TSI-Enhanced Pedagogical Agents to Engage Learners in Virtual Worlds

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ABSTRACT

Building pedagogical applications in virtual worlds is a multi-disciplinary endeavor that involves learning theories, application development framework, and mediated communication theories. This paper presents a project that integrates game-based learning, multi-agent system architecture (MAS), and the theory of Transformed Social Interaction (TSI), the project implements a group of engaging, affectionate and effective pedagogical agents equipped with abilities of self-representation, emotional states reasoning and situational awareness. A prototype of a virtual quiz show, QuizMASter, has been implemented to realize these abilities, and will be used to test for the effectiveness of the approach.

Keywords: Belief-Desire-Intention (BDI) Agent, Multiagent Systems, Pedagogical Agent, Transformed Social Interaction (TSI) Theory, Virtual Quiz Games

INTRODUCTION

Embodied as visually pleasing creatures or agents that live in 3D virtual environments, intelligent and autonomous software agents are able to react to their environment and use multi-modal interaction capabilities to engage users. Together, these technologies have given rise to a convergent concept called intelligent virtual environments (Avlett, Vala, Sequeira, & Paiva, 2007). This advance has revolutionized the virtual world genre of the Internet community that provides computer-simulated intelligent virtual 3D environments whereby users can interact with one another and use 3D objects embedded in the environment. Intelligent virtual environments allow for new and exciting research into developing animated pedagogical agents.
Intelligent virtual environments are characterized by avatars that are not only controlled by human users, but also by software. In contrast to a centralized control model, we argue that a multi-agent system (MAS) architecture is particularly well-suited to environments where virtual entities are self-directed and can actively pursue their goals by means of interaction with the environment, including other entities that are also in pursuit of their own possibly competing goals. These entities, or software agents, are commonly designed based on the Belief-Desire-Intention (BDI) model in which they are given beliefs, desires, and intentions which are expressed by an agent through defining and pursuing goals with the development of plans (Tüzün, 2006; Wooldridge, 2009; Zakharov, Mitrovic, & Johnston, 2008). The BDI model makes it easier for developers to work with, taking a programming exercise that is potentially abstract and grounding them in terms that are easily relatable. Individual interests, motivations, and goals of the agents can be easily monitored, manipulated and changed to suit the dynamics of the virtual environment, including the activities of human users. Mapping the agents to visible non-playing characters (NPCs) manifested in the virtual environment in the form of avatars, agents can reap the visual and immersive capabilities of virtual environments to support pedagogical goals.

Several successful pedagogical projects attribute an increase in learning effectiveness and learner satisfaction to the immersive power of virtual worlds (Wang, & Braman, 2009). However, technical innovations alone do not completely explain the successes. Non-technical factors such as pedagogical design, engagement level and communication among students and instructors are also important in delivering educational applications in virtual environments (Annetta, Murray, Laird, Bohr, & Park, 2008; Holley, & Dobson, 2008). We argue that appropriate design and implementation of the interaction model between the agents and the human users are equally important in achieving pedagogical purposes.

Base on the theory of Transformed Social Interaction (TSI) (Bailenson, Yee, Blascovich, & Guadagno, 2008), the goal of our project is to demonstrate an approach to the development of pedagogical agents to enhance the engagement of students. Applying the three dimensions of TSI theory, we subtly transform the appearance and behavior of the avatars and agents based on the human players’ emotional engagement, with the expectation of raising learning effectiveness and learner satisfaction.

To achieve the goal, we designed and implemented a quiz game show called Quiz-MASter on a virtual world platform. The NPCs, supported by intelligent agents, are enhanced by TSI principles to guide the flow of the game and interact with the human players. This paper details our endeavor to integrating the strengths of virtual worlds, MAS architecture, and TSI theory.

The remainder of this paper is organized as follows: Section 2 describes the studies and theories that compose the foundation of our work. Section 3 describes our design and implementation of the game system. Section 4 describes the experimental design to test the system’s effectiveness. Section 5 concludes with a brief summary of the paper and discusses future research directions for the system.

### RELATED STUDIES

#### Educational Computer Games

Past research on motivation in educational computer games was dominated by Malone and Lepper’s “Taxonomy of Intrinsic Motivations for Learning” (Malone, & Lepper, 1987). Their taxonomy asserted that challenge, curiosity, control and fantasy were the motivational elements for the players of educational computer games. However, this assertion was limited to isolated individuals. In contrast, recent learning theories have emphasized the importance of social and contextual factors in the learning process (Bloom, 1956).

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