Validation of existing perception models within the context of motion sickness

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Title: Validation of Existing Perception Models within the Context of Motion Sickness

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Background: Motion sickness (MS) as an area of scientific inquiry has mostly seen experimental work. A range of models attempt to predict MS, but have not been validated for a broad selection of sickening motion stimuli. By doing so this study aims to identify models that lead to better sickness predictions. Lastly, the study will also elaborate on the effects of vision, a key factor in motion sickness of automated driving in particular.

Methods: Three models of spatial orientation are compared, the TNO model, the Newman model and the probalistic particle filter model. The models are tuned and validated with respect to the perceptual responses to earth-vertical axis rotation, off-vertical axis rotation and centrifugation. Internal conflict terms are used as a proxy for sickness prediction. Sickness responses are evaluated for five motion paradigms: pure roll, pure lateral and vertical acceleration, off-vertical axis rotation and cross-coupled coriolis stimulation. MS susceptibility as a function of frequency is derived for 3D acceleration and rotation for 3 different visual conditions; internal vision, external vision and darkness.

Results: Preliminary results show that models do not adequately explain differences in sickness response observed between motion paradigms. For the TNO model, MS susceptibility as function of frequency matches experiments for vertical acceleration in darkness, but not for horizontal plane acceleration. The inclusion of vision shifts the center frequency from 0.2 Hz to 0.1 Hz for vertical acceleration, but does not affect the horizontal response. The Newman model predictions are the least accurate due to a direct coupling between state estimates and conflict terms. The particle filter model shows promise in that parameter variations approximately reproduce the MS susceptibility observed for lateral accelerations. However unlike the TNO & Newman models, it cannot account for vertical motion sickness as by design its predictions are based on the somatogravitic illusion.