Painterly Rendering
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, \textit{SIGGRAPH 96}

“Painterly Rendering with Curved Brush Strokes of Multiple Sizes”

- Hertzmann, \textit{SIGGRAPH 98}
Painterly Rendering Pipeline

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

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

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.

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