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EXPLORING BRICK-BASED CAMERA CONTROL

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1 Introduction

BUILD-IT is a planning tool based on computer vision technology, with a capacity for complex planning and composition tasks (Rauterberg et al. 1997). The system enables users, grouped around a table, to interact in a virtual scene, using real bricks to select and manipulate objects in the scene (Fig. 1, left). A *plan view* of the scene is projected onto the table. A perspective view of the scene, called *side view*, is projected on the wall. The plan view contains a storage space with originals, allowing users to select new objects. Object selection is done by putting a brick at the object position. Once selected, objects can be positioned, rotated and fixed by simple brick manipulation (Fig. 1, right). They are de-selected, and stay put, when the brick is covered or removed. Objects brought back to the storage space are deleted.

Figure 1: BUILD-IT offers a *plan view* for combined action and perception, and a *side view* with a perspective of the situation (left). Projected objects can be positioned and rotated with a brick (right).

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2 Three-dimensional, brick-based camera control

Some basic issues of two-dimensional, brick-based interaction were previously explored by Fitzmaurice (1996). Bimanual camera control and object manipulation in three-dimensional (3D) graphics interfaces were explored by Balakrishnan and Kurtenbach (1999), using two mouses, screen and keyboard.

The innovative feature of BUILD-IT, beyond the brick-based interaction, is that the objects are part of a 3D scene. The use of the multimedia framework (MET++, Ackermann 1996), allows for full 3D interaction, including *shift*, *rotation*, *zoom*, *tilt* and *roll*. However, planar interaction with bricks provides only position and rotation information. Hence, there is a need to bridge the gap between planar interaction and 3D view control.

The exploration of an environment, or a product, is important in a range of composition and planning tasks, e.g. design of production lines, architecture and industrial design. To explore a 3D virtual world, it is essential to assume different point of views, to take an overview and to look at things in detail. This, at least, calls for a direct control of *shift*, *rotation* and *zoom* in *both views*.

One strategy which we considered was the use of a specialised brick, which would control a side view camera. This would require extending the properties sensed by the computer vision input. We want to explore software solutions, so this approach was not pursued. Instead, *active* virtual objects were introduced (Fjeld et al. 1999). Active objects feature *intelligent behaviour* and support *complex operations*.

Employing active objects, plan- and side view control were implemented. For each view, two alternative methods will be explored: GroundCatcher and FrameCatcher for the plan view, Camera and Window for the side view. Two of the methods, GroundCatcher and Window, are based on *scene* handling. The other two, FrameCatcher and Camera, are based on what shall be called *observer* handling.

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3 Plan view control: GroundCatcher and FrameCatcher

One brick offers shift and rotation, a second brick adds zoom (Table 1). Zoom is given by brick movements along a connecting line; other movements give shift and/or rotation. GroundCatcher (Fig. 2) updates the scene according to user action. One quits by removing bricks. FrameCatcher (Fig. 3) updates a frame of interest according to user action. When bricks are removed, the scene adjusts to the frame. Objects have no real-world analogues.

Table 1: GroundCatcher and FrameCatcher.

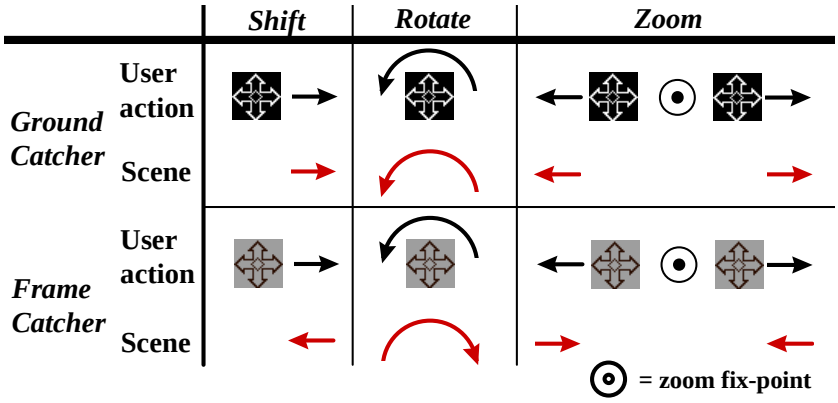

Figure 2: GroundCatcher: Introducing, using, and removing bricks (left to right).

Figure 3: FrameCatcher: Introducing, using, and removing bricks (left to right).

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4 Side view control: Window and Camera

One brick offers shift and rotation, a second brick adds zoom (Table 2). Camera (Fig. 4) sets the virtual camera of the side view. Handle distance sets zoom. Window (Fig. 5) sets the side view border. Scaling it sets the zoom.

Table 2: Camera and Window.

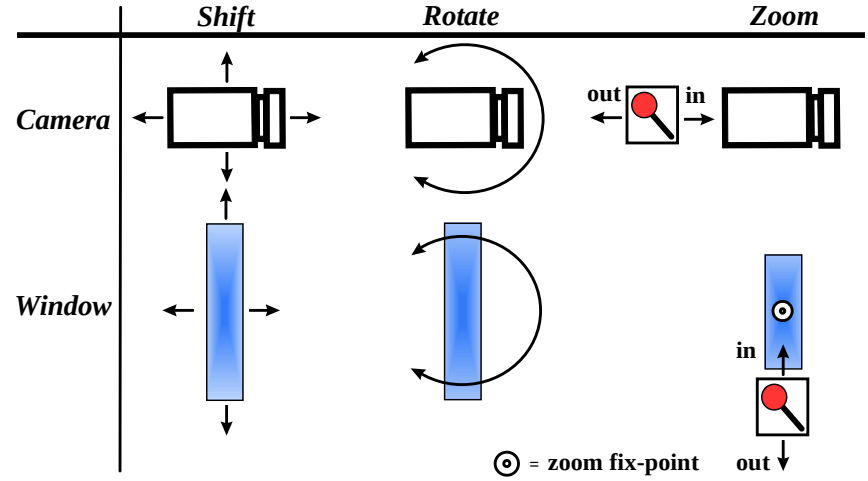

Figure 4: Camera handling: Zooming in (left) and out (right).

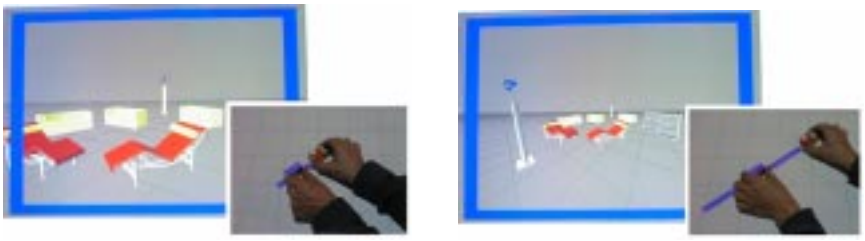

Figure 5: Window handling: Zooming in (left) and out (right).

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5 Usability studies

First, *inspection tasks*, conductive to exploration, will be generated. With these tasks, users are offered *one* (plan *or* side view), *two* (plan *and* side view), or *alternative* (more than two) control methods. For each set-up, mean task completion time will give *quantitative data*. For *subjective evaluation*, participants will be asked to rate their preference of each method after the experiments. We conjecture that methods based on *scene* handling are better than methods based on *observer* handling. Second, *composition task* experiments, following the same set-up, are planned.

6 Discussion and perspectives

Rotation with one brick requires an oriented brick form. GroundCatcher or FrameCatcher using two bricks do not rely on brick orientation. So it may be of interest to fit *form* to *operation*, by employing rectangular and circular bricks.

Zoom may be controlled by *one* or *both* bricks, raising the topic of *asymmetry* (Guiard, 1987). The same applies to the factors *tilt* and *roll* (Fjeld et al. 1999). Combinations of these factors, and their relation to one or two-handed interaction, will be explored in future research. Help may be found in the concept of time- and space-multiplexed input (Fitzmaurice, 1996).

7 References

Ackermann, P. (1996). *Developing Object-Oriented Multimedia Software*. Heidelberg: dpunkt Verlag für digitale Technologie.

Balakrishnan, R. & Kurtenbach, G. (1999). Exploring bimanual camera control and object manipulation in 3D graphics interfaces. *Proc. of the CHI'99,* ACM.

Fitzmaurice, G. W. (1996). *Graspable User Interfaces*. PhD at the University of Toronto, Toronto, Ch. 7.

Fjeld, M., Ironmonger, N., Voorhorst, F., Bichsel, M. & Rauterberg, M. (1999). Camera control in a planar, graspable interface. *Proc. of the 17th AI, IASTED.*

Guiard, Y. (1987). Asymmetric division of labour in human skilled bimanual action: The kinematic chain as a model. *Journal of Motor Behaviour*, 19, 486-517.

Rauterberg, M., Bichsel, M., Meier, M. & Fjeld, M. (1997). A gesture based interaction technique for a planning tool for construction and design. *Proc. of the RO-MAN'97,* 212-217, IEEE.