# Distance Estimation in Virtual Reality: The Effects of Overview Maps

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## ABSTRACT

Peoples' perception of distance is inaccurate in both real and virtual environments; here, we focus on identifying ways in which these estimations can be improved in Virtual Reality. In this study, overview maps are investigated as an aid to distance estimation, used within the context of a virtual environment for the Sorbas region in S.E. Spain.

## INTRODUCTION

The fact that distance is frequently underestimated in both real world environments and Virtual Environments (VEs) is well documented (Proffitt, 2006; Interrante et al., 2008). However, most of the research performed on this subject to date has been within structured environments, either indoors or in urban or abstracted VEs (Ruddle et al., 1999) as opposed to large scale rural areas. The small volume of literature available suggests that providing a range of motion models and observer points can aid in navigational tasks while travelling within a VE (Wu et al. 2009), but whether providing multi-scalar information can improve observational distance estimations is not currently known.

The purpose of this study is to develop tools that aid the estimation of distances, such as multi-scale overview maps, and to investigate whether these tools can improve estimations of observational distance (the distance between two points as viewed by a person). Our focus lies initially with the overview map, and an investigation of the detailed aspects and functionality relating to the approach that might be required.

## METHODOLOGY

### Study area and development of the virtual landscape

The environment used for the experiment is a virtual representation of the Sorbas region in south-eastern Spain. Data relating to contour information, road and river networks, buildings and land use were all manipulated within a proprietary GIS to create raster and vector representations of the significant features in the landscape. Bionatics™ Blueberry™ modelling software was then used to create the terrain and features; this program accepts GIS datasets in order to create terrain representations using procedural geometries. An image from the environment can be seen in Figure 1.

***Figure 1:*** Sorbas model, showing vegetation, and a primary road (centre left to right)

## Implementation of distance estimation support measures

We adopted a 2-dimensional map representation of the environment, portrayed in a graphical manner within a window inset. Perhaps surprisingly, in a VR environment such 'overview' maps have previously only presented information at one scale (Wu et al., 2009); in this case, we adopt an approach whereby the user interactively controls the level of zoom in the sub-window (Figure 2).

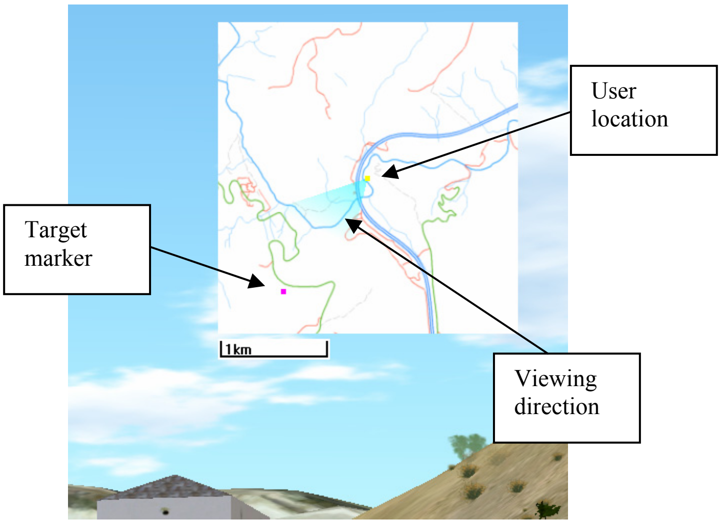


***Figure 2:*** Partial view of the VR screen, highlighting the area of the overview map

The overview maps were developed with ArcMap™ and then exported as images. These images were then used as textures on a geometric primitive (the placeholder for the map), programmed into the environment using VegaPrime™ C++ libraries. To give the effect of scaling the maps, functionality has been inserted to allow user interaction (via a mouse) which dynamically alters the size of the texture whilst leaving the placeholder the same size resulting in a zooming effect.

## User trials

To analyse the effectiveness of introducing an overview map into the environment, several representations of the overview approach will be undertaken, each allowing for different interaction and presenting different information:

- The first instance does not display the overview map;
- The second presentation shows an overview of the environment, with scale bar. However, in this case, the map within the sub window will be fixed to show the entire region in small scale;
- The third representation shows an overview map and scale bar, dynamically scaled to show more or less of the surrounding environment through deliberate user interaction (with a mouse).

Because people find larger distances more difficult to estimate than closer ones (the error range in estimations increases with respect to distance) (Witmer and Kline, 1998), distance to a variety of markers at varied locations is controlled in the trials.

The main method of collecting information regarding the effects of the different types of overview maps will be a series of user trials. In these, the user will be placed within the virtual environment and will visually estimate the distance from their viewing location to a marker found somewhere within the extent of the viewshed. Users will be asked to provide (recorded) verbal feedback regarding their strategies for distance estimation throughout the process. For example, when a building is present in the scene, the test subject may attempt to use this rather than the overview map when gauging the distance to a marker. Further, after completion of the estimation tasks, each user will undertake a short interview to provide more general insight as to why a particular approach may or may not have improved distance estimation.

In order to avoid learning bias within the later main study, each user will undertake only one trial and will then move on to a post trial short interview.

## CONCLUSIONS

In sum, it is clear that the estimation of observational distances in VR is frequently highly erroneous. However, there is little in the way of research exploring how we might improve these estimations within VR; a gap that this study seeks to fill.

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