Chapter XI
Adaptive Animation of Human Motion for E-Learning Applications

Frederick W.B. Li
University of Durham, UK

Rynson W.H. Lau
University of Durham, UK

Taku Komura
University of Edinburgh, UK

Meng Wang
University of Durham, UK

Becky Siu
City University of Hong Kong, Hong Kong

ABSTRACT

Human motion animation has been one of the major research topics in the field of computer graphics for decades. Techniques developed in this area help present human motions in various applications. This is crucial for enhancing the realism as well as promoting the user interest in the applications. To carry this merit to e-learning applications, we have developed efficient techniques for delivering human motion information over the Internet to collaborating e-learning users and revealing the motion information in the client machines with different rendering capability. Our method offers a mechanism to extract human motion data at various levels of detail (LoD). We also propose a set of importance factors to allow an e-learning system to determine the LoD of the human motion for rendering as well as transmission, according to the importance of the motion and the available network bandwidth. At the end of the paper, we demonstrate the effectiveness of the new method with some experimental results.
INTRODUCTION

Human motion animation (Badler, Palmer, & Bindiganavale, 1999) has been incorporated in varieties of applications, such as engineering simulation, virtual conferencing, gaming, military, and education. It can play different roles in the applications. More specifically, as a major supporting role, it helps present certain motions, such as dance performance of the main virtual human characters in an application. This kind of animation must be done in significant fine detail to allow users to have a good understanding of the motion of the virtual human characters. However, doing this would need to involve complicated and costly computations, which may not be able suitable for real-time applications. On the other hand, as a minor supporting role, human motion animation helps reveal motions of supporting characters. For example, it may animate the crowd in an evacuation training application. The level of detail of animation of this type may be decreased without affecting how the users to perceive the motion of the crowd. Although the computation workload for animating an individual virtual character may be greatly reduced in this situation, applications may still incur high computation work if one needs to animate a large amount of virtual characters at the same time.

With the dramatic improvement in networking capabilities and the possible consolidation of rich learning resources over the Internet, e-learning has been admired as a very useful learning environment. It offers remarkable features, which are hardly found in the traditional learning environment. First, unlike traditional learning that requires students to gather at a specific time and place to attend a lesson, e-learning allows students at different geographical locations to join a lesson without physically traveling there. Second, e-learning allows the consolidation and distribution of e-learning contents from a vast amount of Internet Web sites to students. Third, e-learning natively supports the presentation of various types of media, such as 3-D graphics, animation, and sound, to help students visualize and understand concepts in an easier way. For example, Canós, Alonso, and Jaen (2004) propose a multimedia-enabled emergency evacuation training system for an underground metropolitan transportation environment. The system makes use of text, images, audio, video, and simple 3-D graphics to construct the user interface and present evacuation training materials. Results show that such an arrangement could improve students’ understanding on complex procedures.

To further enhance the interactivity of the learning environment and motivate the student participation, 3-D virtual environments with animation (Sims, 1995) would definitely be a crucial complement to the e-learning systems, such as the emergency evacuation training system (Canós et al., 2004). The possible incorporation of such an environment would allow students to be actively trained in various emergency situations. While it is important for students to fully visualize the emergency situations and learn to respond to them interactively, it is also necessary for the instructors to be able to visually monitor the progress of the students from different angles in the virtual environment. Despite these benefits, as we have discussed, 3-D animation, in particular when animating human motions, can be very demanding in terms of rendering. In addition, owing to the large size of the human motion data, the transmission of such data to the e-learning users over the Internet would induce a significant bandwidth consumption on the networks.

In this article, we present an adaptive human motion framework to support real-time rendering and transmission of human motions in e-learning systems. The rest of this article is organized as follows. The second section provides a survey on related work. The third section describes the foundation of 3-D-based e-learning systems. The fourth section shows the adaptive human motion framework in detail. The fifth section presents some experimental results of our method. Finally,
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