Action-based Slant Perception in Real and Virtual Environments

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An innovative action-based motoric measure of slant is proposed, based on gait. This measure is ecologically-valid derived from the angle that the foot makes in relation to the horizontal ground plane immediately before impact (Figure 1). This work explores whether the proposed measure is affected by factors such as material of the walking surface and inclination of the walking ramps. Moreover, experimental studies were conducted in a real environment set-up and in its virtual counterpart. Comparisons between real-world spatial judgments and simulation equivalents provide performance benchmarks as well as tools to assess whether a technological set-up would be of similar functional fidelity to a real-world task situation.

The measures of slant utilized in previous research were derived by a combination of verbal, visual, and haptic assessments which were not ecologically valid or based on involuntary human action. Verbal judgments were simply an estimate in degrees of the hill inclination in respect to the horizontal axis. Slant judgments have also been acquired during exposure to simulation systems involving synthetic scenes. Creem-Reghehr et al. [2004] investigated the influence of action on slant estimates while varying the participants' potential of movement in a virtual environment, i.e. standing, visually translating, walking without slope forces and walking with slope forces. In agreement with the slant literature, this work concluded that in all conditions perceptual judgments were overestimated and motoric adjustments were more accurate. Additionally, walking with slope forces led to increased perceptual overestimation of slant compared to the other conditions and existing literature, while the visually guided action remained veridical. They speculated that the apparent variation in participants' responses could be explained by the differing lighting and context of the synthetic scenes. Environmental variability enhances or diminishes visual realism in synthetic scenes. It is tempting to replicate the real world as accurately as possible in order to provide equivalent experiences. Trade-offs between visual/interaction fidelity and computational complexity should be applied to a simulation system without detracting from its training effectiveness. There is, therefore, a call for efficient techniques in order to assess the fidelity of a VE and determine its relationship with performance.

100 participants were exposed in a comparative real versus virtual setting of the same context. In the real setting participants are instructed to look at inclined surfaces (3 inclination levels: 0^o, 5^o, 10^o) surfaces of varying friction (2 friction levels: carpeted and ceramic tiled surfaces) levels and complete a walking task. Subsequently, participants were instructed to rate those surfaces' degree of friction, by simply looking at them. In order to compare the real-world task with varied synthetic simulations, participants are immersed in the virtual environment (VE) through the use of a stereoscopic HMD. The VE is a photorealistic representation of the environment described above including simulation of the varied specular attributes of the surfaces. Participants are instructed to physically walk on the surfaces of the real-world environment while the visual stimulus is displayed on the HMD in stereo. During exposure to stimuli a hidden video camera records the participants' walking style and foot angle data are extracted post exposure (Figure 1).

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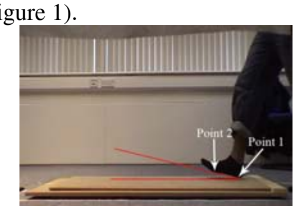

Figure 1. Motoric measure of slant

In the real environment experiment, results revealed that there was a significant effect of material and friction, on the accuracy of the new measure. In particular when the tiled material was used, the foot measure was more accurate compared to the carpet material. The two materials were different in two ways: They had distinct reflective properties with the tiled material being more shiny and reflective. The ceramic tiles had lower levels of friction compared to a carpeted material. Therefore, the significant effect of material on slant perception based on the foot measure could be explained either as an effect of participants perceiving slant differently (i.e. different angles) due to the reflective properties of the material, or due to participants fear of losing balance when walking on slippery surfaces. In the VE experiment there was no effect of material on the accuracy of the foot measure. Observing the synthetic stimulus, it could be argued that the reflective properties of the tiled material were not adequately visualized compared to the carpeted material. Even if participants knew that they would be walking on tiled surfaces, they did not provide different measurements. In the real environment, it might be the specular effects of the material that revealed a significant effect of slant perception rather than the levels of friction.

In both the real and virtual environment setup, the foot angle reported was smaller when the incline of the path increased. In the real world experiment the foot measure proved more accurate as the inclination increased; it was fairly inaccurate at 0 degrees of inclination. In contrast to the real environment, within the VE, the measure gets significantly less accurate as the inclination increases. On average participants' judgments slightly overestimated the inclination of the walking ramp in the real environment. On the other hand, participants' judgments slightly underestimated the inclination of the walking ramp in the VE. This finding should be further explored. The VE of this study does not accurately replicate the forward motion of a human character (translation), thus, it is questionable whether this variation gave rise to these conflicting results.

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Creem-Regehr, S.H., Gooch, A. A., Sahm, C. S., Thompson, W.B. (2004) Perceiving Virtual Geographical Slant: Action Influences Perception. Journal of Experimental Psychology: Human Perception and Performance, 30(5), 811-821