HILITE

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Simulation of lighting in complex architecture is very challenging when it comes to the modelling the scene, but also due to the complexity of the calculation: Besides the light distribution of the luminaires, reflectance and absorbance of the materials have to be considered as well as daylight, which is usually influenced by external objects like buildings or trees.

HILITE is a research project by VrVis Forschungs GmbH in Vienna (A), Zumtobel Lighting GmbH in Dornbirn (A) and Hefel Wohnbau AG in Lauterach (A).

Main focus of the HILITE Project is research into interactive real time simulation of lighting solutions using new rendering and virtual reality technologies (please refer to references).

While the simulation of complex lighting scenes with current lighting design tools will often require a calculation time of several hours, HILITE provides high quality simulations within seconds.

Using this technology interactive modification of the luminaires well as the scene geometry is possible.

Hilite is a simulation technology using optimized calculation methods for shadowmaps with GPU hardware that were developed for gaming and virtual reality to show lighting designers an interactive preview of their lighting design. The direct fraction is displayed in real time, the diffuse bounces are calculated and displayed after a short interval.

Shadow mapping means that images are projected into a room. The process can be compared to a photopraph projected with a slide projector. The projected image illuminates room surfaces and objects. These images are called “intensity maps”

Intensitymaps:
To generate the maps for specific luminaires, photometric data files (LDT, IES) are converted into high dynamic range intensitymaps (EXR). These are projected into the room using shadow mapping in order to calculate the direct fraction of the lighting.

Due to the high dynamic range of these intensity maps it is possible to save complex light distributions in relatively small files (64px * 64px).

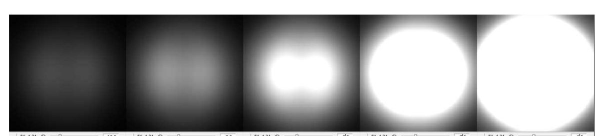

Fig 1.
Intensitymap showing luminance for different distances from the light emitting surface.

A single intensitymap is sufficient for spotlights. Luminaires with more complex light distributions require cubemaps are also optimized to be processed by the GPU.

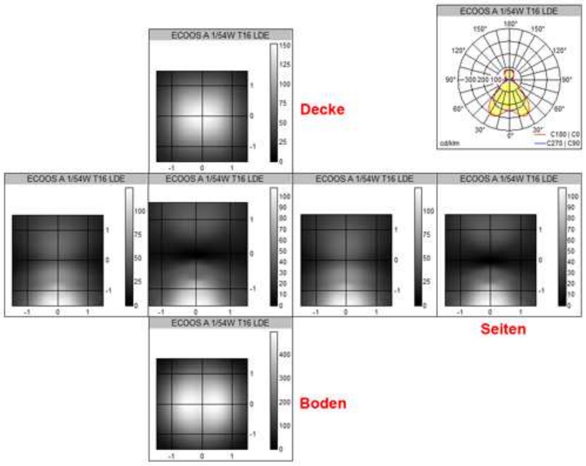

Fig 2.
Cubemap

Virtual point lights:
Hilite uses virtual point lights (VPL) to define the position of a light source. The light emitting surface is defined by polygons.

It is possible to define any quantity of VPLs for each luminaire. As LED luminaires start to replace conventional lighting technology this feature becomes more important: Every LED within a luminaire can be defined by a separate VPL with a specific light distribution and light colour. The accuracy of the simulation results is surpassing current lighting simulation software, especially when RGB luminaires are considered.

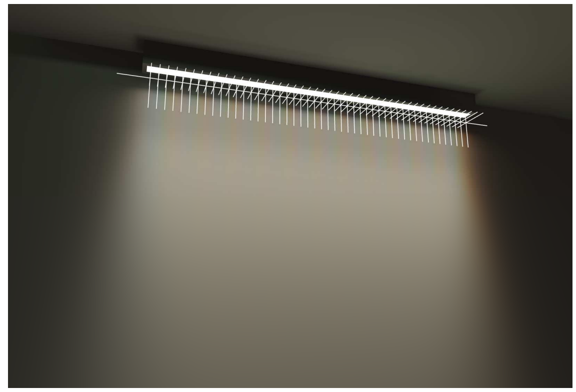

Fig 3.
Separate VPLs for each LED within a luminaire

The simulation is very detailed, shadows and colour mixing for RGB luminaires can be analysed considering location, light distribution and colour of each LED within the luminaire.

Fig 4.
Detailed simulation of shadows for a RGB Spot.

Simulation:
There are different simulation methods for direct illumination and for the diffuse bounces.

The shadowmaps that were assigned to the virtual point lights are projected into the room to simulate the direct fraction of the lighting.

Photons are emittied from the VPLs to simulate diffuse bounces. After the first contact with room surface or an object in the room, areas receiving equal numbers of photons are defined.

For the first diffuse bounce a virtual point light will be created for each of these areas. This VPL will be projected into the room using shadow mapping.

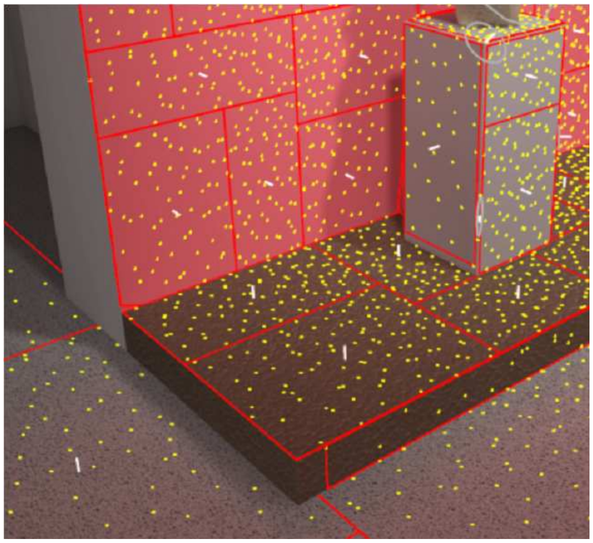

Fig 5.
Photonen and resulting VPLs

The method is flexible and adapts to the complexity of the geometry. The process will be repeated for the required quantity of diffuse bounces.

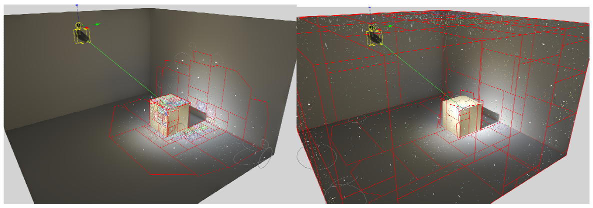

Fig 6.
VPLs for the first and second diffuse bounce.

Lightmaps:
Hilite generates groups of luminaires that can be controlled together. The calculation results will be saved as an individual lightmap for each group of luminaires.

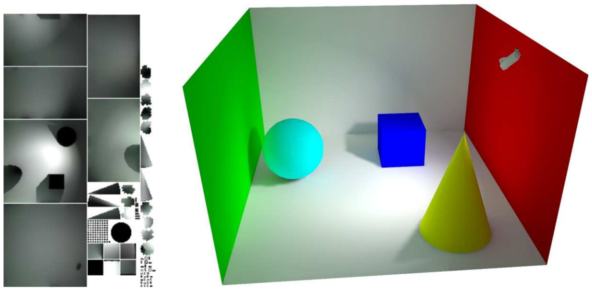

Fig 7.
Lightmap

Intensity and light colour for each luminaire group can be adapted without repeating the calculation. In this way it is similar to the VIVALDI functionality for interactive lighting design.

Using the fast simulation and the optimized handling for luminaire groups lighting concepts for rooms or architectural scenes can be designed in very fast, efficient and interactive way.

Material and Shader:
The material properties in Hilite are based on the Ward Shader Model that enables the simulation of anisotropic reflexions.

The shader was optimized for viewport rendering and the possibility of BSDF fitting was added.

Semiautomatic BSDF fitting enables the conversion of measured BSDF Date into Hilite shaders and will be available from December 2013.

The material editor allows to generate complex materials (reflection fallof, fresnel, flat mirror, roughness etc.) and is already implemented.

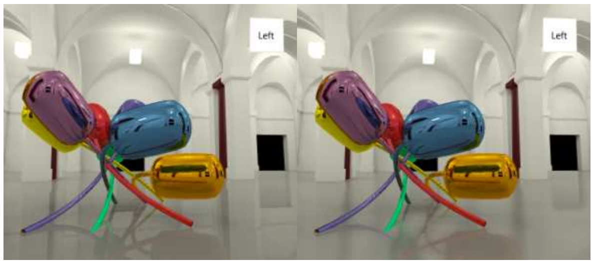

Fig 8.
Different diffuse reflection on the foor

Depending on the shape of the object reflections can be calculated as flat reflections or as cube reflection maps. The cube maps are generated separately for each object considering the illumination of the scene.

Fig 9.
The analysis of reflection on complex surfaces is possible in real time.

False Colour:
The false colour mode in Hilite shows the intensity of illumination.

It enables the designer to optimize the luminaire positions in order to avoid unwanted shadows and to review the light distribution and light output of the selected luminaires.

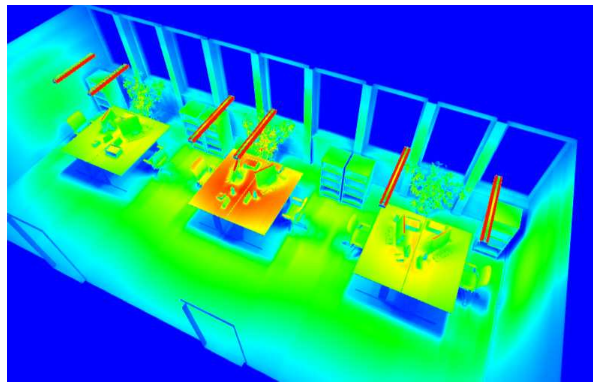

Fig 10.
Comparison of a luminaire with 28W, 49W and 35W.

It is also possible to evaluate the uniformity of a lighting solution or to set focal points as it might be desirable in exhibitions or cultural institutions.

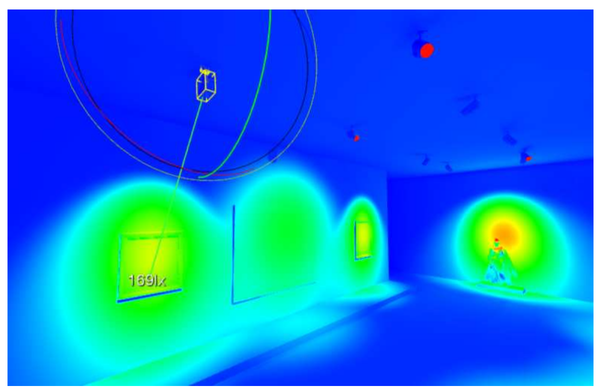

Fig 11.
Interaktive positioning of luminiares in real time.

Recessed Luminaires:
Hilite is using intelligent masking to visualise recesses in ceilings where luminares can be located.

As this technology is faster and less complex than Boolean operations, it is ideal for larger quantities of recessed luminaires.

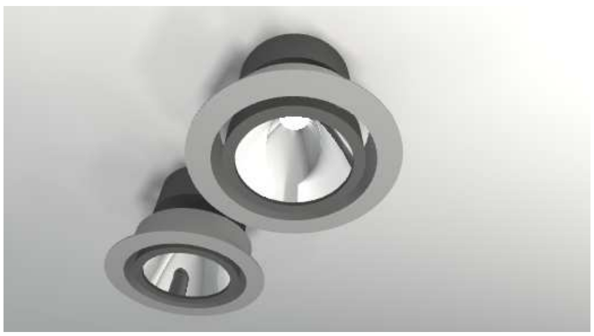

Fig. 12
Typical recessed luminaire with geometry.

Fig 13.
Visualisation of the recessed luminaire in Hilite.

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