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The 'City Game' An Example of a Virtual Environment for Teaching Spatial Orientation

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Abstract: Spatial orientation is an important ability, which should be facilitated in geometry courses of elementary schools. A preferred approach (in Germany) typically involves navigation and orientation tasks with pictures of a town and city maps depicted in a book. Because of increasing use of computer systems in schools, it is very interesting to explore the value a virtual environment possesses for teaching spatial orientation. This articel describes the 'City Game', a computer-generated, virtual 3D city, developed for teaching spatial orientation in elementary schools, and an informal study to see first reactions of children and adults when using the 'City Game'.

Key Words: spatial orientation, children, teaching, virtual environment, virtual city

1 Introduction

We are developing an educational software system to teach children (grades three to four) spatial orientation in two and three dimensional space. We understand the term 'spatial orientation' as the ability of a person to find physically and mentally one's way in two- and three-dimensional space [Maier 94]. Facilitating spatial orientation in two and three dimensional space is one important aspect of geometry in the mathematics curriculum of elementary schools in the state Nordrhein-Westphalia of Germany. Spatial orientation is an important ability for understanding, interpreting and developing the world in which the children live.

The current media-based approach (in Germany) of teaching spatial orientation typically involves pictures of a town depicted in a book. The used perspective projections of the three dimensional buildings awake an impression of their real three dimensional counterparts. Children are given tasks of navigation and orientation inside the town, using these perspective projections together with two dimensional city maps. They are also encouraged to accomplish the same tasks in the real world, using a map to navigate through their home towns.

2 The ’City Game’

The development of the ‘City Game’, a game to orient and navigate through a virtual city (see Figure 1) on a computer, is an interdisciplinary project between the didactics group and the computer science group at our university.

Figure 1: The City

To implement the ‘City Game’ we have chosen VRML 2.0, the Virtual Reality Modeling Language[1]. The complex scenes of the city are modeled with Cosmo™ Worlds, a powerful editor (and free on Silicon Graphics™ workstations) to create VRML worlds. The ‘City Game’ consists of a realistic city structure and typical buildings and objects of a city. Animated objects such as a bus or a train enliven this virtual city. Navigation through the city, along the streets, can be done interactively with various navigation aids, e.g.

- a 2D-map (bird’s view), which shows the actual position of the user in the city and optionally displays the path covered so far
- road signs and a hard-copy of the city map
- a wind rose for orientation with the four directions of the compass (Figure 2)

1. “International Standard (ISO/IEC 14772) file format for describing interactive 3D multimedia on the Internet." *(http://vrml.org/Specifications/)*

Interactive navigation can be done by the standard mouse and direction buttons (forward, backward, left and right) and is implemented through viewpoint animation by automatically keeping the viewpoint at a fixed height.

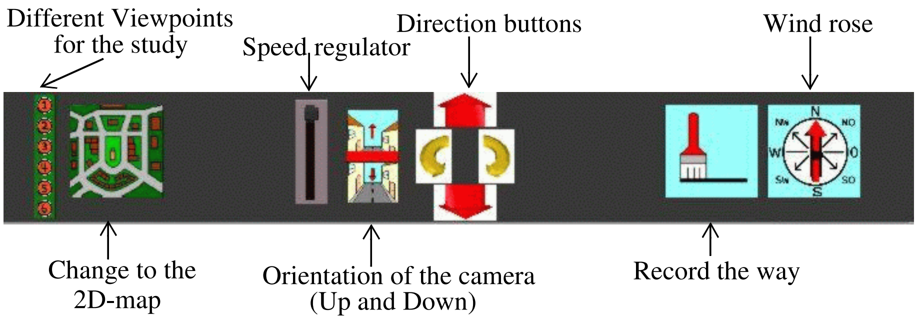

Figure 2: Navigation and Interaction Control

One of our main interests in the ’City Game’ is the value it possesses for teaching children spatial orientation. The use of virtual reality to improve human abilities in the real world has been proven to be successful in other areas as well, such as the overcoming of phobias by training subjects in virtual reality [Strickland et al. 97]. Interest of the computer science group also expands to general requirements of using virtual worlds as teaching tools.

3 A First Informal Study

A first informal study was performed to see reactions of children and adults when using the ‘City Game’. Another goal was to determine what kind of features children use for orientation as compared to adults. The study included ten children (grade four) of an elementary school and ten university students. Each group consisted of five male and five female subjects. In this study subjects had to find their way from different initial positions to different target positions. Each trial should be performed with a different help or method, e.g. with the city map, with photos along the way to be found, with the wind rose or by backtracking a way that was shown before. Additionally after each trial and each session different questions were asked for reviewing the tasks and the ’City Game’, e.g. “What are you remembering of the city?“

Before beginning the study each subject was shown a walk through the city and taught the use of the direction buttons. The subjects were asked "to think aloud"[2] during performing their tasks. The comments were recorded by video and in written notes by the evaluator.

4 First Results

An unexpected result was that adults and children hardly used road signs and the city

2. A common evaluation technique of user interface design.

map for orientation in the virtual city. Their orientation occurred mainly through buildings with particular characteristics (e.g. function, size or color). An explanation may be the relatively small number of streets and the great number of particular buildings. Also the experience with three-dimensional computer games might influence the behavior of the subjects. Mostly the navigation help of such games are objects and directions. The buildings used recurrently for orientation were the museum with a large dinosaur in front, the church, the city hall, and the school.

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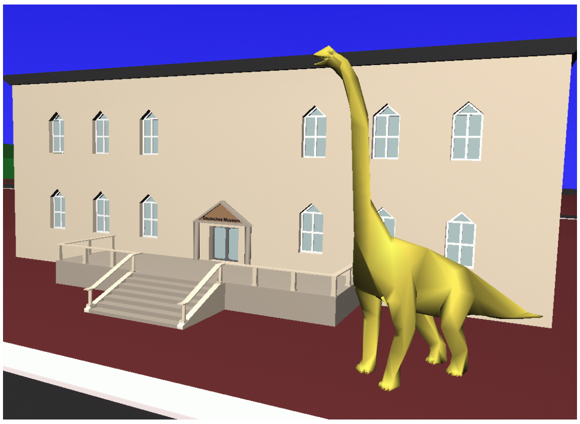

Figure 3: The museum with a large dinosaur

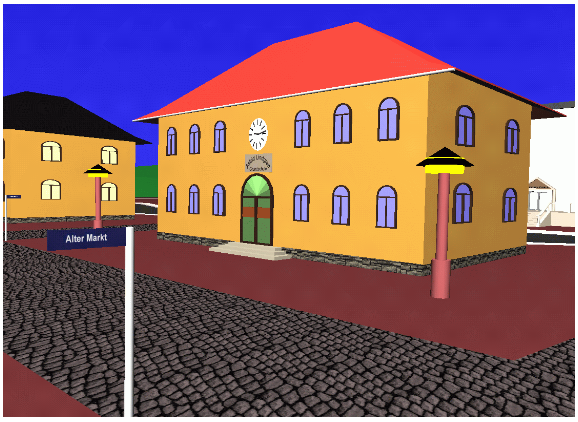

Figure 4: The school

Differences between the children and the adults occurred when they were asked to remember objects of the virtual city immediately after the session. The buildings mostly named by the children were (by decreasing frequencies): the museum with the dinosaur (Figure 3), the school (Figure 4), and the church. In contrast, the major buildings named by the adults were: grocery, petrol station (Figure 5) and church, and museum. This leads to the assumption that children and adults use different objects for orientation dependent on subjective perception and the experience in daily life.

One important result was that subjects (both children and adults) often focused on the navigation tools (mouse and direction buttons) rather than on their tasks. Nevertheless the reactions of the subjects were very positive to the ‘City Game’, specifically to the structure of the city, the appearance of buildings and details. Some of the subjects suggested populating the streets with people, who can be asked for directions.

Figure 5: The petrol station

Based on this preliminary study and the extensive development of the ‘City Game’, we are starting a series of further tests of teaching spatial orientation in virtual environments. We are currently improving the navigation tools of the ‘City Game’ to develop a more intuitive navigation control to simulate a natural walk through the city. Formal studies based on more specific hypotheses will give us a deeper insight into the navigation feature used by children and adults in virtual and real environments.

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