Interactive Modeling of Tree Bark

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Tree Bark in Real World

- Rich surface geometry
  - Ironbark
  - Fracture
  - Tessellation
  - Furrowed cork
  - Lenticel
  - Stringy bark

- Complex appearance
  - Determined by the underlying mesostructure and texture colors
Motivations

- Multi-levels geometry representation of bark
  - Gross shape
  - Mesostructure
  - Microstructure
- Plenty of bark textures
  - Automatic recovering from images, but…
  - Interactive
    - Easy to specify features
    - Easy to editing
Related Works

- Bark modeling
  - Procedure texture [Opperheimer86, Hart96]
  - Physical based simulation [Federl96, Tanoue98, Lefebver02]

- Mesostructure reconstruction
  - From multi-images [Liu01, Rushmeier97]
  - From a single image [Dischler02, Leclerc91]
Our approach

- Based on a single image captured by a handheld camera

- Interactive modeling of a variant of bark with an easy-to-use UI
  - Height fields
  - Texture
Framework

**Specification Component**
- Image
  - Texton analysis
    - Feature 1
    - Feature 2
    - Feature n

**Editing Component**
- Edit tool
  - Mesostructure
  - Color
Feature Specification

- **Texton analysis**
  - Based on low-level vision procession.
  - Segment bark image to a set of texton channels by the method similar to [Malik99]

- **Filtering and clustering**
  - 36 Gaussian derivative filters
  - Clustered using $K$-mean ($K=25$)
Texton Analysis

Bark Image

Filter

Feature Vectors

Cluster

Texton Image (K=25)
Feature Specification (Cont.)

- Merging texton channels
  - Based on high-level human knowledge.
  - Combine texton channels to several bark features by user interactions
Merging Texton Channels
Merging Texton Channels
Merging Texton Channels

Horizontal fractures
Merging Texton Channels

Other regions
Height Field Construction

- **Height assignment**
  - Assign height value for a single pixel for each feature channel

- **Height field propagation**
  - Height is propagated to other pixels in the feature channel
    - Self-similarity [Brooks02]
    - Grey-scale value
    - Mean value
Editing UI (video)
Texture Correction

- Bark image combines texture and illumination
  - Calculate the per-pixel illumination coefficients by local normal direction ($N$) and approximated light direction ($L$)
  - Correct the Illumination: $T_0 = \frac{I_o}{N \cdot L}$

Bark Image  Height Field  Texture  3D view
Experiment Result (1)

- **Input images**
  - Captured by a CANNON digital camera

- **Failed case**
  - Stringly bark
  - Others whose microstructure can not be represented by height fields
Experiment Results (2)
Experiment Results (3)
Result Video: (rendered by VDM)
Conclusion

● Advantages
  ● Convenient to capture
  ● Easy to specify and model bark with our UI
  ● Appropriate for a variant of bark

● Limitations
  ● Difficult to model non-height-field-represented bark
  ● Difficult to precisely construct the surface geometry
Future work

- A better initial height fields estimated from computer vision techniques
- More general bark surfaces
  - Height fields
  - Non height fields
- Modeling of general mesostructures
Thank You!