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Diplomarbeit

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Validierung einer Gathering-Strategie zur Szenendiskretisierung für Partikeldaten im Kontext der Berechnung von ambienter Verdeckung

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Aufgabenstellung

Selbstständigkeitserklärung

Hiermit erkläre ich, dass ich die von mir am heutigen Tag dem Prüfungsausschuss der Fakultät Informatik eingereichte Arbeit zum Thema:

Validierung einer Gathering-Strategie zur Szenendiskretisierung für Partikeldaten im Kontext der Berechnung von ambienter Verdeckung

vollkommen selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt sowie Zitate kenntlich gemacht habe.

Dresden, den 9. Januar 2018

Maximilian Richter

Kurzfassung

Abstract

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1 Introduction

1.1 Motivation

Global illumination allows to visualize complex structures in particle data, that otherwise would remain unseen. For real-time rendering less expensive approximations like ambient occlusion are used. Ambient occlusion is especially useful for visualization, as it assumes no parameters for illumination and by that introduces no new information. Instead it mimics indirect diffuse light by calculating the level of occlusion for visible surfaces. The calculation of the ambient terms is still costly, but several methods exist to approximate it. One of them, Voxel Cone Tracing, uses an discretized voxel representation of the geometry. This requires a method to transfer particles into a voxel grid. Scattering iterates all particles and adds their partial contributions to the intersected voxels. Parallel scattering processes the particles simultaneously. Synchronization has to assure correct summation of the contributions whenever multiple spheres intersecting the same voxel cause race conditions. As synchronization increases, parallelism decreases. Therefore scattering performs the worse, the more dense the particle data is.

1.2 Task

To find a particle voxelization technique that better fits the parallel nature of graphics processing units a gathering approach is validated. Gathering determines for each voxel which particles it intersects with. Contrary to scattering each voxel is processed by an individual thread. This ensures that all write operations on one voxel happen sequentially and require no synchronization. For efficient particle search around voxels an acceleration data structure is required. Starting from an unordered list of particles an algorithm is designed to first build a hashed uniform grid and then use it to calculate the voxel densities. To compare the gathering approach against scattering both construction time and memory usage are measured for particle clouds of variable size and density. The created voxel data structure is used to calculate ambient occlusion using voxel cone tracing. To evaluate the quality of the proposed solution a ground truth renderer using ray-casting is implemented. The influence of both voxelization and voxel cone tracing on the determined error is examined.

1.3 Outline

The work is organized as follows. In chapter 2 related works are discussed. First concerning acceleration data structures on particles, followed by voxelization techniques and finally ambient occlusion for particle data. Chapter 3 presents the proposed gathering based voxelization technique. Chapter 4 details the techniques used to calculate ambient occlusion. In chapter 5 implementation details are given. Chapter 6 finally presents the results of the work.

2 Related Work

3 Ambient Occlusion

3.1 Ray Casting

idea + hemisphere sampling ray sphere intersection math

3.2 Voxel Cone Tracing

cone tracing idea + cone approximation with voxels construction of hierarchy

4 Gathering Voxelization

Review of possible data structures considering requirements of gathering approach.

4.1 NAME OF SELECTED DATASTRUCTURE

Presentation of a fast particle access data structure including underlying structure (grid..) and acceleration methods (sorting..).

4.2 Particle Voxelization

(basically how to transfer particles to voxel contributions)

5 Algorithm

5.1 Gathering Voxelization

5.2 Ambient Occlusion

5.3 Voxel Cone Tracing

-> hemisphere of n cones per frame -> variable cone size + variable voxel grid size for comparison

5.4 Ray Casting

-> GPU Pathtracer on spheres -> progressive pipeline -> also on voxels for comparison

6 Results

6.1 Evaluation

1. Qualitativ

VCT on standard resolution grid - ray tracing on particle data -> Fehlerquellen:

VCT on high resolution grid -> voxelization error

Ray casting/Fine cones on voxel grid -> cone tracing error

2. Quantitativ

Scattering vs Gathering Performance + Speicherverbrauch

6.2 Discussion

7 Conclusion

Literaturverzeichnis