Sketch2Photo: Internet Image Montage

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Motivation
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Challenges?
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• Automatically find good image components

• Seamlessly compose these components
Contributions

• Automatically find good image components
  – Extensive filtering of internet images

• Seamlessly compose these components
  – Hybrid compositing technique
System Overview

Sketch -> Candidate Image Selection -> Image Combination Optimization -> Ranked Output

- Sketch: Man throw, dog jump, tree
- Scene Item: Background
- Candidate Image: Various images of man throwing frisbee
- Image Combination: Optimization of images
- Ranked Output: Final output image
Involved Problems

• Image search
• Image segmentation
• Image composition

*Difficult problems in general!*

• Key point:

*Use simple images by filtering!*
User Interface
Image Filtering

Saliency Filtering

- Identify salient region
- Over-segment all images
- Choose simple images (less segments in *non-salient* region)
Image Filtering

Saliency Filtering
- Identify salient region
- Over-segment all images
- Choose simple images (less segments in non-salient region)
Image Filtering

Contour filtering

- Image segmentation (by Grabcut [Rother et al 2004])
- Check consistency between segmentation boundary and user sketched contour (by shape-context [Belongie et al. 2002])
- Choose consistent images
Image Filtering

Contour filtering
- Image segmentation (by Grabcut [Rother et al 2004] & dilation)
- Check consistency between segmentation boundary and user sketched contour (by shape-context [Belongie et al. 2002])
- Choose consistent images
Image Filtering

Content filtering

- Group segmented images in a feature space
- Choose images associated with large (>5%) clusters
Filtering Performance

Statistics:

Download Images
- Saliency Filtering:
- Contour Filtering:
- Content Filtering:

SIGGRAPH ASIA 2009
the pulse of innovation
Some observations:
- Contour filtering is critical
- Saliency filtering is helpful
- Additional verbs are necessary

**False positive rate at each stage of the filtering**

<table>
<thead>
<tr>
<th></th>
<th>Man throw</th>
<th>Dog jump</th>
<th>Frisbee</th>
<th>Sailboat</th>
<th>Moto rider</th>
<th>Seagull</th>
<th>Dog</th>
</tr>
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<tbody>
<tr>
<td>IS (%)</td>
<td>83</td>
<td>65</td>
<td>79</td>
<td>71</td>
<td>86</td>
<td>72</td>
<td>97</td>
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<tr>
<td>SF (%)</td>
<td>81</td>
<td>--</td>
<td>80</td>
<td>61</td>
<td>81</td>
<td>70</td>
<td>97</td>
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<tr>
<td>CF1 (%)</td>
<td>30</td>
<td>47</td>
<td>31</td>
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<tr>
<td>CF2 (%)</td>
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<td>37</td>
<td>27</td>
<td>27</td>
<td>24</td>
<td>23</td>
<td>68</td>
</tr>
</tbody>
</table>

IS = internet search; SF = saliency filtering; CF1 = contour consistency filtering; CF2 = content consistency filtering
Improved Image Composition

Limitations of previous methods

Inputs
Matting
Photo Clip Art
Drag & Drop Pasting
blending boundary optimization

Super-pixel level boundary optimization

- Evaluate image consistencies at super-pixels
- Find a most consistent chain of super-pixels
- Mark out inconsistent super-pixels (shown in red)
blending boundary optimization

Pixel level boundary optimization
blending boundary optimization

Pixel level boundary optimization

- Boundary in red cells: matting boundary
- Boundary in green cells: optimized by Drag & Drop Paste [Jia et al. 2006]
hybrid blending

- Poisson blending with mixed boundary condition
  - Fix pixel value on purple boundary
  - Fix pixel gradient on yellow boundary
- Alpha blending
  
  \[ f(p) = \begin{cases} 
  \alpha f'(p) + (1 - \alpha)f^t(p) & \text{if } p \in \text{Green Zone} \\
  f'(p) & \text{if } p \in \text{Red Zone} 
  \end{cases} \]
example

Source image and blending boundary

Superpixel

Target image background
Evaluate consistency for each superpixel:
  - Texture Similarity
  - Color Similarity
  - Matting Feasibility
In consistent super-pixels are marked in red
Optimize pixelwise blending boundary
example

- Evaluate consistency for each mutual superpixel:
  - Texture Similarity
  - Color Similarity
  - Matting Feasibility
- In consistent super-pixels are marked in red
- Optimize pixelwise blending boundary
- Final blending result
Image Combination Optimization

Optimize image combination
- Rank by the consistency score over the optimized boundary

Blending cost is 0.2, 0.4, 0.6 and 0.8 from left to right.
Interactive Refinement

- Discard compositions with incorrect scene items

- Refine segmentation
More Results

snow field

kid ski  man ski  snow man

river

bear catch  salmon jump
User Study II: to evaluate the generalization

- Four novice subjects (one specifies composition tasks, the others generate results accordingly)
- Evaluated by 5 evaluators, 78% success rate
Limitations

- Image filtering is still limited
  - Background filtering works better for landscapes
  - Each scene item often has 30% false positive

- Other possible artifacts:
  - Incorrect perspective
  - Incorrect occlusion
  - Incorrect scales
Conclusion

A method to convert a sketch to a photo-realistic picture

- A novel filtering scheme leads to small false positive
- A novel blending algorithm tolerates large image differences
Thank you!