Chapter 22
Architectures for 3D Virtual Environments

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ABSTRACT

A very important aspect in the development of systems that allow access to virtual environments is their architecture, along with both the requirements and the type of offered services, once they significantly affect the design of an application. The concept of architecture refers to how the components that constitute a software system are arranged, their interfaces and relationships. Thus, this chapter aims to present and discuss different architectures that can be used in the development of 3D virtual environments. The first architecture addresses issues about the design of virtual environments for educational purposes with the goal of making collaborative e-learning services available. The second architecture proposes a modular structure for the development of 3D virtual environments that support collaboration, remote experiments and content adaptation. Lastly, the third architecture presents issues related to the sharing and management of 3D virtual environments, making use of software reuse techniques combined with web services.

INTRODUCTION

3D virtual environments can be described as interactive environments, consisting of 3D objects and being generated in real time by a computer system. This technology aims at simulating real environments or building imaginary environments, and allows one or more users to interact through the visualization and manipulation of objects, expanding the sensory system (Kirner & Kirner, 2011; Martins, Gomes, & Guimarães, 2015).

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Through the use of virtual reality (VR) techniques, the virtual environments have emerged as an attractive tool for the development of more dynamic and realistic interfaces to the user. Some research in artificial intelligence (AI) and virtual environments has shown that the integration between these areas represents a strong trend. Aylett and Luck pointed the following factors as the motivators of this integration (as cited in Osório et al., 2004, p. 240): first, a greater computer processing power has made it possible not only the development of visual realism, but also the inclusion of an intelligent layer in such environments; second, the incentive given to the development of 3D environments due to the increasing availability of 3D graphics libraries and standards; and third, AI techniques have been constantly improved and explored in the interactions between users and the environment.

In this sense, the purpose of the integration between these areas is the development of virtual environments capable of exploring, with a certain degree of intelligence, the use of entities and the effective ways of their graphical representations, besides taking into account different forms of interaction (Osório et al., 2004). Therefore, it is intended to provide these environments with a greater dynamism, realism and usability.

One of the most promising uses of VR technology is the employment of virtual environments in collaborative e-learning. Many studies have been performed in the area of networked virtual environments for sharing of events, but little emphasis has been given to research on specific services and functionality (Bouras & Tsiatsos, 2006).

It is also known that educators around the world have invested a lot of time and resources in research which aims to analyze the pedagogical potential of technologies that have captured their attention, such as 3D games, simulations and virtual worlds. It can be considered that the continued development of and investment in 3D virtual environments for educational purposes can revolutionize the way distance (and traditional) learning is performed. These technologies have caused a great impact on higher education by providing an environment where learning can occur collaboratively (Lee, 2009; Moura, Bispo, Souza, & Ferreira, 2015).

With the aim of incorporating the advances of information technology to learning environments, various types of applications have been developed. Support for e-learning is already present in many systems, which use different types of learning methods implemented through the use of different technologies (Bouras, Triglianos, & Tsiatsos, 2014). In addition, there is a variety of virtual environments that provide different services and functionalities.

In this context, 3D virtual environments have been applied in various areas, being potentially used in entertainment, education and simulation. Each area in which these environments can be applied has its characteristics in terms of functionality and way of use, which must be strongly taken into consideration during the 3D virtual environment development process.

A very important aspect that must be considered in the development of systems that allow access to virtual environments is their architecture, along with both the requirements and the type of offered services, once they significantly affect the design of an application. Bass, Clements, and Kazman (2012) say that the concept of architecture is associated with the way system's structures are arranged, the components that constitute the software, their interfaces and relationships. Barbosa (2009) describes architecture as the system organization through its components, taking into account the principles of design and evolution. Thus, the purpose of this chapter is to present and discuss different architectures that can be used in the development of 3D virtual environments, considering, for example, the social and collaborative support, the use of immersive interfaces with 3D representations, content adaptation, artifacts reuse, modular characteristics and others.