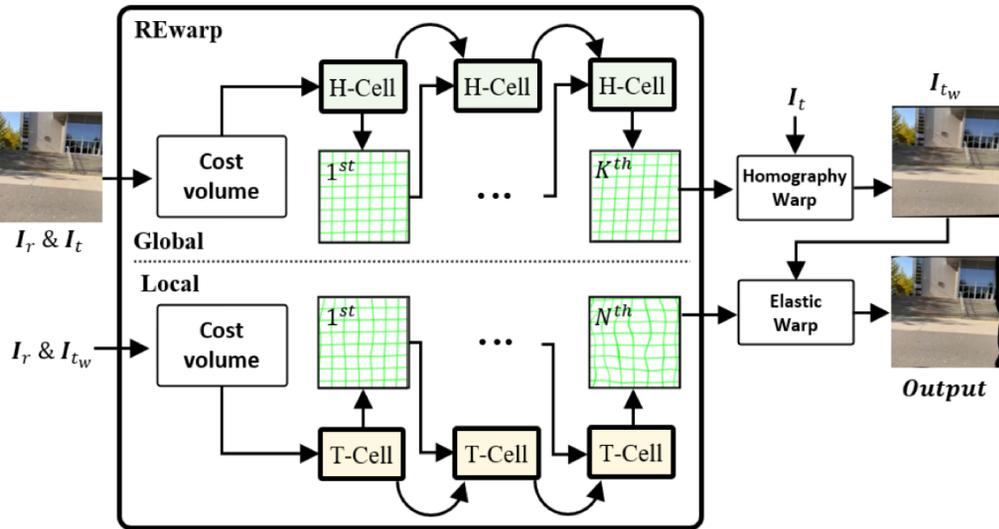


## Overview

### 1. Residual Elastic Warps for Overlap Region Align



Multi-step Sequential Alignment of Two Images with Homography and Thin-plate Spline.

### 2. Dirichlet Boundary Condition for discontinuity free deep image stitching



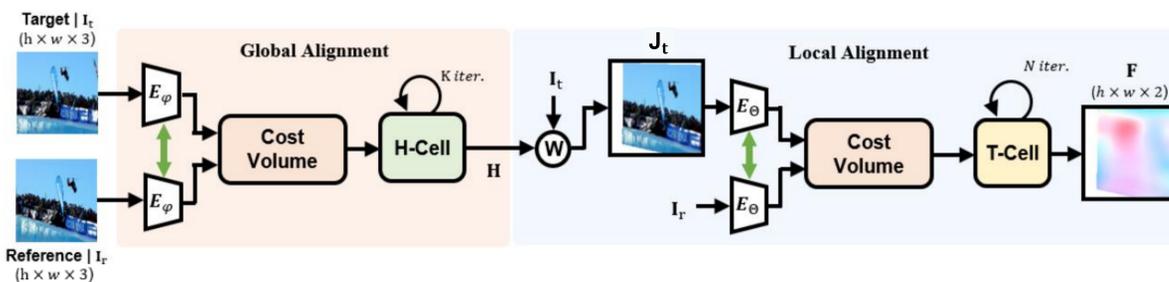
Previous Deep Image Stitching



w/ Dirichlet Boundary Condition

- Previous deep stitching focuses on reducing L1 Loss of Overlapping region.
- **The criteria cause discontinuity** between overlap and non-overlap regions.
- Our introduction of Dirichlet boundary condition resolves the limitation.

## Method



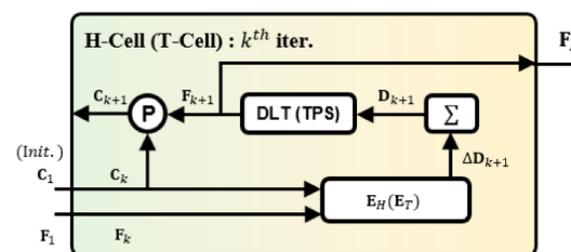
Global Alignment  $H = S_V(\sum_K \Delta D_k^G)$ ,

Local Alignment under boundary condition  $F = S_{P_r}(P_r[1:-1, 1:-1] + \sum_N \Delta D_n^L)$ ,

$\Delta D^G$  (or  $\Delta D^L$ ): Four corner (or Control Point) Displacement vector for DLT (or TPS warp),

$S_V$ : DLT,  $S_{P_r}$ : TPS warp,  $N/K$ : Iteration Number of Global/Local Alignment,  $P_r$ :  $12 \times 12$  Uniform Grid.

### Recurrent Estimation

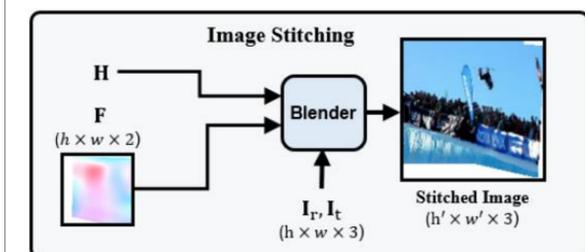


$\Delta D_{k+1} = E_{(\cdot)}(C_k, F_k)$ ,  $C_{k+1} = \text{Pool}(C_k, F_{k+1})$ ,

$E_H, E_T$ : CNN Regressor for Homography or TPS,

$C$ : Cost volume, Pool: pooling  $C$  with  $H$  (or  $F$ ).

### Image Stitching



Stitched Image = Blender( $I_r$ , Warp( $I_t$ ,  $Y$ )),

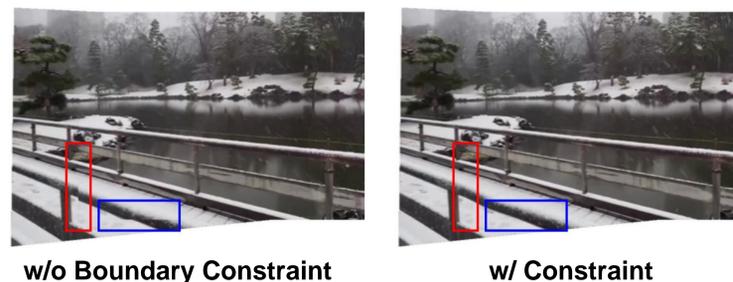
Where  $y \in Y$ ;  $y = H \cdot x + F[x]$ ,

## Results

### Qualitative Comparison



### Ablation study on Boundary Condition

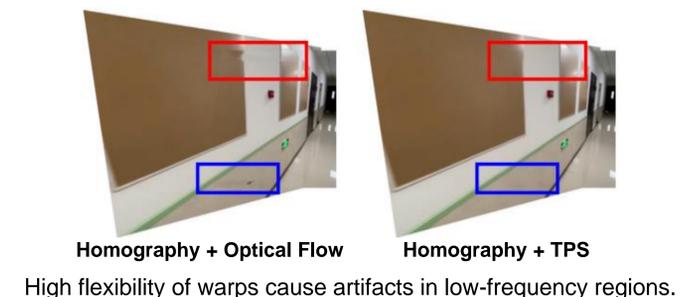


### Quantitative Comparison

| Benchmark            | UDIS-D       |              |              |              |               |           |
|----------------------|--------------|--------------|--------------|--------------|---------------|-----------|
|                      | ~ 30%        | 31 ~ 60%     | 61% ~        | Average      | Failure Ratio | Time (ms) |
| SIFT + RANSAC        | 18.32        | 21.68        | 22.30        | 21.48        | 1.27%         | 111       |
| UDIS                 | 19.61        | 20.15        | 19.88        | 19.97        | 0%            | -         |
| IHN                  | 20.09        | 21.73        | 23.27        | 22.99        | 0%            | 38        |
| APAP                 | 21.28        | 22.30        | 23.54        | 22.69        | 12.30%        | 574       |
| SPW                  | 20.74        | 21.71        | 22.45        | 21.95        | 85.08%        | 383       |
| LPC                  | 17.07        | 21.04        | 21.59        | 20.82        | 42.13%        | 1395      |
| Robust ELA           | 21.84        | 22.91        | 24.29        | 23.48        | 0.72%         | 79        |
| <b>Rewarp (ours)</b> | <b>22.11</b> | <b>24.55</b> | <b>26.08</b> | <b>24.84</b> | <b>0%</b>     | <b>50</b> |

## Discussion

### Deep elastic warps with Optical Flow vs Thin-plate Spline



### Stitching under Very Large Parallax

