# Navigation Modes in Virtual Environments: Walking vs. Joystick

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## 1 Introduction

There is considerable evidence that people have difficulty maintaining orientation in virtual environments. This difficulty is usually attributed to poor idiothetic cues, such as the absence of proprioception and other sources of information provided by self locomotion. The lack of proprioceptive cues presents a strong argument against the use of a joystick interface, and the importance of full physical movement for navigation tasks has also recently been confirmed by Ruddle and Lessels [2006], who showed that subjects performing a navigational task were superior when they were allowed to walk freely rather than when they could only physically rotate themselves or only move virtually. Our study seeks to confirm the results of Ruddle and Lessels.

However, Ruddle and Lessels used a desktop monitor for their *visual only* condition and a head-mounted display (HMD) for the other two conditions. Display type has a strong effect on many tasks, so we do all tasks on an HMD. Also, the Ruddle and Lessels environment included a simulated rectangular room that was always visible.People are sensitive to environmental geometry, but the exact effect on navigation is an active area of research [Kelly et al. 2008], therefore our environment omitted any such cues.

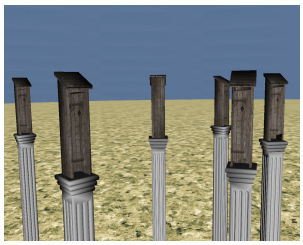

Figure 1: Virtual environment used in the experiment.

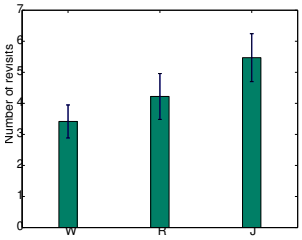


Figure 2: Number of revisits per condition.

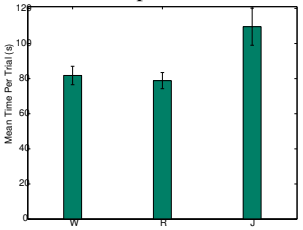


Figure 3: Average time per trial per condition.

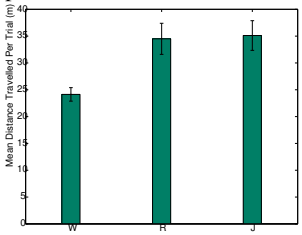


Figure 4: Distance traveled per condition.

## 2 Methods

Twelve subjects (six male) aged 23–35 participated. Subjects wore a full color stereo NVIS nVisor SX Head Mounted Display with 1280 x 1024 resolution per eye, and a field of view of 60° diagonally. Subjects also wore headphones through which random noise was played to remove any sound artifacts from the room that might provide orientation cues.

At each trial in the experiment, participants saw a virtual scene that consisted of 16 identical objects ("birdhouses" atop pedestals), half of which contained red balls as target objects. The positions of the birdhouses was randomly distributed in each trial in 2m radius circle according to a Poisson-disk distribution. The orientation of the birdhouses was also randomized. The ground plane provided strong optic flow but no orientation cues (Figure 1).

Subjects started in the center of the environment, holding a joystick. Their task was to find all eight red balls without revisiting any birdhouse. Upon approaching a birdhouse, the subject pressed a joystick button and the birdhouse became momentarily transparent, revealing its contents. If the birdhouse contained a red ball (target), a success sound was played through the headphones and the target ball's color changed to blue. If it contained no target, a sorry sound was played and a blue target ball appeared in the birdhouse. If the birdhouse had been visited before, a revisit sound was played, and the blue target ball was shown. Subjects continued a trial until all eight target balls were found or until eight consecutive revisits without finding an unvisited target ball occurred.

Subjects locomoted through the environment in one of three ways. In the first condition they walked (W). In the second condition they used the joystick to translate, but physically rotated their bodies to change orientation (R). In the third condition, they used the joystick to both translate and rotate, and no physical movement occurred (J). One training trial followed by three experimental trials occurred in each condition, with the orders counterbalanced, and the experiment conducted within-subjects.

## 3 Results

The number of revisited targets versus condition is shown in Figure 2. Subjects were marginally better in the walking condition than in other conditions ($F(1,11) = 2.88$, $p = .07$, $\eta^2 = .21$). Subjects were significantly slower in the joystick condition than in other conditions ($F(1,1)=5.44$, $p = .01$, $\eta^2 = .33$) (Figure 3). Subjects traveled significantly less distance in completing the task in the walking condition than in other conditions ($F(1,11)=4.28$, $p = .03$, $\eta^2 = .28$) (Figure 4). In general, we conclude that walking seems a better method for locomotion in virtual environments than locomoting with a joystick.

## References

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