Rendering Natural Scenes with Generalized Object Instancing

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Why the Outdoors?

- Great beauty
- Geometric and material complexity
- Many modes of light transport
- Challenging to many classic algorithms
Evaluating Rendering Algorithms

• Geometric Complexity
  – Millions of primitives

• Material Complexity
  – BRDFs and many texture maps

• Illumination Complexity
  – Multiple scattering, atmospheric effects
IBR?

• Acquisition is difficult
  – Complex visibility, translucency
• Close up views?
• If synthetic scene, must render anyway
Progress in Modeling

- Ecosystems with tens of thousands of plants
- Controlled levels of abstraction
Controlled Descent Into Complexity

- REYES
- Probabilistic rendering of particle systems
Generalized Instancing

- Lossy geometric compression
- Parametrized by more than transformation
  - shader
  - textures
- Opportunity for precomputation
Geometry Quantization

- A way to do lossy compression of geometry
- Quantize parameter space
*Lychnis coronaria*

Vigor

Age
Sample Distribution

Vigor

Age
Result

17 Million triangles
8 hours to render
15:1 compression

30,000 individual plants
Originally 580MB
Problems: How Much Error?

- Some dimensions may be more important
- Non-linear effect of parameter changes
- Requires careful construction of L-system
- No accounting for neighbors
Possible Algorithm

• Register candidate models
  – Horn, Besl, Fisher, Turk & Levoy…
• Incorporate non-uniform scaling
• Ability to match sub-parts
• Include in error term:
  – Color/Material
  – Context
Implications

- Can lazily pick instances
- Satisfy error bound in perceptual space
- No need to modify L-systems, etc.
- Non-procedural models?

"Instancing to manage complexity, not just generate it"
Challenges in Illumination

- Lighting and material model
- Making it efficient
  - Reeves/Blau, Max et al, Daubert et al, Patmore...
Precomputed Illumination

- Classic idea (shadow maps, …)
- Amortize over all uses of an instance
- Be independent of any lighting environment
Instance Independence

- Precomputed sky visibility

25 minutes
1.5 minutes
Other Possibilities

• Probabilistic shading parameters (Reeves/Blau)
• Leaf area index (Ross, Baldocchi, ...)
• Volumetric clusters (Sillion, Drettakis)
• Global accessibility (Miller)
• Basis-function lighting (Dorsey et al, ...)

Conclusion

• Innovation in modeling is driving rendering
• Perceptual error metric for shape x BRDF?
• Fight the good fight to delay the onset of complexity
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