Examplar-Based Image Completion

0456024 Pei-Shan Tsai

NCTU NCLAB

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What is Image Completion

Given an input image I, as well as a target region T and a source region S (where S is always a subset of $I - T$), the goal of image completion is to fill T in a visually plausible way.

Types of Image Completion

- Texture Synthesis

- Image Inpainting

- Object Removal

An Ideal Algorithm for Image Completion

An ideal algorithm for image completion should be able to

- complete complex natural images
- handle large target region
- done in a fully automatic manner

Approaches for Image Completion

- Statistical-based
  - estimating statistics
  - for images with stochastic content (i.e., texture synthesis)
- PDE-based
  - simulating diffusion process by partial differential equations
  - for image with small target region (i.e., image inpainting)
- Examplar-based

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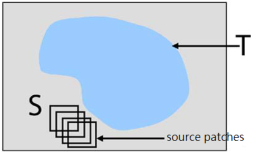
Examplar-based Approach

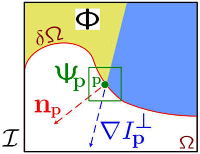
- Copying source patches to target patches
  - what is the order of target patches to be filled
  - which source patch is the best choice for the specific target patch



Criminisi's Algorithm

A. Criminisi, P. Perez, K. Toyama
Region filling and object removal by exemplar-based inpainting
In 2004 IEEE Transactions on Image Processing 9 1200-1212

Criminisi's Algorithm



- Extract the manually selected initial front $\delta\Omega^0$.
- Repeat until done:

1a. Identify the fill front $\delta\Omega^t$. If $\Omega^t = \emptyset$, exit.

1b. Compute priorities $P(\mathbf{p}) \quad \forall \mathbf{p} \in \delta\Omega^t$.

2a. Find the patch $\Psi_{\hat{\mathbf{p}}}$ with the maximum priority, *i.e.*, $\hat{\mathbf{p}} = \arg\max_{\mathbf{p} \in \delta\Omega^t} P(\mathbf{p})$.

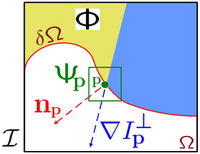
2b. Find the exemplar $\Psi_{\hat{\mathbf{q}}} \in \Phi$ that minimizes $d(\Psi_{\hat{\mathbf{p}}}, \Psi_{\hat{\mathbf{q}}})$.

2c. Copy image data from $\Psi_{\hat{\mathbf{q}}}$ to $\Psi_{\hat{\mathbf{p}}} \; \forall \mathbf{p} \in \Psi_{\hat{\mathbf{p}}} \cap \Omega$.

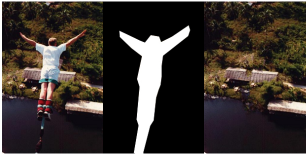
3. Update $C(\mathbf{p}) \quad \forall \mathbf{p} \in \Psi_{\hat{\mathbf{p}}} \cap \Omega$

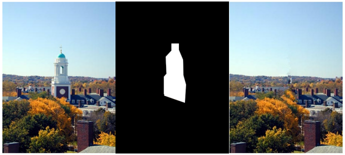
1b. Computing priorities of target patches

- the priority computation is biased toward those patches which are
  - on the continuation of strong edges
  - surrounded by high-confidence pixels
- $P(p) = C(p)D(p)$
  - confidence term $C(p) = \frac{\sum_{q \in \Psi_p \cap (I - \Omega)} C(q)}{|\Psi_p|}$
  - data term $D(p) = \frac{|\nabla I_p^{\perp} \cdot n_p|}{\alpha}$ (α is a normalization factor)

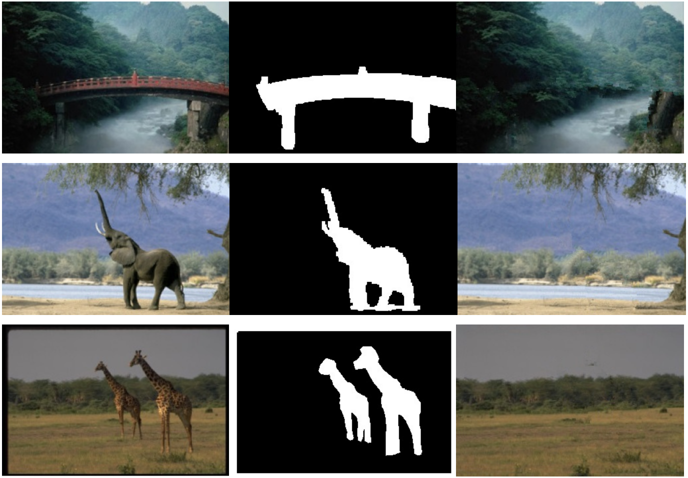


Results





Results



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