

Percentage-Closer Soft Shadows

Louis Bavoil Ibavoil@nvidia.com

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Document Change History

Version	Date	Responsible	Reason for Change
1.0	July 8, 2008	Louis Bavoil	Initial release

Overview

Soft shadows are typically rendered in games by using shadow mapping and Percentage Closer Filtering with a uniform kernel size. The Percentage-Closer Soft Shadows (PCSS) algorithm computes a variable kernel size based on the distance between the relative position of the receiver point, an approximation of the blocker, and the area light. It produces perceptually plausible soft shadows that harden on contact (see Figure 1). For more information about PCSS, please refer to the integration guide and other material at the end of this whitepaper.



Figure 1. PCSS produces soft shadows that harden on contact. Image rendered at 200 fps in 1024x768 on GeForce 8800 GTX Ultra.



Running the sample

The left button controls the light position and the right button the camera position. The mouse wheel zooms in and out.

The light source is a square area light. The "Light Size" slider changes the radius of the light.

The number of samples and their associated sampling patterns used for the blocker search and the PCF filtering can be changed in the GUI. The available presets are:

- "25/25 Poisson": 25 samples for the blocker search, 25 samples in the PCF filtering, all samples using a Poisson disk
- "32/64 Poisson": 32 samples for the blocker search, 64 samples for the PCF filtering, all samples using a Poisson disk
- "49/225 Regular": 49 samples for the blocker search, 225 samples for the PCF filtering, all samples using regular sampling (faster than Poisson disk)

The "Use PCSS" check box allows to compare using PCSS (variable-size penumbra) with non-PCSS (fixed-size penumbra).

The "Use Texture" check box renders the ground plane without any shading to show how undersampling artifacts in the shadows are hidden by textures.

The "Visualize Depth" check box outputs the shadow map depths on the screen.

Integration

This sample is assuming the shadow map is a regular depth buffer (non-linear depths), and the shadow-map is generated using a perspective projection with the center of projection at the center of the area light simulated by PCSS.

The sample uses a gradient-based depth bias to scale the depth bias based on the uv-space distance from the center of the kernel. To avoid self-shadowing artifacts, an additional depth bias may also been applied while writing depth into the shadow map.

Resources

<u>"Integrating Realistic Soft Shadows into Your Game Engine"</u>, Kevin Myers, Randima Fernando, Louis Bavoil, NVIDIA whitepaper, 2008

"Advanced Soft Shadow Mapping Techniques", Louis Bavoil, GDC slides, 2008

"Percentage-Closer Soft Shadows", Randima Fernando, SIGGRAPH sketch, 2005

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