Geometry-Aware Image Completion via Multiple Examples

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System Overview



Motivation

✓ Ubiquitous digital cameras ✓ Internet photo collections

Goal

> To preserve the geometry consistency and generate visually plausible result from multiple examples



Geometry-Aware Completion **Reference Selection**

Our Approach

Reference Image Selection

- Register input image *I* into the reconstructed 3D model via SFM.
- A few of reference images with closest camera poses are selected.

For each candidate image I_i , we compute its score:

$$S(I_{i}) = \frac{V_{i} \cdot V}{\|V_{i}\| \|V\|} + \frac{d_{max} - d_{i}}{d_{max}}$$

Multiple Examples

Warped Reference Images

• Warp each selected reference image to provide image content for the region with complex structures.

Shifted Input Images

• The visible parts of the original input image can



The projected 3D points in the missing region can be found in other images.



The completion is formulated as a discrete labeling problem, with the cost function defined as $C(L) = \sum_{p \in R} C_d(p, L(p)) + \sum_{(p,q) \in N} C_s(p,q, L(p), L(q))$

The data term $C_d(p, L(p)) = \varpi(p) D(I, I_{L(p)}, p)$

The smooth term $C_s(p,q,L(p),L(q)) = D(I_{L(p)},I_{L(q)},p) + D(I_{L(p)},I_{L(q)},q)$

The appearance difference composed of color difference and gradient difference defined as $D(I_{a}, I_{b}, p) = \|I_{a}(p) - I_{b}(p)\| + \|\nabla I_{a}(p) - \nabla I_{b}(p)\|$





often provide many supplementary examples due to texture repetition.

Confidence Map & Weighted Average Image

Given the positions of the visible points on the reference image I_i , we compute the confidence map of the region Ω in I_i^w as

 $\omega_{i}(\mathbf{p}) = \begin{cases} 0, & \text{if invalid } I_{i}^{w}(\mathbf{p}) \\ \frac{1}{n} \sum_{j=1}^{n_{i}} N(\sigma, \mathbf{p} - \mathbf{p}_{j}), & \text{otherwise} \end{cases}$

The confidence map and weighted average image:

 $\varpi(\mathbf{p}) = \frac{1}{K_w} \sum_{i=1}^{K_w} \omega_i(\mathbf{p}), \ \overline{I}(\mathbf{p}) = \sum_{i=1}^{K_w} \frac{\omega_i(\mathbf{p})}{K_w} \sigma(\mathbf{p}) I_i^w(\mathbf{p})$

Labeling Optimization



Confidence map and weighted average image











Photoshop Image Melding [2012] [He and Sun 2012] [Whyte et al. 2009] Ours Input

Optimized composition of multiple examples.