Processing Images and Video for an Impressionist Effect

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Introduction

- New technique to produce painterly animations from video clips *automatically*

Claude Monet. Impression: Sunrise. 1872.

Motivation

- Video clips as input
- Automatic processing of image sequence
- Noise vs Shower-door effect

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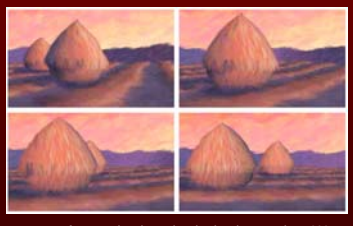
Previous Work

- Haeberli technique
  involves extensive human interaction to produce the final image
- Hsu technique
  a system for producing 2-1/2D key-framed animations using "skeletal strokes"

Paul Haeberli, Siggraph 1990

Previous Work

- Meier technique
  a system for transforming 3D geometry into animations with a painterly look



Frames from a painterly rendered animation. B.Meier. 1996

Process Overview

- Rendering strokes
  - Stroke generation
  - Random perturbations
  - Clipping and rendering
  - Using brush textures
- Brush stroke orientation
- Frame-to-Frame coherence

Renoir. Nude in the Sunlight. 1875-1876.

Rendering Strokes

- Stroke generation
  brush strokes are generated with an antialiased line centered at (cx,cy), with a given length, a given brush thickness, and a given orientation

Original image

Processed image without stroke clipping

Rendering Strokes

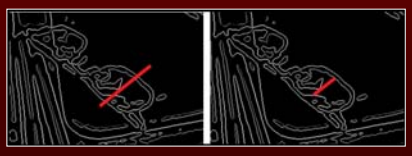
- Random perturbations
  adding random variations and perturbations to a stroke helps to create a hand-crafted look

Perturb and scale length, radius, color and orientation by a random amount in ranges supplied by the user

Processed image without stroke clipping

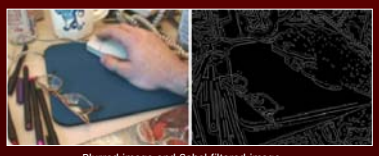
Rendering Strokes

- Clipping and rendering
  - To render a brush stroke, an antialiased line is drawn through its center in the appropriate orientation
  - In order to preserve detail and silhouettes, strokes are clipped to edges that they encounter in the original image



Rendering Strokes

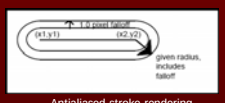
- Clipping and rendering process
  1. Create intensity image [I = .30*r + .59*g + .11*b]
  2. Apply Gaussian blur
  3. Apply Sobel filter [Sobel(x,y) = Magnitude (Gx, Gy)]
  4. "Grow" the stroke
  5. Draw the stroke



Blurred image and Sobel filtered image

Rendering Strokes

- Clipping and rendering process
  1. Create intensity image
  2. Apply Gaussian blur
  3. Apply Sobel filter
  4. "Grow" the stroke
  → 5. Draw the stroke



Antialiased stroke rendering

Without clipping

With clipping

Rendering Strokes

- Using brush textures

Rectangle to render textured brushes

Lower right corner shows basic brush intensity and alpha

Brush stroke orientation

- Draw brush strokes in the direction of constant color
- Orientation can be approximated automatically by drawing strokes normal to the gradient direction

Strokes are oriented using a gradient-based technique

Brush stroke orientation

- Problem: when the magnitude of gradient is near zero

Strokes are oriented using a gradient-based technique

Brush stroke orientation

- Problem: when the magnitude of gradient is near zero
- Solution: smoothly interpolate the directions defined at the boundaries of a constant color region

Gradient values are interpolated

Brush stroke orientation

- Using the normal to the gradient causes strokes to look glued to objects in a scene

Direction Angle = arctan(Gy/Gx) + 90° + Δtheta

Gradient values are interpolated

Frame-to-frame coherence

- Optical flow
- Delaunay triangulation

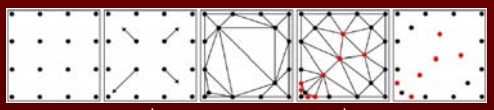
Frame-to-frame coherence

- Optical flow
  a concept for considering the motion of objects within a visual representation

Two frames and the optical flow field that maps pixels from one frame to another

Frame-to-frame coherence

- Delaunay triangulation



a b c d e

a) Initial brush stroke positioning
b) The four middle strokes are to be moved as shown
c) Delaunay triangulation of the moved strokes
d) Add new vertices to satisfy maximal area constraint
e) The updated list of brush strokes

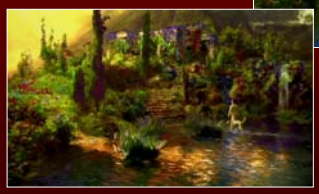
Summary

- Algorithm for producing painterly animations from video clips
  - Strokes are clipped to edges
  - Strokes are oriented normal to the gradient direction
  - Optical flow used to enhance temporal coherence

Flying Dog. What Dreams May Come. 1998

Conclusion

Find 12 differences



What Dreams May Come. 1998