An Embodied Empathic Tutor

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Abstract

This paper reports work being carried out in the EMOTE project (http://www.emote-project.eu/) towards the development of an empathic robot tutor at a multi-touch table for geography curriculum teaching for 11-14 year olds.

Introduction

The EMOTE project (http://www.emote-project.eu/) is working towards the development of an empathic robot tutor to be used with the 11-14 group and a multi-touch table for geography curriculum teaching. Saerbeck et al. showed that employing social supportive behavior in a robot tutor increases the learning efficiency of students [9]; and Han et al. found that home robots are more effective for children's learning concentration, learning interest and academic achievement than other types of instructional media [3]. Studies on robotic companions in real world classroom environments [6] indicate that robotic platforms are promising tools for experimental learning. The hypothesis to be explored is that a robot tutor able to detect aspects of the user's affective state [2] and respond in an empathic manner will improve the motivation of learners and produce better learning outcomes. It should also be better able to produce personalised learning support, adapting to the user's skills, ablities and difficulties.

Developing the tutor

The torso-only version of Aldebaran Nao robot is currently being used as the embodiment for the tutor, as seen in Figs. 2 and 3 below. While an inexpensive and readily available platform, it does have the disadvantages of being the size of a large doll, which may reduce its perceived authority as a tutor, and minus an expressive face, although it can use gesture and to some extent posture as expressive modalities. We are also researching a repertoire of non-verbal expressive sounds.

A generic integration framework, Thalamus [8], has been developed within which two different teaching applications can be integrated with a learner model, tutorial actions relating to the application, and pedagogical dialogue management (Fig. 1). The two applications under development are a Treasure Hunt exercise designed to teach map-reading skills, and a multi-player game Enercities-2 designed to teach aspects of sustainable urban development.

Map-based treasure-hunt

The physical layout for this application can be seen in Figure 2. The robot acts as a conventional tutor while the (single) learner follows instructions posed as a hunt for a specific item in a map location that can be reached by following compass directions and reading map symbols correctly. The tutor can give reinforcement (eg. 'well done'), draw attention to errors (eg. 'are you sure that is the right direction?') and provide hints (eg. ' if you know where north and west are on the compass, can you find NW?'). Studies have been carried out to establish what pedagogical actions teachers carry out in this scenario, and a Wizard-of-Oz (WoZ) study with the robot has examined how these translate into robot actions and dialogue.

The Enercities-2 game

WoZ study will establish how far these carry over when a teacher operates the robot as a tutor player. Enercities was originally a single-player web-based game [4] developed in the EC programme Intelligent Energy Europe during 2009-2011. It has been converted in EMOTE into a collaborative multi-player touch-table based application in which players take on the roles of Mayor, Economist and Environmentalist, each with different options and outcomes. The aim is to create a city they like that can support a large

number of inhabitants [7]. It should be noted that the best move for a specific role may not be the best move for the overall game, giving scope for pedagogy as well as for emotional conflict.

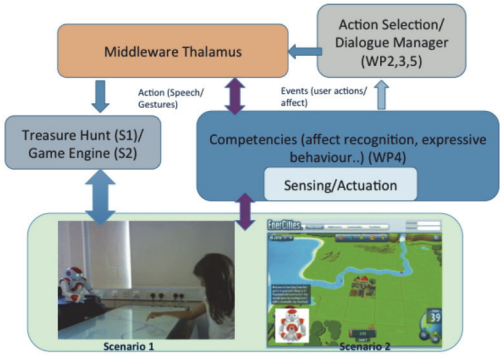

FIGURE 1: EMOTE Architecture

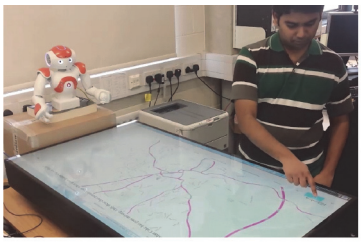

FIGURE 2: Map-based Treasure-hunt

FIGURE 3: Playing Enercities with the robot

Here the robot does not act as a conventional tutor but as a tutor-player, showing the players that there are different trade-offs to be made and different visions of what a sustainable city should be like. The tutor stimulates discussion between the players about trade-offs as well as their personal values by asking questions and setting an example.
As such, the personal value of the robot is to create balance, but it invites the players to think and act differently.
A study has been carried out examining the dialogue actions of three human players [1], and a WoZ study will establish how far these carry over when a teacher operates the robot as a tutor player.

Empathy and pedagogy

In order to establish empathic responses, the first issue is to be able to reliably assess significant aspects of the user's affective displays.
The use of sensors such as the OKAO and Kinect2 are being investigated as means to analyse facial images and extract facial expressions correlated with affect. These are however necessarily ambiguous – consider the many interpretations of a smile [5]. This will therefore be combined with expectation-driven processing using the task-context: where the user is in the treasure-hunt and whether they are succeeding in it; what move has been played and the overall game state.

Empathy can be thought of as cognitive (understanding the state of the other) or affective (responding behaviourally to the state if the other). However the relationship between emotions, empathy and pedagogy is not as straightforward as one might assume. A degree of negative affect may help users to learn; thus knowing the affective state of the learner does not automatically imply a particular action, such as mirroring, counter-acting, change in the level of scaffolding, offering general support. Similarly, recognising a counter-productive level of stressful frustration is not the same as noticing frustration; motivation is not solely related to affect. Furthermore, empathy may be a component of establishing the positive relationship known as rapport. These are all questions to be investigated within the two developing test beds just described.

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Acknowledgments

This project is supported by the European Community (EC) under the 7th Framework Programme (EMOTE, ICT-317923). This document does not represent the opinion of the EC and the EC is not responsible for any use that might be made of its content.