



Painterly Rendering

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Course 600.456: Rendering Techniques, Professor: Jonathan Cohen



Types of Computer Painting

Physical simulation

- User applies strokes
- Computer simulates media (e.g. watercolor on paper)

Automatic painting

- User provides input image or 3D model and painting parameters
- Computer generates all strokes



Two Painterly Rendering Systems

“Painterly Rendering for Animation”

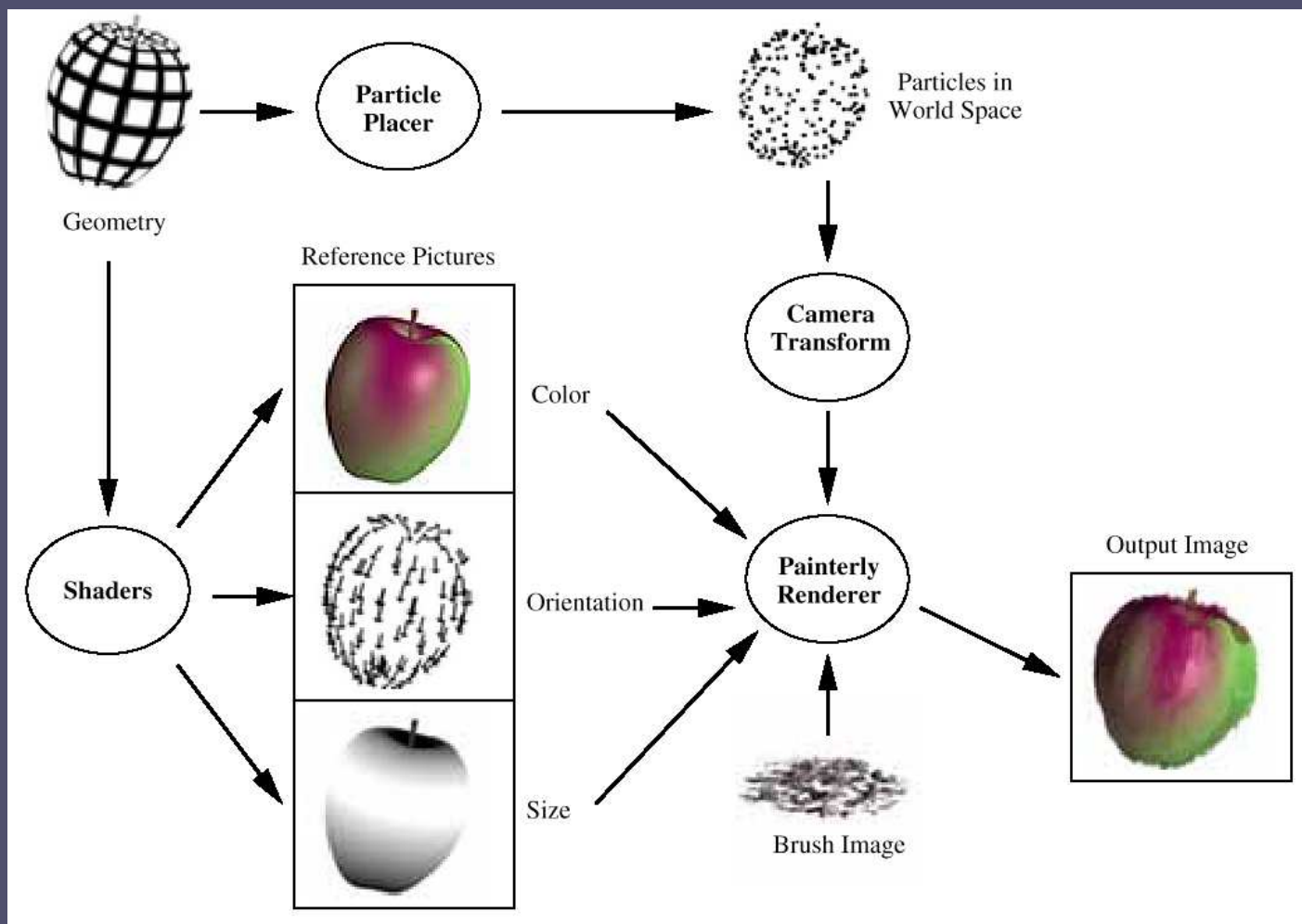
- Meier, *SIGGRAPH 96*

“Painterly Rendering with Curved Brush Strokes of Multiple Sizes”

- Hertzmann, *SIGGRAPH 98*



Painterly Rendering Pipeline



from Meier,
“Painterly
Rendering for
Animation,
*Proceedings of
SIGGRAPH 96*,
page 480.



Basic Approach

Algorithm

- Surface particles placed in world space
- Reference images rendered
- Each particle becomes a screen-space stroke

Features

- Greater temporal coherence than purely screen-space approaches
- More natural style than purely geometry (texture-mapped) approaches



Particle Generation

Compute area of surface primitives

Randomly place particles on primitives

- **number proportional to area**



Reference Images

Used to determine stroke attributes

- color
- orientation
- size
- many others possible

Rendered with programmable shaders



Stroke Rendering

Particle transformed to screen-space

Stroke parameters from reference images

- **perturbed according to user-specified variation**

Brush image rendered according to stroke parameters

- **oblong brush shapes work best**
- **grayscale brushes typically sufficient**
 - **color brush textures may be used to modify particle colors**



Example - Haystacks



Haystacks *without* random parameter perturbation



Similar view *with* random parameter perturbation

from Meier, "Painterly Rendering for Animation, *Proceedings of SIGGRAPH 96*, pages 481 and 478.



Example - fruit

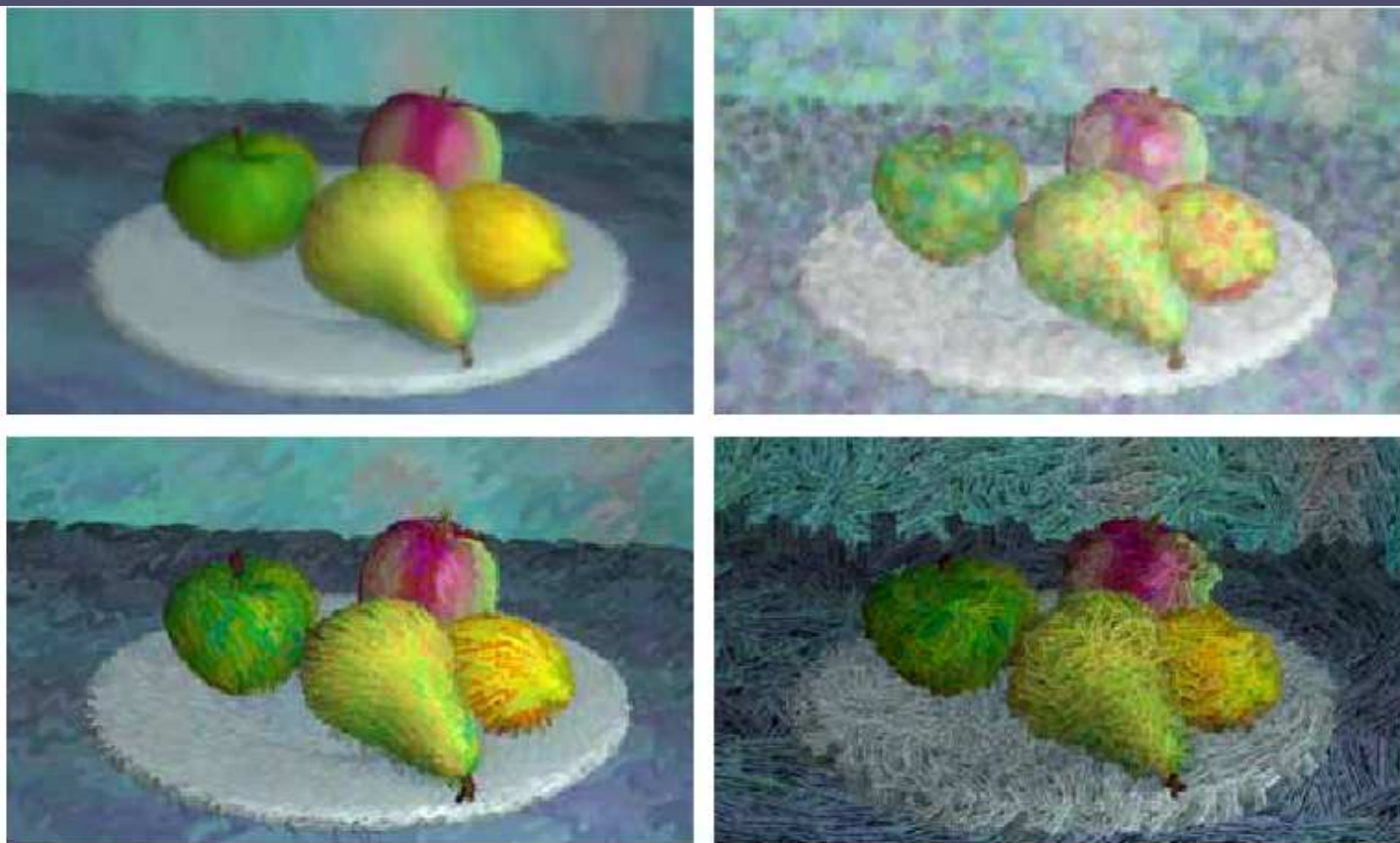


Figure 5: Four styles of painterly rendered fruit. By choosing different brush images and painting parameters, we have created four different looks from the same set of reference pictures. The upper left image has the soft, blended quality of a pastel painting. The pointillistic version, in the upper right, remaps the original saturations and values from the color reference picture to a new range. A squiggle brush image and increased hue variation were used to create marker-style strokes in the lower left image. The brush used to create the lower right contained some opaque black that helps to create a woodcut print style.

from Meier,
“Painterly
Rendering for
Animation,
*Proceedings of
SIGGRAPH 96*,
page 481.



Layered Approach

Similar objects rendered together

Dissimilar objects often rendered as separate layers and composited later

- **Large strokes intrude less onto nearby objects**



Video (or .mov movie files)

Meier, “Painterly Rendering for Animation”,
Proceedings of SIGGRAPH 96.



Hertzmann's Approach

Apply to color images with no 3D model information

Allow longer, curved brush strokes

- **makes different styles possible**

Multiple rendering passes

- **larger strokes first**
- **add detail with smaller strokes**



Stroke Description

Constant color per stroke

B-spline path

Constant radius circle (or other shape)

swept along path

Applied in layers, with opacity control



Building Up Layers

Start with large strokes

Each pass reduces stroke size

**New strokes placed according to error
metric of current painting**



Painting a Layer

Select stroke size for layer

Blur input image

Start strokes within uniform grid cells

Start each stroke at point of maximum error within grid cell

Walk perpendicular to image gradient to place control points

Render strokes in random order as circles along cubic B-spline path



Style Parameters

Approximation threshold

Brush sizes

Curvature filter

Blur Factor

Min/Max stroke lengths

Opacity

Grid size

Color jitter



Example Styles

“Impressionist”

“Expressionist”

- long strokes, color value jitter

“Colorist Wash”

- transparency, RGB color jitter

“Pointillist”

- densely placed circles, random hue and saturation



Example - adding passes



(a)



(b)



(c)



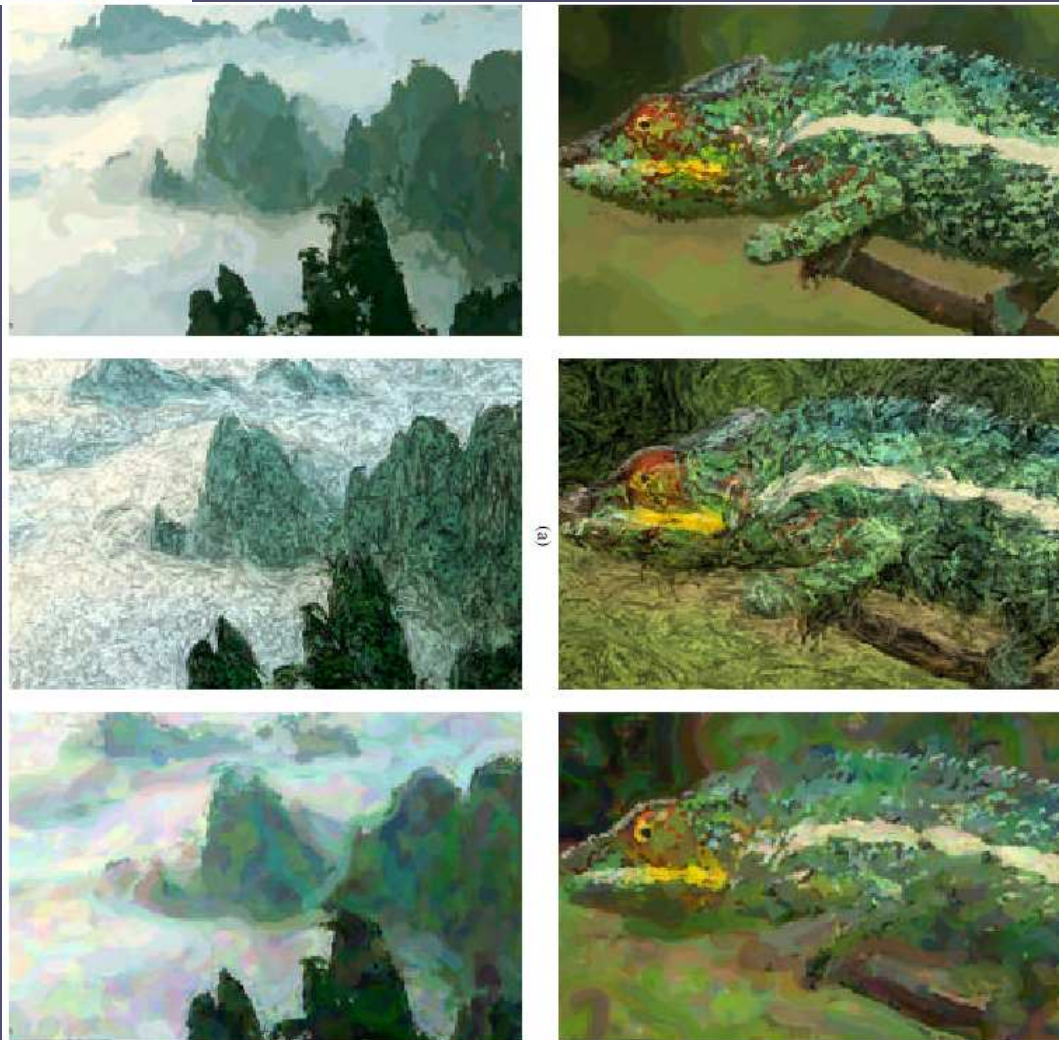
(d)

Figure 2: Painting with three brushes. (a) A source image. (b) The first layer of a painting, after painting with a circular brush of radius 8. (c) The image after painting with a brush of radius 4. (d) The final image, after painting with a brush of size 2. Note that brush strokes from earlier layers are still visible in the painting.

from Herzmann,
“Painterly
Rendering with
Curved Brush
Strokes of
Multiple Sizes,
*Proceedings of
SIGGRAPH 98*,
page 456.



Example - styles



**Three styles:
impressionist,
expressionist,
colorist wash**

from Herzmann, “Painterly Rendering with Curved Brush Strokes of Multiple Sizes, *Proceedings of SIGGRAPH 98*, page 460.



Video

**Hertzmann, “Painterly Rendering with Curved Brush Strokes of Multiple Sizes”,
*Proceedings of SIGGRAPH 98.***