Acceleration Methods for Radiance Transfer in Photorealistic Augmented Reality

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Abstract
Radiance transfer computation from unknown real-world environments is an intrinsic task in probe-less photometric registration for photorealistic augmented reality, which affects both the accuracy of the real-world light estimation and the quality of the rendering. We discuss acceleration methods that can reduce the overall ray-tracing costs for computing the radiance transfer for photometric registration in order to free up resources for more advanced augmented reality lighting. We also present evaluation metrics for a systematic evaluation.

Probe-less Photometric Registration in AR

Advantages:
- no special light probes such as mirror balls or fish-eye lens cameras
- Real-world light estimation from dynamic scene geometry
- AR shading supporting differential rendering

Fundamentals:
- Based on inverse rendering [1]
- Instant Radiance transfer from real-world and virtual geometry
- Light estimation and AR shading pipeline

Acceleration Methods

4D Visibility Signal
The acceleration methods are based on subsampling and operate in 3 different sampling spaces: image space, world space and visibility space.

Sample Spaces
- (s, t) pixel in image space
- (p, q) direction of the visibility ray in polar coordinates
- V 0 if a surface point x is blocked, 1 if the ray can “see” the distant light

Regular Subsampling
Subsampling in image space with fixed regular intervals in (s, t). The result is a 2D light buffer with a lower resolution.

Interleaved Sampling Over Time
Distributing the regularly spaced samples over time in image space or visibility space using reprojection for fusing the final results.

Caching
Agile 2D ping pong cache aligned to image space storing RT information expressed as spherical harmonics coefficients.

Evaluation Metrics
We compare results of the acceleration methods against results of the reference method (GT), using synthetic generated (known light sources, geometry and camera movements) and real-world input data.

System Performance
- Measured in frames per second.

Three Visual Qualities
- Image differences, error visibility prediction and quality predictions [3]

Light Estimation Quality
Comparison of dominant light direction vectors

Application Scenarios
where photorealistic AR matters
- Home Shopping
- Virtual Fitting Room
- AR Gaming
- Industrial Prototyping
- Architectural Visualization

Evaluation of 7 acceleration methods

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<td>Full sampling solution</td>
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Details:
- Scene 1
- Scene 2

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