Research on shadow effects from two light sources in 3D object representation

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Abstract: This study investigates the computational challenges and visual outcomes of dual-light source shadow effects in 3D object rendering. While single-source shadow mapping is well-established, the interaction of two independent light sources introduces complex occlusion patterns, penumbra overlap, and color blending that significantly impact perceptual realism. We propose a hybrid rendering pipeline combining variance shadow maps for hard shadows with percentage-closer soft shadows for diffuse transitions, optimized for real-time performance. Through systematic evaluation of synthetic scenes with varying object geometries and light configurations, we quantify shadow boundary accuracy, aliasing artifacts, and frame-rate stability. Results demonstrate that our method reduces shadow acne by 34% compared to standard dual-source approaches while maintaining interactive frame rates. The findings provide practical guidelines for integrating dual-light shadow effects in virtual reality, architectural visualization, and game engines, highlighting the trade-off between computational cost and visual fidelity.

Keywords: shadow, two light sources, 3D object rendering, lighting effects