Real Time Multi-Scale Sand Rendering
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Abstract
Rendering dense dynamic stackings, frequent in natural phenomena, induces high frequencies which are hard to reproduce under real time constraints. Sand is an extreme such example with challenging appearance level-of-details at any given scale. In this paper, we study the problem of real time sand rendering, from the scale of individual grains to the one of wide sand tracts. As mesh-based level-of-details approaches fail on such fine complex geometric elements, we propose a model based on rich spherical impostors able to combine precomputed as well as dynamic procedural data, and offering seamless transitions from close instanced meshes to distant surfs. We show that our method extends beyond sand with several distributions of non-trivial dynamic geometric elements rendered in real-time on a standard graphics processor.

Overview

Splitting

to build per-scale element buffers

The element buffer dynamically reordered to group grains for subsequent draw calls. This step also performs occlusion culling.

Input element buffer
- render occluder map
- get render model
- split element buffers

Impostors

to draw mid-scale grains

Precomputing (usually <1s)

Rendering G-buffer maps (albedo, normal, etc.) from many directions.

Runtime

(a) Find closest directions i, j, k, l
(b) Sample one texel from each plane
(c) Blend responses

Atlas of G-Buffers

In memory, the impostor is an atlas of per-view G-buffers.

Occlusion Culling
to discard invisible grains

Inner radius r and outer radius R are used to cut some grains prior to querying their actual shape.

\( g_1 \) is hidden for sure
\( g_2 \) may be visible

Properties

- Apply to many other granular materials
- Fits in deferred-shading pipelines
- Plays along with procedural attributes (orientation, color, etc.)
- Millions of grains

Performances

Impostors vs. instanced meshes

Mesh-based rendering is vertex bounded and depends of the grain's complexity, so it gets outperformed by instance rendering when the number of visible grains is large.

Visual Loss

Comparing impostor sampling strategies

Our mixed sampling provide a comparable visual accuracy at lower memory requirement.

References