Motion Sickness

Most of us have experienced motion sickness, for instance in cars or on ships. Motion sickness also arises in simulators, and is potentially a "show-stopper" for the young virtual environments industry.

The standard "sensory rearrangement theory" holds that motion sickness arises from conflicting motion cues, either between different sensory channels or between expected and experienced stimuli. In a simulator, for instance, one often has visual cues indicating that one is moving, but not inertial ("physical") motion cues.

In a line of thought closely related to our work on Class A ("objective") measures for presence, we suggest a slight refinement to the sensory rearrangement theory. Motion sickness does not arise from conflicting motion cues per se, but rather from conflicting ideas about what is stationary (the "rest frame") which are deduced from these motion cues.

This refinement means that it is not necessary to remove all conflicting motion cues to avoid motion sickness, but only those motion cues which indicate conflicting rest frames. A great deal of previous research suggests that the visual system's decisions about what is stationary are heavily influenced by the perceived visual background. This suggests a technique for dealing with motion sickness in virtual environments.

The usual "content-of-interest" in a virtual environment is made semi-transparent (using either display optics or software techniques) and a separate "independent visual background" (IVB) is placed behind the content-of-interest. The IVB can be made consistent with the inertial cues. Because the visual background influences the visual impression of stability, this may serve to reduce motion sickness in simulators.

The authors have recently submitted a paper suggesting that this technique is useful for low-end virtual environment systems. A pilot study has been conducted with high-end systems and a grant application has been made to continue this work.

Using Speed of VOR Adaptation to Predict Motion Sickness

Many factors of the simulator and task affect motion sickness. However, it is understood that some individuals are simply more susceptible to motion sickness than others. Prediction of individual susceptibility to motion sickness could improve participant screening and the development of appropriate countermeasures for those most prone to experiencing symptoms.

It has been hypothesized that one's relative ability to adapt to visual-vestibular sensory rearrangements predicts sickness susceptibility (Reason & Graybiel, 1972). The problem has been the selection of an appropriate and objective measure of this 'adaptability trait' to test the hypothesis.

We have chosen to focus on the vestibulo-ocular reflex (VOR). The VOR automatically controls compensatory eye rotations during head movements in order to maintain a stable retinal image. The VOR can adapt its gain and/or phase in response to altered visual-vestibular stimuli arrangements.

Speed of VOR adaptation to visual-vestibular rearrangements is a promising measure of one's adaptability to visual-vestibular rearrangements. It is hypothesized that fast adaptors (as determined by relative speed of VOR adaptation) will be less susceptible to motion sickness than slow adaptors. Studies are underway to explore this hypothesis.

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