Chapter VIII
Model–Based Design for Multimodal Interaction in a VE

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ABSTRACT

The creation of virtual environments is often a lengthy and expensive process. Especially defining the interaction dialog between the user and the environment is a difficult task, as the communication is often multimodal by nature. In this chapter, we elaborate on an approach which facilitates the development of this kind of user interfaces. In particular, we propose a model-based user interface design process (MBUID), in which the interface is defined by means of high level notations, rather than by writing low level programming code. The approach lifts the design to a higher level of abstraction, resulting in a shortened development cycle leaving the opportunity for creating intermediate prototypes and user evaluation, ultimately resulting in better and cheaper virtual environment interfaces.

INTRODUCTION

Much attention has been paid lately to the use of virtual environments (VEs). Applications range from computer games to scientific simulations. For this purpose, several frameworks, such as VR Juggler [Bierbaum et al., 2001] and XVR [Carrozzino et al., 2005] have been created. However,
little attention has been paid to development tools, which allow the designer of a virtual environment to abstract away from the code level. Existing tools, such as Virtools [Virtools inc, 2008], support the design of VE applications by using a graphical notation. Although, this provides a first necessary step, it is important to take advantage of further abstractions, where the design of a virtual environment is refined from a conceptual phase to the actual implementation using a tool-supported process. This allows domain specialists, designers and developers to concentrate on their part in the creation of a VE application, while still being able to discuss design decisions with each other.

On the other hand, over the last years, the design of form-based and multi-device user interfaces using high-level specifications has been investigated extensively. Often, a Model-Based User Interface Design (MBUID) process is employed. In such an approach several models are used to describe the different aspects of user interaction. Those models may describe the tasks performed by the application, the dialog with the user and the presentation of the User Interface elements. Based on these models, the final application can be created using a (semi-)automatic process.

The advantages that are provided by using a MBUID process can also benefit the creation of virtual environments. However, due to the highly-dynamic nature of the interaction in VEs, the requirements for the design process are more complex. VEs try to provide an interface to the user which is as intuitive as possible. Therefore, the user interaction is not restricted to a limited set of possibilities, but is based on direct manipulation and multimodal interaction such as speech, the sight, the hearing and touch as we know from the real world. This obviously complicates the design of the user interface in such a VE.

Applying multimodal interaction often requires the use of specialised hardware, such as stereo projection, 3D trackers and haptic devices. As each device has to be handled in a specific way, a design process should also be able to abstract away from those specific technical details, while still allowing to use all the functionality (e.g. haptic feedback).

To achieve an intuitive interface, metaphors are often used in order to transfer knowledge a user already has from previous experiences or from within the real world. Examples include the ray casting technique [Liang and Green, 1994] for object selection, where an object is selected by simulating pointing at it with a flashlight; another example is the flying vehicle metaphor [Ware and Osborne, 1990] for navigation, where the virtual camera is moved as if it is mounted on a flying vehicle.

Metaphors have the benefit to transfer earlier knowledge from the user to the new situation, however, it is difficult to predict in advance whether or not a solution will succeed in this aim. Therefore, newly proposed metaphors have to be extensively tested and adjusted. A process that facilitates the creation of an interactive virtual environment should hence provide an easy manner to realise such interaction techniques.

Finally, the interaction techniques do not stand on their own. They act upon the object available in the 3D world. Users should for instance be able to open a door by pushing it open. Walls on the other hand should not move if they are pushed against. It is therefore necessary to take this kind of semantic information into account when designing the interaction.

MBUID may be a promising solution in order to simplify the creation of virtual environments, by abstracting from the programming code, and lifting the design process to a higher level. However, the difficulties and special requirements of virtual environments pose a challenge to model-based design of the interaction. In this chapter, we give a comprehensive overview of the benefits, problems and possible solutions when bringing a MBUID process into the domain of virtual environments.
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