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vrLib: A Designer Oriented Interaction and 3D User Interface Library

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Abstract

In this paper we propose vrLib, a toolkit which aims to make 3D graphical user interface and interaction very easy to design in virtual environments. This project provides well known and new interaction techniques and ready to use widgets, which are totally hardware independent. The main contribution allows to elaborate complex 3D user interfaces in same way it is done in 2D. This toolkit provides adaptive interaction, which means interaction techniques can automatically adapt their behavior to 2D and 3D widgets. This short paper describes the vrLib architecture for construction of 3D interactive applications.

Categories and Subject Descriptors (according to ACM CCS): I.3.4 [Computer Graphics]: Virtual device interfaces I.3.7 [Computer Graphics]: Virtual reality I.3.8 [Computer Graphics]: Applications

1. Introduction & related work

Since many years, many 3D interaction techniques and widgets have been proposed such as GoGo [PBWI96] and WIM [SCP95]. But there is no standard 3D interaction and 3D graphical user interface toolkit.

Several toolkits exist to help designing 3D applications, allowing to abstract the hardware in order to easily change devices, possibly during run time, such as CAVELib or VR-Juggler. But those low-level libraries do not provide full support to reusable interaction techniques and user interface components. Some higher-level projects propose limited 3D widgets support [ZHR*93], or a set of interaction techniques [BIP00]. All-in-one systems, such as ErgoDesk [FLZ98] are too complex, or have functionalities too much platform-specific oriented to be used in production. Grappl 3D [GL04] is currently the most advanced library, by offering support of interaction techniques and user interface components which are able to adapt their behavior to underlying hardware.

vrLib project has double objective: to be able to convert our team's CAD applications from desktop to 3D environment, then test and compare new ideas of interaction, in the same way we already do in 2D with Trolltech Qt.

2. Motivations & objectives

The design of this toolkit was initiated by following motivations:

- Propose off-the-shelf interaction techniques and widgets, such as GoGo.
- Facilitate extension of interaction techniques and widgets, without re-implementing existing functionalities.
- Reduce dependance between application data and user interface.
- Facilitate conversion of 2D applications in 3D environments.
- Reduce dependencies with input and output hardware.
- Address software platform dependence problems.

Main goal of vrLib is to describe a virtual reality scene with graphic representation of its objects, stored in a scene graph, and manipulated by interaction techniques. Figure 1 gives imbrication of vrLib in other components and operating system on specific designing application.

3. vrLib architecture

vrLib comprises support for application control, objects representation and interaction techniques, and management of events and communication between these entities.

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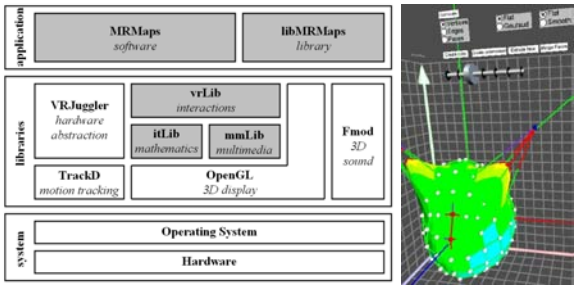

Figure 1: *vrLib architecture through a 3D application.*

3.1. Application control

vrLib comprises a WIMP-like implementation of application control with solid widgets controlled by pointing metaphor, but the idea is for user to design his own application control, based on the communication tools and classes provided by vrLib.

3.2. Objects representation

vrLib implements a scene graph to easily store objects. Nodes can be generally triangulated meshes, which are most popular objects representation or anything else, even other kind of objects representation, such as discrete or parametric representation. The scene graph allows to intuitively handle object properties such materials, lighting and physical attributes.

In addition, vrLib offers some widgets, like widgets available in 2D environments: containers, buttons, data input or data display widgets.

3.3. Interaction techniques

Objects stored in a scene graph are manipulated by abstract interaction metaphors. Pointing metaphor is the most common interaction technique, allowing to point and manipulate objects, navigate into scenes, and control application. The concrete representation of this metaphor uses generally ray starting from a 3D device. vrLib comprises various implementation of laser metaphor, laser aperture metaphor, such as deformable raycast [SB05] allowing to point objects hidden by others objects in complex scene. Other interaction metaphors are implemented in vrLib, such as bimanual techniques, gesture and voice recognition.

3.4. Events management

vrLib uses intensively two communication mechanisms between library, application and objects, according to system and user events. The application delivers messages generated from hardware events to the objects. Signals and slots are used to communicate between objects. Objects define a default action for each message and signal, but vrLib allows to redefine a specific behavior for each message and signal if needed.

4. Conclusion

We have presented our toolkit vrLib, a cross-platform application development framework, used for development of 3D GUI programs. This toolkit provides an easy way to combine and create interaction techniques and both 2D and 3D widgets, and has few dependencies with external libraries. We have shown how the adaptive interaction is able to improve the interaction process by adding a semantic to each interaction tool – widget couple.

We are currently working on improving vrLib by adding multi-modal and multi-user interaction, and automatic generation of user interface from an XML document. We would like to add vrLib Designer, a 3D GUI layout and forms builder, which could enable rapid designing of user interfaces without almost no extra coding, such as Trolltech Qt and Microsoft Visual Studio .Net. Another ambitious project is VR Desktop, a full usable desktop in an immersive environment, based on vrLib exactly as KDE is based on Qt.

Finally, vrLib has been successfully used in several 3D modeling software as well as a radio frequency surgery planning tool.

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