Efficient modeling of entangled details for natural scenes

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Introduction
Context/problem

• Natural scenes
  • Numerous details
  • Entangled
  • Different kinds

⇒ Tedious authoring
Related work

Simulations
- Realistic
- Limited user control
- Does not scale

Procedural
- Efficient
- Specific
- Memory

Interactive editing
- Control
- Specific
- Interpenetrations
Our approach

• Key observation: if not regular, repetitions are not visible

• Split the process into two steps
  1. Pre-compute collisions in a very dense tile
  2. Fast Instantiation
• Multiple control types

+ Realistic
+ Efficient
+ Not object-specific
+ Light in memory
+ Scalable
+ Controllable
The method
Pipeline in 2 steps

1. Ghost Tile Generation
   - Input objects
   - Candidates
   - Collision graph

2. Instantiation
   - Density fields
   - Ghost Tile

Introduction | Method | Results | Conclusion
The method

Step 1 – Ghost tile construction
Ghost tile

Objects $O$

Frames $\mathcal{F}$

Candidates $O_i^j = F_i^j(O_i)$

Ghost Tile $\mathcal{T}$

Collision graph $\mathcal{G}$

References
Ghost tile construction

Algorithm

1. Pick a random frame in the tile

2. Compute intersections inside the same tile in the neighbor tiles

3. If intersection, add two reciprocal arcs in the graph

⇒ Repeat (and use a spatial acceleration)
Collision detection

- Volume approximated by spheres
- Automatic or manual according to the context

Distance between unions of spheres is easy

\[ d(A, B) = \min_{i,j} \|b_j - a_i\| - (r_i + r_j) \]
The method

Step 2 : Instantiation
Density description

Density functions

\[ f_i : \mathbb{R}^3 \rightarrow \mathbb{R} \]

Stones density function \( f_j \)

Twigs density function \( f_i \)
Culling step

- Remove candidates whose density vanishes at anchor point(s)
Instantiation step

- Select the highest priority candidate (green)
- Discard colliding candidates (orange)
Priorities

- Random: 4.3k instances
- Altitude: 4.5k instances
- Distance to the boundary: 4.5k instances
- Distance to the boundary + partial filling: 3.8k instances
Results
Volumetric objects

Method that accounts for volumetric objects
Control over density

Density functions to control the relative density of each object type

23k instances
19k instances
18k instances
Complex scenes - Borie

Introduction

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63k flat stones
Instantiation time 17s
Complex scenes - Field

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4.3M straw instances
Instantiation time 54.6s
Complex scenes - Meadow

Interactive authoring
Standard stroke
1k instances in 1.5s
Conclusion
Conclusion

- Limitations
  - No structure
  - No animation
- General framework to model entangled details
- Two steps
  1. Offline pre-computation
  2. Instantiation
- Efficient
- Handle interpenetrations
- Several user controls
Thank you for your attention!

See video and more on: http://liris.cnrs.fr/eric.guerin/efficient-modeling-of-entangled-details-for-natural-scenes/