

# Non-visual Zoom and Scrolling Operations in a Virtual Haptic Environment

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**Abstract.** This article reports results from tests performed to investigate three different designs of a scrolling function that make it possible for the user to navigate a virtual environment larger than the limited workspace of the haptic device. A preliminary zoom function was also tested. The results indicate the proposed zoom function to be intuitive and that different sizes are used for different purposes. All three scrolling functions were found to be useful. The choice of scrolling function also appears to depend on the task.

## 1 Background and introduction

In most haptic virtual environments for the blind, the working area of the haptic device (such as the PHANToM) limits the size and complexity of the virtual environment that can be displayed.

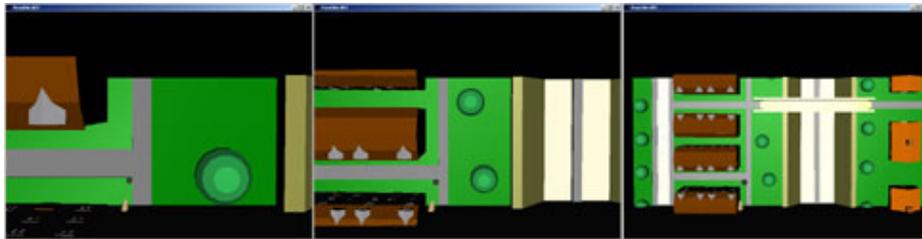
Realistic haptic environments, on the other hand, often need to be quite large. To solve this problem, one could either use a haptic device with a large working area or provide some way of scrolling and/or zooming in the virtual environment. One-point haptic non-visual scrolling and zooming has not been explored to any great extent. Within the ENORASI study described in [1], however, a simple scrolling function was tested by a subset of the test users. Zoom functions to gain access to greater detail in virtual haptic line graphs are also suggested by Roberts et al [2].

In a project entitled “Haptics and Traffic – A Pre-study”, we are investigating if and how virtual traffic environments can be made accessible for blind users with the help of haptics and sound. With a virtual traffic environment, a blind user could safely investigate different traffic environments and situations. In 1999, Van Scoy et al [3] suggested a similar project. In our project, different ways to move/scroll the haptic world, preliminary zooming, the design of sound feedback and environmental sounds are being investigated in separate user tests. As a final test, a virtual model of a limited section of a real traffic environment will be built and the way users interact with this environment will be tested.

## 2 Method

Preliminary zoom and scroll tests [1][4] indicate that the user needs to stay in contact with the virtual world when scrolling. Based on these results, we chose to make the following zooming and scrolling tests.

The virtual test environment is a model world with representations of houses, roads, walkways, a freeway and grass (see Fig. 1). The working area is contained within a limiting box, and the entire virtual environment is constrained by high walls to prevent the user from accidentally sliding off the world. Spoken sound labels are provided for the different objects, house addresses and road names. All surfaces have friction. The ReachinAPI has been used for the implementation.



**Fig. 1.** The virtual test environment shown in 3 different zooming sizes: 100%, 50% and 25% (from the left).

Six users performed the tests (five sighted blindfolded users, one blind user). They first familiarized themselves with the PHANToM and then were allowed to explore the virtual environment and the sound label functions. During this first exploration, a fixed 25% zoom was used and scrolling was disabled. After the initial exploration, the zooming function was tested. Four different zooming sizes were provided (100%, 50%, 25% and 10%). Keys F1-F4 were used to change between the different zoom sizes. The zooming operation did not change the relative x-z PHANToM position in the virtual world and the y coordinate of the ground was kept constant.

The scrolling test consisted of three different scrolling functions:

1. Pushing the limiting box: The user could press the sides of the limiting box. The world was then moved so that objects behind the wall being pressed were moved into the limiting box. Pressing the right wall would thus move the entire world to the left.
2. Using arrow keys on the keyboard: The user could press the different arrow keys to move the world in the direction of the key, i.e., pressing the right arrow moved the world to the right.
3. PHANToM drag: The user could press a button on the PHANToM stylus, and then drag the world along the horizontal plane. With this function the user is at the same position relative to the world before and after the scroll operation.

The user received auditory feedback (sound from a sliding rock) when the world moved. Pressing the space bar disabled the scroll operations, in which case the audi-

tory feedback also changed. Finally, the user was asked to perform a navigation task from one address in the virtual world to another. The aim of this final test was to see what different scrolling and zooming operations were used in a more complex task. During all parts of the tests, the user was asked to think aloud and comment on the tasks. After each test, the user was also asked to rate the difficulty of the operation.

### 3 Results

All users could handle the zoom function. They were observed to use it the way it was intended, and they did not in general appear to get lost after the zooming operation. They would put the PHANToM point on the ground next to an object in the world, zoom, and then explore this object in the new size. The users were asked to rate the difficulty of this task on a scale 1 (very easy) to 5 (very hard), and no user rated it at 5. The average rating was 3.4 and the highest rating (4.5) was obtained from the user that had most problems with the PHANToM (user 3 in the tables below). Despite this, the user was observed to be able to zoom in on a selected object. The 10% size suffered from technical problems and users would often fall through (cf. [1], [5]). Only users 1, 2 and 4 in the tables below commented on this size. User 2 thought it too small, while both user 1 and 4 expressed that it could be useful for generating an overview. User 1 also commented on the possibility of reducing the amount of detail in this size.

**Table 1.** User ratings of scroll functions (1: very easy to 5: very hard). Grey squares indicate the least preferred functions. User nr 1 (pilot) rated the task differently.

User nr	Arrow keys	Limiting box	PHANToM drag
1	not natural	natural	most natural
2	1.5	4	1
3	3	4	5
4	2	3	1.5
5	4	4	5
6	4	5	5

**Table 2.** Completion time for the final test in minutes along with the scroll functions and zoom sizes used.

User nr	Time (min.)	Scroll used	Zoom used
1	3	Limiting box	50%, 25%
2	6	Limiting box	50%, 25%
3	13	Limiting box	50%
4	4	Limiting box	25%
5	7	Limiting box	50%, 25%
6	8	Limiting box	100%, 50%, 25%

It turned out that the users preferred different scrolling functions (see Table 1). For the final test (to navigate from Cross Street 1A to Border Road 4), the overall results are shown in Table 2.

#### 4 Discussion and conclusions

The zoom function appeared to be fairly intuitive to use for the users included in this test. All users could handle it, although they used the different sizes for somewhat different purposes. The 25% size was the preferred size used for navigation, while the 100% and 50% were used more for the investigation of details in the model. The tests indicate that a working 10% size may be useful, particularly if the amount of detail is reduced.

Contrary to our original expectation, which was to find one, or at most two preferred scroll functions, it turned out that all three were useful. When exploring the world, the one scroll function liked by all sighted users was to move the world with the arrow keys on the keyboard. Pushing the limiting box or dragging the world with the PHANToM was less popular, but still found useful. The greatest difference in opinions was found for the drag function, as some users found it close to impossible while others liked it very much. The blind user thought this scroll function was the most natural one, and one of the sighted users commented in particular that this function allowed a user to adjust uncomfortable working positions. In the final navigational test, the pattern was different. Here all users pushed the limiting box to move the world. This is not necessarily inconsistent with the previous ratings, as the tasks (exploration and navigation) are different. Our conclusion is that all these scroll functions are useful, although it is possible that the drag function should be considered an advanced feature suitable for experienced users.

#### References

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