behaviors of the users. Therefore, we propose architecture for an intelligent emotional system. This system is called EMASPEL (Emotional Multi-Agents System for Peer to peer E-Learning), based on a multi-agents architecture [15]; it thus makes it possible to recognize the emotional state running of learning in the peer-to-peer network.

2. Multi agents technology

Recently, distributed Artificial Intelligence techniques have been evolved towards multi-agents systems (MAS) where each agent is an intelligent system that solves a specific problem. All these agents work together, communicate, collaborate, and negotiate among them, to achieve common goals. The software agents can thus be seen as a quite appropriate platform to analyse and simulate human organizations and human teams. Recently, MAS are used to simulate human societies to analyse macro-societies (collective behavior). This is a multi-disciplinary approach where social science, psychology and cognitive science theories are implemented in a multi-agent environment. [9] According to (Hayes-Roth 1995) "Intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences, and determine actions." [6] Now we are facing the challenge to emulate or simulate the way human act in their environment, interact with one another, cooperatively solve problems or act on behalf of others, solve more

[1] Goleman, D. *Emotional intelligence*. New York: Bantam Books. Hancock et al., 1995.

and more complex problems by distributing tasks or enhance their problem solving performances by competition. Multi-agent systems open a number of extremely interesting and potentially useful research avenues concerning inter-agent negotiation, persuasion and competition in agent societies.

Thus multi-agent system technology seems very relevant for implementing these types of systems.

3. The architecture of EMASPEL

Over the past few years, peer-to-peer (P2P) networks have revolutionized the way we effectively exploit and share distributed resources. In contrast to the traditional client-server architecture, P2P systems are application level, collaborative systems where agents work together to perform certain tasks. The architecture of a peer in our P2P e-learning system is the following (figure 1).

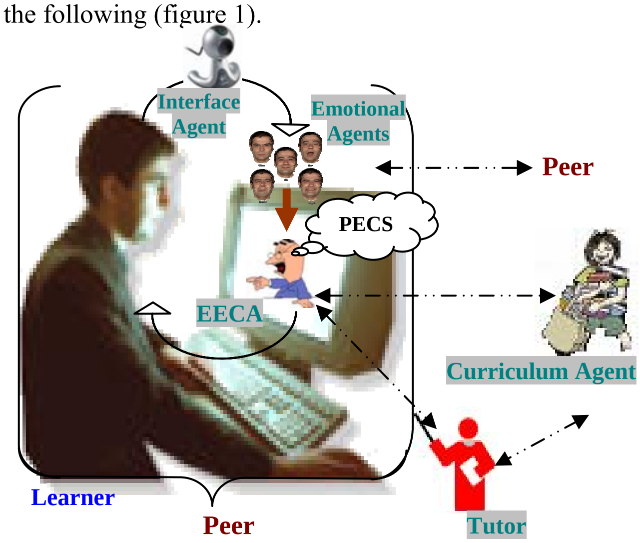

Figure 1: General architecture of EMASPEL

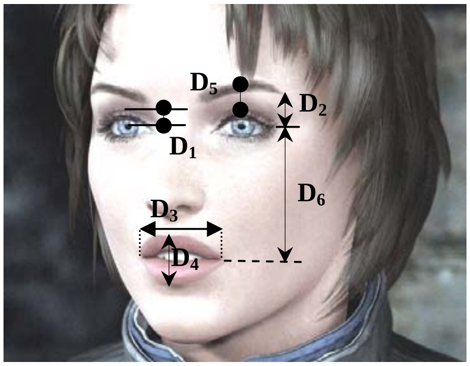

Figure 2: Definition of the distances D_i

3.1 General architecture of EMASPEL

The proposed system includes five kinds of agents:

3.1.1 Interface Agent

- Transmit the facial information coming from the learner to the other agents of the Multi-Agents System (MAS).
- Assign the achieved actions and information communicated by the learner, to agents Curriculum, EECA and the other agents of the MAS.

The agent interfacing is a merely reactive agent.

3.1.2 Emotional Agents

Extracting and validating emotional cues through analysis of users' facial expressions is of high importance for improving the level of interaction in man machine communication systems. Extraction of appropriate facial features and consequent recognition of the user's emotional state that can be robust to facial expression variations among different users is the topic of these emotional agents.

- **Analysis of facial expression**

A machine system of analysis of the facial expressions by the emotional agents is generally carried out according to following stages: detection of the face, the automatic extraction of contours of the permanent features of the face to knowing: the eyes, the eyebrows and the lips. These features detected must be useful like basic information of an automatic system of recognition of the emotions on the face of one learning in front of a PC and in situation from training. Extracted contours being sufficiently realistic, we then use them in a system of recognition of the six universal emotions on the face (joy, surprise, fear, disgust, anger, sadness).

- **Recognition and interpretation of facial expression**

•Recognition of the facial expressions [18]: classification of the structural deformations facial in abstract classes based on visual information.

• Interpretation of the facial expressions: bond with the basic emotions[2].

The expressions considered are the six universal emotions (smile, disgust, surprise, sadness, anger, fear) as well as the neutral. Classification is carried out

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[2] Ekman, P. (1999) Basic Emotions In T. Dalgleish and T. Power (Eds.) The Handbook of Cognition and Emotion Pp. 45-60. Sussex, U.K.: John Wiley & Sons, Ltd.

while being based on the analysis of characteristic distances calculated on skeletons of expressions resulting from a segmentation of contours of permanent features of the face. The characteristic distances considered make it possible to develop an expert system (for classification) which is compatible with the description MPEG-4 of the six universal emotions. Contours of the eyes, the eyebrows and the mouth are extracted automatically by using the algorithms described in [2]. The segmentation leads to obtaining what we call skeleton of expression. Six distances were defined on these D1 skeletons: opening of the eye, D2: outdistance between the interior corner of the eye and that of the eyebrow, D3: opening of the mouth in width, D4: opening of the mouth in height, D5: outdistance between the eye and eyebrow and D6: outdistance between the corner of the mouth and that of the corner external of the eye (cf Figure 2). The objective of work presented is to set up a system of recognition of facial expressions starting from the analysis of these 6 distances.

- Joy: {D4 increase}, {D3 decrease and D6 decrease}, {the other distances remain constant}
- Sadness: {D2 increase and D5 decrease}, {D1 decrease}, {the other distances remain constant}
- Anger: {D2 decrease}, {D1 increase}, {D4 either decrease D4 increases}
- Fear: {D2 increase and D5 increase but more that D2}
- Disgust: {D3 increase AND D4 increase}, {the other distances remain constant}
- Surprised: {D2 increase}, {D1 increase}, {D4 increase}, {the other distances remain constant}

The table 1 gives a scripts of evolution of the distances Di for the six emotions (↑means increase,↓ means decrease and " = " translates the absence of evolution). Notice that for the fear, we don't make any hypothesis on the evolution of D1 because we don't know how to translate the condition {eyes are contracted and in state of alert}.

Extracted contours being sufficiently realistic, we use them in a system of analysis and recognition of the six universal emotions on the face. The classification or recognition of an emotion is based on the temporal evolution of the information contained in the "skeleton" resulting from this stage of segmentation (temporal evolution of six characteristic distances). For example, joy and disgust differ by the evolution of the distance D6. One notes that emotions (joy and surprise) differ by the evolution of distances D1, D2, D3 and D6. This permits a distinction between these two emotions.

	D1	D2	D3	D4	D5	D6
Joy	=	=	↑	↑	=	↓
Sadness	↓	↑	=	=	↓	=
Anger	↑	↓	=	↑or↓	=	=
Fear	?	↑	=	=	↑	=
Disgust	=	=	↑	↑	=	=
Surprise	↑	↑	=	↑	=	=

Table 1: Di evolution for every emotion

3.1.3 Curriculum Agent

The agent Curriculum saves the trace of the evolution of the system in interaction with the learner. The trace constitutes the history of progression of the learner in the exercise. While analyzing the profile of the learner, this agent proposes sessions of activities subsequently to apply.

3.1.4 Tutor Agent

The tutor has the role of ensuring the follow-up of the training of each learner. He has a role of support for the learner in their activity, of stimulative of training. The role of the tutor is to support the human relations, the contacts between learners, in order to break the insulation in which they can be.

3.1.5 The emotional embodied conversational agent

Our objective is to produce an emotional visual entity be in charge of several software's able at the same time to enclose, evaluate and react with the effort of the learner. Motivated by this principle, we have introduced the concept of an emotional embodied conversational agent (EECA).[14]

In the construction of embodied agents [4] capable of expressive and communicative behaviors, an important step is to reproduce affective and conversational facial expressions on synthetic faces.[1] Consequently and based on HUMAINE [16] that is investigates how emotions can be expressed by EECA systems we follow-up these steps:

- In the perception domain, an important pre-requisite for believable emotional interaction is an ECA capability to perceive the user, events, or other agents.
- At the level of interaction, rather than modelling the ECA merely as a speaker, it is important to attempt the generation of listener behavior.

- On the generation side [13], six basic emotions are converted to facial expressions by a fuzzy rule-based system.

The internal state of the EECA agent is based on the PECS architecture proposed by Schmidt (2000) and Urban (2001) [3]. The PECS architecture is a model of agent that aims to simulating the human behavior in a group. PECS stands for Physical Conditions, Emotional State, Cognitive Capabilities and Social Status. These are the four main building blocks of a particular PECS agent architecture adding a Sensor-Perception module and a Behavior-Actor module. (fig.3) The PECS reference model aims at replacing the so-called BDI (Belief, Desire and Intention) architecture. [17] Architectures, such as BDI, which conceive of human beings as rational decision makers, are sensible and useful to a very limited degree only. Restriction to the factors of belief, desire and intention is simply not appropriate for sophisticated models of real systems where human factors play an important role. [11]

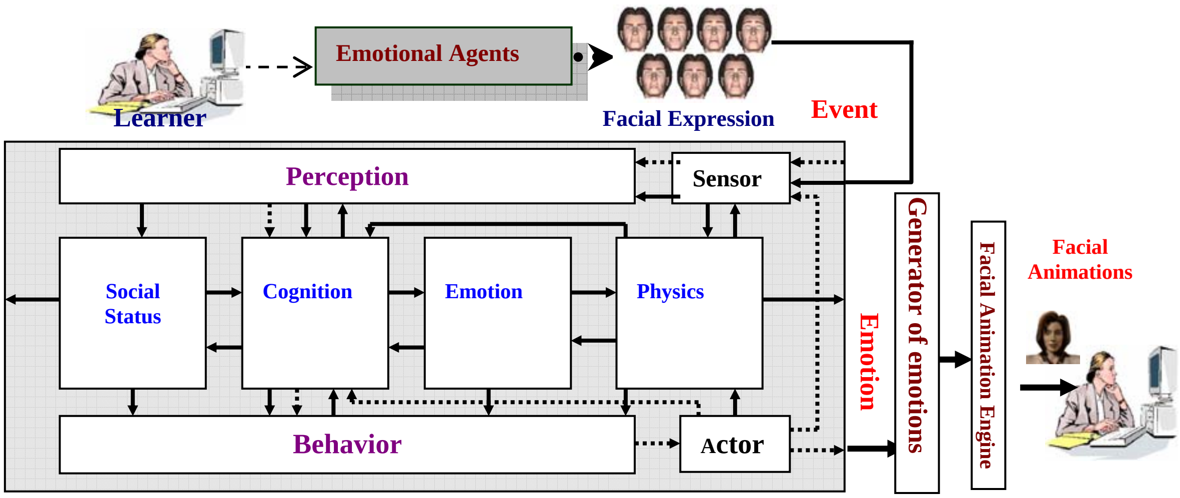

Figure 3: The emotional embodied conversational agent (EECA) Architecture

The emotional agents aim at extracting the facial expressions (acquisition and facial alignment) and categorizing them (classification) using the evolution temporal of the Di distances while referring to the table1; The analysis of table 1 shows that it will be possible to differentiate between different emotions while being interested in priority in the Di distances which undertake significant modifications. Indeed, there is always at least one different evolution in each scenario. The EECA first of all carries out an analysis of the emotional state of the learner. The purpose of this analysis is to translate the meaning of the emotion in the training context. It is carried out while being based on several factors with knowing: emotion sent by the emotional agents, the current emotional profile, the history of the actions carried out before the appearance of the emotion, the cognitive state, the evolution of the emotion and the social context (if it is about a social training or collaborative). The expressions in entry are "joy", "fear", "dislike", "sadness", "anger", "surprised" and the analysis makes it possible to determine if the learner is in state of "satisfaction", "confidence", "surprise", "confusion" or "frustration". The interpretation of the analyzed emotional state is then established. It will thus determine the causes having led to this situation (success/failure with an exercise, difficulty of work, misses knowledge, etc), while being based again on the cognitive state of the learner and thus making it possible to the tutor to take, if it is necessary, of the adapted teaching actions. The action layer consists in defining, if it is necessary, a whole of tasks making it possible to cure at the emotional state observed in order to bring the learner in a state more favorable with the assimilation from knowledge. (fig.3). For this reason a collaborative reciprocal strategy in ITS can gain advantage from "mirroring" and then assessing emotions in P2P Learning situations.

4. Implementation of the EMASPEL Framework

4.1 The Interaction among Agents

The interaction among human agents is not restricted to the proposed computational model. On the contrary, the computational interaction among the artificial agents aims at contributing even more for the communication and the exchange among the human agents. The interaction will be one of the main objectives of this model, because the proposal is about a model of collaborative learning. The several interaction forms involved in the model are interaction among artificial agents; interaction among artificial and human agents, and interaction among human agents. In respect to communication among the human agents, the system offers tools (synchronous or asynchronous) when physical presence is not possible (for example, in the case of virtual classes).

4.2 The organizational model

Our organizational model is based on the Agent Group Role meta model (AGR for short) [8]. This Meta Model is one of the frameworks proposed to define the organizational dimension of a multi-agent system, and it is well appropriate to the Elearning context. According to this model, the organization of a system is defined as a set of related groups, agents, and roles. There are several reasons, which justify the interests of this Meta Model. The main reasons are the following: (i) it is possible to construct secure systems using groups viewed as "black boxes" because what happens in a group cannot be seen from agents that do not belong to that group. (ii) It is possible to construct dynamically components of system when we view system as an organization where agents are components. Adding a new group or playing a new role may be seen as a plug-in process where a component is integrated into a system. (iii) Semantic interoperability may be guaranteed using roles because a role describes the constraints (obligations, requirements, and skills) that an agent will have to satisfy to obtain a role.

4.3 Implementation

We programmed agents used in the Emaspel Framework (fig 4) with the MadKit [7] Platform. MadKit is a modular and scalable multi-agents platform written in Java and built upon the AGR (Agent/Group/Role) organizational model [8]: agents are situated in groups and play roles. MadKit allows high heterogeneity in agent architectures and communication languages, and various customizations. In fact MadKit does not enforce any consideration about the internal structure of agents, thus allowing a developer to freely implements its own agent architecture. Communication among agents is implemented by a set of communication primitives, which is a subset of FIPA-ACL [5] extended with specific primitives. We used the JXTA [12] Framework to build an open source p2p network. The Sequence diagram of Emaspel Framework is given in figure 5.

Figure 4 : Emaspel Framework

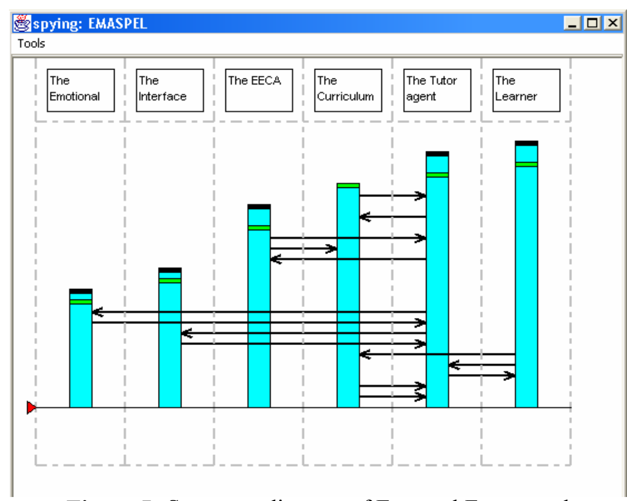

Figure 5: Sequence diagram of Emaspel Framework

5. Conclusion and future work

In this paper, we proposed the Emotional Multi-Agents System for peer-to-peer E-Learning. This system is able to recognize the current emotion of the learner according to his facial expression.

The development of complete architecture EMASPEL is in hand. We plan to take account of the temporal evolution of measurements knowing that an expression cannot completely be changed from one image to another. Moreover, we think that it is necessary to further go and to provide the additional EECA of two functionalities, which are closely dependent according to Sansonnet [10]:

1. Rational Agent: an EECA should be capable of reasoning on the structure and the operation of the application, which it has in load.
2. Dialogical Agent: an EECA should be able to interact with the user in natural language to answer isolated requests (questions of the user, bearing about control, the operation, assistance etc.)

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