Predicting simulator sickness by tracking the user's postural sway

Rationale:

The Vive's Lighthouse tracking solution reportedly resolves simulator sickness. However,tracking quality (accuracy, precision, low latency) by itself is necessary, but not sufficient to address nausea. Lighthouse enables "stand-up" VR where virtual and actual head movements are identical, which, in accordance with the "sensory conflict" explanation of motion sickness, would simply avoid modes of virtual locomotion that cause vection.

We propose that simulator sickness remains a safety concern even in stand-up VR. For one, nausea can arise for reasons unrelated to tracking quality, and would, regardless of the cause, be attributed to the specific VR experience or VR in general. Furthermore, stand-up VR is not always possible or desirable. In any event, an actual loss of balance carries more risk for a "boxed" user standing upright than for a seated user.

Hence, simulator sickness remains a concern affecting VR content development and VR hardware design. We do not consider simulator sickness "solved" by Lighthouse, based on information available.

Objective:

Based primarily on the published work by Stoffregen et.al. at the APAL/Univ. of Minnesota, we intend to use Lighthouse and IMU sensor-fused tracking data from headset and, where applicable, controllers to track postural sway of whole body and upper torso in standing and seating VR use.

We hope to be able to provide a building block for VR applications that delivers one or more of the following:

(a) prediction of individual simulator sickness susceptibility based on postural sway at rest and/or in brief, controlled "benchmark experiences",

(b) prediction of possible simulator sickness during an VR experience, with sufficient lead time to modify or end the experience early enough to mitigate or avoid entirely actual nausea, and/or

(c) recognition of imminent simulator sickness "just in time" to end the experience and aid the user in headset removal prior to the user experiencing sickness.

We have in 2014 provided one of our DK2 headsets to Stoffregen for an ongoing series of experiments. Our hope is to be able to leverage the HTC Vive Developer Kit or Retail Kit sensor data stream "out of the box", or - at least in experimental setups - extend Lighthouse tracking to torso/body data using additional receptors, or, if necessary in the interim, fuse Lighthouse head tracking results with e.g. Kinect2 body tracking data.

We also want to take advantage of the SteamVR controller/hand tracking. One of the open questions of motion/simulator sickness is the importance of agency ("driver never gets sick") as well as task challenges (such as reading, pursuit eye movements, hand-eye coordination), all of which have been found to have impact on postural sway and hence subsequent sickness. We expect hand-tracking to be adversely affected at the same time postural sway changes.

We intend to use the Vive for in-house R&D, with results to be made publicly available.

Timeframe: end of year.

Reference literature at
http://www.oneArrow.com/limited/RnD/sway/papers/

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