THE DESIGNERWORKBENCH PROJECT
SEMI-IMMERSIVE INTERACTIVE MODELING

Falko Kuester[1] and Bernd Hamann

CENTER FOR IMAGE PROCESSING AND INTEGRATED COMPUTING
DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF CALIFORNIA, DAVIS 95616-8562

ABSTRACT

The DesignerWorkbench project aims at transforming the classical industrial modeling and design paradigm into its virtual analog using state-of-the-art three dimensional l display technology, data gloves and spatial tracking. This paper outlines the fundamental tools and design paradigms required for the implementation of this modeling environment and demonstrates the usability of virtual environments (VEs) for the simulation of two-handed clay modeling and design tasks on the basis of non uniform rational B-splines (NURBS).

Keywords: Computer Graphics, Computer Aided Design, Virtual Reality, Virtual and Immersive Environments, Interactive Modeling

1 INTRODUCTION

As companies focus on streamlining productivity in the pursuit of global competitiveness, the migration to computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) systems has established a new backbone of modern industrial product development. While most of these technological advances are of high benefit to the engineering and design community, they still lack some of the important visual and haptic features crucial to product development. A car design, for example, traditionally originates from a clay model, that after digitization, forms the basis for a numerical CAD description in Bezier, B-spline, or NURBS format. Consequently, physical models, so called mock-ups, still play a key role in the otherwise CAD-centered development cycles. The DesignerWorkbench aims at closing this technology gap experienced by design and CAD engineers by transforming the classical design paradigm into its fully integrated digital and virtual analog (Figure1). Previously complex tasks such as the creation or modification of objects in 3D space can now be achieved with intuitive hand gestures while working in a semi-immersive environment. This approach allows the preservation of the hands-on experience from the physical world while overcoming the well known classical 2D constraints introduced through the keyboard. A powerful feature of this implementation is its ability to provide an unprecedented amount of real estate for the user in the form of a 3D desktop. Anyone with experience in working with multiple open and overlapping windows or virtual 2D desktops on a regular display will appreciate that objects, tools, and other components can now be placed and arranged in an almost unlimited 3D domain.

2 HARDWARE SETUP

The DesignerWorkbench was specifically designed to work with a new generation of stereo projection systems currently marketed under names like ImmersiveWorkbench, ResponsiveWorkbench and ImmersaDesk. We use the ImmersiveWorkbench from Fakespace which allows stereo projection of 3D computer-generated images onto an approximately 2*1.5m projection area. A 4-processors SGI Onyx2 InfiniteReality (225MHz, R10000 processor) system was used as the rendering engine. The basic hardware setup is illustrated in Figure 2. The user is wearing shutter glasses with integrated head tracking for stereoscopic viewing and uses a set of pinch gloves for interaction with the VE. The input devices are described next:

- **Stylus**: Using a fixed transmitter as reference, this pencil-like system accurately tracks position (x, y and z coordinates) and orientation (yaw, pitch and roll) of a receiver contained in the stylus. In addition, it provides an integrated button that can be associated with particular actions.
- **Gloves**: The Pinch System uses cloth gloves with electrical sensors in each fingertip. Contact between any two or more digits completes a conductive path, providing a variety of possible "pinch" gestures that can be associated with distinct actions. Additionally, an attached electromagnetic tracker captures the position of each glove.

[1] {kuester,hamann}@cs.ucdavis.edu

3 IMPLEMENTATION

The core component of this modeling environment is the virtual toolbox. The virtual toolbox merges the advantages of conventional physical tools with the high-precision components of today's CAD systems. Cumbersome operations suddenly become possible by exploiting the strength of the hands-on approach and the possible elimination of physical constraint in the VE. Instead of actually defining tools, the user defines actions and functionality, which can be applied to arbitrary objects in the VE. This approach provides the designer with unlimited space for creativity and the means for the creation of new tools and design concepts. The fact that tools can be used to shape models which then can be turned into tools on their own is one of the crucial features of this environment.

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