Reference Based Image Inpainting

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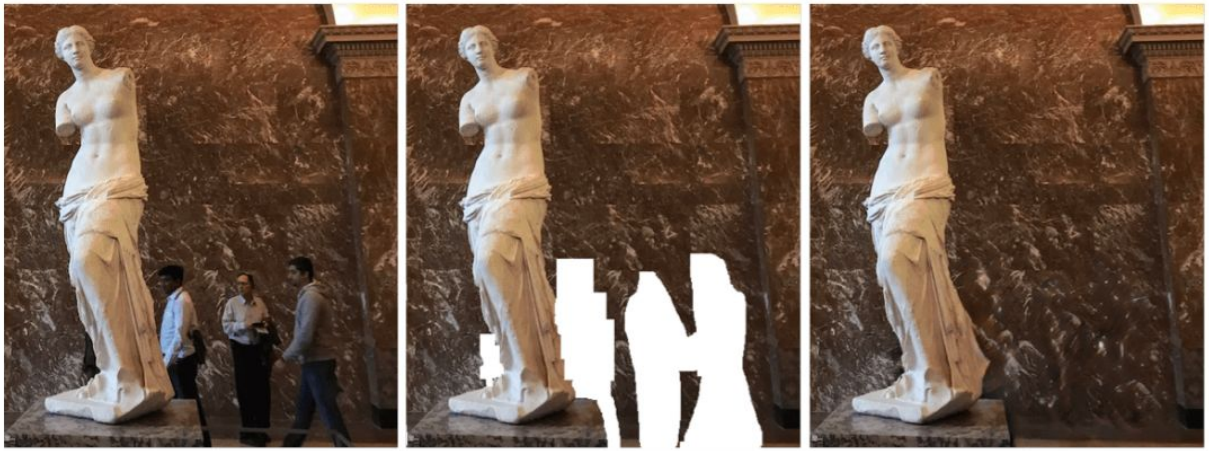
Outline

- Background Information
- Our Task
- Method
- Visual Results
- Evaluation

Image Inpainting



- Diffusion based
- Exemplar based
- Deep neural networks

Our Task

Reference Image

Target Image

Dataset*: Real Estate 10K.
Image pairs from a moving camera.

* Tinghui Zhou, Richard Tucker, John Flynn, Graham Fyffe, and Noah Snavely. Stereo magnification: Learning view synthesis using multiplane images. In SIGGRAPH, 2018.

Pipeline

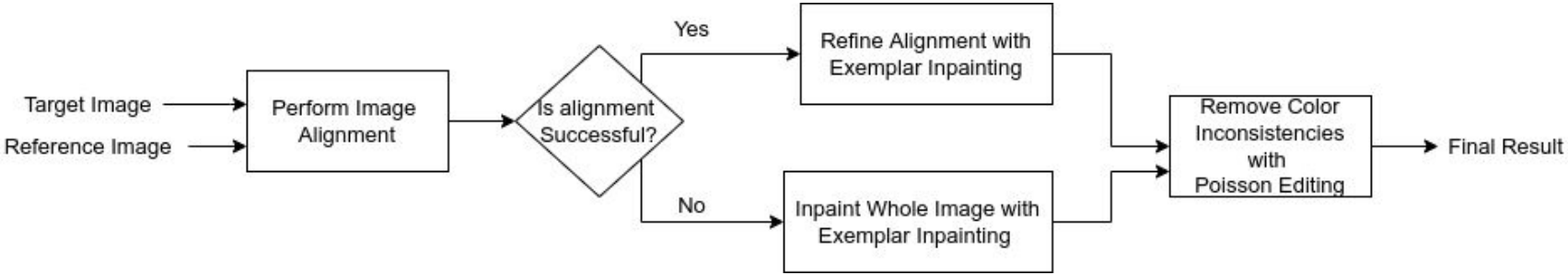
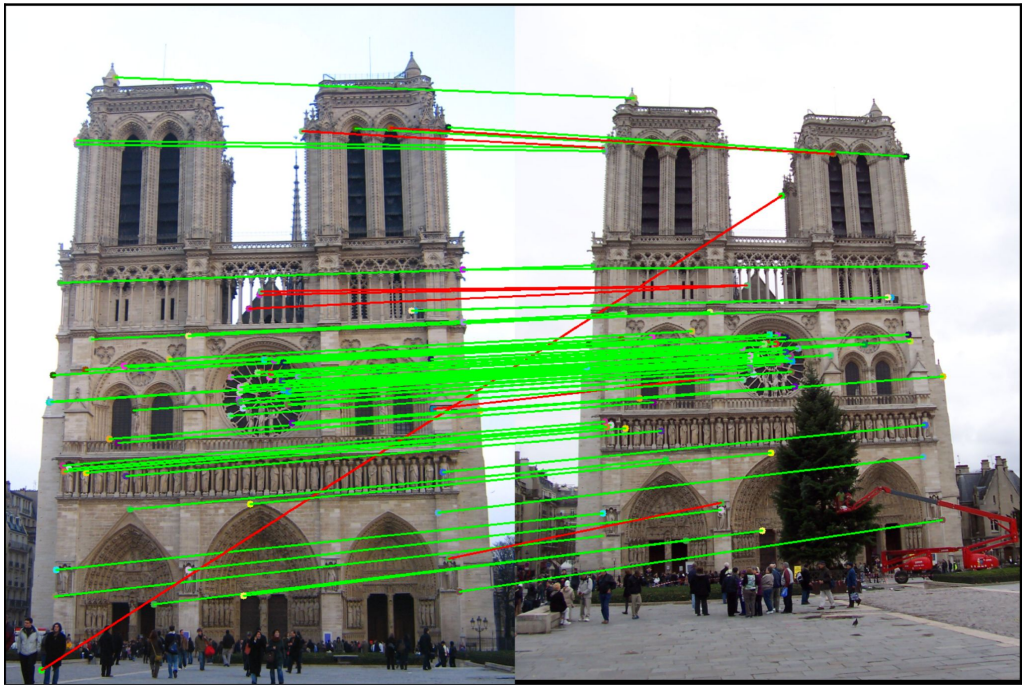

Target Image
Reference Image
Perform Image Alignment
Is alignment Successful?
Yes
No
Refine Alignment with Exemplar Inpainting
Inpaint Whole Image with Exemplar Inpainting
Remove Color Inconsistencies with Poisson Editing
Final Result

Image Alignment Based Inpainting



- SIFT keypoints and descriptors
- Matching with NNDR
- Calculating homography with RANSAC

$$I_f = I_t \odot M + I_{r \to t} \odot (1 - M)$$

David G. Lowe. Distinctive image features from scale-invariant key- points. *Int. J. Comput. Vision*, 60(2):91–110, November 2004.

Martin A. Fischler and Robert C. Bolles. Random sample consensus: A paradigm for model fitting with applications to image analysis and automated cartography. *Commun. ACM*, 24(6):381–395, jun 1981.

Original

Masked

Reference

Warped

2 Problems

1-) Cannot align some regions (Red arrows)

2-) Cannot align flat regions

Flat Region

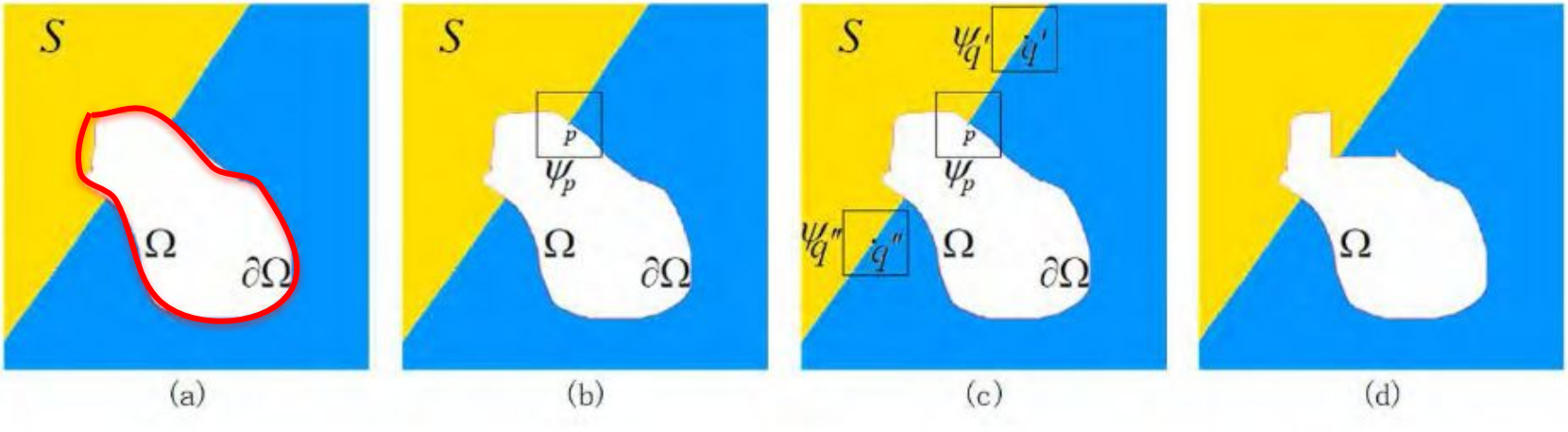
Exemplar Based Image Inpainting

S: Source Region (Yellow and Blue Regions)

Ω: The hole (White region)

∂Ω: Boundary of the hole. (Red)

ψ: Patch around a pixel.

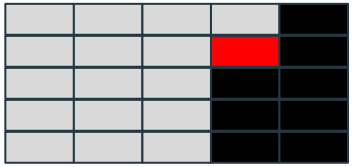


Huaming Liu, Xuehui Bi, Guanming Lu, and Weilan Wang. Exemplar-based image inpainting with multi-resolution information and the graphcut technique. IEEE Access, 7:101641–101657, 2019.

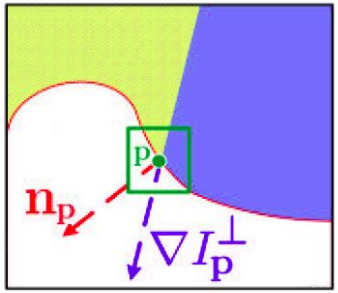
Priority for Inpainting

Criminisi et al. proposes to calculate two terms: **Confidence Term** and **Data Term.**
(We slightly modified this terms in the implementation)

Confidence Term: Ratio of known regions to patch size



Data Term: Edge information near to boundary.



$$P(x) = C(x)D(x)$$

A. Criminisi, P. Perez, and K. Toyama. Object removal by exemplar-based inpainting. In 2003 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2003. Proceedings., volume 2, pages II–II, 2003.

Filling Holes

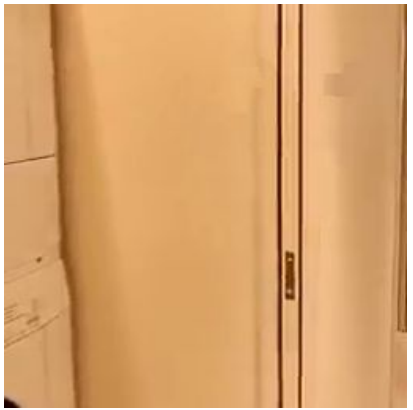
- Holes are filled with exemplar based inpainting.

Original

Masked

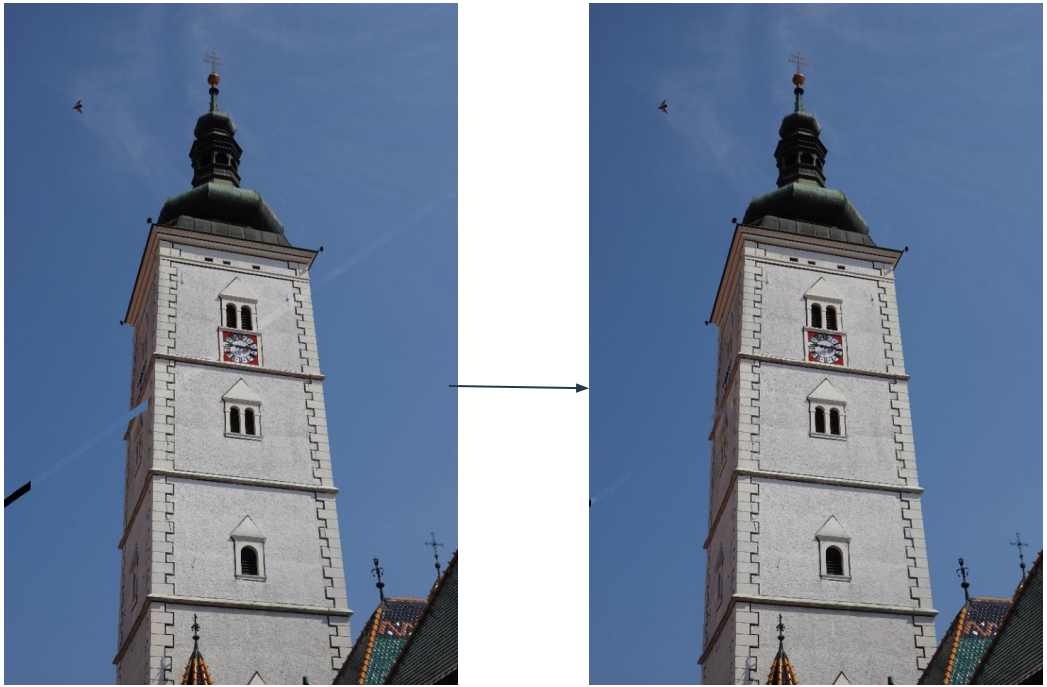
After Some Iteration

- Flat Regions are inpainted with Exemplar Based Inpainting.



Result

Poisson Blending



$$\min \int \int_{\Omega} (\nabla R - \nabla I_r)^2$$
$$s.t. \;\; R(x,y) = I_t(x,y) \quad \forall (x,y) \in \delta\Omega$$

Change color values so that they can match with target.

Patrick P´erez, Michel Gangnet, and Andrew Blake. Poisson image editing. ACM Trans. Graph., 22(3):313–318, jul 2

Applying Poisson Editing

Before Poisson

After Poisson

Applying Poisson Editing

Before Poisson

After Poisson

Visual Results - Extreme Viewpoint Change

Reference

Target

Aligned

Blending

Visual Results - Extreme Lightning Change

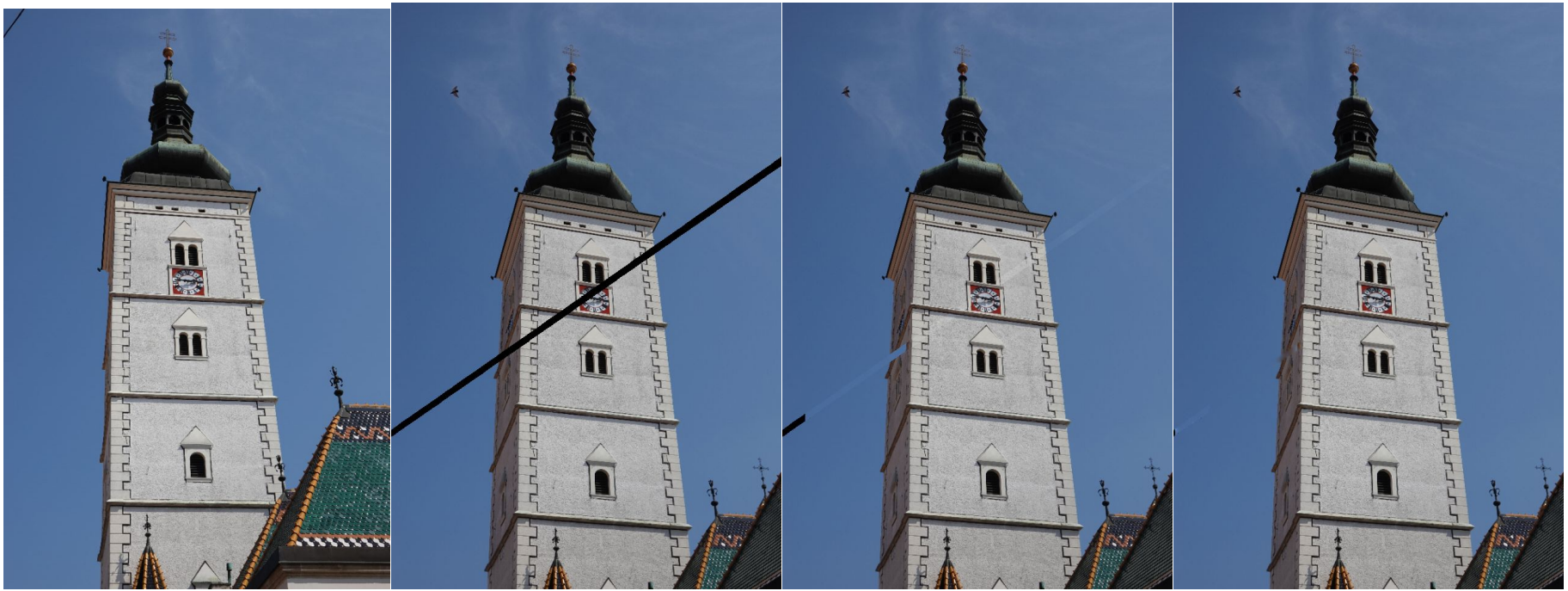
Reference

Target

Aligned

Blending

Visual Results - Object Removal



Reference **Target** **Aligned** **Blending**

Visual Results - Object Addition

Reference

Target

Result

Ablation Study

SSIM: Structural Similarity. Higher is better.

PSNR: Peak signal-to-noise ratio. Higher is better.

	SSIM	PSNR
With Poisson Blending	**0.9693**	**33.7108**
Without Poisson Blending	0.9662	32.8033

Comparison with Other Works

TransFill: Classical Methods + Attention Based Network (CVPR 2021)

ProFill: Attention Based Deep Neural Network for single image inpainting (ECCV 2020)

	SSIM	PSNR
TransFill*	**0.9914**	**38.83**
Ours	0.9693	33.71
ProFill**	0.9690	30.95

*Zhou, Yuqian, et al. "Transfill: Reference-guided image inpainting by merging multiple color and spatial transformations." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2021.

**High-Resolution Image Inpainting with Iterative Confidence Feedback and Guided Upsampling (ECCV 2020). *Yu Zeng, Zhe Lin, Jimei Yang, Jianming Zhang, Eli Shechtman, Huchuan Lu*