VR Management Tools: Beyond Spatial Presence

John A. Waterworth and Luis Serra

Institute of Systems Science
National University of Singapore
Heng Mui Keng Terrace, Singapore 0511
john@iss.nus.sg, luis@iss.nus.sg

ABSTRACT

We have created three types of user-controlled management tool for use in virtual reality environments: the *3DMenu*, the *M-Cube*, and the *SuperCube*. 3DMenus are equivalent to the menu systems found in two-dimensional interactive environments, but have the necessary spatial presence for the immersive 3D world of a VR application. M-Cubes are directly equivalent to 3DMenus but, by using all six available surfaces to present selection alternatives, occupy significantly less space. SuperCubes, in contrast to both these approaches, reflect a move beyond spatial presence by the attachment of meaning to their manipulation; the dimensions of space are also dimensions of information.

KEYWORDS: Virtual Reality, VR, interface management tools, 3D, information dimensionality, menus.

INTRODUCTION

Most of today's user interfaces for standard 3D applications do not make much use of the third dimension [1]. The result is that users interact with variations of standard, 2D interface objects such as menus. No attempt is made to capitalize on the possibilities for enhanced HCI that the extra dimension provides, partly due to the absence of appropriate design models.

Work to develop convincing VR has focused chiefly on achieving a realistic sense of a 3D world, and of manipulable 3D objects with which the user can interact within that virtual world [4]. Relatively little attention has been directed to how the user interacts with those aspects of the application that do not form part of the simulated 3D reality. We refer to techniques that support such interactions as *VR management tools*, and we report three approaches to their design.

THREE VR MANAGEMENT TOOLS

Any tools existing in a VR environment must possess full three-dimensional presence. The most obvious approach is to adapt standard interaction techniques, such as menus, for 3D worlds.

3DMenus

The 'virtual menus' described by Jacoby et al. [3] are essentially standard menu systems rendered in three dimensions for use in VR environments. Gloved hand gestures are used for menu invocation, to highlight an item, to select an item, and to move the menu. Our focus is on more accurate interactive tools for precise 3D work such as surgery [5], and our 3DMenus were designed with this type of application in mind.

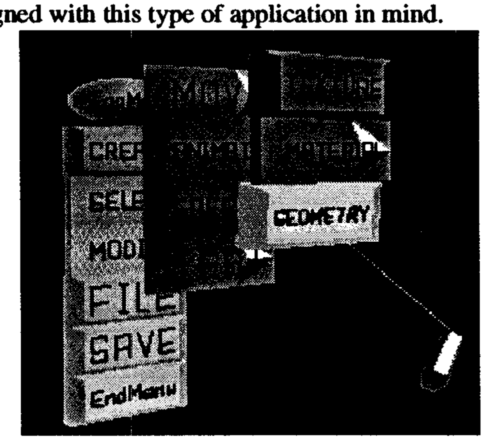

Figure 1 - 3DMenus

A colour scheme based on parameters such as diffuse reflectance, specular reflectance and emission is used for each set of buttons belonging to the same hierarchy level. In other words, the colour of each individual button is a gradual variation of the basic colour for that menu level. Menus may also be cascaded, as in Figure 1, with the current level pushing earlier ones (which may be reselected) back in space from the user's viewpoint.

M-Cubes

The idea of using cubes as management tools was inspired by Henry and Hudson's [2] 'multi-dimensional icons' for use in 2D GUI environments. With these, icons representing different views of a software object are shown as the sides of a cube. Users can select either the front face or one of the four adjacent faces; the cube can be tilted up, down, left or right to reveal each of the five available selections. The sixth (back) side of the cube cannot be viewed or selected.

M-Cubes duplicate all the functionality of 3DMenus, but have certain advantages. They occupy less space, so that the problem of long menus is avoided, and they can be handled more efficiently, with less gesticulation by the user. But some faces are hidden, so the user must sometimes rotate the cube in space. On the other hand, they make equal sense viewed from any position in the VR, whereas 3DMenus must always be oriented towards the user.

M-Cubes are rotated to reveal the hidden faces by clicking on the appropriate corner (see Figure 2). When a selectable item is the equivalent of a cascading menu, this is indicated by a bulge on the corresponding M-Cube face (e.g. 'FILE' option in Figure 2). Selection of that face results in the replacement of the existing M-Cube with the new. To move back up the hierarchy to the previous M-Cube the (central) corner nearest the user is selected. Each M-Cube is colour coded as for the 3DMenus, to facilitate user orientation through the various selection levels. Labels are rotated on the M-Cube faces so that they always appear the right way up for the user, whichever ways the M-Cube has been manipulated.

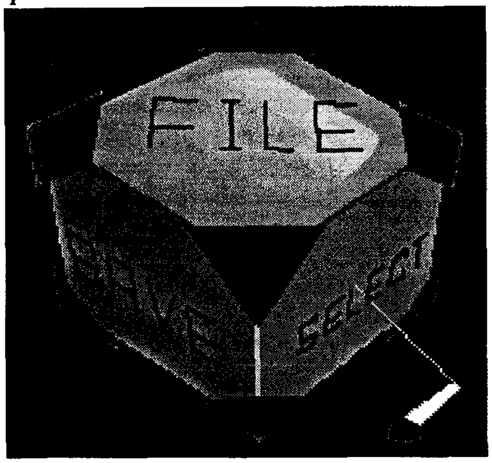

Figure 2 - M-Cubes

SuperCubes

SuperCubes combine the advantages of M-Cubes with the assignment of meaning to the three dimensions of space.

What appears on the faces of the SuperCube depends on how it is manipulated (see Figure 3).

Rotating the SuperCube by pushing away the left edge of the nearest face corresponds to moving back through *history*; as a fast way to return to previous selections, for example. Upward rotation (top edge away from the user) corresponds quite naturally to moving up the hierarchy of options to *more general* cases, while pushing the bottom edge selects *more detail*. Rotating in the third dimension (turning the nearest face clockwise or anticlockwise) selects the kind of *view* presented to the user, iconic versus textual or annotated versus terse, for example.

For other applications, spatial dimensions could, of course, be matched to different informational dimensions; but *history*, *specificity* and *view* should have considerable generality.

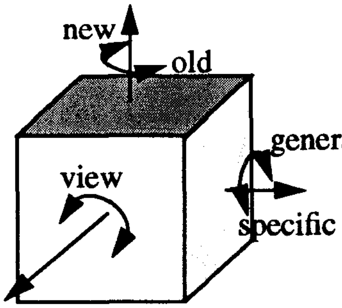

Figure 3 - SuperCube Informational Dimensions

DISCUSSION

The major limitation of cubes is the number of views available at any one time (3) and the total number of alternatives available at any level of interaction (6). But there is no reason to be confined to cubes, any regular polygon can support the same rich style of interaction. A *dodecahedron*, for example, would show six alternatives at any one time, with a total of twelve alternatives per interaction level.

SuperCubes possess informational dimensionality, not merely spatial presence. This gives them great power and generality as VR management tools. They are particularly appropriate for applications such as information-enhanced medicine, where VR is proving increasingly useful and yet where minimal gesticulation is also essential [5].

The approach is not limited to VR and we foresee the use of tools like the SuperCube wherever user-controlled exploration of information along several dimensions is required: education, information access and multimedia document creation, for example.

REFERENCES

[1] Conner, D. B., Snibbe, S. S., Herndon, K. P., Robbins, D. C., Zeleznik, K. P. and van Dam, A. (1992) - 'Three-Dimensional Widgets'. Computer Graphics , 25, 183-188, 1992.

[2] Henry, T. R. and Hudson, S. E. (1990) - 'Multidimensional Icons'. ACM Transactions on Graphics, 9, 133-137.

[3] Jacoby, R. H. and Ellis, S. R. (1993) - 'Using virtual menus in a virtual environment'. In Course Notes 43 - Implementing Virtual Reality - pages 7.1 to 7.8. SIGGRAPH'93, 20th International Conference on Computer Graphics and Interactive Techniques (Anaheim, August 1993). New York: ACM.

[4] Serra, L., Ng, H. and Fairchild, K. M. (1993) - 'Building Virtual Realities with Bricks'. In Proceedings of Informatique'93, 2nd International Conference on 'Interface to Real and Virtual Worlds', Montpelier, France, 101-109, 22-26 March 1993.

[5] Singh, G., Serra, L., Fairchild, K. M. and Poston, T. (1993) - 'Visual Creation of Virtual Design Environments: Virtual Worlds Research at ISS'. Lab Report, ISS, National University of Singapore.