FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Real-Time Rendering of Photometric Area Lights for Interactive Lighting Design

Masterstudium:
Visual Computing

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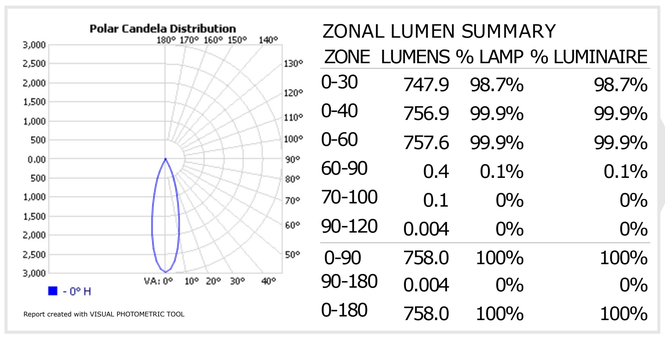
MOTIVATION

Photometric area light sources are used in modern lighting-design software to represent real-world luminaires. Their light emission profile is defined in a photometric report, which is derived by measuring the light emission of real-world luminaires.
To enable an interactive workflow for lighting designers, it is necessary to render visually plausible approximations of their illumination in real time.

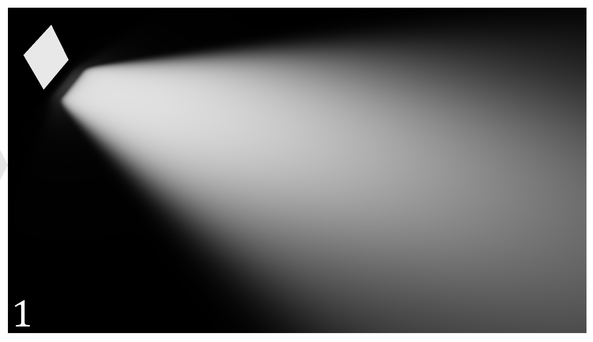
PHOTOMETRIC REPORT

A luminaire's photometric report describes the amount of light (Lumen) emitted for each direction (Candela).



ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
0-30	747.9	98.7%	98.7%
0-40	756.9	99.9%	99.9%
0-60	757.6	99.9%	99.9%
60-90	0.4	0.1%	0.1%
70-100	0.1	0%	0%
90-120	0.004	0%	0%
0-90	758.0	100%	100%
90-180	0.004	0%	0%
0-180	758.0	100%	100%


1

The report to the left defines the light emission of the area light in Figure 1.

PROBLEM STATEMENT

Monte Carlo integration techniques require many samples on the light source to accurately compute the illumination (20,000 in Fig. 1 and Fig. 2).
As this is not feasible in real time, approximations with a smaller number of samples are used. However, using less samples results in visible artifacts when the light source is close as shown in Fig. 3, because the light source is not sampled densely enough.


2

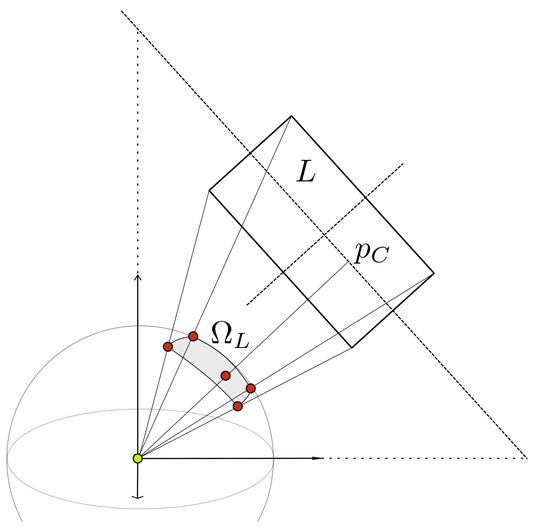
Reference (20,000 samples)


3

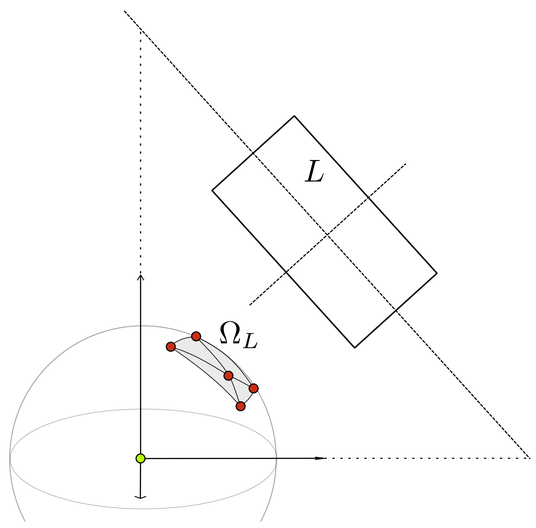
Approximation (40 samples)

SOLUTION

We propose to sample the subtended solid angle of the area light source with a sample set consisting of the corners [1] and one representative sample [2], i.e., a sample positioned such that it contributes a high amount of lumen.
The representative sample's position depends on the candela distribution and may be expensive to compute. Instead we use the point on the light source closest to the illuminated point, which shows to be representative for luminaries where the main emission direction is forw#ard. We implemented our solution in a fragment shader to achieve real-time performance.

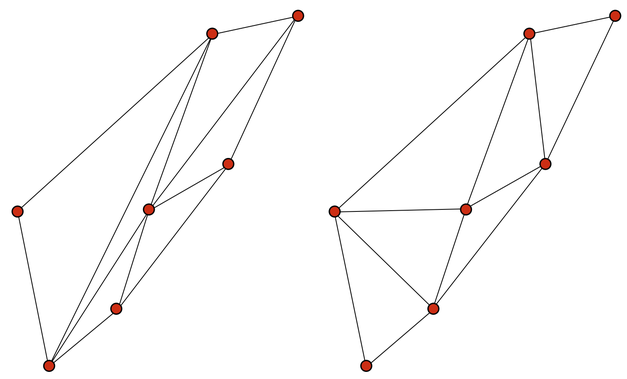


Compute the closest point p_C on L and use it and the corners to create a sample set on the light source's subtended solid angle Ω_L.



Triangulate Ω_L with the samples as vertices.

Transform the triangulation such that it becomes Delaunay, i.e., there are no long and thin triangles if possible as shown below.
To do this efficiently in real time on the GPU, we developed a compact triangle



Not Delaunay Delaunay

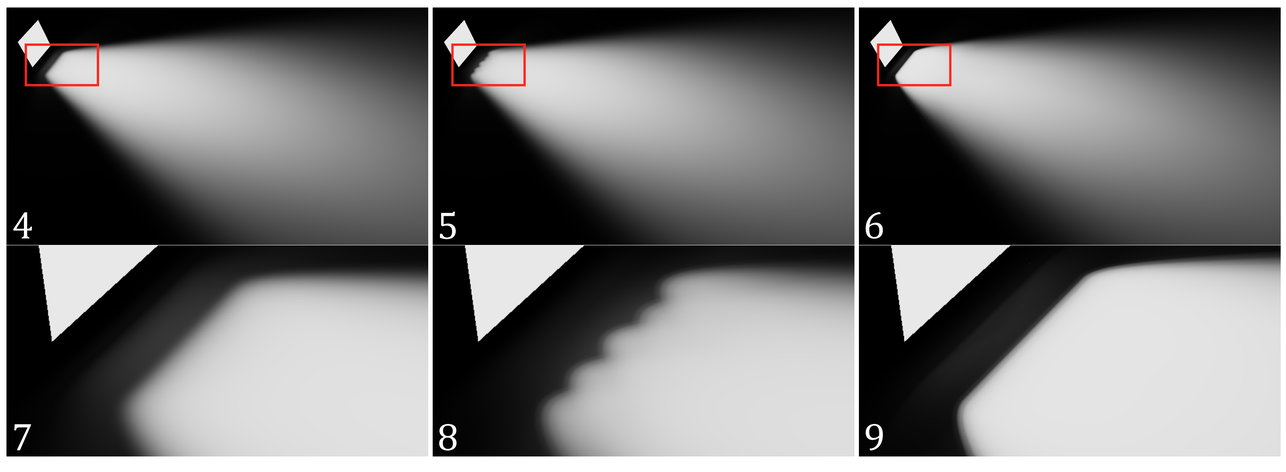
Compute the illumination I with

$$I = \sum_{\triangle_{ijk} \in D} \frac{f(x_i)+f(x_j)+f(x_k)}{3} |\triangle_{ijk}|$$

where D is the triangulation on Ω_L, $f(x)$ is the illumination coming from x and $|\triangle_{ijk}|$ is the area of the spherical triangle (x_i, x_j, x_k).

RESULTS

Our novel approach allows creating visually plausible approximations of the illumination by a photometric area light in real time, i.e., ~300 FPS on a Nvidia GeForce GTX 1080 at a resolution of 1920 × 1080. The resulting approximation (Fig. 6 and 9) is visually plausible and similar to the reference solution (Fig. 4 and 7).
The artifacts observed with the approximation based on Monte Carlo integration (Fig. 5 and 8) do not appear with our solution. This is due to the representative sample, which is computed dynamically for each fragment guaranteeing that the used sample set contains at least one sample on the light source which contributes illumination.


4 5 6 7 8 9

Reference (20,000 samples) Approximation (40 samples) Our solution

References:
[1] Lagarde, Sébastien, and Charles de Rousiers. "Moving frostbite to physically based rendering." SIGGRAPH 2014 Conference, Vancouver. 2014.
[2] Drobot, Michal. "Physically based area lights." GPU Pro 5 (2014): 67-100.

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