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Virtual reality and mixed reality for virtual learning environments

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Abstract

This paper explores educational uses of virtual learning environment (VLE) concerned with issues of learning, training and entertainment. We analyze the state-of-art research of VLE based on virtual reality and augmented reality. Some examples for the purpose of education and simulation are described. These applications show that VLE can be means of enhancing, motivating and stimulating learners' understanding of certain events, especially those for which the traditional notion of instructional learning have proven inappropriate or difficult. Furthermore, the users can learn in a quick and happy mode by playing in the virtual environments.
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1. Introduction

Virtual reality (VR) is the use of computer graphics systems in combination with various display and interface devices to provide the effect of immersion in the interactive 3D computer-generated environment. We call such an environment a virtual environment (VE). Research and development into VR and VE applications can be found in many places all over the world.

Mixed reality (MR) refers to the incorporation of virtual computer graphics objects into a real three dimensional scene, or alternatively the inclusion of real world elements into a virtual environment. The former case is generally referred to as augmented reality, and the latter as augmented virtuality. Azuma [1] has defined three characteristics that are integral to an augmented reality interface. Firstly, it combines the real and the virtual. Secondly, it is interactive in real time. Third, it is registered in three dimensions.

VR and MR have been proposed as a technological breakthrough that holds the power to facilitate learning. The research and application of VR/MR technology in education have enriched the form of teaching and learning in current educational strategy. Virtual learning environment (VLE), not only provides rich teaching patterns and teaching contents, but also helps to improve learners' ability of analyzing problems and exploring new concepts. Integrated with immersive, interactive and imaginational advantages, it builds a sharable virtual learning space that can be accessed by all kinds of learners inhabited in the virtual community.

Based on VR/MR techniques, learning action may be processed as following scenery: History students can learn about ancient Greece by walking its streets, visiting its buildings, and interacting with its people. Biology students can learn about anatomy and physiology through adventures inside the human body. The range of worlds that people can explore and experience is

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unlimited, ranging from factual to fantasy, set in the past, present, or future [2]. That is the VLEs' first important task. In the virtual community, learners can model, act and express anything they want as long as the system provides the tool. As an advanced facility toolkit for learning, training and simulation, the principal components of a VLE requires:

- *Knowledge Space* provides integrated learning resource, including the tool that helps to access to learning resources, assessment and guidance.
- *Communication Community* supports general communications, including email, group discussion, web access and social communication.
- *Active Action* functions as the tool for learners that express their active actions. In VLE, learners are not simple knowledge accepters. They are information providers, question askers, question answers and concept analyzers.
- *Facility Toolkit* helps to map of the curriculum into elements (or 'chunks') that can be assessed and recorded, helps to track student activity and achievement against these elements.

In addition, precision of knowledge visualization for learning materials and realistic social interaction among learners are two critical technical factors for building VLEs.

At present, E-Learning shows its power on global learning market. Though lack of immersion factor, it still hits the peak of learning market. Estimated by IDC [3], the E-learning market in 2001 was US$ 5.2 billion and will grow to $23.7 billion in 2006, an increase of 35.6% worldwide. With the application of VR/MR to E-Learning, the market will bloom in the near future.

This paper overviews recent works and applications in several fields related to VLE. Some examples of applying VLE in different fields are presented. Finally, a conclusion is drawn.

2. Virtual learning environments

In this section, we discuss prominent capabilities by analyzing the educational using of VLE. Since VLE is a developing technique in most of the education/training areas, researchers from each of the main communities involved have different starting positions and still, rather different perspectives. Thus, these technologies are far from homogeneous or universally agreed.

2.1. General architecture

VLE provides an environment based on network, and the resources in the network are free to share. Therefore, the study process can enhance the collaboration among learners. The VLE can help learners do cooperative study, and make necessary interactions between each other. For example, ExploreNet [4] is a general-purpose object oriented, distributed two-dimensional graphic-based computational environment with features to support role-playing games for educational purposes, and cooperative learning of many kinds. Among the research works, Prada [5] in his Belife system implements an explicit collaborative mode of utilization. The collaborative mode will challenge learners to share a virtual greenhouse. Each group will be able to alter some environmental conditions parameters to maximize their crop. Liu [6] focuses on Web-based collaborative virtual learning environment. He provides a cognitive learning architecture based on constructivism. The prototype learning system is effective based on the evaluation.

2.2. Human computer interaction

Interaction can promote learners' active learning. During the studying experience, interaction can offer the learner various controls, such as interacting with the virtual environment and manipulating characters or objects in the virtual environment. VLE technologies can address a wide range of interaction capabilities. For example, Maes [7] constructs a video-based interaction with artificial agents called the Alive system. The system is ideally suited to teach users with physical skills, for its convenience to use and immediate feedback. Picard and her affective computing groups [8,9] describe affective wearable computers that are with users over long periods of time, like clothing, and that are therefore potentially able to build up long-term models of users expressions and preferences. The affective wearables offer new ways to augment human abilities, such as assisting the speaking-impaired, and helping remember important information that is perceived.

2.3. Synthetic characters

Synthetic characters with its significant feature of interactive and intelligent behavior can provide a potential tool for learning in VLE. A number of worthy systems and architectures for synthetic character behavior control have been proposed [10–12]. For example, Blumberg and his synthetic character groups focus on developing a practical approach for real-time learning using synthetic characters. Their implementations are grounded in the techniques of reinforcement learning and informed by insights from animal training. They work on building characters that have the everyday common sense, the ability to learn, and the sense of empathy that one finds in animals such as dogs [13] (see Fig. 1).

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