Study on intelligent emotional agents for learning

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Abstract

In this paper we examine the use of graphical animated lifelike agents that are able to portray emotions in e-learning environments in order to achieve an improved human computer interaction. We briefly review previous attempts that were using agents with emotional intelligence from 1992 onwards. We describe the impact of emotion in learning and focus on issues referring to difficulties that arise from the lack of communication between educators and students in distance learning. A study that was conducted in the Technological Institute of Thessaloniki, in the department of Informatics between 52 first year students is presented. Results are reported which show that the use of agents with such capabilities improve the learning procedure.

Keywords: emotional agents, artificial intelligence, adaptive interfaces

Introduction

Nowadays learners often spend a part of their time learning through computers. Results that revealed from eUSER, a research project from the 6th Framework Programme of EC reported that 76% of adult students use the Internet in the course of organized learning activities and that every second person taking an eLearning course certifies that they would not have done it if it had not been available online. They conclude that learning must be understood as a social process rather than the straight reception of knowledge (http://www.euser-eu.org, accessed on 20-11-2009). Gareis (2006), one of the researchers that worked for eUser argues that users confirm that the social aspect of learning is diminished when it is done online. The above findings show that there is an increased number of adults that follow e-learning courses or use e-learning activities and this inspire us to make more effective learning applications that might need to have a more social aspect that could improve learning.

Academics in traditional teaching might have the ability to inspire students and create motives that could enhance the learning process. In e-learning, the absence of human presence may create a lack of communication between academics and students that could act as an obstacle between the student and the learning environment. Due to the absence of a human tutor the emotional process that takes place in a traditional learning environment is absent too. In order to include this emotional process in human computer communication we propose the use of an agent that will be represented by a graphical animated synthetic character.

The agent uses expressions, gestures and body movements to communicate with students by "talking" to them with oral and written language, expressing their sympathy when they have a certain problem in the educational process. Researchers note that the expressiveness of agents can create a sense of confidence between the users and the system.

(Lee et al, 2007). Agents may increase user's engagement in tasks and make a user pay attention. As John Zimmerman from Carnegie University states (Zimmerman, 2005):

> *"Embodied interface agents transform the experience of interacting with a computer, making it more social by explicitly referencing human-human interaction. When an agent's interaction design harmonizes with its tasks and the human's needs and expectations, wonderful things can happen"*

Previous work

Several attempts have been made in the field from 1992 onwards with the pioneer Joseph Bates and his team from MIT with Oz Project (Bates et al, 1992). Since then research studies have shown (Lee et al, 2007) that this is an interdisciplinary field with different expertise needed (cognitive psychology, artificial intelligence, multimedia, human computer interface to name a few). We will briefly name Maldonado's and his colleagues work who created an agent who acted as a classmate (Maldonado, 2005), Burleson and Picard with their innovative project "Learning" who use an agent who acts as a learning companion through a graphical representation (Burleson & Picard, 2007) and Conati and Maclaren's work which relates causes, effects and emotional states of the user (Conati & Maclaren, 2009). Review papers by Dehn and Van Mulken in 2000 and by Beale & Creed in 2009 show that the use of emotions in computer systems are promising but systematic studies have to be conducted in order to be able to compare and evaluate the studies contacted in a common manner. It has been noted by researchers (Beale & Creed, 2009) that these studies focus on different issues and investigate different factors thus very few of them can be reviewed upon certain criteria.

Emotions in education

Why it is useful to give computers the possibility of recognizing or of expressing an emotional reaction? Education systems usually focus on memory, thought and reasoning. Nevertheless emotions play an important role on the comprehension of knowledge. Emotions and attitudes affect student's development. We often hear students report (Olson & Torrance, 1998) of how liking of hating a teacher has influenced their decision on choosing a particular direction on their studies which sometimes influences their whole career. The same way tensions in house may cause difficulties in learning due to the bad emotional state of learners.

Several theorists have proposed theories of emotions. Ontony's model and appraisal theory research suggests that the choices people make are related to the emotions that occur (Ortony 1991). Scherer (2000) claims that thoughts and behaviours involved in an emotional experience takes place as interdependent nonlinear processes. Appraisal theory that was defined by Shrerer describes the emotional process as the result from beliefs and personal theories about the world.

The most crucial factor in human communication, the transmission of emotions (Cogan, 1994) has also been incorporated. We experience an emotion and we communicate it to another person. The other person receives it, this adds to his/her current emotional state, produces another emotional state and communicates the latest to the other person.

Agents through their graphical representations, that are part of the application's interface, have the ability to have goals and a strategy to achieve them. When equipped with emotional intelligence they might be able to establish some sort of communication with users. This communication can be based upon the appropriate rules that will allow users and agents to interact emotionally and create a sense of caring and empathy.

This paper is an attempt to understand the effects of emotions in agents upon users in e-learning environments. Animated lifelike agents can facilitate rich learning interactions (in many cases, similar to face-to-face ones) and when equipped with multimedia functions they are able to portray several different emotions by moving different muscles in face and body that represents certain expressions. Different tone and volume of voice represents certain emotions too. Overall, the combination of all media in animated agents that gives them the ability to show empathy, comfort, and sympathy for the users might have the potential to improve the quality and the effectiveness of education (Baylor & Kim, 2003; Lee et al. 2007).

We are not claiming that it is possible to replace human presence with agents. The variety and complexity of emotions involved in learning and the emotional interaction that takes place between learners and educators is very difficult, maybe impossible to be represented. We are looking at incorporating some basic emotions related to learning such as encouragement and rewarding into e-learning applications and transmit them through embodied agents that posses some sort of emotional intelligence.

Model's architecture

Several learners might use the system. They are asked to provide some personal information in order to be assign to different user profiles.

The agent uses facial expressions, hand gestures and body movements in order to communicate with the user. The synthetic character is "talking" to the user through verbal and written language and provides empathic feedback to help him/her recover from negative emotions as well as encourages learners to overcome academic problems. He collects information about student's emotion and intensity of motion. The user communicates with the user in the form of written text that the user sends to the User Behaviour manager (UBM).

UBM collects information from users' operations of the application by recording his/her actions e.g. puts in different variables users actions and by using an algorithm that corresponds to a five grades scale assigns the emotional state of the user.

The users performance is been timed so assumptions about users emotional state may be made e.g. if the user spends more time than expected in a given task the agent takes action and communicates with the user to ask him/her if there is a problem and gives him/her clues for the given task. The pedagogical agent uses an encouraging voice message that embeds emotional tones (empathic feedback) to prompt the student to express him/her self by writing messages to the agent. The agent gets the appropriate behaviours from the emotion expression database to express motion with encouraging voice in order for the user to feel that the agent empathises with him/her. All data, from recorded user's operation and direct user's input text is been collected in the UMB and categorized. In Administrative module (AM) the appropriate emotional reactions of the agent is decided and the appropriate emotional state of the agent is portrayed.

Each student that uses the system can choose the agent they prefer to accompany them.

Description of study

In our study that took place in the Technological Institute of Thessaloniki, in the Department of Informatics we use a graphical representation of an agent who is attempting to create a communication channel through verbal and visual emotional creations. In SeDICT (ICT Applications in Special Education Laboratory, University of Thessaly) we developed an

agent, which we named Sofia (Figures 2 and 3) who is able to express emotions by portray facial expressions that are related with learning. Sofia's goal is to communicate emotionally with the user in a pedagogical manner.
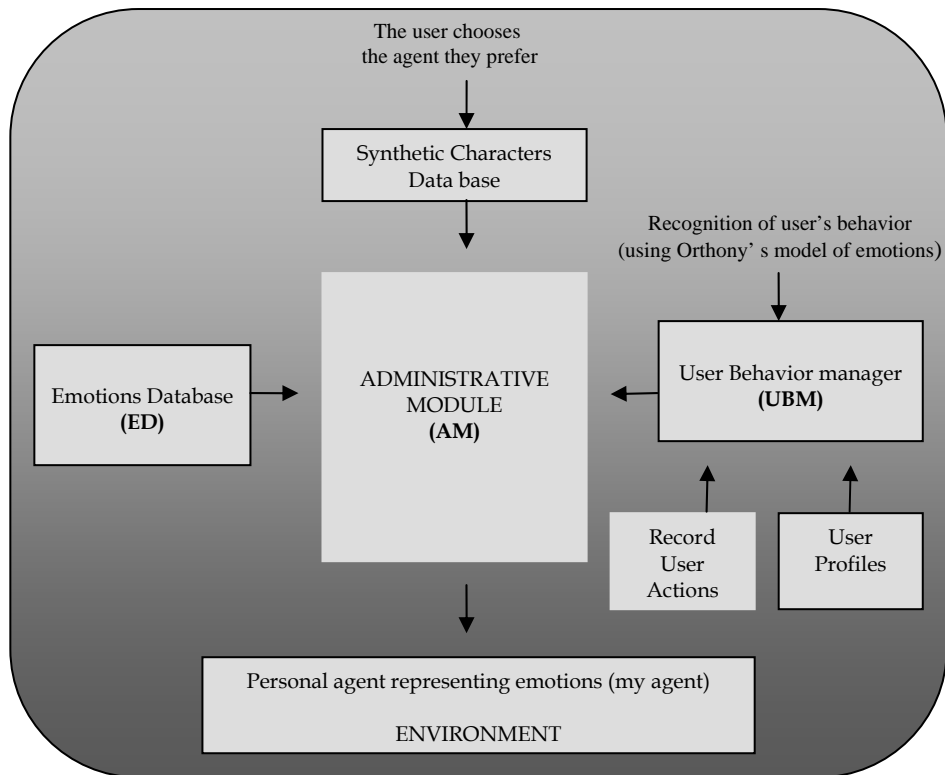

Figure 1. Model's architecture

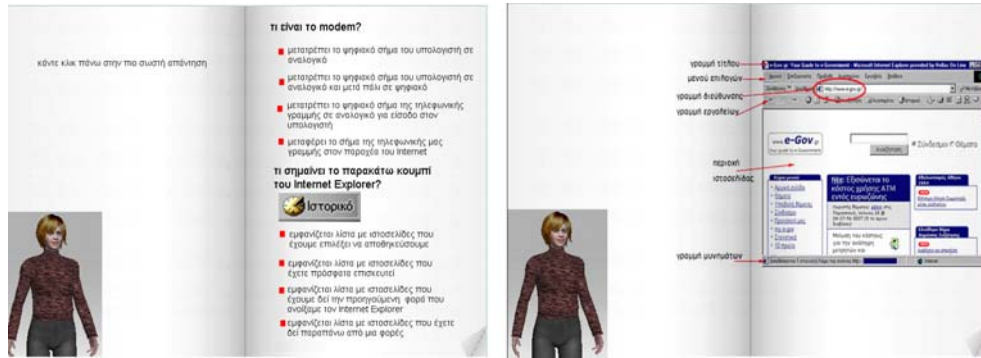

Figure 2. Different emotional states of Sophia

Figure 3. Sophia placed in the e leaning environment

A pilot experiment with 52 subjects (nine of them with learning difficulties) has shown a positive perception of Sophia. Results revealed that the caring agent may not only increase the interaction between students and the learning system, but also have positive effects on students' emotions and engage them in learning. The results of two factors have already been reported (Chatzara et al., 2010) and they show that users felt that they could communicate with Sophia and that she helped them in the learning procedure (exact percentages are shown in Figures 4 a and b).
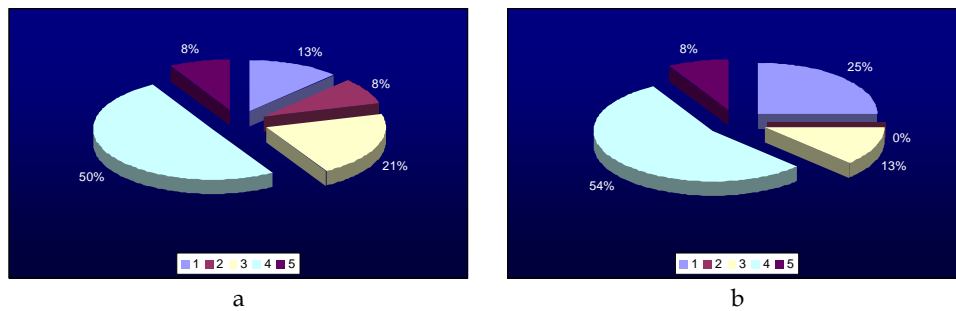

a   b

Figure 4. Data referring to user percentages that felt that the agent a) communicates with them, b) helps them to complete the learning tasks

Another asking issue was if positive or negative emotions were revealed from this communication between the agent and users. The particular factor was included due to recent research (Fredrickson, 2003) that reveals the importance of positive emotions in education. The results were analyzed and show that the majority of users (61%) seem to have positive emotions towards the agent and that he helps them have positive emotions when operating the application. Exact percentages are shown in Figure 5a.

A basic problem in affective computing (computing that relates to emotion) (Picard, 2003) is that it is very hard to predict user's emotional state in order for the system to react accordingly. Therefore we asked the students to report if the system correctly identified their emotions. Results showed that 58% of students reported that Sophia identified correctly their emotions. Exact percentages are shown in Figure 5b.
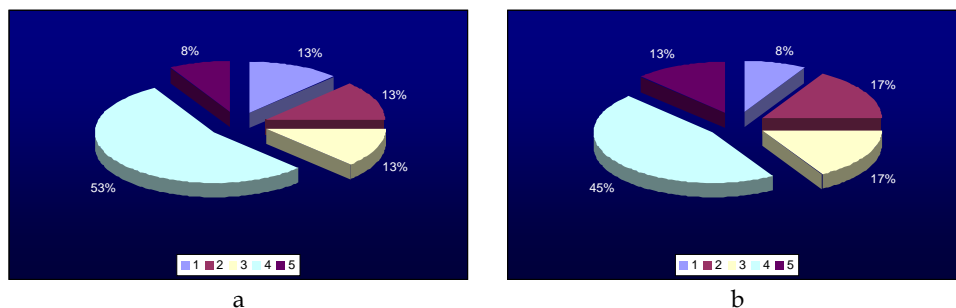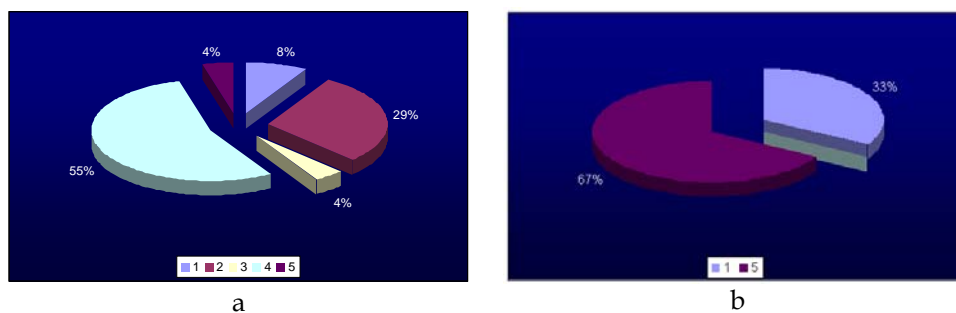
Figure 5. Data referring to user percentages that felt that the agent a) had positive emotions through their interaction with the agent, b) the agent diagnoses correctly their emotional state

The notion of comfort is basic in education and educators often comfort learners through their attitude. This "relieves" students in certain circumstances and unblocks the educational procedure. We asked users if they felt that Sophia comforts them at certain points (failure of tasks). 59% reported that they felt that Sophia succeeded in this task (Figure 6a).

Finally they were asked if they were satisfied overall with the operation of the learning system and the completion of learning tasks with Sophia's help. 67% answered positively again (Figure 6b).

1= I strongly disagree, 2= I disagree, 3= Neutral, 4= I agree, 5= I strongly agree

Figure 6. Data referring to user percentages that a) felt that the agent comforted them when they faced difficulties in the learning procedure, b) enjoyed using the agent

Conclusions

People tend to apply the same social rules, expectations and behaviours from human-human interaction to computer-human interaction (Reeves and Nass, 1996) therefore the findings that show that the agent can reflect these basic anthropomorphic characteristics of tutors could lead us to investigate further their implementation (instructional role and communicative role) to e- learning applications.

Sophia's comforting emotional reactions helped them to complete the learning tasks and users reported that the existence of the agent made the learning procedure more enjoyable.

The presence of the emotional pedagogical agent empathic responses made students obtain higher interest in the tasks.

The results indicate that one of the basic problems in this "transmission of emotions" is to predict user's emotional state. A very high percentage 42% indicates that the agent could not understand how they felt. This issue is one to be examined further and maybe adjust our research based on this evidence. Other issues to be examined in more detail are the transmission of emotions not only by the agent's behaviour but from the whole environment that the learning application operates (learning scenario, interface design, pedagogical methods and settings).

Further research will include controlled experiments that will use a larger sample of students as well as specific special groups of students i.e. students with learning difficulties.

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