Perceptual evaluation of illumination effects in virtual environments

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Abstract

In this work, different techniques for the generation of shadows and reflections have been compared in terms of the perceived quality by the final user. Results show that, for the analyzed scenarios, users do not present a clear preference for the images generated with the more sophisticated techniques.

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Keywords: perception, hard shadow, soft shadow, reflections

1 Contents

Illumination effects are known to have a great impact in the final quality of the rendered image. However, the high computational cost of these techniques supports the necessity of studying the impact in the final visual quality from a perceptual point of view [Sattler et al. 2005; Fleming et al. 2003]. The goal of this paper is to analyze the perceived quality of images obtained with different degrees of realism in shadows and reflections generated by techniques of different computational cost.

The experiments carried out try to simulate scenarios in which the users' attention is not clearly driven towards specific features but it is distributed over the whole image. The analyzed population is composed of 60 subjects (from 9 to 84 years). These subjects were initially classified as experts or non-experts, obtaining a balanced distribution.

Four experiments were designed to analyze whether the computation of soft shadows and realistic reflections contributes significantly to increase the final perceived quality; the goal of the first test is to evaluate the capacity of identifying inconsistencies in the simulation of shadows and reflections (number, position, orientation). The second and third tests compare the generation of soft shadows with shadow maps and raytracing. Renderings using both of these techniques have been compared to the rendering of the same scene using local illumination plus hard shadows simulation (Figure 1). Finally, the goal of the fourth test is to evaluate the generation of reflections. In this case, raytracing was used to generate realistic view-dependent reflections, while local illumination plus precomputed static reflections was used as the low cost alternative to compare to.

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Figure 1: *Experiment 2. Left image rendered using hard shadows. Right image rendered using shadow maps*

2 Results

In relation to the first test, non-expert subjects are not able to determine inconsistencies in shadows ($p < 0.005$). In this case, experts can detect the inconsistency, with a significant difference between experts and no-experts subjects ($p<0.05$). This difference between subjects does not appear in the case of determining any error in the generation of reflections ($p<0.05$). Results related to the second and third tests say that non-experts showed no preference for any shadow map ($p<0.02$) or raytracing techniques. Non-significant preference for shadow maps or raytracing in the case of experts has been found. Regarding the fourth test, the high computational cost of raytracing techniques did not increase the final visual quality perceived by none of the evaluated subjects ($p<0.02$).

Finally, during the experiments it was observed that the performance of the attention task was not influenced by the different qualities chosen for the illumination.

3 Conclusions and future work

It can be concluded that the users do not perceive a significant decrease in the quality of the analyzed scenes when using basic shadowing and reflection techniques.

Regarding future work, it is interesting to perform a similar analysis to different contexts of experimentation and the validation of the obtained results using psycho-physiological techniques evaluating presence in immersive environments.

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