Simulating Spatial Assumptions (sketches_0296)

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Abstract

This sketch presents a new method for assessing 'functional realism' across a range of applications in an effort to match the capabilities of a Virtual Environment (VE) to the requirements of the human perceptual and motor systems. The basic assumption is that an individual's prior experience will influence how he or she perceives, comprehends and remembers new information in a scene. 36 participants across three conditions of varied rendering quality of the same space were exposed to the computer graphics environment and completed an object-based memory recognition task. The results presented could have significant future implications while identifying areas of an interactive computer graphics scene that require higher quality of rendering as well as areas that lower fidelity could be adequate.

1 Methodology and Results

Being in a certain place (say, an office) results in mentally representing spatial elements that humans perceive there, depending on prior experience. These representations could be described as 'assumptions' or spatial 'hypotheses' than humans adopt after a very short exposure to a space. If we were able to exploit existing research on how these 'assumptions' or 'schemata' are formed in real life and then be able to simulate those assumptions in a VE scenario, we would have a powerful new measure of 'functional' realism (same information is transmitted in real and artificial scenes). The first experimental results are presented here which hold promise and can lead to an efficient use of graphics resources, via a rendering engine which renders only those objects to a high level which require detailed inspection, and vice versa. This approach could be applied across a range of application fields and in situations when there is no overt task which is capable of being learned and assessed in a quantitative manner (Mania et al.), offering a *generic* approach.

An individual's prior experience will influence how he or she perceives, comprehends and remembers new information. Schemata are knowledge structures based on past experience. When participants are exposed to a large amount of information in a scene, cognitive psychologists have suggested that schemata are used to guide the search for information in memory (Brewer & Treyens). An activated schema could aid retrieval of spatial information which is present in a specific space and also trigger the apparent recall of non-present (inferred) spatial information after exposure. This research initially explores whether schema related information is easier to recall than information which is not related to the schema for a computer graphic scene rendered in varying levels of quality.

36 participants across three conditions of varied rendering quality of the same space were exposed to the VE (Figure 1) and completed a memory recognition task related to the objects in the room, which was a typical academic's office. The VE was displayed on a Head Mounted Display (HMD) in stereo. The objects in the scene felt under five distinct categories:
High-schema expectancy objects that are present, High-schema objects that are absent, Non-schema present, Non-schema absent and Frame objects (floor, ceiling, lights, walls, etc). They were then asked to indicate on a scale of 1 to 5 how strongly they believed each object on the list was present in the environment to which they had been exposed, with 1 being positively not present and 5 being positively present (76 objects in total).

One-way ANOVA analyses, separately for each object category, were employed. There was a significant effect of condition for the non-schema present objects, $F(2,35)=5.08$, $p<0.05$. Post-hoc Scheffe tests revealed that memory performance associated with this category of objects positively correlated with the quality of the rendering. There was no significant difference associated with the schema present objects across conditions, $F(2,35)=1.007$, $p>0.05$. For those objects, a gross quality of rendering was adequate; they just had to be visible. A Paired comparison t-test was conducted for the present schema compared to the present non-schema objects recognition scores. There was a significant main effect, $t(11)=14.3$, $p<0.01$. This is an important result, since it verifies the general premises that schema related information is easier to be recalled compared to non-schema related information, here, for computer graphics scenes.

Figure 1: Experimental space (high quality)

Based on these results, it could be concluded that gross quality of the rendering (render less) was adequate for schema related spatial information to be recalled, compared to non-schema objects that require detailed inspection (render more) of a photorealistic scene. Rendering computation, therefore, for applications that require a high level of spatial awareness (simulation, games, etc.) could be associated with the relation of each object in a scene to the scene's context or schema, no matter what the task is. Future work will include formal experimentation and a psychophysical validation of an object-based rendering engine based on experimental results.

References

BREWER, W.F. & TREYENS, J.C. (1981). Role of Schemata in Memory for Places. *Cognitive Psychology*, 13, 207-230.

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