FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Adaptively Clustered Reflective Shadow Maps

Masterstudium:
Visual Computing

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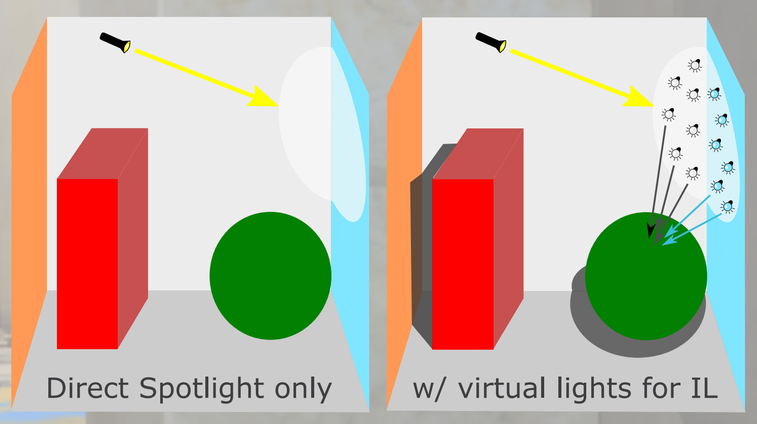
Context

In natural environments most lighting occurs via indirect light sources, where light rays are partly absorbed and partly reflected from objects until all the energy has been consumed. As such, simulating **indirect illumination** is an important feature in modern rendering environments. Faithfully reproducing indirect lighting (IL) features in **real time** enables architects, light designers and game creators to see the results of their changes more quickly, which in turn allows for faster iteration on their designs.
In this master thesis we present **ACRSM**, a technique to compute single-bounce diffuse indirect illumination in real-time for dynamic scenes.

Overview & Motivation

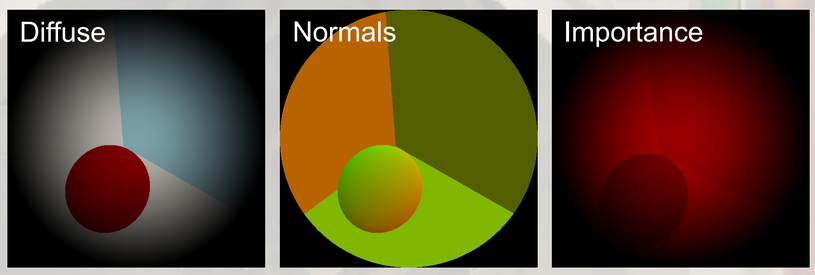
Virtual area lights are used to simulate the indirect illumination effect as illustrated to the right. To help with the generation of these virtual lights, **clustering** methods have already been used in the past. However, simple *k*-Means based clusterings proved strongly limited in dynamic scenes because the convergence of the clusters is highly dependent on their initial seed positions.
We envision a *progressive* clustering technique that adapts the clustering on-the-fly.



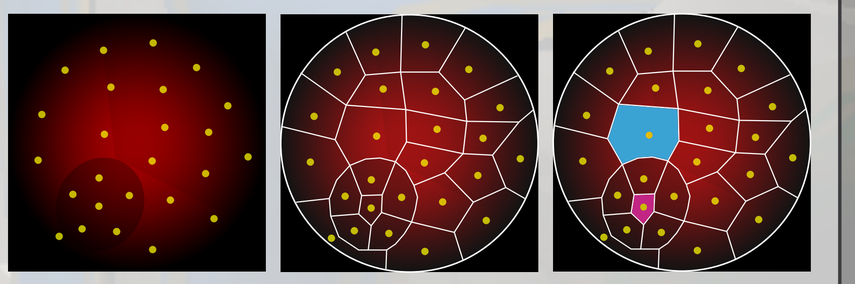
Approach

1. **Reflective Shadow Maps** (RSM) are used to represent scene information from the point-of-view of the main light source. We store *diffuse* albedo, *normals*, *importance* and *depth* information in a G-Buffer.
2. An initial VAL cluster positioning is achieved through *importance-warping of Halton samples*. The *k*-Means inspired **clustering** maps pixels of the reflective shadow map to individual clusters based on a *distance metric μ*.
3. The **evaluation** is an additional step that aims to correct unbalanced cluster distributions through neighborhood evaluation. It consists of two subprocesses:
   - a. Clusters c_m that are identified as being *too small* for their vicinity are **merged** by removing them from the current clustering. Merged clusters are added to a free cluster list.
   - b. These free clusters can be used during **splitting** when a cluster c_s is *too large* for its neighborhood. Then, a free cluster is reinserted near c_s.
4. Each cluster is treated as a virtual area light (VAL) to perform indirect **illumination** with. Light properties such as *color & orientation* are given by the RSM.

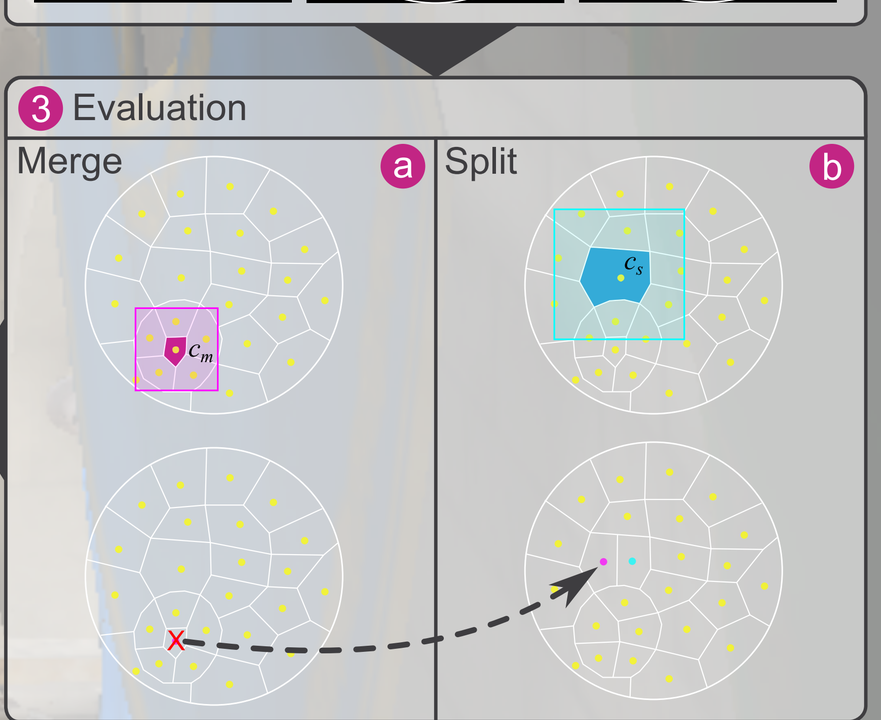
1 Reflective Shadow Map



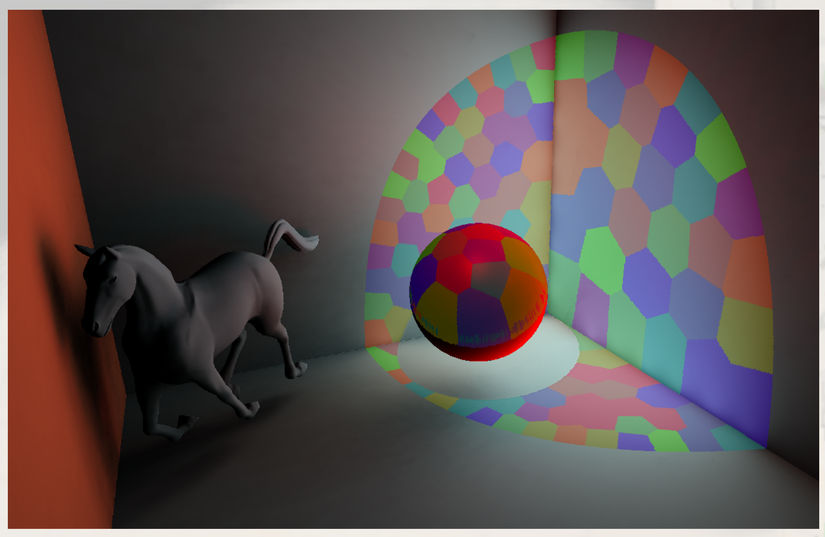
2 Clustering



3 Evaluation

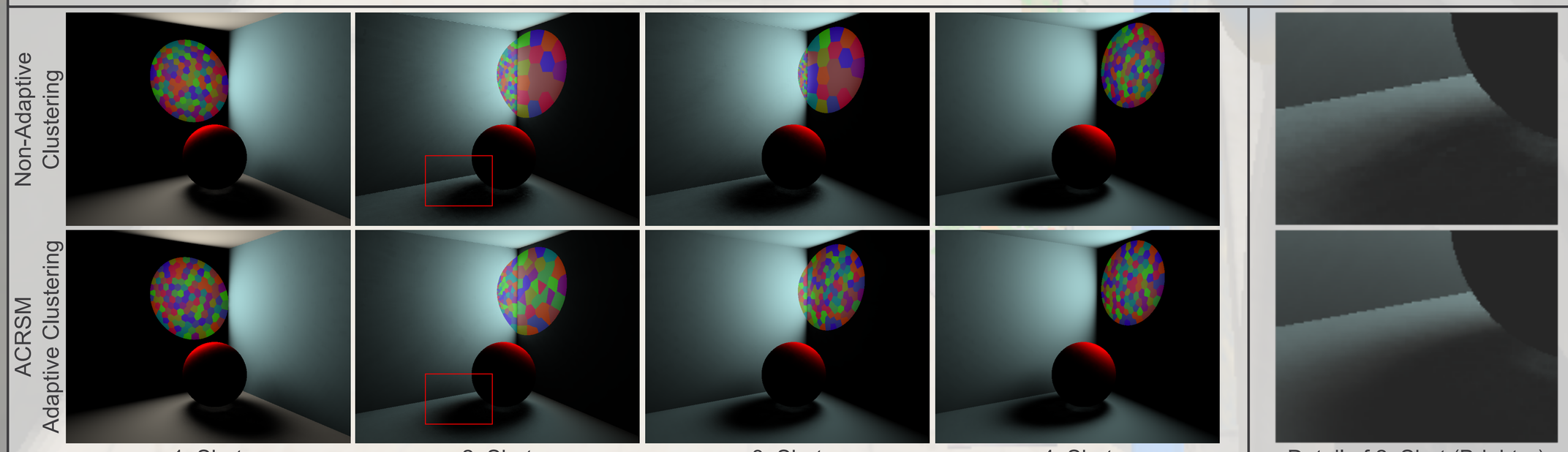


4 Direct & Indirect Lighting w/ Cluster-Vis.



Results

Timeseries Comparison



We implemented a real time global-illumination renderer based on virtual area lights using a progressive clustering algorithm. In the above time series, a spotlight is moving from the back wall to the right wall over the course of a few seconds. This dynamic change of the scenery proves difficult for a non-adaptive clustering (top). Only a handful of clusters initially migrate to the right wall (2nd & 3rd shot). The detail shot to the far right reveals artifacts in the shadows cast from the indirect light sources due to the insufficient amount of shadow maps generated for virtual lights on the right wall.
On the other hand, our ACRSM method (bottom) maintains a balanced clustering throughout the process and much more artifact-free shadows.

Background Image: Crytek Sponza rendered using ACRSM with 256 VALs

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