Identification of Out-of-View Objects in Virtual Reality

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ABSTRACT

Current Virtual Reality (VR) devices have limited fields-of-view (FOV). A limited FOV amplifies the problem of objects receding from view. In previous work, different techniques have been proposed to visualize the position of objects out of view. However, these techniques do not allow to identify these objects. In this work, we compare three different ways of identifying out-of-view objects. Our user study shows that participants prefer to have the identification always visible.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in HCI*; *Visualization techniques*;

KEYWORDS

Out-of-view; Visualization; Identification; Virtual Reality

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1 INTRODUCTION

Over the past few years, head-mounted Virtual Reality (VR) devices have been steadily advancing. However, the limited field-of-view of Virtual Reality devices leads to objects receding from view. This is a problem because users cannot perceive the positions of these out-of-view objects. Different techniques have been proposed to address this problem (e.g., *EyeSee360* [1]). However, these techniques do not allow users to identify the visualized out-of-view objects. In this work, we compare three different ways of identifying out-of-view objects. Therefore, we added labels to the proxies (dots that represent out-of-view objects in *EyeSee360*) that are either always visible, only show up when gazed at or show up when gazed at and an additional button is pressed.

2 EXPERIMENT IN VIRTUAL REALITY

2.1 Study design

To evaluate the identification of out-of-view objects in the visualization technique *EyeSee360*, we conducted a within-subjects controlled laboratory study in VR using EyeMR [2]. We investigate whether the dependent variables, identification error and subjective performance, are influenced by the independent variable Identification (always visible vs. on-gaze vs. on-gaze + button pressed).

2.2 Procedure

Our experiment started with a short introduction into out-of-view objects and VR. Then, each condition was tested in a block with ten trials (counter-balanced). In each trial, we randomly placed five objects out of view with their position visualized in *EyeSee360*. Each out-of-view object (proxy) got a label assigned (between 5 to 8 letters). Afterwards, we asked to select an out-of-view object with a randomly chosen label. Participants could select these objects by locating them out of view and pressing a button on the remote control. After all trials, participants were asked to fill out our individual subjective questionnaire and a demographic questionnaire. Overall, each participant took approximately 25 minutes to finish the experiment.

2.3 Participants

We recruited 12 participants (7 female), aged between 20 and 29 years (M=25.92, SD=2.19). None suffered from color vision impairments, all had normal vision.

2.4 Results

The percentage of identification errors are: always visible 14.17% (17/120), on-gaze 16.67% (20/120) and on-gaze + button-pressed 10.83% (13/120). The high error rate for always visible was mainly caused by overlapping with other labels. We asked participants to rate how they could perceive the identification for each method: always visible (Md=5, IQR=1.5), on-gaze (Md=4, IQR=2) and on-gaze + button-pressed (Md=3, IQR=0.5).

3 CONCLUSION

In this work, we compared three different ways to identify objects out of view. Subjectively, participants preferred to have the identification always visible, while they made the least errors when using a combination of gaze and button pressed. In future work more interaction methods (e.g., speech) can be investigated.

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