AnyOrbit: Fluid 6DOF Spatial Navigation of Virtual Environments using Orbital Motion

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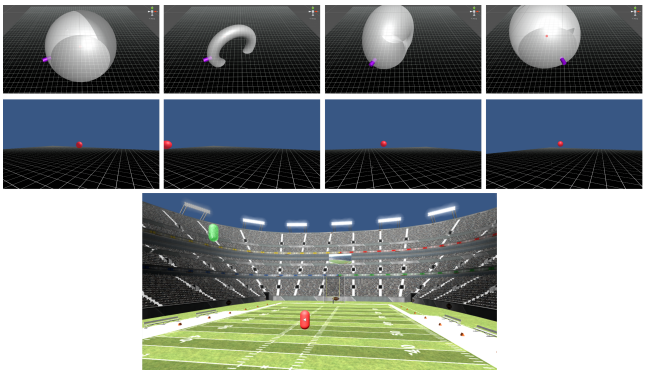

Figure 1: Left: Orbital motion on toroidal surface. Right: Virtual environment used for evaluation.

ABSTRACT

Emerging media technologies such as 3D film and head-mounted displays (HMDs) call for new types of spatial interaction. Here we describe and evaluate AnyOrbit: a novel orbital navigation technique that enables flexible and intuitive 3D spatial navigation in virtual environments (VEs). Unlike existing orbital methods, we exploit toroidal rather than spherical orbital surfaces, which allow independent control of orbital curvature in vertical and horizontal directions. This control enables intuitive and smooth orbital navigation between any desired orbital centers and between any vantage points within VEs. AnyOrbit leverages our proprioceptive sense of rotation to enable navigation in VEs without inconvenient external motion trackers. In user studies, we demonstrate that within a sports-spectating context, the technique allows smooth shifts in perspective at a rate comparable to broadcast sport, is fast to learn, and is without excessive simulator sickness in most users. The technique is widely applicable to gaming, computer-aided-design (CAD), data visualisation, and telepresence.

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1. PAST WORK AND IMPLEMENTATION

Orbital movement is ubiquitous in CAD software where it is instantly intuitive and suited to observational tasks [2]. Orbiting was first used with HMDs by Chung et al., where head orientation controls the angle, and the radius is fixed or controlled using an input [1]. Tan combined orbiting with flying and other 'modes' [3].

Previous techniques confine the user to a spherical surface, however, we position the user on the surface of a torus (figure 1), which allows the control of the horizontal and vertical radii of curvature individually, such that as the user rotates their head, they move on a spiral trajectory towards a spherical orbit about any chosen new point-of-interest (the red dot shown in figure 1).

2. EVALUATION

A study of 13 inexperienced users (9 male, age $= 25.9 \pm 3.2$) evaluated AnyOrbit for simulator sickness and performance. Users were tasked with navigating between positions and facing directions in a VE (figure 1) representing camera angles typical of broadcast sport, in 3 trials of 5 minutes each. Users averaged 14 ± 8.6 seconds per task. In addition, an expert user completed tasks in 3.8 ± 1.2 seconds. This compares to 5 to 11 seconds for average shot lengths in sport broadcasts. There was a measurable increase in Simulator Sickness Questionnaire (SSQ) scores after the first 5 minute trial, but no significant increase on subsequent VE exposure.

3. CONCLUSION

We have presented an algorithm for allowing smooth navigation between orbital trajectories in VEs using HMDs, and 6DOF navigation and perspective selection. The technique is quick to learn and does not cause excessive simulator sickness in most users. The technique is well suited to future 3D sports media formats, storytelling in VEs, and spatial navigation tasks.

4. REFERENCES

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