Aesthetic Enhancement of Landscape Photographs based on depth

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Acknowledgement

• The presenter acknowledges that some slides in this presentation were prepared by professor Martin Constable.
Outline

- Motivation
- Objective
- Related works
- Depth-based analyses of landscape paintings and photographs
- Aesthetic enhancement of landscape photographs
- To Do List
Some images from the movie Star Wars. This film was made in 1977, before the age of digital film making, but was digitally re-mastered in 1997.
The landscape scene need to be rendered with different relative range and variance of values across their Z and X/Y planes.

- One Screenshot of games “Word of Warcraft”
- One Screenshot of “Flower game”
A painting is not simply a plane surface. There are 2D and 3D geometries.
- 2D geometry: center, corner and edge values.
- 3D geometry: usually understood by painters in terms of the traditional depth zones (FG, MG, BG, and sky).
Objective

- Learn the contrast arrangement in 2D and 3D geometries in landscape paintings.
- Explore algorithms to transfer this special organization to photographs.

Corner/center contrast in 2D geometry

Depth-based contrast in 3D geometry
Related Works

- **Atmospheric perspective (Aerial perspective):** is the effect that an atmosphere has on the appearance of far away scenery.
- It is a physical phenomenon for the scattering and absorption of light in the atmosphere.

In painting, aerial perspective is one technique to create sensation of depth by depicting distant objects as fading away, less detailed, and usually shifting the color to the sky color.
- It is also one technique to control the mood of the painting.
Related Works

- Atmospheric perspective has been used in graphic models for landscape design. They model the scattering of sunlight in atmosphere.

One scattering model

- It also used in depth perception enhancement.

Atmospheric scattering

Jae-II Jung et al “Improved depth perception of single-view images,” ECTI TRANSACTIONS ON ELECTRICAL ENG., ELECTRONICS, AND COMMUNICATIONS, vol. 8, no. 2, pp. 164–172, 2010

Enhancing the depth cues: linear perspective, aerial perspective, focus, and shadow effects
Related Works

- **Vignetting:** is clear in the center and fades off at the boundaries.
- In photograph the effect can be created by camera settings, or during post-processing.

- In painting, painters might have enforced weighted corners by selecting points of view that naturally presents them.
Depth-based analyses of landscape paintings and photographs
<table>
<thead>
<tr>
<th></th>
<th>Contrast of Light and Dark</th>
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<tbody>
<tr>
<td>2</td>
<td>Contrast of Saturation</td>
</tr>
<tr>
<td>3</td>
<td>Hue Contrast 1: Contrast of Complements (opposites on the RYB Color wheel)</td>
</tr>
<tr>
<td>4</td>
<td>Hue Contrast 2: Contrast of Hue (distance between values on the RYB Color wheel)</td>
</tr>
</tbody>
</table>
Hudson River Painters

- Thomas Moran (1837–1926)
- Sanford Gifford (1823–1880)
- Thomas Cole (1801–1848)
- Frederic Church (1826–1900)
- Albert Bierstadt (1830–1902)
We compared the Hue, Saturation and Lightness contrast of paintings with those of photos. This we did across the depth plane.
The estimation method can roughly explore the depth of the scene, but it is difficult to accurately segment the depth according to the four visual depth.

So we partition the depth layers manually to their FG, MG, BG, and Sky.

This partition was not derived from true accurate depth but are ‘cards’ that underpin the painter’s structural conventions.
Contrast: Lightness

Michelson Contrast

\[ \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}} \]

Gradient range

Gradient in logarithm domain is one measure of the contrast in complex image
Results

Lightness contrast photo / painting:
• Both show a lessening of contrast from FG to sky
• Paintings show more organisation than photos, with clearly defined FG, MG, BG differences
• Painting FG uniformly high contrast
• Painting skies more likely to either show high or low contrast
Results

‘Road Scenery Near Lake George’, Sanford Gifford

‘Near Fort Wingate, New Mexico’, Thomas Moran
Contrast: Saturation

Michelson Contrast

\[ \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}} \]

Gradient range

Gradient in logarithm domain is one measure of the contrast in complex image.
Results

Saturation contrast photo / painting:
• Paintings generally more contrasty
• Paintings show more organisation than photos, with clearly defined FG, MG, BG differences (though not as clear as in lightness values)
• Paintings FG uniformly high contrast
• Skies more likely to either show high or low contrast
Contrast: Hue

The hue contrast is defined as the arc-length distance of dominant hues on the artist hue wheel (RYB).
Hue spread photo / ‘Home in the Woods’:
• Paintings show more organisation than photos, with clearly defined FG, MG, BG differences (though not as clear as in lightness or saturation values)
• Painting spread wider than that of the photograph
• Painting spread more likely to encompass a complimentary axes
• Painting spread more likely to encompass ‘linguistic’ differences
• Sky shows huge spread width
Results

Hue spread photo / painting:
• Paintings show more organization than photos, with clearly defined FG, MG, BG differences (though not as clear as in lightness or saturation values)
• Painting spread wider than that of the photograph
• Sky shows huge spread width

<table>
<thead>
<tr>
<th></th>
<th>FG</th>
<th>MG</th>
<th>BG</th>
<th>Sky</th>
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<tr>
<td>Paintings</td>
<td>89.13</td>
<td>61.30</td>
<td>46.32</td>
<td>61.64</td>
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<tr>
<td>Photographs</td>
<td>82.85</td>
<td>56.28</td>
<td>47.58</td>
<td>27.8</td>
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</table>
Lightness weight in 2D geometry

- A painting requires an active flat dimension should it pictorially succeed.
- The lightness of paintings are more inclined to be weighted on one side.

Average lightness distribution of paintings

Average lightness distribution of photographs

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paintings</td>
<td>10</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Photographs</td>
<td>4</td>
<td>5</td>
<td>21</td>
</tr>
</tbody>
</table>
Summary:

The Hue, Saturation and Lightness contrast values of the Hudson River paintings show clear depth-based organization, and lightness in paintings are more inclined to be weighted on one side.
Aesthetic Enhancement of Landscape Photographs
Methods

- This part attempts to use this contrast organization informing the visual appeal of paintings to enhance the aesthetic feeling of acquired digital photographs.
Methods

- The lightness and saturation play a more important role in the influence of depth perception comparing with hue.
- Currently, in this aesthetic enhancement, we only consider lightness and saturation contrasts.

**Contrast mapping:**
- Mapping of contrast within depth layer:
  - conducted by gradient histogram matching around and on Canny edge in logarithm domain.
- Mapping of contrast between layers:
  - measured by the corresponding means difference across the layers.
  - the mapping is conducted by shifting the mean of each layer.
- The lightness weighting in 2D geometry is enhanced based on weighting template.
Results

Reference

Original Photo
Results

Reference

Result Photo
Results
Results
Results
To Do List:

- Much work remains to be done on how this understanding of contrast in paintings can be further expanded upon.
- Sky need to be processed separately for a captured photograph with only a simple blue or white sky that has little texture, cannot be contrast matched to paintings that have contrast rich skies.

Thank You!

Comments and suggestions?