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# Painterly Rendering

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Course 600.456: Rendering Techniques, Professor: Jonathan Cohen



# Types of Computer Painting

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## 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

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## “Painterly Rendering for Animation”

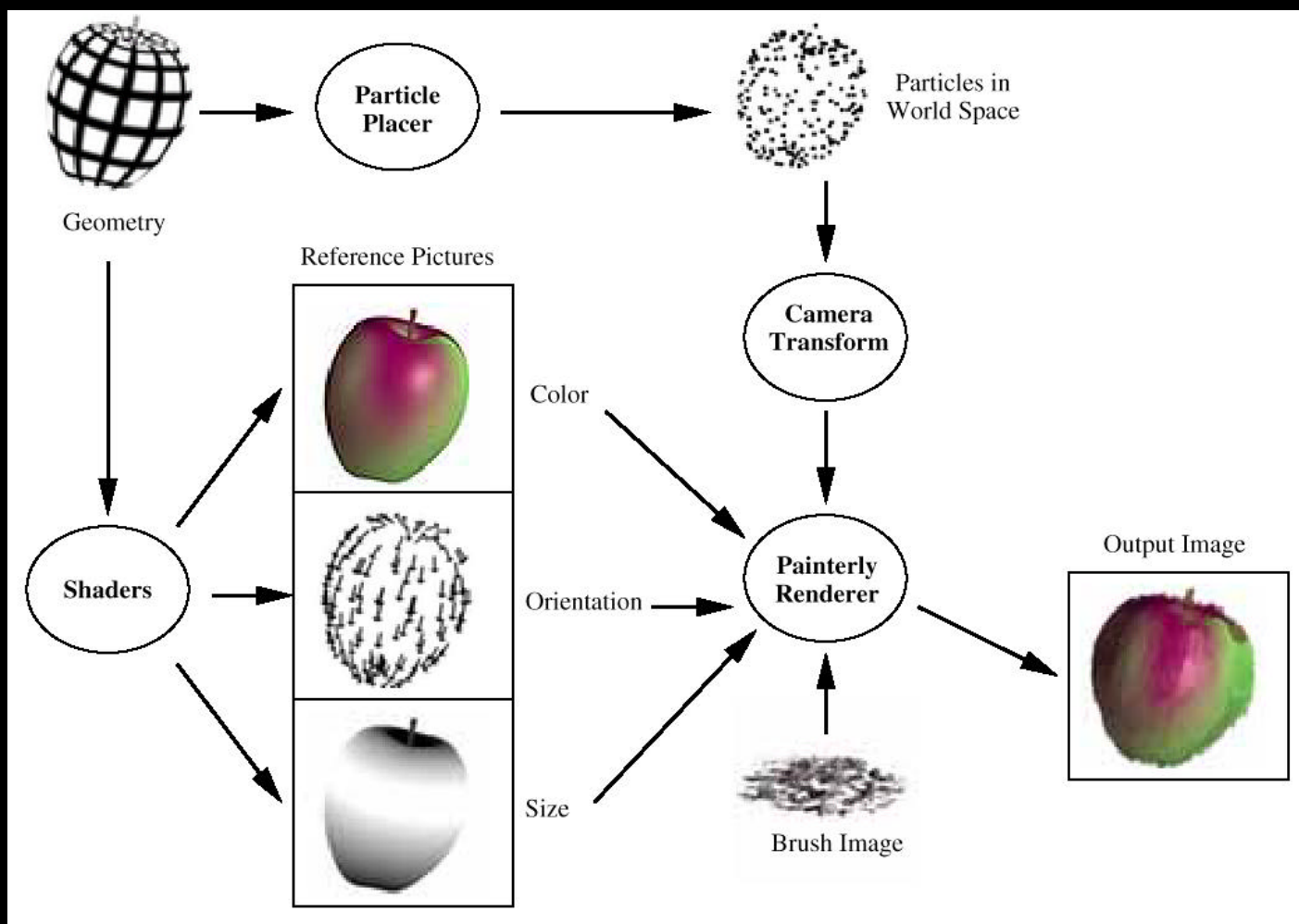
- Meier, *SIGGRAPH 96*

## “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

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## 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

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**Compute area of surface primitives**

**Randomly place particles on primitives**

- **number proportional to area**



# Reference Images

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Used to determine stroke attributes

- color
- orientation
- size
- many others possible

Rendered with programmable shaders



# Stroke Rendering

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**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

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**Haystacks *without* random parameter perturbation**

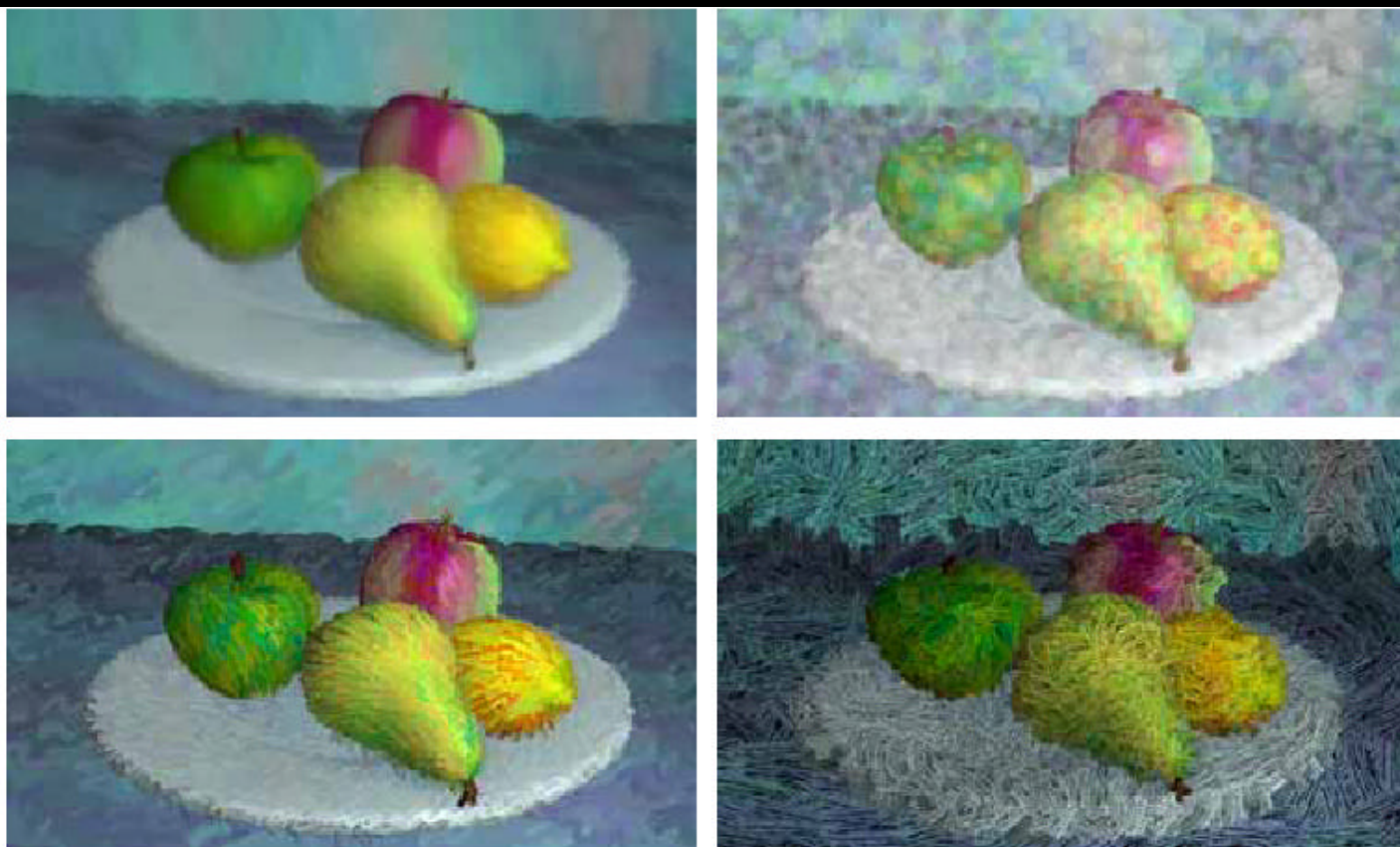


**Similar view *with* random parameter perturbation**

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

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**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)

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



# Hertzmann's Approach

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**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

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**Constant color per stroke**

**B-spline path**

**Constant radius circle (or other shape)**

**swept along path**

**Applied in layers, with opacity control**

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# Building Up Layers

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**Start with large strokes**

**Each pass reduces stroke size**

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



# Painting a Layer

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**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**

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# Style Parameters

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**Approximation threshold**

**Brush sizes**

**Curvature filter**

**Blur Factor**

**Min/Max stroke lengths**

**Opacity**

**Grid size**

**Color jitter**



# Example Styles

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**“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)



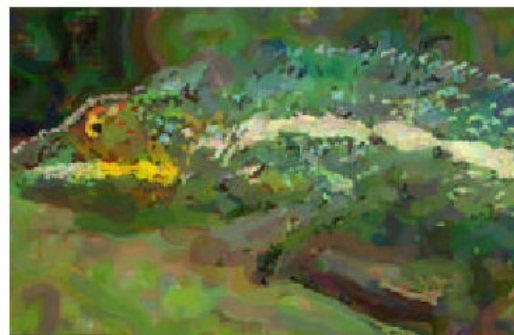
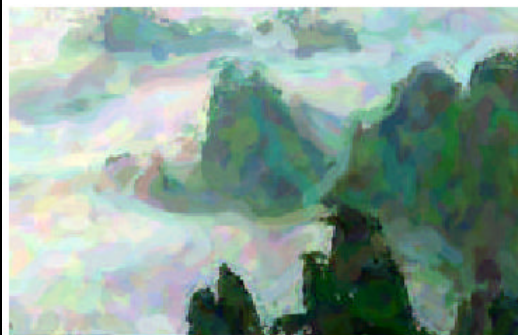
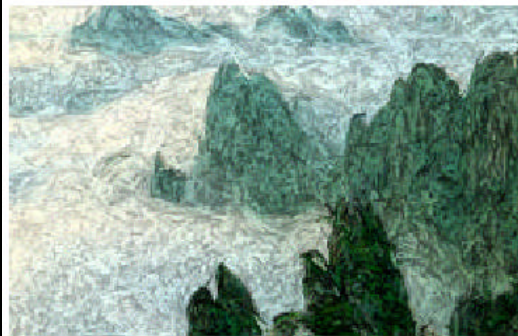
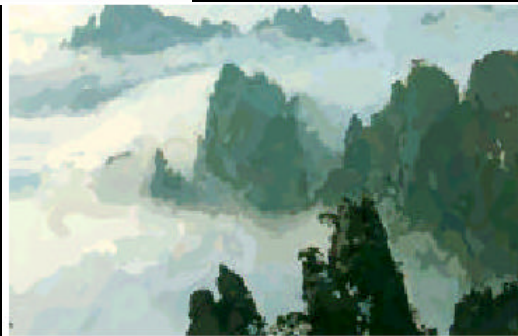
(d)

**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

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