ABSTRACT

Human Navigation Performance Using 6 Degree of Freedom Dynamic Viewpoint Tethering in Virtual Environments

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This thesis investigated human navigation performance in relation to various display viewpoint configurations. Previous research on egocentric and exocentric viewpoints identified a performance trade-off between two navigational sub-tasks, i.e. local guidance and global awareness. It is the goal of this study to design a viewpoint that seamlessly integrates information from both the egocentric and the exocentric frames of reference, thus facilitating users' local navigational guidance and global spatial awareness simultaneously. The proposed solution is *dynamic viewpoint tethering*, an algorithm that supports the attaching of a viewpoint to an avatar through an elastic tether.

Three experiments have been completed in this study to investigate how various dynamic tether configurations affect users' navigational performance. The highlights of the results can be summarized very briefly as follows:

1. Modeled as a mass-spring-damper system, dynamic viewpoint tethering provides a wide design space for characterizing display efficiency. By exploring the dynamic tether space, tethered viewpoints with various configurations can be constructed to accommodate different navigational task requirements.

2. As a way of seamlessly integrating information from egocentric and exocentric frames of reference, dynamically tethered viewpoints appear to support both local guidance and global awareness navigational subtasks simultaneously.

3. Local guidance performance is greatly affected by the tether dynamic parameters, i.e. the tether spring constant and its damping coefficient. An optimal tether setting appears to be a critically damped configuration with a rigidity value in the intermediate range.

4. Performance in both local guidance and global awareness are significantly affected by the length of a tether. With an increase of tether length from its minimum value, improvements in global awareness and reduction in local guidance performance are observed. The overall best navigational performance appears to be supported by an intermediate length dynamically tethered viewpoint.

Design guidelines generated from this study are expected to provide general support for navigational display system implementation. Furthermore, the experimental data should advance our understanding of human navigation behaviour in virtual environments.