Implicit Neural Image Stitching With Enhanced and Blended Feature Reconstruction

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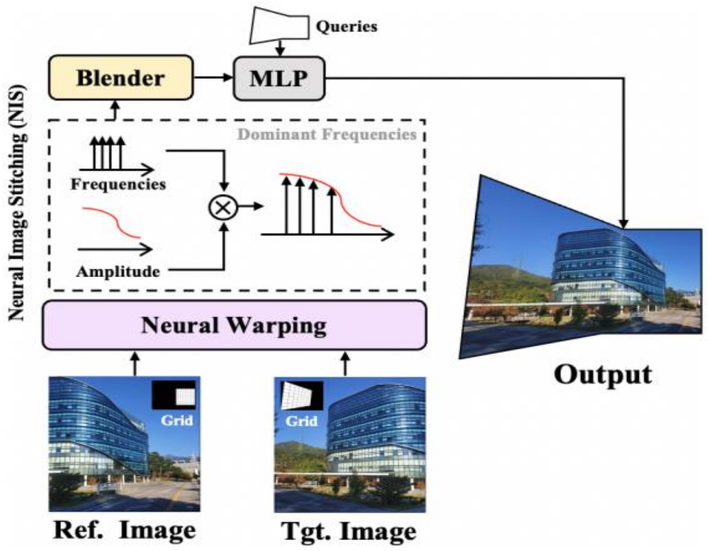
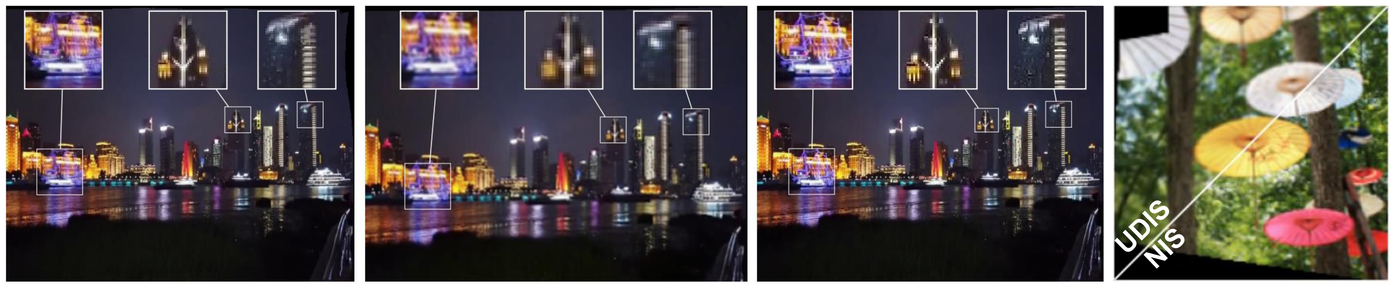
Overview

1. Novel Implicit Neural Representation for Stitching



Takes in Aligning Transformation, Corresponding Images, and valid region Queries.
Outputs Representation of a stitched image.

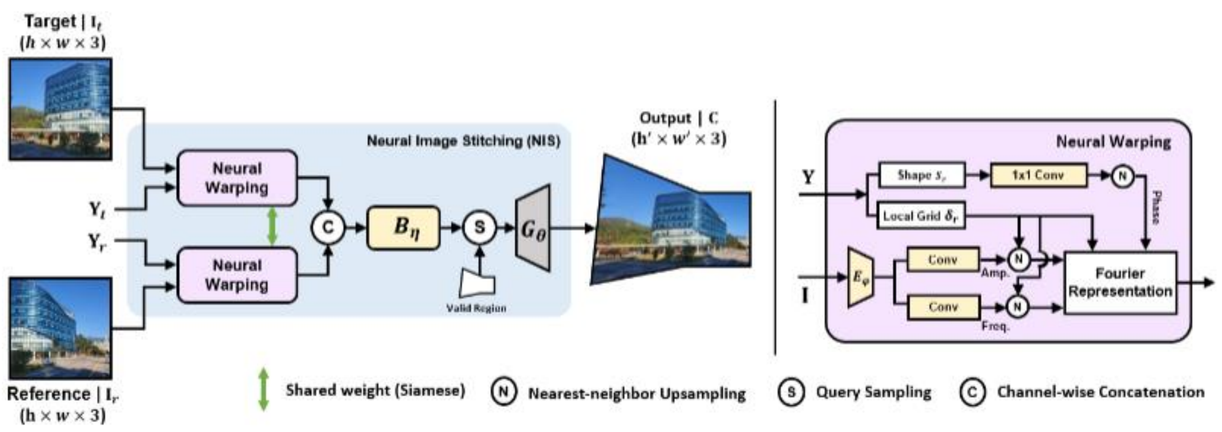
2. Enhanced and Blended Feature Reconstruction Resolving Blurry Artifacts



APAP UDIS ***NIS (Ours)***

- Top: **Resolving severe blurry artifacts of previous learning-based work**'s stitched feature reconstruction.
- Bottom: Our 2-stage training consisting of **learning Enhancement** (left) and **automatically Blended stitching** (right).

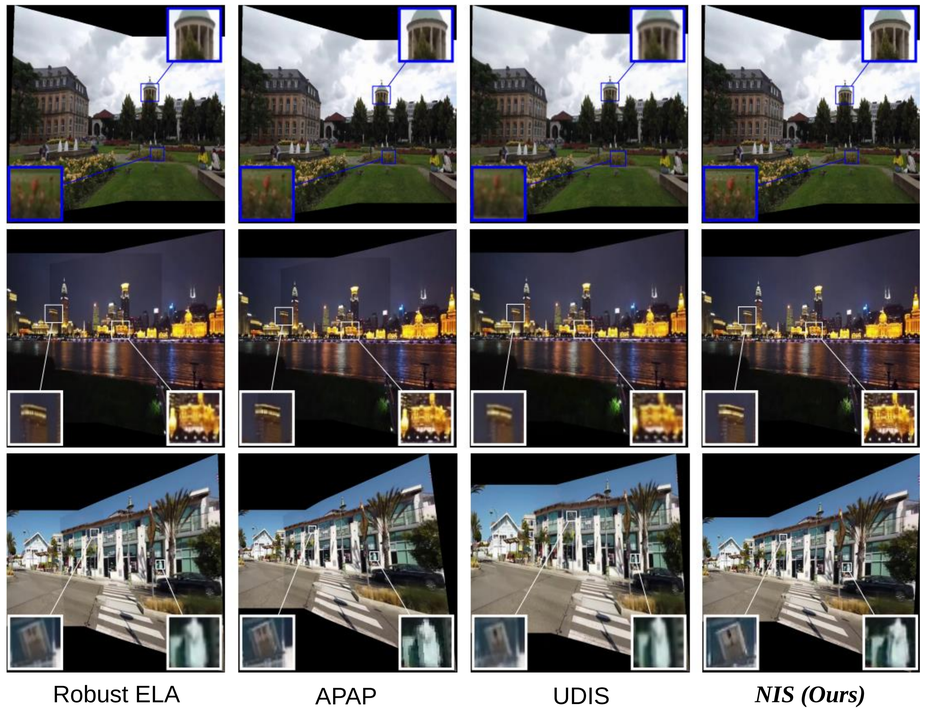
Method



1. Estimation of Fourier Coefficients	3. Stitched representation
$\mathbf{Amp.} = \boldsymbol{g}_a(\mathbf{z}')$, $\mathbf{Freq.} = \boldsymbol{g}_f(\mathbf{z}')$, $\mathbf{Phase} = \boldsymbol{g}_p(\mathbf{s};\mathbf{y})$, $\mathbf{z}' = \mathbf{E}_\varphi(\mathbf{I}^{IN})$, $\boldsymbol{g}_{(\cdot)} \coloneqq$ CNN Coeff. Estimator, $\mathbf{s} \coloneqq$ [Jacobian and Hessian of given mesh] $\in \mathbb{R}^{10}$.	$\hat{\mathbf{C}}[\mathbf{y_u}] = \boldsymbol{G_\theta}(\mathbf{B}_\eta(\mathbf{z_t}, \mathbf{z_r}), \mathbf{y_u})$; $\mathbf{y_u} \in \mathbf{Y_u} \subset \mathbf{U}$ denotes a coordinate of valid region, $\mathbf{U} \coloneqq [0, h] \times [0, w)$ is a uniform mesh.
2. Capturing Dominant Frequency via warped Fourier Rep.	**4. Strategy for enhancing and blending**
Fourier Representation: $\mathbf{z}[\mathbf{y}] = \mathbf{A}[\mathbf{y}] \cdot (\cos \mathcal{F} + \sin \mathcal{F})$, where $\mathcal{F} = \pi(\langle \mathbf{F}[\mathbf{y}], \mathbf{c}_m \rangle + \mathbf{P}[\mathbf{y}])$, $\mathbf{c}_m = \mathbf{y} - \mathbf{X}[\mathbf{y}]$, $\mathbf{X} \coloneqq \{x \mid x \in \mathbb{R}^2\}$, $\mathbf{X}[\mathbf{y}] \coloneqq$ nearest neighbor sampling $\mathbf{X}$ with coordinate $\mathbf{y}$.	**Enhance:** Minimizing L_1 loss between GT and $\hat{\mathbf{C}}$, **Blending:** Seam Loss of UDIS.

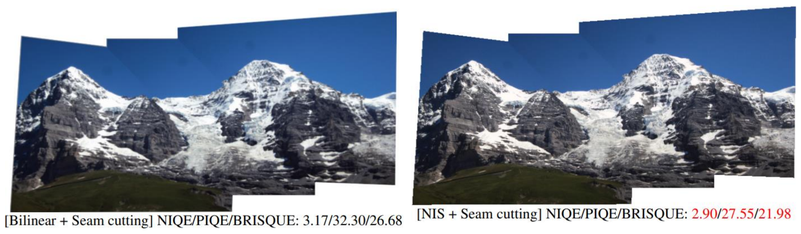
Results

Qualitative Comparison



Robust ELA APAP UDIS ***NIS (Ours)***

Applying Seam cutting on NIS



[Bilinear + Seam cutting] NIQE/PIQE/BRISQUE: 3.17/32.30/26.68

[NIS + Seam cutting] NIQE/PIQE/BRISQUE: 2.90/27.55/21.98

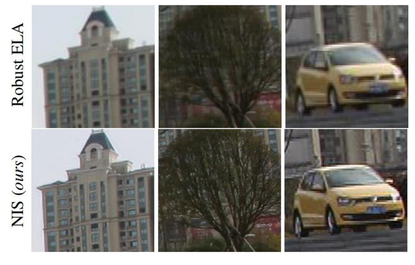
- Association of a unified feature: $\hat{\mathbf{C}}[\mathbf{y_u}] = \boldsymbol{G_\theta}(\mathbf{M}_t \cdot \mathbf{z}_t, +\mathbf{M}_r \cdot \mathbf{z}_r, \mathbf{y_u})$, $\mathbf{M}_{(\cdot)} \coloneqq$ Seam mask.

Quantitative Comparison

Benchmark	UDIS-D			MS-COCO (Synthetic)		Param.
Metric	NIQE	PIQUE	BRISQUE	mPSNR	mSSIM	-
APAP	3.30	46.95	34.72	-	-	-
Robust ELA	3.59	53.67	37.78	-	-	-
LPC	3.37	50.81	37.15	-	-	-
LPC + Graph Cut	3.50	50.63	37.14	-	-	-
Bilinear	-	-	-	34.78	0.96	-
Bicubic	-	-	-	36.25	0.97	-
UDIS	3.43	50.01	36.71	33.45	0.97	8.0 M
***NIS* (Enhance)**	3.28	46.21	33.17	-	-	**3.2 M**
***NIS* (Enhance + Blend)**	**3.15**	**43.05**	**31.14**	**38.69**	**0.98**	**3.2 M**

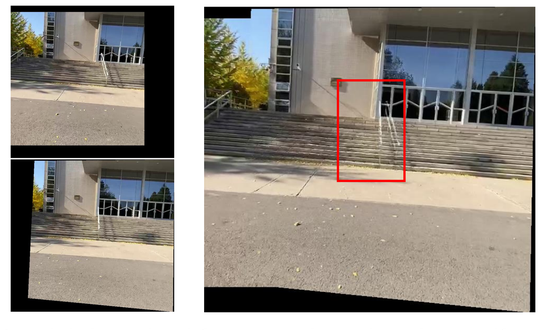
Discussion

Generalization on elastic warps



Top: Robust ELA's Stitching w/o NIS, Bottom: **Robust ELA w/ NIS.**

Stitching under **Very Large Parallax**



No trivial method for escaping ghosting artifacts.