

An immersive CAD testbed

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Abstract

Today Virtual Environments in industry are predominantly used for passive analysis of product or production data, mostly exported from CAD systems. To investigate on potentials of future immersive CAD-modeling and feasible user interfaces therefore, we have developed a basic CAD system for Virtual Environments. The application yet provides a variety of modeling and assembly functionalities and builds a testbed for the design of proper user interaction techniques.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism: Virtual reality; J.6 [Computer-aided engineering]: Computer-Aided Design (CAD)

1. Introduction

CAD evaluation in Virtual Environments at industrial facilities is mostly used to analyse data and to detect and document errors or optimization potentials in the designed products. If the immersive evaluation results in a change to be carried out at the design, it is mostly not realised in the VE, but at the CAD system on the desktop of the engineer. After design work at the CAD system is done, another immersive CAD evaluation session might be required to fulfil the according design milestone and proceed in the development process. These time-consuming and thus expensive design iterations could be diminished by direct access to CAD functionalities and design parameters of the product at the VE-application, used for the immersive CAD evaluation. Furthermore some of the typical CAD tasks benefit from the intuitive 6DOF-interaction and stereoscopic perception. As long as CAD systems do not provide their own VE-abilities, the following strategies are conceivable to accomplish access to CAD modeling functionalities while working at the VE:

1. Use of a standard desktop CAD workstation nearby the VE, export and reload 3D-data in the VE-application.
2. Use of a handheld device like a tablet-PC in the VE, that runs the CAD system.
3. Remote control of the possibly distant desktop CAD system at the engineer's workplace. This can be achieved by mechanisms like VNC to access the 2D-GUI of the CAD system right from the VE user interface.

4. Remote control of a separate CAD application by its API, using an immersive GUI for modeling in the VE.
5. Implementation of a VR-CAD system as an integrated VR-application [dAFS01].

While investigating on strategy 1, 2, 3 and 5 of the above mentioned possibilities [HB07], we here report on the latter point of implementing a VR-CAD system. To research on the integration of CAD in Virtual Environments and feasible immersive CAD interaction techniques, we have implemented ItCAD as an application for VEs. The system extends an existing CAD kernel by topology management, VR capabilities and basic immersive functionalities for both part- and assembly-design tasks.

2. Implementation

2.1. Configuration and User Interface

The implemented VR-CAD application provides an immersive User Interface for basic CAD modeling functionalities. For part design modeling it provides point, line, spline, circle, face, extrusion, rotation, boolean, mirror, fillet and chamfer functions. At assembly design, parts get positioned against each other relatively to assemble a product out of its components. Parallelism, contact or angle conditions between shapes like faces, edges or points have to be defined. To realise this, a set of constraint-functionalities has been implemented. The application provides icon menus to control modeling functionality and select ray interaction to

draw, position and manipulate objects. The system can be used in arbitrary display configurations, like monoscopic desktops up to immersive 6 wall projection rooms. ItCAD allows to import design data from existing CAD systems, model new, arbitrary volumetric parts, assemble the components to a product and save the results. The set of functionalities yet is basic but their use is comparable to existing desktop CAD systems. Design data is stored in a native format and can as well be exchanged for interoperability with other CAD systems in STEP or IGES format. The application can be used stand-alone or as a CAD server in conjunction with arbitrary VE and desktop clients that work on the same design data concurrently. We use the client server setup predominantly to extend the immersive VE application with a tablet PC that provides an alternative way to draw plane 2D profiles that 3D shapes are often based on. It's conceivable to use a web browser as an additional client to get access to the hierarchical topology structure of the designed objects.

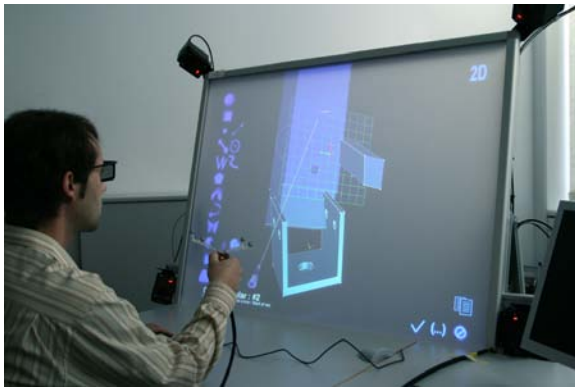


Figure 1: ItCAD on an immersive desk, controlled by the 6DOF interaction device Hornet.

2.2. Architecture

In the underlying architecture, we encapsulated the core geometry generation and management functionality in a CAD-VR library. It is completely separated from the specific VR or desktop application that builds the User Interface. The most reasonable way to realise the required set of functionalities for geometry generation and tessellation is the integration of an existing industry standard CAD kernel library. We use the CAD kernel OpenCASCADE of Open CASCADE S.A.S. and extended it by adding a modular messaging system, data- and id-administration, topology management and interfacing functionalities to communicate with front-end applications. The internal control mechanisms, used for intermodular communication in the management layer as well as handling of modeling commands and GUI updates, are based on the implemented messaging system. The core message distribution module also constitutes the network based

client server mechanism that transparently integrates different frontend-clients into one CAD system with shared design data. Access to the CAD kernel is constricted to the geometry and the tessellation module only to facilitate future change of the used CAD kernel. The immersive User Interface is based on the VR-development system Lightning of the Fraunhofer IAO.

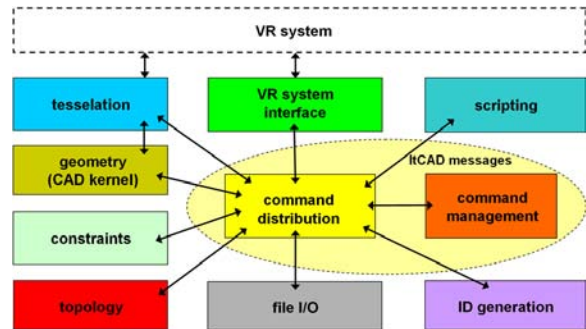


Figure 2: Core module overview and messaging mechanism at the architecture of ItCAD.

3. Conclusion and Future Work

The immersive CAD system ItCAD provides a suitable testbed for investigation on appropriate interaction techniques that meet the specific requirements of immersive parametric modeling. It yet revealed interesting new aspects in the comparison of immersive against desktop CAD, which we will investigate further on. In particular the assembly design tasks benefit from the specific qualities of Virtual Environments, leading us to currently focus on that aspect. A user test, held to investigate on some new concepts like numerical input with the tracked hand held 6DOF device Hornet was successful.

4. Acknowledgments

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References

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