Photoshop Quickselect & Interactive Digital Photomontage

By Joseph Tighe
Photoshop Quickselect

- Based on the graph cut technology discussed (Boykov-Kolmogorov)
- What might happen when we use a color model?
Photoshop Quickselect

(b) Graph.
Demo
So we abandon the color model and only use pixel similarities.

The “Refine Edge” matting is applied as a post process step to give good edges boundaries.
Interactive Digital Photomontage

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Photomontage: “combining parts of a set of photographs into a single composite picture”\(^1\) while keeping noticeable seam to a minimum.

1 Agarwala et al.
Examples: Group Shot
Examples: Depth of Field
Examples: Depth of Field (Result)
Video
Overview of Approach

- Use a graph cut optimization to determine what regions from which images are used (Labeling)
- Use gradient domain fusion based on the Poisson equation to blend any remaining artifacts away.

(note: alignment is needed as a pre-processing step and is not covered in this paper.)
Graph-cut Optimization

Cost function to minimize:

\[ C(L) = \sum_{p} C_d(p, L(p)) + \sum_{p,q} C_i(p, q, L(p), L(q)) \]

Data penalty (Image Objective)

Interaction penalty (Seam Objective)
Image Objectives

- Designated Image
- Designated Color
- Min/Max Luminance
- Min/Max Contrast
- Min/Max Likelihood
- Eraser
- Min/Max Difference
Designated Image

- For each stroke the user specifies which source image the pixels are to come from.
Designated Color

- Specify a target color and find source images that have similar or different colors.
- Cost function given by: Euclidean distance in RGB space.
Min/Max Luminance

- Min (max) of luminance channel. Good for adding shadows/highlights.
- Cost function given by: the distance in the luminance channel between the current source pixel and the min/max for that pixel’s span (all source pixels at that location).
Min/Max Contrast

- Min: Remove small sharp obstructions (wires)
- Max: Good for increased depth of field (ant)
- Cost function given by: Min/Max of a difference of Gaussians for each pixel’s span
Min/Max Likelihood

- Good for removing people in front of buildings.
- Cost function given by: the probability of that pixel given by the distribution across that pixel’s span in RGB.
Eraser

- The color most different from the current color (works like designated color, except for the color is designated by the current composite)
- Cost function given by: Euclidean distance in RGB space
Min/Max Difference

- The min or max difference between some specified source image at each pixel
- Cost function given by: the Euclidean distance in RGB space between the pixel in the specified source and the pixel’s span
Seam Objectives

- Colors (Faces)
- Colors & Gradients (Automatic/Global approaches)
- Colors & Edges (Multiple versions of the same scene)
Seam Objectives

\[ c_i(p, q, L(p), L(q)) = \begin{cases} 
0 & \text{if } L(p) = L(q) \\
X & \text{if matching "colors"} \\
Y & \text{if matching "gradients"} \\
X + Y & \text{if matching "colors \& gradients"} \\
X / Z & \text{if matching "colors \& edges"} 
\end{cases} \]

\[ X = \| S_{L(p)}(p) - S_{L(q)}(p) \| + \| S_{L(p)}(q) - S_{L(q)}(q) \| \]

\[ Y = \| \nabla S_{L(p)}(p) - \nabla S_{L(q)}(p) \| + \| \nabla S_{L(p)}(q) - \nabla S_{L(q)}(q) \| \]

\[ Z = E_{L(p)}(p, q) + E_{L(q)}(p, q) \]

\( \nabla S_z(p) \) is a 6-component color gradient in RGB of image \( z \) at pixel \( p \).

\( E_z(p, q) \) is the scalar edge potential between two neighboring pixels \( p \) and \( q \) of image \( z \).
Graph-cut Optimization

Cost function to minimize:

\[ C(L) = \sum_{p} C_d(p, L(p)) + \sum_{p,q} C_i(p,q, L(p), L(q)) \]

- Data penalty (Image Objective)
- Interaction penalty (Seam Objective)
Graph-cut Optimization (Boykov-Kolmogorov)

1. Start with an arbitrary labeling $f$
2. Set success := 0
3. For each label $\alpha$ in L
   3.1. Find $\hat{f} = \arg \min E(f')$ among $f'$ within one $\alpha$ - expansion of $f$
   3.2. If $E(\hat{f}) < E(f)$, set $f := \hat{f}$ and success := 1
4. If success = 1 goto 2
5. Return $f$

Graph-cut Optimization (Boykov-Kolmogorov)

How is this applied?

- Globally
- Locally (painting strokes)
Globally

- No user interaction
- Cost function is minimized for all pixels and all images
Locally (Single Image Brush)
Locally (Multiple Image Brush)

- Applies an Image Objective locally but draws from multiple sources to minimize that objective
- Seam Objective is applied globally
Gradient-domain Fusion (Blending)

- Use the labels to determine where to copy the color gradients from.
- Create a composite image using the techniques described in Perez et al. 2003 (Poisson image editing)
Demo
Observations

- Image Objectives rarely produce results that can’t be obtained just by using the designated image objective.
  - Exceptions are the fully automatic methods.