

# Definition and Evaluation of an Interaction Model for a Three-dimensional Interface

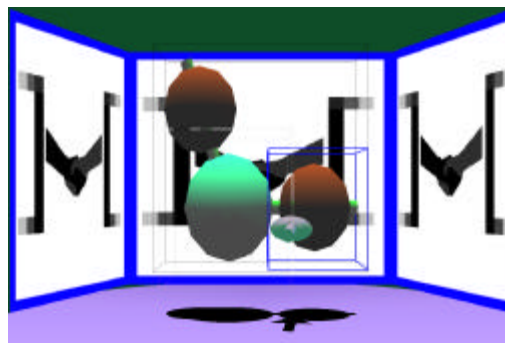
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## Abstract

We have elaborated a new 3D virtual workspace for distant meetings. 2D/3D documents can be integrated. The interaction must be generic so that the users can manipulate all documents in the same way. From real-time computer graphics techniques and users'abilities in a 3D virtual environment, we have defined a model on interaction together with the spatial organisation of the workspace. We emphasize the interaction based on two-handed direct manipulation, the use of two 3D input devices, simple metaphors, suggestive visual cues. Three experimentation tested our model. The first concerned the structure of the visual field and motor performances. The results show the latter is influenced by the visual context. The second one studies what are the relevant perceptible hints to enhance the pointing task performance according to the kind of input device used. The results show that isotonic devices are superior and that shadows are helpful to guide the action. The last one investigates the effect of shape of the shadow. The results suggest that the shape shadow was processing as a action's affordance.

## A 3D INTERACTION MODEL

We define navigation as changes in the user's point of view. Interaction refers to how the user acts in the scene: the user manipulates objects without changing his overall point of view of the scene. Navigation and interaction are intrinsically linked; in order to interact with the interface the user has to be able to move within the interface. Unfortunately, the existence of a third dimension creates new problems with positioning and with user orientation (Hinckley, 1994); these need to be dealt with in order to avoid disorienting the user. This is especially true for our interface, where the main objective is not to navigate within the interface, but rather to act on the interface. This entails designing a coordinate frame where navigation within a restricted space is adequate and easy. With an 3D isotonic input device (Zhai, 1998) like Ascension™ trackers, translation of the dominant hand's movement is immediately reflected in the interface by the pointer (figure 1). In a real life situation, users cannot go search for documents or tools without getting up from the table. With our room metaphor, the user does not have to navigate to find objects, he can select them directly with the pointer, it can be moved throughout the entire meeting room. Although the appropriate input device is available to the user he may still lose his pointer when moving around in the interface. There are several ways of dealing with this problem. First, pointer orientation is used to indicate any change in direction and to enhance the impression of movement. Secondly, we use shading effects and the pointer's shadow is projected onto the floor. This helps the user to perceive meeting room depth accurately and to get his bearings quickly and easily (Kersten, 1997).



**Figure 1:** pointer on an H<sub>2</sub>O molecule, with progressive bounding-boxes surrounding objects

Our model uses visual cues to show that an object has been selected or that it can be selected (figure 1): a graphical representation of a box appears progressively around the object. The closer the pointer is to the object,

the more the surrounding box is visible and closer to the object. This progressive bounding box system greatly simplifies the manipulation of the pointer.

Once an object is selected, the user may want to manipulate it. In order to maintain direct manipulation and to avoid widgets, we use an isometric device, a 3D trackball, in the non-dominant hand to apply actions to the object (like rotation, etc.). So, our model uses bimanual interaction (Kabbash, 1994), because the user has more interaction possibilities and it simulates reality. It should reduce dominant hand movement and thus increase precision for object manipulation (with the isometric device).

## EVALUATION

We show here the first experimentation but the poster will give the three experimentations that have tested our model at different levels of the conception. Recent developments for a 3D interactions showed that people had trouble in identifying the depth of a visual scene (Wanger & al, 1992; Carr & England, 1995) when using 3D input devices. The shadow enables users to infer both the position and the location of an object. The gap between an object and its shadow indicates the object's height above the ground plane. The location of a shadow on the ground plane indicates the object's distance. We hypothesize that shadow cues provided by objects and the dynamic shadow cues provide by the pointer influence the access to the depth and distance perception. They enhance the guidance for pointing an object in 3D scene and the pointing performance. The user is enabled to use static shadow and dynamic shadow information to guide actions, to achieve a particular goal and make decisions in a three-dimensional world.

The aim of this first experimentation was to analyse the effects of manipulating the contextual cues of depth on the accuracy of an aiming task. Expert and Novice subjects performed a pointing task in a three-dimensional environment. For this task, we used two kind of input devices : a combinaison mouse and keyboard, and isotonic device. The target was a cube presented in a 3D room. The 3D context is configured by three factors which are texture, dynamic shadow or no shadow to the pointer and static shadow or no shadow to the target. The pointer shadow is considered as the shadow follows the pointer moves. These three variables were allowed to build eight experimental conditions. The results have shown the superiority of using isotonic input device and the usefulness of the shadow for a guidance in a 3D computer environment.

## CONCLUSION

Our interaction model is able to exploit the advantages of two sorts of devices (isotonic and isometric). We can manipulate easily 3D documents. We plan to further evaluate our model, especially with two-handed manipulation.

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