Emotional eLearning System

Mahmoud Neji
Faculté des Sciences Economiques et de Gestion, University of Sfax, –Tunisia
E-mail: Mahmoud.Neji@fsegs.rnu.tn

and

Mohamed Ben Ammar
Research Group on Intelligent Machines (REGIM), University of Sfax - Tunisia
E-mail: ben_ammar@acm.org

Abstract

In order to promote a more dynamic and flexible communication between the learner and the system, we integrate five kinds of adaptive agents in emotional framework. We focus on human facial characteristics to develop general-purpose agents that can recognize human emotion and create emotional framework with the implications of peer-to-peer technology. Emotions play an important role in cognitive processes and specially in learning tasks. Online learning is no exception. Detecting a learner's emotional reaction for a given situation is an essential element for every eLearning system. In this paper a system for identifying facial expressions by using facial features is presented, it can recognizes 6 basic emotional expressions (happiness, sadness, surprise, fear, anger, and disgust).

Keywords: affective communication, virtual environments, virtual entities, affective states, eLearning systems

1. Problem Formulation

The field of affective computing was proposed and pioneered by Rosalind Picard (Picard 1997) from the MIT Media Laboratory. Her definition of affective computing is: "computing that relates to, arises from, or deliberately influences emotions." Her argument for putting emotions or the ability to recognize emotions into machines is that neurological studies have indicated that emotions play an important role in our decision making process. Our "gut feelings" influence our decisions. Fear helps us to survive and to avoid dangerous situations. When we succeed, a feeling of pride might encourage us to keep on going and push ourselves even harder to reach even greater goals. Putting emotions into machines makes them more human and should improve human-computer communication. Also exploiting emotions could lead to a more human decision-making process.

Consequently, in this paper, collaborative affective eLearning framework aims at reintroducing emotional and social context to distance learning while offering a stimulating and integrated framework for affective conversation and collaboration. Learners can become actively engaged in interaction with the virtual world. Further, the use of avatars with emotionally expressive faces is potentially highly beneficial to communication in collaborative virtual environments

(CVEs), especially when they are used in a distance eLearning context. However, little is known about how or indeed whether, emotions can effectively be transmitted through the medium of CVEs. Given this, an avatar head model with human-like expressive abilities was built, designed to enrich CVEs affective communication. This is the objective of introducing the Emotional Embodied Conversational Agent (EECA) (M. Ben Ammar et al. 2006). We are arguing, then, that the use of peer-to-peer network in combination with collaborative learning is the best solution to the eLearning environments. Peer-to-peer (p2p) technology is often suggested as a better solution because the architecture of peer-to-peer networks and collaborative learning are similar. (Biström 2005). This paper explores CVEs as an alternative communication technology potentially allowing interlocutors to express themselves emotionally in an efficient and effective way. Potential applications for such CVEs systems are all areas where people cannot come together physically, but wish to discuss or collaborate on certain matters, for example in eLearning, based on the affective communication.

There are several novel elements to this research. Firstly, although CVEs as a technology have been available for more than a decade, user representations are still rudimentary and their potential is not well explored, particularly the avatar as a device for social interaction. Secondly, the use of emotions to complement and indeed facilitate communication in CVEs is equally under-explored. This is partly because early CVEs research was mainly technology driven, leaving aside the social and psychological aspects, and partly because the required computing, display and networking resources became available only recently. Thirdly, design guidelines for an efficient, effective, emotionally expressive avatar for real-time conversation did not exist prior to this research. The multi-agent methodology can certainly bring several advantages to the development of eLearning systems since it deals well with applications where such crucial issues (distance, cooperation among different entities and integration of different components of software) are found. As a result, multi-agent systems, combined with technologies of networking and telecommunications, bring powerful resources to develop eLearning systems. In this research work, we propose emotional framework for an intelligent emotional system. This system is called EMASPEL (Emotional Multi-Agents System for Peer to peer eLearning), based on a multi-agents architecture. (Ben Ammar et al. 2006).

2. EMASPEL framework

2.1 Architecture

The figure1 illustrates the architecture of a peer in our P2P eLearning system. In order to promote a more dynamic and flexible communication between the learner and the system, we integrate five kinds of agent:

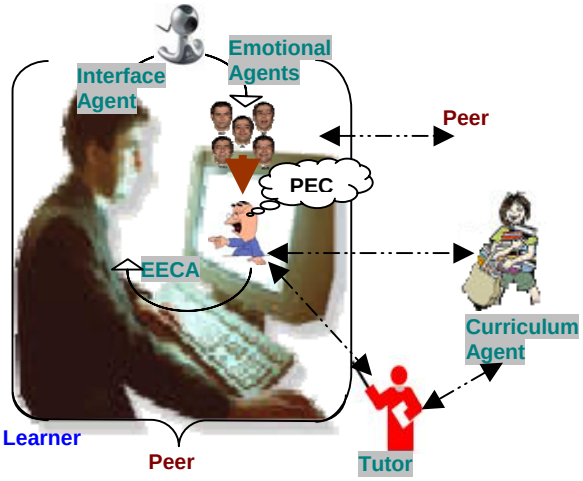

Figure 1: EMASPEL architecture

2.1.1 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.

2.1.2 Emotional Embodied Conversational Agent

Emotional Embodied Conversational Agents (EECAs) are a powerful user interface paradigm, aiming at transferring the inherent richness of human-human interaction to human-computer interaction. ECAs are virtual embodied representations of humans that communicate multimodally with the user (or other agents) through facial expression.

Our work aims at creating one EECA (Fabri et al 2005, Chaffar et al 2005) which is able to:

To interact with the learner: not only communicating information in a general deterministic way but also exhibiting a consistent behavior with his personality and with contextual environment factors.

Expresses emotions: in reaction to the learner's actions.

The action of the EECA includes processes that take decision about relevant pedagogical actions, which can control the observed emotional state, in order to place the learner in a better state.

Our goal is to create a model to generate and visualize emotions on embodied conversational agent. One ascertains that an agent exhibit an emotional behavior was treated like human and that the interpersonal distance between the user and the avatar was reduced when the glance or the smile was maintained between the two (Bailenson et al 2002). In addition, the emotions are particularly important for a conversational agent since they reveal an essential share of the speech through nonverbal signals. William James perceives the emotions like a direct response to the perception of an event contributing to the survival of the individual and insists on the changes induced on the body behavior of the individual. The body answer initially in a programmed way of this change constitutes what one calls the emotions. The feedbacks of the body by the nervous system contribute largely to the experiment of the emotions. Research proved that the emotions succeed the facial expressions.

During the learning process and when interacting with the learner, some tutoring agents may want to express affects. Thus, they use EECA, which is able, within a specific activity, to translate through a character the emotions of the tutoring agent. It has to be aware of the concerned task and of the desired emotional reaction (by the designer or the concerned tutoring agent). The emotional state of EECA is a short-term memory, which represents the current emotional reaction. To be able to compute emotion, a computational model of emotion is required. Our approach is built on Fridja model.

2.1.3 The Emotional Agents

Integrated into a learning environment, aim at capturing and managing the emotions expressed by the learner during a learning session. They currently capture emotions only through facial expression analysis and they are in charge of learner emotion detection. They recognized the learner emotional state by capturing emotions that he or she expressed during learning activities. (Nkambou 2006). For making the affective communication between an EECA and a learner, they need to be able to identify

the other's emotion state through the other's expression and we call this task emotion identification established by the emotional agents. Extracting and validating emotional cues through analysis of users' facial expressions is with 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 is the topic of these emotional agents.

Analysis of Facial Expression

The analysis of the facial expressions by the emotional agents is generally done according to the following stages: detection of the face, the automatic extraction of contours of the permanent features of the face: the eyes, the eyebrows, and the lips. Extracted contours being sufficiently realistic, we then use them in a system of recognition of the six universal emotions on the face.

Recognition and interpretation of facial expression

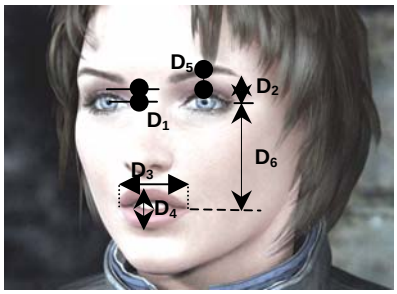

Figure 2: Definition of the distances Di

The Classification is based on the analysis of the distances computed on face's skeletons. The 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 (NEJI et al. 2004, Ben Ammar et al. 2005). The segmentation leads to obtain what we call skeleton of expression. Six distances were defined:

D1: opening of the eye, D2: outdistance between the interior corner of the eye and 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 the external corner of the eye (cf Figure 2).
Joy: {D4 increases}, {D3 decreases and D6 decreases}, {the other distances remain constant}
Sadness: {D2 increases and D5 decreases}, {D1 decreases}, {the other distances remain constant}
Anger: {D2 decreases}, {D1 increases}, {D4 either decrease D4 increases}
Fear: {D2 increases and D5 increases but more that D2}
Disgust: {D3 increases AND D4 increases}, {the other distances remain constant}
Surprised: {D2 increases}, {D1 increases}, {D4 increase}, {the other distances remain constant}

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

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

Table 1: Di evolution for every emotion

The classification 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.

2.1.4 Curriculum Agent

Saves 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.

The agent curriculum keeps the trace of:

- the evolution of the interacting system with learner
- the history of progression of learner in the exercise.

The agent curriculum carries out the following operations:

- to manage the model of learner throughout the training.
- to initialize the session of training by communicating the exercise to the learners according to their courses.
- to be the person in charge for the individualization of the training.
- to carry out the update of the history of the learner model.
- to record in the base of errors the gaps met (errors made by learner) to help the tutor to be useful itself of this base to direct its interventions.

2.1.5 Tutoring Agent

The tutor's role is:

To ensure the follow-up of the training of each learner.

To support learners in their activities.

To support the human relations and the contacts between learners.

To seek to reinforce the intrinsic motivation of learner through its own implication from guide who shares the same objective. These interventions aim at the engagement and the persistence of learner in the realization from its training.

To explain the method of training and to help to exceed the encountered difficulties.

To help the learner how he can evaluate his way, his needs, his difficulties, his rhythm and his preferences.

2.2 Implementation

We programmed agents used in the EMASPEL Framework (figure 3) with the MadKit (Ferber et al. 1998) Platform. MadKit is a modular and scalable multi-agents platform written in Java and built upon the AGR (Agent/Group/Role) organizational model: 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 to a developer to freely implement his own agent architecture. Communication among agents is implemented by a set of communication primitives, which is a subset of FIPA-ACL (FIPA 2004), extended with specific primitives. We used the JXTA Framework (Gong 2002) to build an open source p2p network.

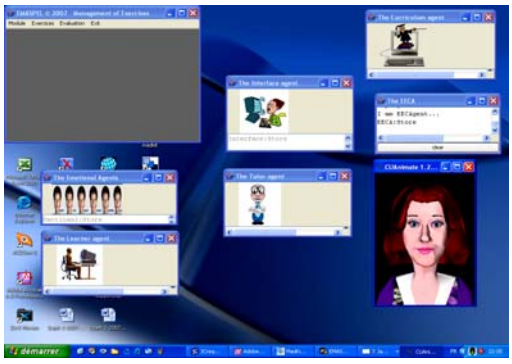

Figure 3 : EMASPEL

3 Conclusions and further work

The emotion analysis may reveal if the learner feels "satisfaction", "confidence", "surprise", "confusion", or "frustration". These states are more precise in educational context and appropriated pedagogical actions can be taken in order to influence those emotions. Another important process is the diagnosis of the analyzed emotional state. This process determines the possible causes which has led to this situation (success/failure in an exercise, difficulty of the tasks, lack of knowledge, incorrect command of the knowledge, etc.). This is done using the learner's cognitive state and the historic of his actions.

Showing emotions, empathy and understanding through facial expressions and body language is central to human interaction. More recently, emotions have also been linked closely with decision-making, problem solving and intelligence in general. We therefore argue that computer-based communication technologies ought to emulate this in some way. We have conducted an experimental study on visualization and recognition of emotion in the human face and an animated face. The study used six "universal" facial expressions of emotion, as established by Ekman: happiness, surprise, anger, fear, sadness, disgust, together with the neutral expression. Results show that emotions can be visualized with a limited number of facial features, and build a potentially strong basis for communication in collaborative environments.

To further establish the possible role emotions can play in collaborative environments, we are currently concentrating on real-time interaction. A group of people enters the virtual space and is assigned a task to complete.

The main objective of the experiment is to investigate how the perception of emotion affects individual and group experience in the virtual world. From the real world, we know that emotions of others influence us in our decisions and in our own emotional state. Emotions can motivate, encourage, can help us achieve things. But they can also change our mood to the negative, make us feel angry or sad when someone else feels that way. Emotions are contagious, and their contagious nature in the real world is potentially transferable and beneficial to the virtual world.

The proposed framework mainly includes the peer to peer based network platform, for further work we would like to:

Integrate the peer to peer based network platform into grid system. The newly emerged Peer to Peer (P2P) and grid computing will serve as the key driven forces to bring revolutionary impact on the future society.

Standardize the eLearning materials: we will implement the SCORM (ADL 2004) specification to describe the educational resources in EMASPEL, which will provide the interoperability with other system as well as the reusability of learning materials.

References

Bailenson J, Beall A, Blascovich J, Raimundo M, Weishbush M (2000) "Intelligent agents who wear your face: User's reactions to the virtual self" Technical Report, Center for the Virtual Environment and Behaviors Department of Psychology, University of California, Santa Barbara,.

Ben ammar, M. & Neji, M. (2006). "Affective Elearning Framework." In T. Reeves &

S. Yamashita (Eds.), *Proceedings of World Conference on Elearning in Corporate, Government, Healthcare, and Higher Education 2006* (pp. 1595-1602). Chesapeake, VA: AACE.

Chaffar, S. and Frasson, C. (2005). "The Emotional Conditions of Learning". *Proceedings of the FLAIRS Conference* 2005, .pp. 201-206

Fabri, M., Moore, D.J., Hobbs, D.J (2004) "Mediating the Expression of Emotion in Educational Collaborative Virtual Environments: An Experimental Study", in *International Journal of Virtual Reality*, Springer Verlag, London

FIPA (2004) Agent Management Specifications [Online], Available: http://www.fipa.org/specs/fipa00023/

J. FERBER and O. GUTKNECHT (1998): "Le méta modèle AGR : a meta-model for the analysis and design of organizations in multi-agent systems". Dans DEMAZEAU, Y., éditeur: *3rd International Conference on Multi-Agent Systems*, pages 128–135, Paris. IEEE.

Johnny Biström (2005), "Peer-to-Peer Networks as Collaborative Learning Environments", Seminar on Internet working.

Li Gong (2002). Project JXTA: A Technology Overview. Technical Report. Sun Microsystems, Inc.

M. Ben Ammar, M. Neji, G. Gouardères, (2006), "Conversational Embodied Peer agents in affective Elearning," G. Rebolledo-Mendez, E. Martinez-Miron (Eds): *Workshop on Motivational and Affective Issues in ITS. 8th International Conference on ITS 2006*, pp 29-37.

M. BEN AMMAR, Mahmoud NEJI, ADEL.M Alimi (2005) "The integration of an emotional system in the Intelligent Tutoring System", *Computer Systems and Applications*, 2005. *The 3rd ACS/IEEE International Conference* Page(s):145.

M. NEJI, Mohamed BEN AMMAR, ADEL.M Alimi (2004) "Emotion expression function in human computer interaction", *Medianet*, Tozeur, Tunisia.

Picard RW (1997). *Affective Computing*. Cambridge, MA: MIT Press;

R. Nkambou, (2006) "Towards Affective Intelligent Tutoring System", *Workshop on Motivational and Affective Issues in ITS. 8th International Conference on ITS* 2006, pp 5-12.