FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Interactive Curved Reflections in Large Point Clouds

Masterstudium:
Computergraphik & Digitale Bildverarbeitung

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Scope of the work

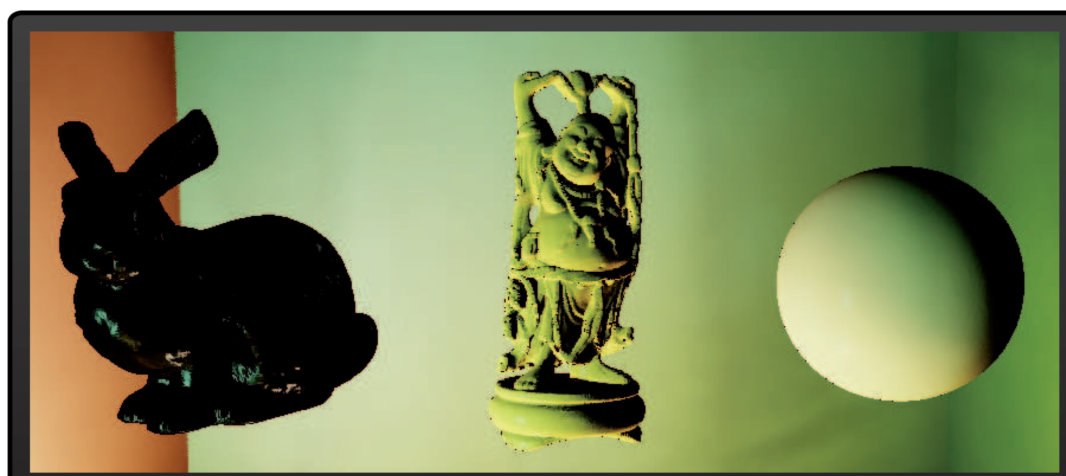
We have implemented a new algorithm that produces physically correct reflections on curved surfaces in large point cloud scenes.

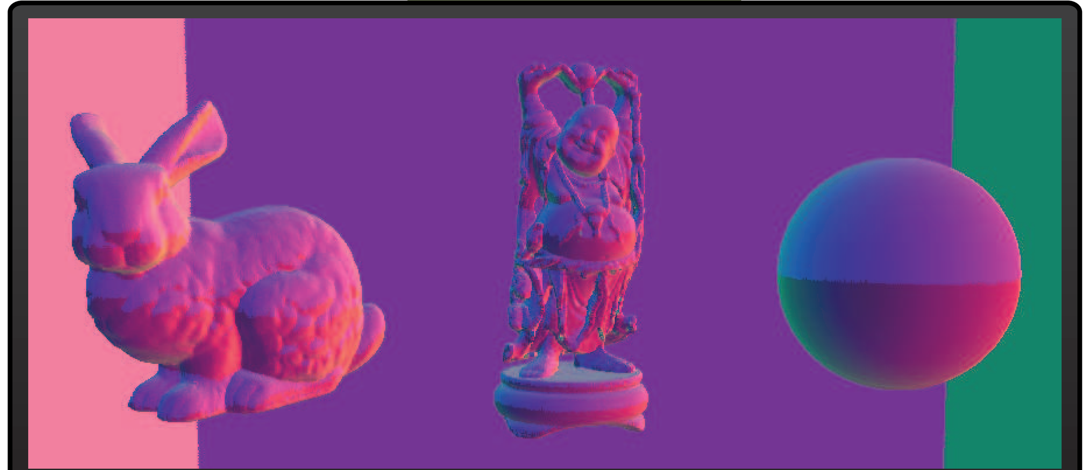
It is based on a previously implemented Global Illumination renderer for point clouds, that could only visualize diffuse and glossy surfaces so far. Generally, there is no work on reflections in point clouds up to now.

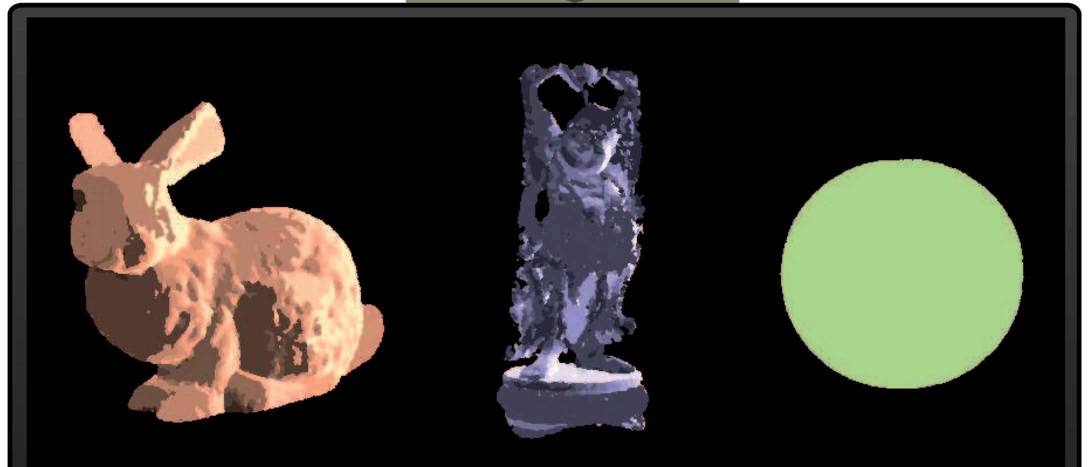
Our method performs a fast root finding in screen space in order to find reflection points corresponding to scene points.

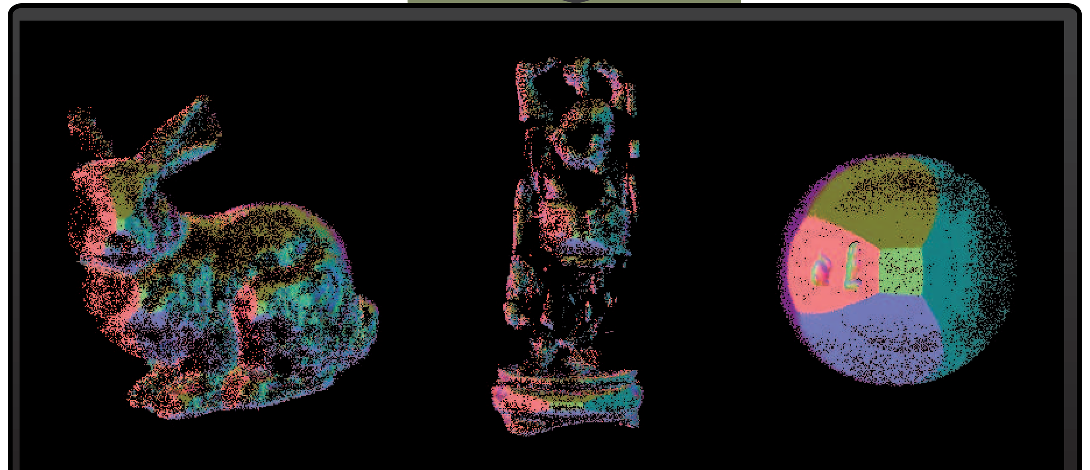
Contributions

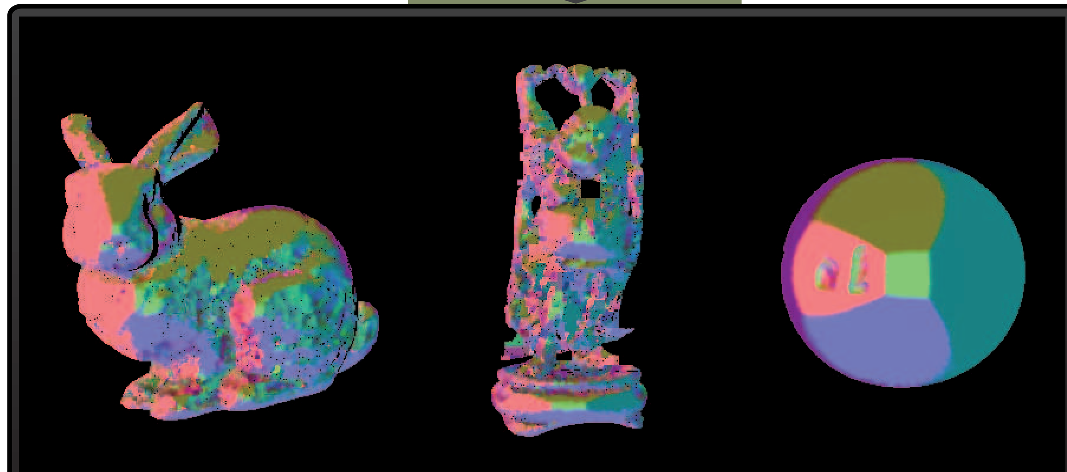
- We have developed a novel technique called ***Screen-Space Curved Reflections (SSCR)*** for fast calculation of curved reflections in large point cloud scenes.
- We have introduced a new affine space, the mirror space, and a new function over a surface for finding a reflection point, the ***mirror-space error function***.
- The algorithm operates completely in screen-space, i.e there is no need for any surface tesselation, scene subdivision or build up of surface hierarchies or other datastructures.
- The approach can be easily integrated into any point-sample based Global Illumination renderer. It even could be potentially applied to conventional polygonal scenes.


Diffuse, low specular GI scene


Normal Map extraction

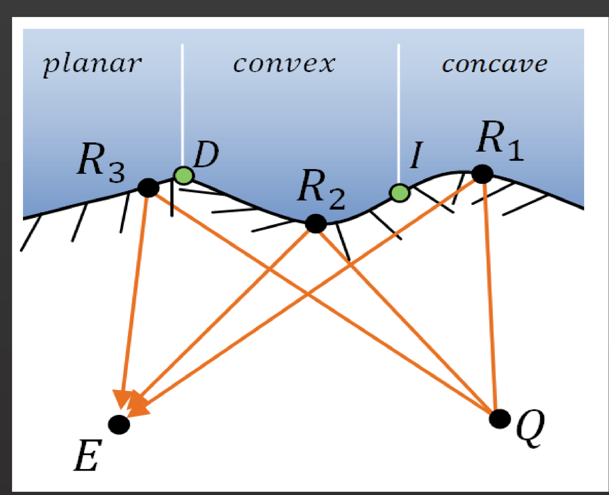

Labeled Homogeneous Curvature Map


Scene point cloud splatting

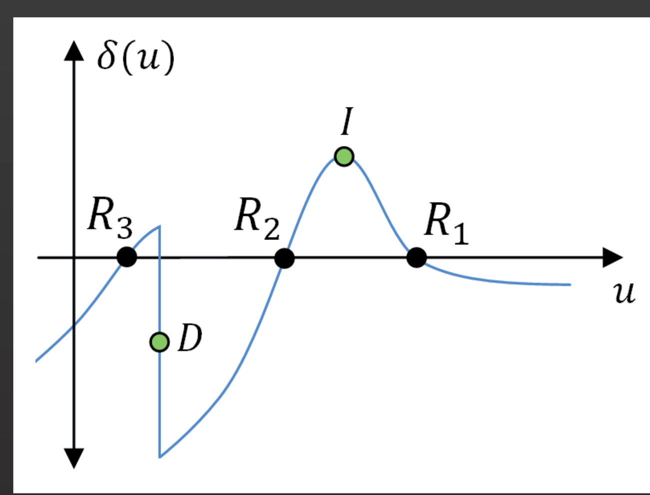

Pull-Push closing

Algorithm

Our algorithm is based on a function $\partial_{QE}(P)$, the mirror-space error function, evaluated for a triplet of eye-point E, scene point Q and surface point P on a mirror surface. The roots of this function define the location of points R, which exactly reflect Q into the eye-point. A fast root finding on this function is applied in screen-space in order to find a pixel that contains such a point.



mirror surface M (3 regions)



∂ function of M

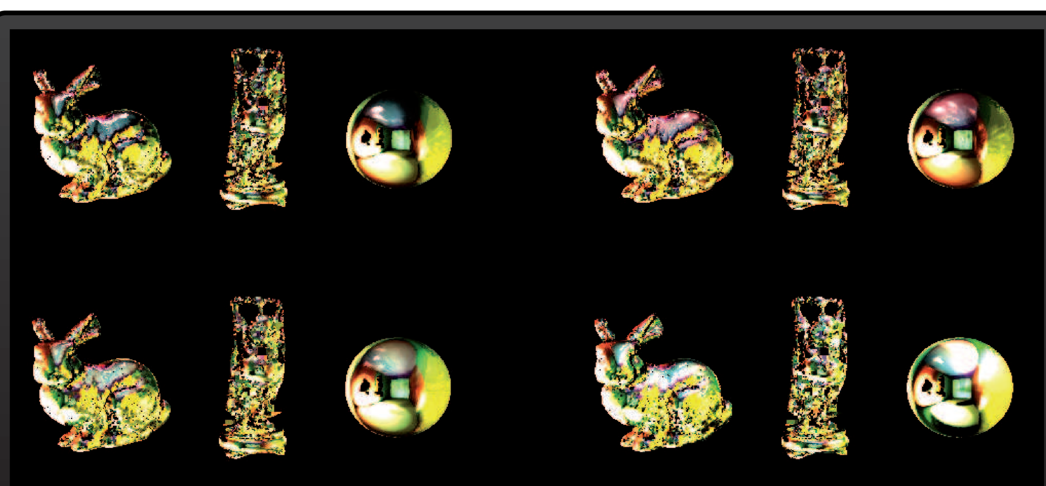
We store the attributes of Q in that pixel and shade it afterwards using our Global Illumination framework. Our algorithm operates on local surface intervals of homogeneous curvature. We thus first create a Labeled Homogeneous Curvature Map, containing unique IDs for each homogeneously curved region per pixel. We assign each scene point to one of those regions and perform the root finding, resulting in dense reflection images when applied in large point clouds.

Results

We are able to handle arbitrarily complex and detailed mirroring geometry. In opposite to e.g. simple environment mapping, we correctly evaluate the reflection function of a surface. Especially, we can correctly reproduce difficult warped mirror reflection images as on concave surfaces. The quality of the result depends on the balance between available scene points and amount of mirror pixels to shade.

Although performance is heavily affected when combining with Global Illumination, it still runs at interactive rates. For GI only, frame computation time for the adjacent demo scene (9M points) at 2 indirect light bounces and 1024x768 resolution is around 110ms on our platform*. Adding SSCR splatting all 9M points adds 280 - 410 ms (increase of 250 - 370%) depending on image quality. Splatting just every second point approximately halves the additional time. Depending on the scene, splatting only a subset of the points can be sufficent, while other scenes could require more than one root-finding pass.

* CPU: Intel Xeon X5550 2.67GHz, GPU: GeForce GTX 285 1 GB RAM


Interleaved Global Illumination shading


Final image blending

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