FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Using Perception-Based Filtering to Hide Shadow Artifacts

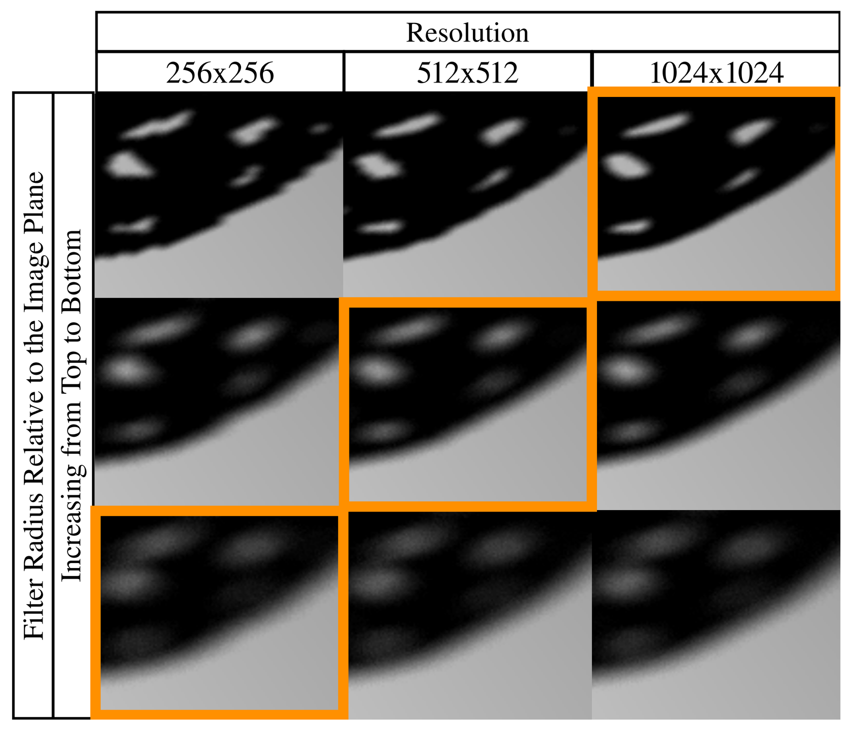
Masterstudium:
Visual Computing

Felix Kreuzer

TU Wien
Institut für Computergrafik und Algorithmen
Arbeitsbereich: Rendering
BetreuerIn: Associate Prof. Dipl.-Ing. Dipl.-Ing. Dr.techn Michael Wimmer

Problem Statement / Motivation

Currently, the most widely used techniques for computing shadows in interactive applications are based on *shadow mapping* [Wil78]. Shadow-mapping approaches rely on a proper selection of the underlying shadow-map resolution. If the resolution is chosen too low, detail gets lost and staircase artifacts appear. Choosing a high resolution prevents such artifacts, but also increases the computational effort. If configured properly, filtering algorithms can be used to hide undersampling artifacts on the shadow boundary by substituting missing bandlimiting with a blur during reconstruction.
The figure on the right illustrates the visual impact of increasing the shadow-map resolution versus a growing filter radius.
The **goal of this thesis** is to exploit common filtering algorithms in order to find a function of blur radius and shadow-map sampling frequency that allows for optimized computational performance, while mostly preserving the visual quality of the shadow.

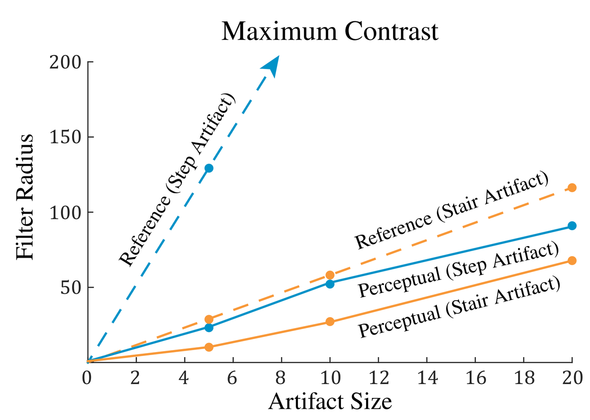


Contribution: User Study

We design a perceptual user study that allows us to analyze the impact of undersampling artifacts on shadow perception.

- The study gives us information about how large the reconstruction filter has to be in order for the observer not to recognize undersampling artifacts.
- The results of the study allow for evaluating a linear function which describes the correlation between filter radius and artifact size.

During the study participants were asked to identify staircase artifacts.



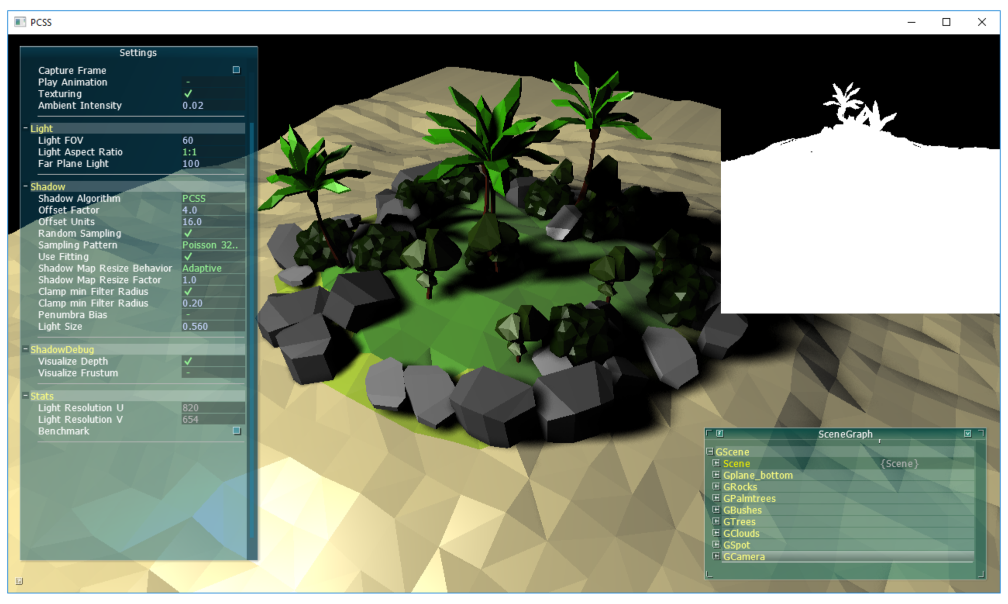
Graph of user study results.

Contribution: Algorithm

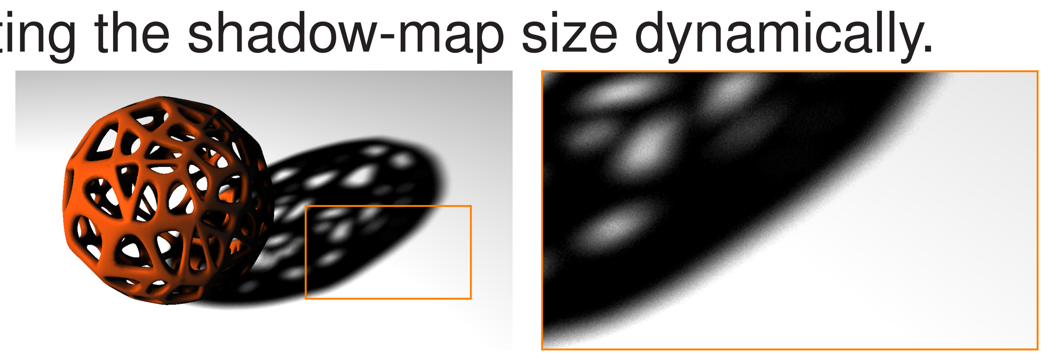
- We develop a novel approach to dynamically adjust shadow-map sizes for real-time shadowing algorithms.
- Based on the user study results, we were able to define a optimal ratio between shadow-map resolution and reconstruction-filter radius that can be incorporated in our algorithm.
- By reducing the number of depth samples in a shadow map, we can increase performance in shadow-map generation since there are fewer fragments to process and fewer texture lookups. This also improves cache efficiency because shadow samples are tightly packed and redundant samples being avoided.
- Our generic method is adaptable and can be applied to several existing shadow-mapping algorithms. We demonstrate how to incorporate our algorithm into percentage closer filtering and percentage closer soft shadows.

Results

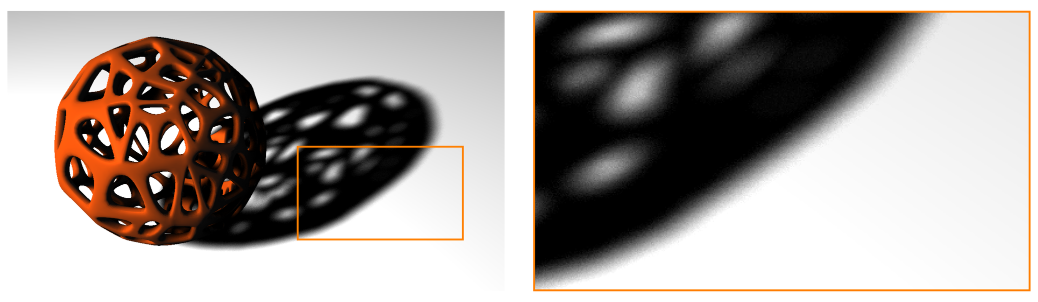
- We can define the required resolution for any desired filter radius.
- Algorithm evaluated using *percentage closer filtering* (PCF) and using *percentage closer soft shadows* (PCSS).
- We observe benefits in performance by adjusting the shadow-map size dynamically.



Screenshot of the application that was developed exclusively to test our algorithm.

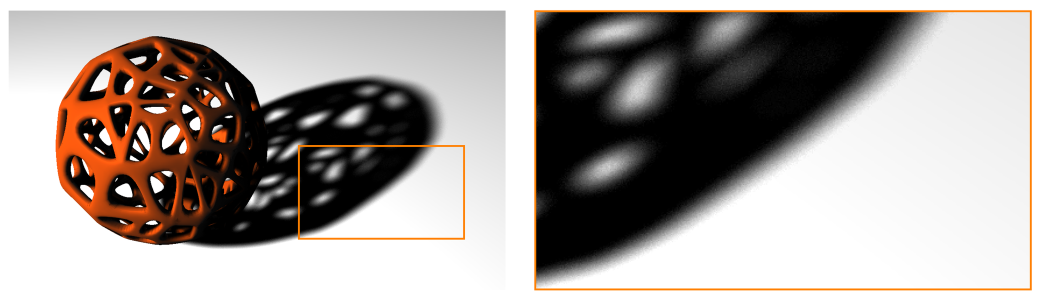


PCF 2048×2048

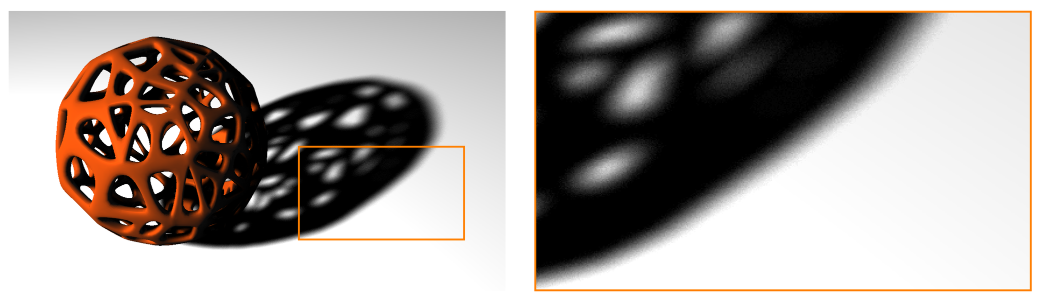


PCF 184×193

Example: PCF-filtered shadow rendered at full and optimized resolutions for a given blur radius.



PCSS 2048×2048



PCSS 271×285

Example: Soft shadow rendered at full and optimized resolutions for a given blur radius.

References

- Lance Williams.
  Casting curved shadows on curved surfaces.
  In *ACM Siggraph Computer Graphics*, volume 12, pages 270–274. ACM, 1978.

Kontakt: falichs@gmail.com