Efficient Light Transport Simulation through Utilization of Temporal Coherence

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Physically based light transport simulation has long been used to create photorealistic images and animations of computer-generated structures in many areas, from special effects in movies to architectural vizualisation. However, these methods require large amounts of calculation. Especially in animations, which often consist of thousands of frames, computation on a single workstation can take up to a month in these cases. However, most research that tries to accelerate these methods focuses on individual frames, ignoring the remarkable coherence between frames in an animation. Especially when there is little or no object movement in the scene, a significant number of rays can be reused. In this project, a method for correctly reusing lightpaths in bidirectional light transport algorithms is presented. By rendering multiple frames in a batch instead of rendering frame after frame, individual paths can be generated for the first frame and then efficiently be checked for validity in following frames. Only if the ray becomes invalid, it is traced again. Since the validity check is exact, full camera, object and light motion can be allowed while still converging to the exact same result as a comparable non-reusing implementation. Pseudo-Code algorithms for lightpath-reusing Vertex Connection and Merging, Progressive Photon Mapping and Bidirectional Path Tracing are provided that demonstrate the flexibility of this method, which is then implemented in combination with Vertex Connection and Merging. Using this implementation, rendering time reductions of up to 60% can be obtained in animated scenes while still allowing full camera and object movement.

Awards Won: