

Shadow WIM: A Multi-Touch, Dynamic World-In-Miniature Interface for Exploring Biomedical Data

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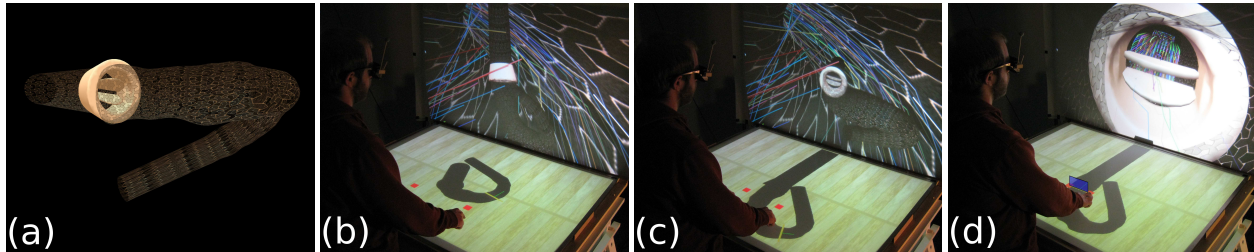


Figure 1: Exploring a time-varying visualization of simulated blood flow through a heart valve model. (a) The 3D anatomical model. (b) The shadow shows an orientation of the WIM that the user wants to change. (c) Using seamless multitouch gestures, the user reorients the WIM, changing the shadow. (d) With the WIM set, the user defines a film plane, overlaid in blue, between the fingers.

1 Introduction

Advances in high-performance (supercomputer) simulations are revolutionizing biomedical research. Figure 1 shows a visualization of data from a cutting-edge computational fluid dynamics (CFD) simulation of blood flow through a replacement heart valve. Our collaborators in medical device design hope to use these data as part of a new approach to redesigning the valve hinging mechanism, ultimately improving the longevity of these devices. Biomedical engineers face significant challenges in exploring and understanding these data.

This work addresses the specific challenge of navigating through virtual reality visualizations that include complex anatomic geometries, such as the MRI-reconstructed geometry shown in Figure 1. Although navigation in virtual environments has been studied extensively, emerging datasets present new challenges. Our approach builds upon well known World In Miniature (WIM) techniques, e.g. [Wingrave et al. 2006]. The contributions of our work are extending scalable and scrollable WIMs [Wingrave et al. 2006] to apply to virtual environments that do not include a ground plane or a well-established default viewing orientation, developing a multi-touch interface to control the Shadow WIM that we introduce, demonstrating this interface in a biomedical engineering application, and reporting on lessons learned.

2 Shadow WIM

Our system consists of a dual surface, multi-touch, virtual reality environment. The first surface is a vertical stereo screen, the second a horizontal multi-touch table as seen in Figure 1. In contrast to a typical WIM, which is a flat map, the Shadow WIM has 2 parts: a shadow projection and the floating 3D geometry that casts it. The user interacts directly with the shadow, while the 3D geometry is useful, and only displayed, during reorienting operations. A WIM reorientation mode is used to change the orientation of both parts of the WIM (3D and shadow) simultaneously. The view definition mode is used to define the real world view. Multi-touch gestures are used to seamlessly transition between the two modes.

WIM Reorientation: To reorient the WIM to create a useful inter-

active shadow, a single point of contact is used for filmplane translation and two for scaling and rotating. Then, in an extension to typical direct manipulation interfaces, the virtual environment can be tilted or rolled by moving two points of contact together in the y or x direction respectively, effectively changing the up direction of the environment. The reorientation process can be seen in Figure 1 (b) and (c).

View Definition: New global 3D views for the vertical display are created by defining a new film plane using the Shadow WIM. Four points of contact (two fingers from each hand) are used to define the width of the film plane by touching directly on the shadow. The resulting plane is mapped directly to the physical plane of the vertical display. The height of the film plane is initialized to the center of the anatomical model and can be adjusted by moving a thumb of either hand in a vertical motion.

3 Design Lessons and Future Work

In implementing the Shadow WIM, we faced two interesting issues. First, we found that reorienting the WIM relative to a film plane fixed on the table surface was too confusing for users because both the WIM and the global 3D view changed at the same time. By moving the film plane along with the WIM when it is reoriented, we avoid this. Second, we found that the 3D part of the WIM was distracting and difficult to view when the WIM was scaled to large sizes because it was positioned very close to the user's eyes. By scaling down and slightly offsetting the 3D part of the WIM, creating a slight mismatch between the two parts, we allow for meaningful reorienting when the WIM is at a very large size. In the future, we plan to study the perceptual issues raised by this mismatch, to see if it effects the interaction.

References

WINGRAVE, C. A., HACIAHMETOGLU, Y., AND BOWMAN, D. A. 2006. Overcoming world in miniature limitations by a scaled and scrolling wim. *Proceedings of the IEEE conference on Virtual Reality*, 116.

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