Painterly Rendering with Curved Strokes of Multiple sizes

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Presented by Ran Chen

Outline

- Motivation
- Related work
- Painting Techniques
  - Varying the brush size
  - Creating curved brush strokes
- Style Parameters
- Experiments
- Apply to Video
- Conclusion

Motivation

- Most current systems: brush strokes
  - Manual
  - Equal size and shape
    Looks mechanical!
- Idea: automatic painting
  + painterly effect
  - Multiple size
  - Long and curved strokes
    Looks natural!

Related Work

- Automatic Painting
  - Pen-and-ink illustration for images: Salisbury et al 97'

  No visible (oil) brush stroke, lack of painterly effect!

Related Work

- Painterly Effect
  - Strokes with same size and shape:
    Litwinowicz 97', Processing Images and Video for An Impressionist Effect (week 5).
  - Statistical analysis to guide stroke size:
    Treavett and Chen, 97'
  - Local detail level to guide stroke size:
    Microsoft Image Composer 1.5, Treavett and Chen, 97'

  Paint image in a single pass, cannot refine the painting!

Painting Technique

- Draw most attention
- Fine strokes!
- Draw little attention
- Coarse strokes!

At the Seashore by Degas
Painting Technique

- **Input**
  - Source image
  - A list brush sizes B1, ..., Bn (e.g. 8, 4, 2)
  - Canvas

- **Methods**
  - Varying the brush size to create layers
  - Creating curved brush strokes (B-spline)

- **Output**
  - A destination image with painterly effect and using different brush strokes to capture fine and coarse details.

A. Klein, 557 course notes 04' 88/20/20

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Varying the brush size

Brush stroke: location, color, size, direction, shape

Source image

Blur \( *G_{fb} \)

Reference image

Grid size \( f_R \) Region

Original Canvas

Constant color

Difference image

Stroke list: \( \{(x_1,y_1), ..., (x_n, y_n)\} \), render in random order for better effect!

The canvas after first layer Painting

Stroke list: \( \{(x_1,y_1), ..., (x_n, y_n)\} \), render in random order for better effect!

Curved Brush Strokes

- **Idea:**
  - B-Spline
  - Control points following the normal of the image gradient
  - If colors differ too much, or stroke gets too long, end stroke.

Brush stroke shape: circle

Too mechanical!
Creating curved brush strokes

Task: Find the control points

Stroke:
- Brush radius
- A list of control points, distance between CP=brush radius, follow normal of image gradient;
- Color (as first control point)

Style Parameter

<table>
<thead>
<tr>
<th>Artist</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opacity, transparency (wash-like effect)</td>
<td>Opacity $\alpha$. (low opacity)</td>
</tr>
<tr>
<td>Loose and tight curves</td>
<td>Curvature Filter fc.</td>
</tr>
<tr>
<td>Brush stroke length</td>
<td>Minimum and maximum stroke length: minLength, maxLength</td>
</tr>
<tr>
<td>Color noise</td>
<td>Color jitter: add jitter to HSV or RGB</td>
</tr>
</tbody>
</table>

Style Parameter

<table>
<thead>
<tr>
<th>Artist</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A bunch of brushes</td>
<td>A list of brush sizes (R1, ..., Rn)</td>
</tr>
<tr>
<td>Capture fine/coarse details</td>
<td>Blur factor $f_b$: $\text{img} \times G_{blur}$</td>
</tr>
<tr>
<td>Closely or roughly match color in source object</td>
<td>Approximation threshold $T$: $(\sum \text{pixelDiff})/\text{grid}^2 &gt; T$</td>
</tr>
<tr>
<td>Control the spacing of brush strokes</td>
<td>Grid size: fgRi,</td>
</tr>
</tbody>
</table>

Experiment

Impressionist: $T=100$, $R=(8,4,2)$, $fc=1$, $fs=.5$, $fg=1$, $\text{minLength}=4$, $\text{maxLength}=8$

Expressionist: long brush strokes, jitter to color value; $T=50$, $R=(8,4,2)$, $fc=.25$, $fs=.5$, $fg=.7$, $\text{minLength}=10$, $\text{maxLength}=16$

Colorist Wash: Loose semi-transparent brush strokes, jitter to RGB; $T=200$, $R=(8,4,2)$, $fc=1$, $fs=.5$, $fg=1$, $\text{minLength}=4$, $\text{maxLength}=16$, $jr=jb=jg=.3$
Apply to Video

- Interactive painterly video processing
  - Only paint the regions where the source video is changing.
  - Without optical flow, subjective impression of "hand-made"; with optical flow, painting surface flows and deforms.
  - For music video, different painting styles enhance the changing mood and intensity of the music.

Hertzmann & Perlin, 00

Music Video Play

- Larger strokes: more abstract, for intense and meditative passages;
- Smaller strokes: less abstract, for transitional passages;
- Expressionist: more active and abstract, for most intense passage and during the solos

Hertzmann & Perlin, 00

Conclusion

- Strength: Looks nicer than previous work;
- Weakness: Artists use fine strokes to wherever they want to draw attention; here fine strokes are used where color changes much.

Remember!

- Different brush stroke sizes convey level of details of source image.
- Long, curved strokes can express different painting styles.