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Automatic generation of emotions in tutoring agents for affective e-learning in medical education

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ABSTRACT

Web-based education is particularly appropriate for remote teaching and learning at any time and place, away from classrooms and does not necessarily require the presence of a human instructor. The need for time and place independence is even greater in some cases, such as for medical instructors who are usually doctors that have to treat patients on top of their tutoring duties. However, this independence from real teachers and classrooms may influence negatively the students who may feel deprived of the benefits of human–human interaction. In this paper we describe a novel approach for incorporating affective characteristics into e-learning through an authoring tool. The authoring tool incorporates and adapts principles of a cognitive theory for modeling possible emotional states that a tutoring agent may use for educational purposes. Medical instructors may use this authoring tool to create their own educational characters that will interact affectively with their students in the e-learning environment.

1. Introduction

Medical students have many learning and training obligations, ranging from clinical work at hospitals to reading theory and doing coursework. A similar situation is faced by medical instructors who are usually doctors that have to treat patients on top of their tutoring duties. In view of these obligations, the technology of mobile computing can assist considerably the medical educational process, since both students and instructors may have access to educational software applications from anywhere at anytime through handheld devices of mobile phones. However, this independence from real teachers and classrooms may affect the educational process in a negative way because as Goleman (1995) points out, how people feel may play an important role on their cognitive processes as well. As it is also stated in Falout, Elwood, and Hood (2009), negative affective states of learners can negatively influence their attitudes and behaviors, degrade classroom group dynamics and teacher's motivation, and result in long-term and widespread negative learning outcomes. At the same time, teachers could overcome difficulties in students' management by knowing the affective states of their students (Hwang & Yang, 2009).

Our main scope is to address these problems by providing an authoring tool for medicine that constructs animated medical agents with emotional interaction capabilities, thus rendering human–computer interaction for e-learning more human-like. Medical instructors may use this authoring tool to create their own educational characters that will interact with their students in the medical e-learning environment. Agents may be parameterized in many aspects, the way they speak, the pitch, speed and volume of their voice, their body-language, their facial expressions and the content of their messages.

Additionally, for educational purposes, agents may express specific emotional states and this capability is based on the incorporation of the OCC (Ortony, Clore, & Collins, 1990) cognitive model of emotions, proposed by Ortony et al. (1990). The novel system that we developed encapsulates an affective authoring module that relies on the OCC theory for modeling possible emotional states of users–students as well as for proposing tactics to medical instructors in order to improve the interaction between tutoring agents and medical students. Through the incorporation of the OCC model, the system may suggest that a tutoring agent should express a specific emotional state to the medical student for the purpose of motivating her/him while s/he learns. Consequently, the agent may become a more effective teacher, reflecting the instructors' vision of teaching behavior.

In many cases it would be extremely useful to have such facilities in handheld devices, such as mobile phones rather than desktop or portable computers so that additional assets may be gained. Such assets include device independence as well as more independence with respect to time and place in comparison with web-based education using standard PCs. This is certainly the case for medical education due to the heavily loaded schedule of doctors–instructors and medical students. At the current state, there are not many mature mobile authoring systems, since the technology

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of mobile computing is quite recent and has not yet been used to the extent that it could. The resulting educational system, Mobile Medical Tutor (MMT) deals with the problem of facilitating the medical instructor in the educational software management. Moreover, MMT makes use of the desktop application, which is designed in a way that can support the emotional state of learners for educational purposes, based on a cognitive model (Alepis, Virvou, & Kabassi, 2008; Virvou & Alepis, 2003a; Virvou & Alepis, 2003b). Many researchers believe that the future of e-learning in medical education will move towards more personalized learning supported by a range of new technologies (Larvin, 2009; Sandars & Haythornthwaite, 2007).

2. Related work

In the last decade, education has benefited a lot from the advances of web-based technology. Indeed, there have been many research efforts to transfer the technology of ITSs and authoring tools over the Internet. An important review (Brusilovsky, 1999) has shown that all well-known technologies from the areas of ITS have already been re-implemented for the web. Indeed e-learning is not panacea in medical education. It has disadvantages as well. These disadvantages include social isolation, up-front costs, and technical problems. As it is stated by Cook (2007), web-based learning is purported to facilitate individualized instruction, but this is currently more vision than reality. Some important assets in e-learning include platform-independence and the practical facility that is offered to medical instructors of authoring e-learning courses at any time and any place. A remedy for these problems may lie in rendering human–computer interaction more human-like and affective, especially in educational software. To this end, the incorporation of speaking, animated agents in the user interface of educational applications can be very important.

The presence of animated, speaking agents has been considered beneficial for educational software (Chua & Lee, 2008; Johnson, Rickel, & Lester, 2000; Lester et al., 1997). Hence, there have been many educational applications that incorporate animated pedagogical agents in their user interfaces (Chua & Lee, 2008; Glavinić, Rosić, & Zelić, 2008; Rist, André, & Müller, 1997; Sun & Li, 2008). However, medical instructors that will use an authoring tool should not necessarily be computer experts and should be helped to develop sophisticated educational applications in an easy and cost-effective way. In Hwang and Yang (2009) a distance learning system has been developed that identifies affective states of users through capturing face images. This system accurately identifies negative affective states but does not elicit other emotional states for pedagogical reasons. The authors of Zatarain-Cabada et al. (2008) have developed an authoring tutoring system for distance and mobile learning. This system recognizes and classifies learning characteristics of learners but does not incorporate affective interaction modules. Another research effort has been made in Van Velsen (2008) where an authoring tool called Naratoria is presented. This authoring tool allows non-technical experts in the field of digital entertainment to create interactive narratives with 3D graphics and multimedia, but also does not recognize nor generate emotional states.

However, as yet there are no authoring tools that provide parameterization in user—computer affective interaction, such as speech-driven, affective animated agents that incorporate a highly sophisticated cognitive model for affective interaction. As Picard et. al. point out in Picard et al. (2004), the extension of cognitive theory to explain and exploit the role of affect in learning is in its infancy. The present authoring tool provides the important facility to medical instructors to develop and author medical tutoring systems that incorporate speaking, animated agents who can be parameterized by them in a way that reflects their own vision of teaching behavior in the resulting applications.

3. General architecture of MMT

In this section the general architecture of MMT is described. It should be emphasized that the educational application is meant to assist the overall medical educational process. For this purpose we have improved the communication of instructors and students by incorporating mobile technology, while the basic concepts of programming for educational purposes are retained.

As we can see in Fig. 1, the main architecture of MMT consists of the main educational application, a database, mobile devices and personal computers.

In particular, the main application is installed either on a public computer where both students and instructors have access, or alternatively each particular user may retain a copy on his/her own personal computer. A simple overview of using the main application is shown at Section 4, where the use of MMT by

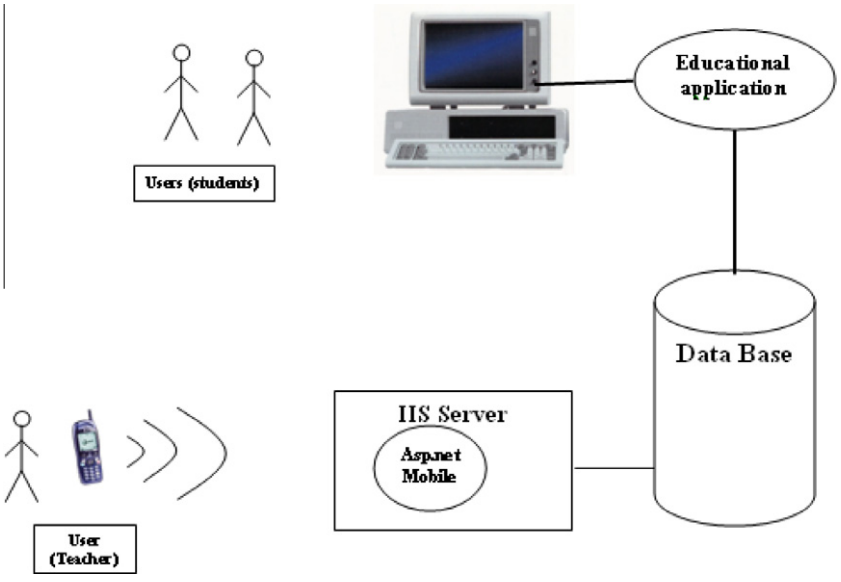

Fig. 1. Communication between Instructors, Students and the educational application.