

# Navigation Methods for an Augmented Reality System

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## ABSTRACT

BUILD-IT is a planning tool based on computer vision technology, supporting complex planning and composition tasks. A group of people, seated around a table, interact with objects in a virtual scene using real bricks. A plan view of the scene is projected onto the table, where object manipulation takes place. A perspective view is projected on the wall. The views are set by virtual cameras, having spatial attributes like shift, rotation and zoom. However, planar interaction with bricks provides only position and rotation information. This paper explores two alternative methods to bridge the gap between planar interaction and three-dimensional navigation.

## Keywords

Augmented Reality, ubiquitous, tangible, groupware, interaction, design, bricks, navigation, viewpoint control

## INTRODUCTION

We present two alternative navigation methods for a brick-based Augmented Reality (AR) system. The given examples have been implemented with the BUILD-IT system [4, 6]. BUILD-IT enables users, grouped around a table, to interact in a virtual scene, using real bricks to select and manipulate objects in the scene. Users have two up-to-date views of the scene: the plan view and the side view (Fig. 1). The plan view is the bird's eye view from above; the side view is the human eye's view from the side. The system consists of a rack with a mirror, a camera, a computer, two projectors and several bricks. A virtual storage space, or menu, allows users to create and delete objects. This menu also offers the navigation methods.



Figure 1. Plan and side view (left); object handling (right).

The innovative feature of BUILD-IT, beyond the brick-based interaction, is that the objects are part of a three-dimensional (3D) setting [4]. Two-dimensional, planar brick-based interaction has already been explored [3, 7]. Also, bimanual camera handling and object manipulation in 3D graphics interfaces has been investigated [2] using two mice, a keyboard and a screen. Here, we combine the strengths of these two approaches.

The exploration of an environment or a product is important in a range of composition and planning activities, for instance design of production lines and walkthroughs of architectural simulations [4]. To explore a 3D virtual world, a set of operations are required. It is necessary to assume different points of view, to get an overview and to look at things in detail. With BUILD-IT, the use of a multimedia framework [1] allows for *full 3D* interaction, including *shift, rotation, zoom, tilt* and *roll*. However, planar interaction with bricks provides only position and rotation but not height information. Hence, there is a need to bridge the gap between planar interaction and 3D, spatial navigation [4]. In a first approach, a *full 3D* control of the side view was explored [5].

Searching for a general answer to this problem, applicable to both views, we explored different ways of handling a virtual scene [4]. Based on the idea of grabbing and handling a virtual world directly, we implemented the *Continuous Update* method. Based on the idea of handling a virtual viewpoint and then updating the virtual scene, we implemented the *Select and Reframe* method.





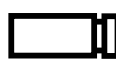

	Continuous Update	Select and Reframe
Plan view control 	<i>GroundCatcher</i> 	<i>FrameCatcher</i> 
Side view control 	<i>Camera</i> 	<i>ViewFrame</i> 

Table I. *Continuous Update; Select and Reframe.*

Each method consists of two tools, one for the plan and one for the side view control (Table I). The tools are offered in the virtual storage space (Fig. 1, right). By employing one brick - unimanual handling - *shift* and *rotation* of the controlled view can be set. By employing two bricks - bimanual handling - *shift, rotation* and *zoom* of the controlled

view can be set (this case will be shown here). Both tools of a method can be used at a time. However, only one tool per view can be activated and used at a time.

#### METHOD 1: CONTINUOUS UPDATE

As soon as the *GroundCatcher* (Fig. 2) is selected from the menu and placed, it locks to the scene. All subsequent handling affects the plan view. To quit the tool, the bricks are covered and removed.



Figure 2. *GroundCatcher*: Placing bricks; view handling; removing bricks (left to right).

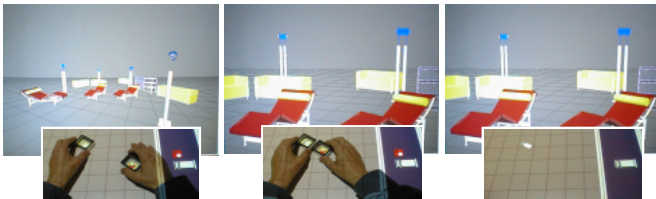


Figure 3. *Camera*: Consecutive zoom handling steps (left and center); removing bricks (right).

By selecting the *Camera* (Fig. 3) from the menu, the part of the scene shown in the side view can be set. A zoom handle is selected with a second (here: right hand) brick. By moving the zoom handle and the camera further apart, the side view can be enlarged; by moving them closer, the side view can be focused. Covering and removing the second brick freezes the zoom. The *Camera* remains visible and accessible in the scene.

#### METHOD 2: SELECT AND REFRAME

When the *FrameCatcher* (Fig. 4) is selected from the menu, the scene automatically is zoomed out to show a wider context. As soon as the *FrameCatcher* is placed within the frame, it locks to the frame. All subsequent handling affects the frame and the desired part of the scene can be selected. Covering and removing the brick triggers a reframe of the view, responding to user selection.



Figure 4. *FrameCatcher*: Placing bricks (left); selection (center); reframe (right).

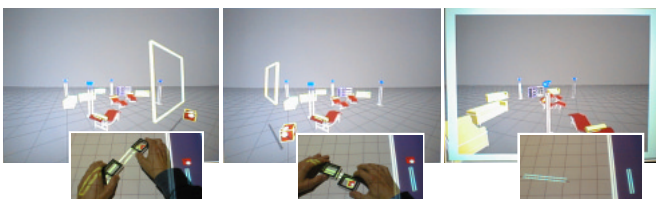


Figure 5. *ViewFrame*: Consecutive selection steps (left and center); reframe (right).

When the *ViewFrame* (Fig. 5) is selected from the menu, the side view automatically is zoomed out to show a wider context. The desired part of the scene can be selected. A zoom handle is selected with the second brick, thus resizing the window. Covering and removing the second (here: right hand) brick freezes the zoom. Covering and removing the first brick triggers a reframe of the side view, responding to user selection. The *ViewFrame* remains visible and accessible in the scene.

#### DISCUSSION AND FUTURE WORK

To evaluate how the methods may enhance exploratory latitude, and thereby user performance, target selection and object docking tasks [2] will be generated. These tasks must call for bimanual navigation of the plan *and* the side view. Users will be offered one or both methods. Task completion time will indicate user performance. To control the results, participants will be asked to rate their personal preferences.

For reasons of continuous feedback and a lower number of operations, we expect *Continuous Update* to deliver higher performance than *Select and Reframe*. However, we also suspect that users may prefer to combine tools from both methods. For different phases of task solving activity, users may even prefer to choose among all the tools.

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