Processing Images and Video for an Impressionist Effect
by Peter Litwinowicz

Presentation by Dmytro Prykhodko

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


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

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

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.

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.

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.

Clipping and rendering process
1. Create intensity image \[ I = 0.30 \times r + 0.59 \times g + 0.11 \times b \]
2. Apply Gaussian blur
3. Apply Sobel filter \[ \text{Sobel}(x, y) = \text{Magnitude}(G_x, G_y) \]
4. "Grow" the stroke
5. Draw the stroke

Using brush textures
- A rectangle is used to render textured brushes.
- Lower right corner shows basic brush intensity and alpha.
- Antialiased stroke rendering.
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

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

Direction Angle = \arctan\left(\frac{\text{Gy}}{\text{Gx}}\right) + 90^\circ + \Delta \theta

Frame-to-frame coherence
- Optical flow
- Delaunay triangulation

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) 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

Conclusion

Find 12 differences