

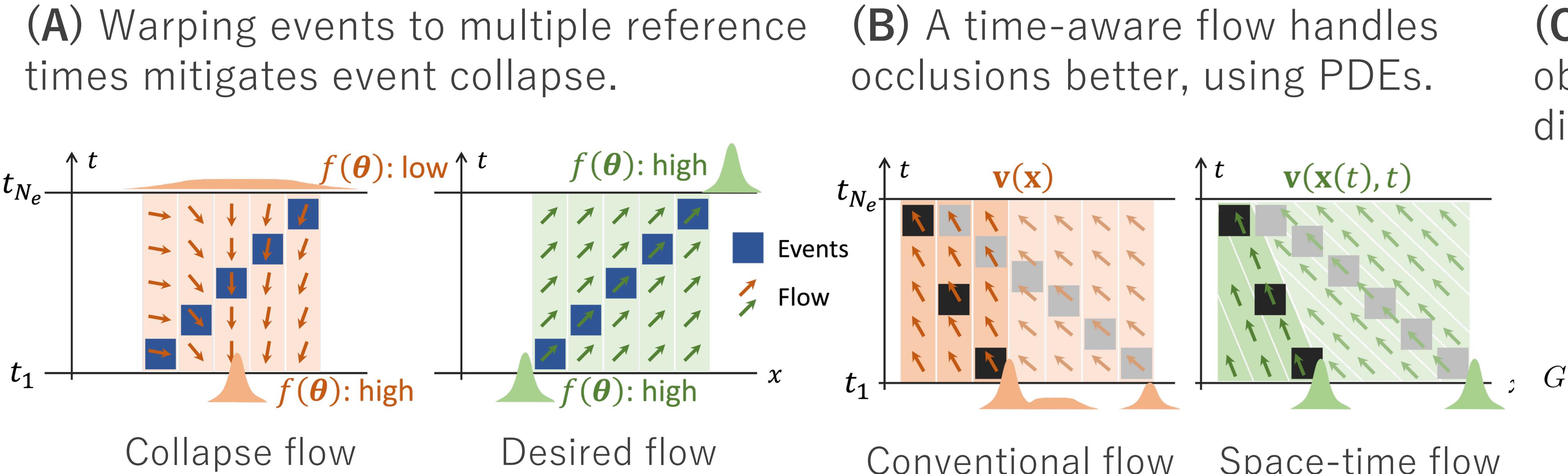
Secrets of Event-based Optical Flow, Depth and Ego-Motion Estimation by Contrast Maximization

S. Shiba, K. Yannick, Y. Aoki, G. Gallego, IEEE T-PAMI, 2024.

Summary

- We propose a principled method for estimating optical flow based on event alignment.
- The proposed simple method can also estimate depth and ego-motion, with applications to motion segmentation, denoising, deblur, and intensity reconstruction.
- We evaluate on seven datasets of various resolutions (including 1 megapixel), real/simulation, and scene complexity.
- We discuss challenges of the current optical flow benchmarking.

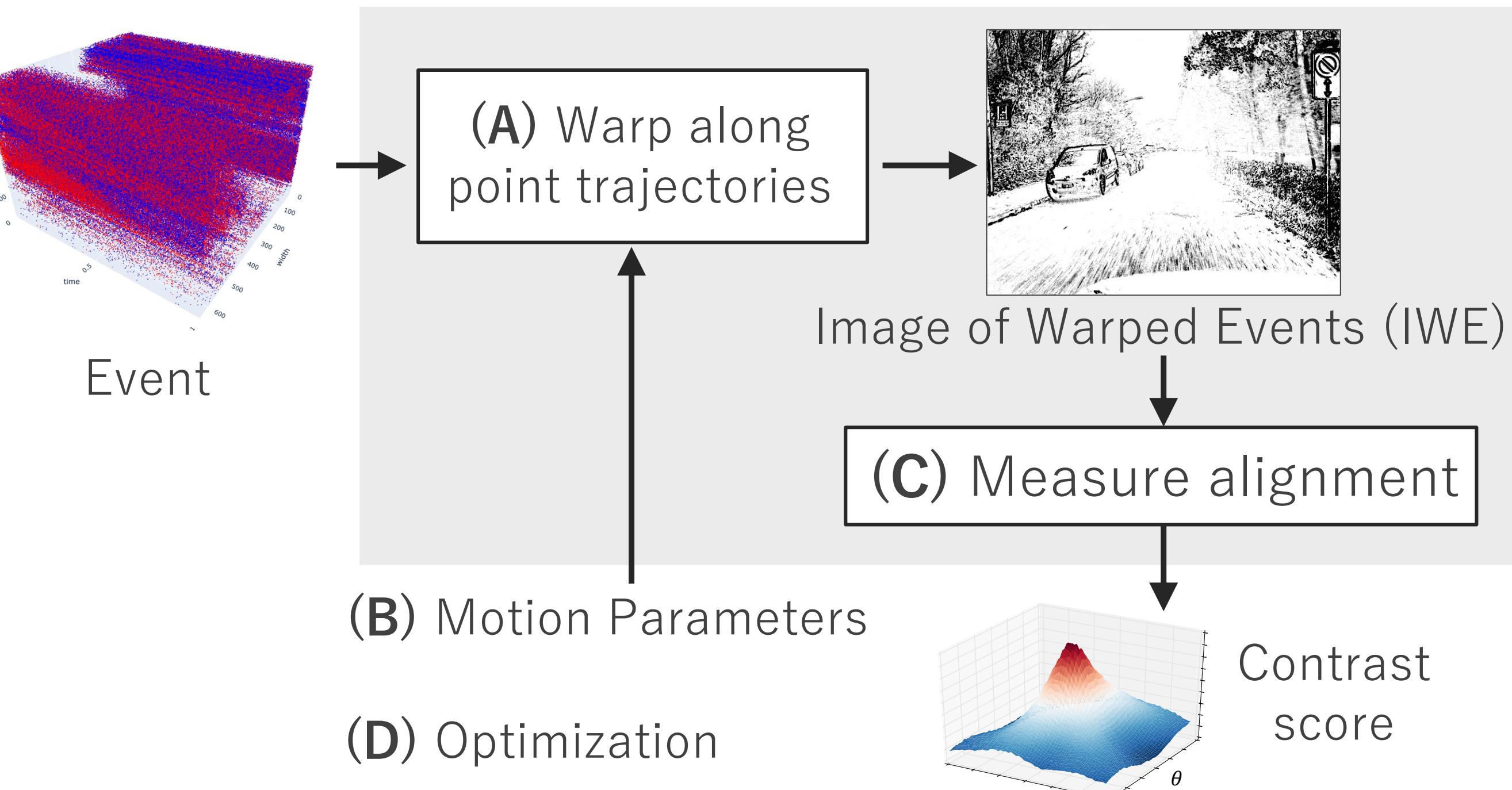
Method



$$I(\mathbf{x}; \mathcal{E}'_{t_{\text{ref}}}, \theta) = \sum_{k=1}^{N_e} \delta(\mathbf{x} - \mathbf{x}'_k)$$

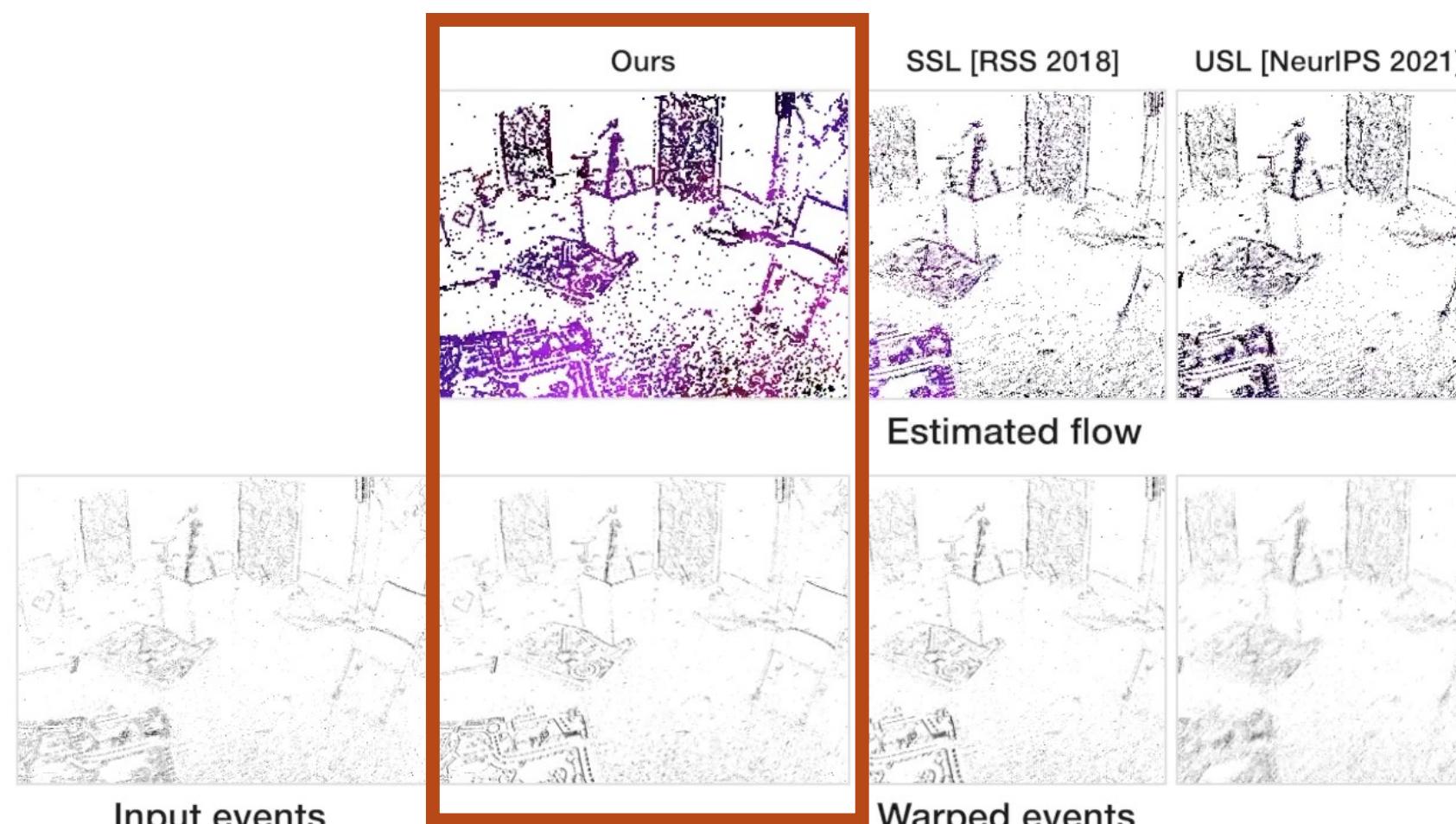
$$G(\theta; t_{\text{ref}}) = \frac{1}{|\Omega|} \int_{\Omega} \|\nabla I(\mathbf{x}; t_{\text{ref}})\|^q d\mathbf{x}$$

Contrast Maximization



Optical Flow

Indoor, drone (346x260 px)

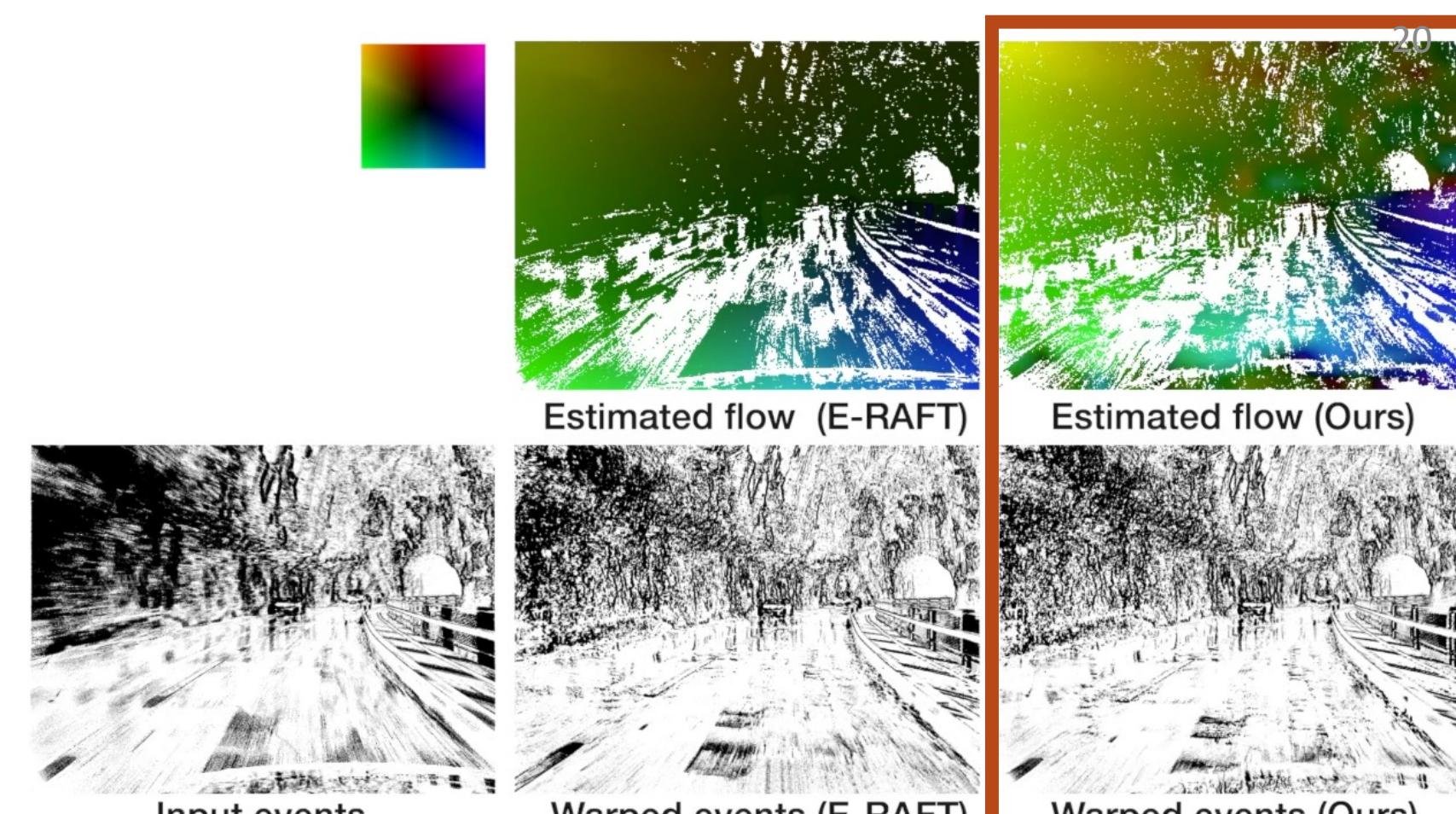


- 1st in indoor sequences among all
- Sharper IWEs than ground truth (GT)

Outdoor, bike (1280x720 px)



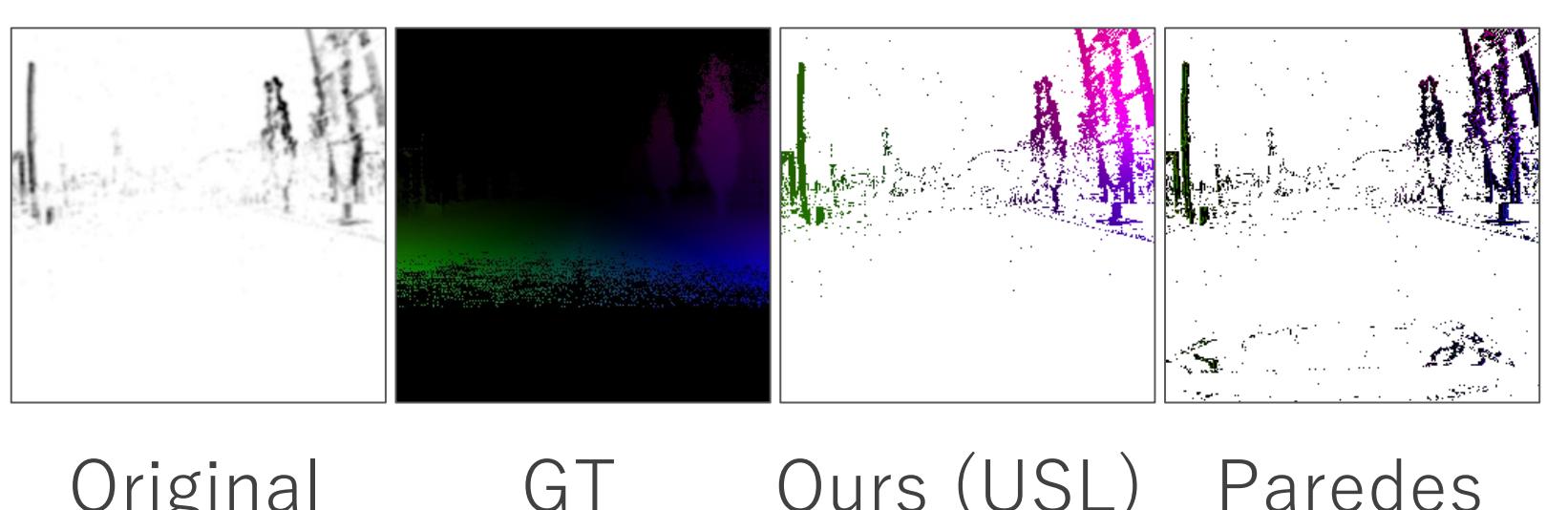
Outdoor, car (640x480 px)



- Competitive results w/o using GT
- Sharp edges for dynamic objects

MVSEC	AEE [px]↓	%Out↓
SL	0.66	1.00
SSL	0.79	1.60
USL	1.02	4.00
Ours (Optimization)	0.60	0.59

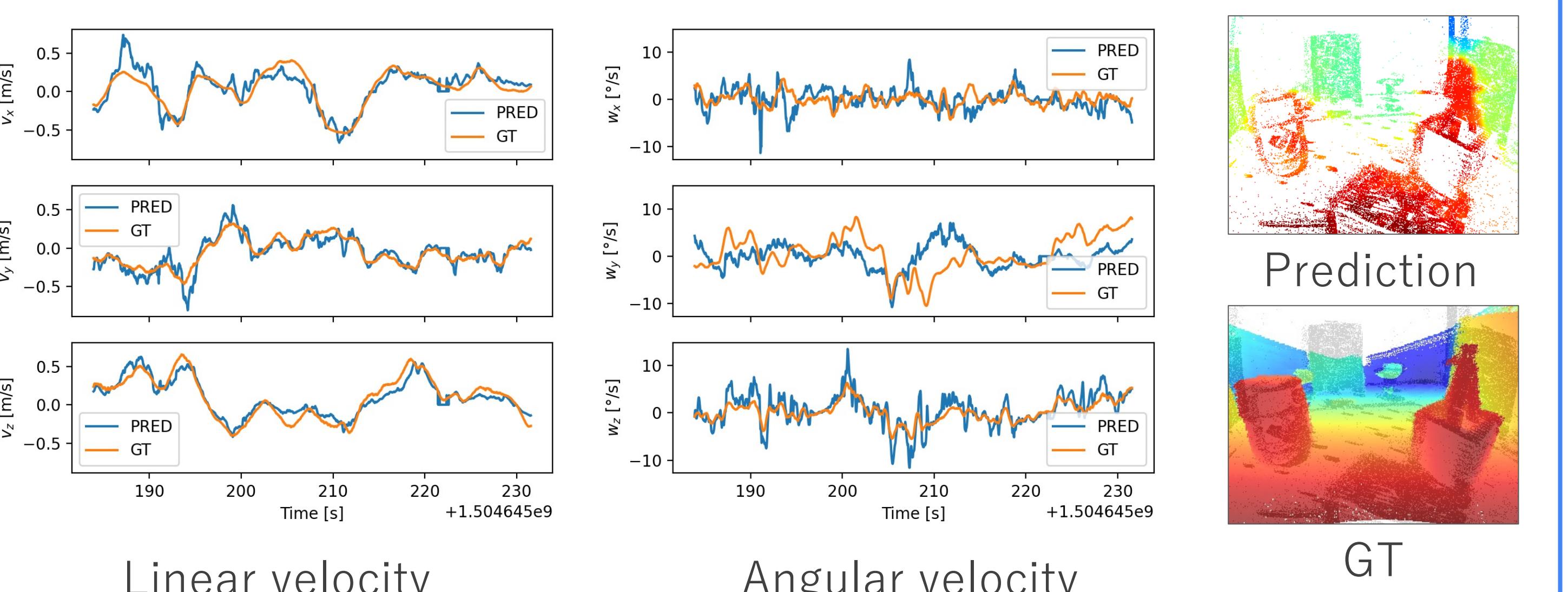
Unsupervised learning



We achieve remarkable results when the secrets are transferred to unsupervised learning settings.

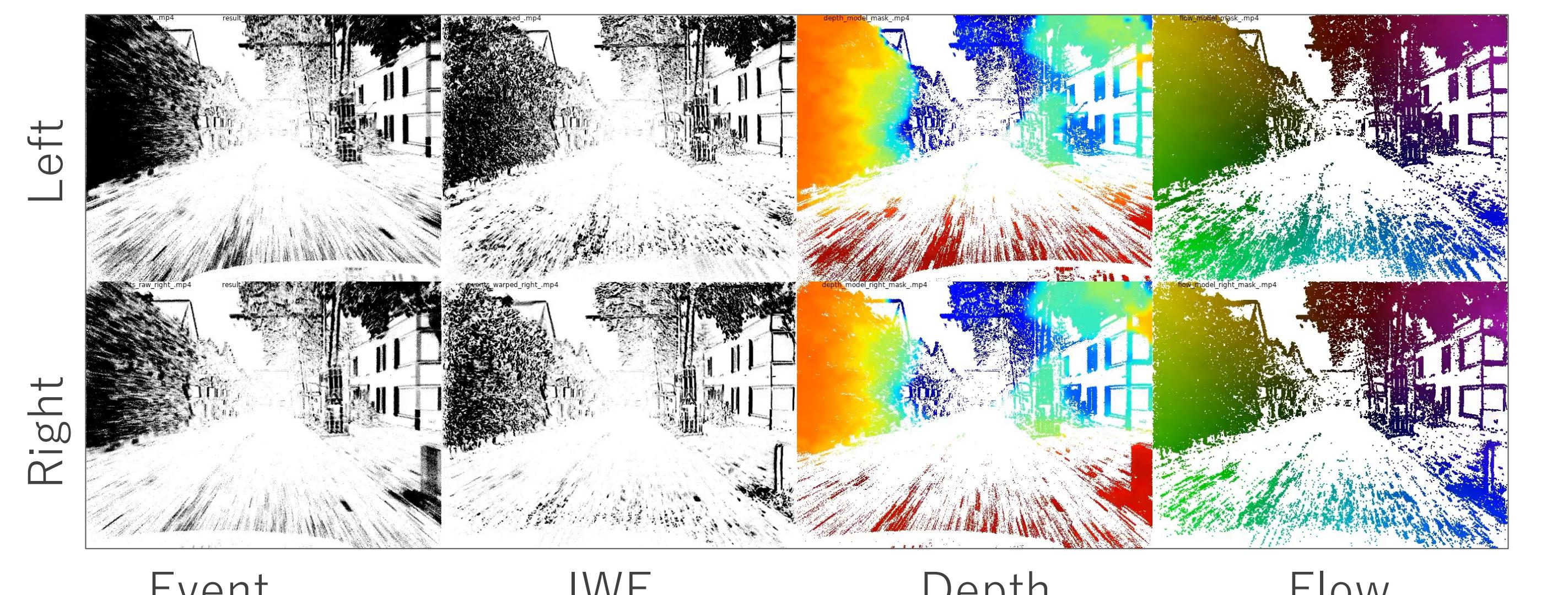
Depth and Ego-Motion

(B') We estimate (mono) depth and egomotion via motion field. $\mathbf{v}(\mathbf{x}) = \frac{1}{Z(\mathbf{x})} A(\mathbf{x}) \mathbf{V} + B(\mathbf{x}) \boldsymbol{\omega}$.



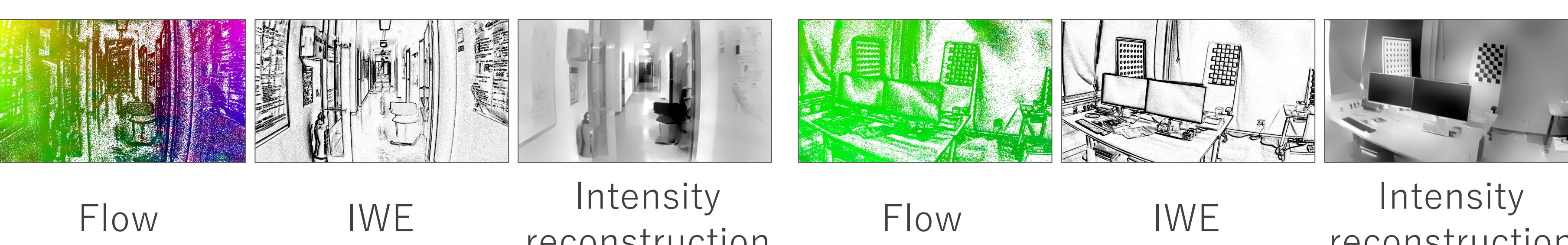
(D) By parameterizing depth from one camera and warping it to another camera, we tackle the stereo problem.

$$\theta^* = \arg \min_{\theta} \left(\frac{1}{f_l(\theta)} + \lambda \mathcal{R}_l(\theta) + \frac{1}{f_r(\theta)} + \lambda \mathcal{R}_r(\theta) \right)$$

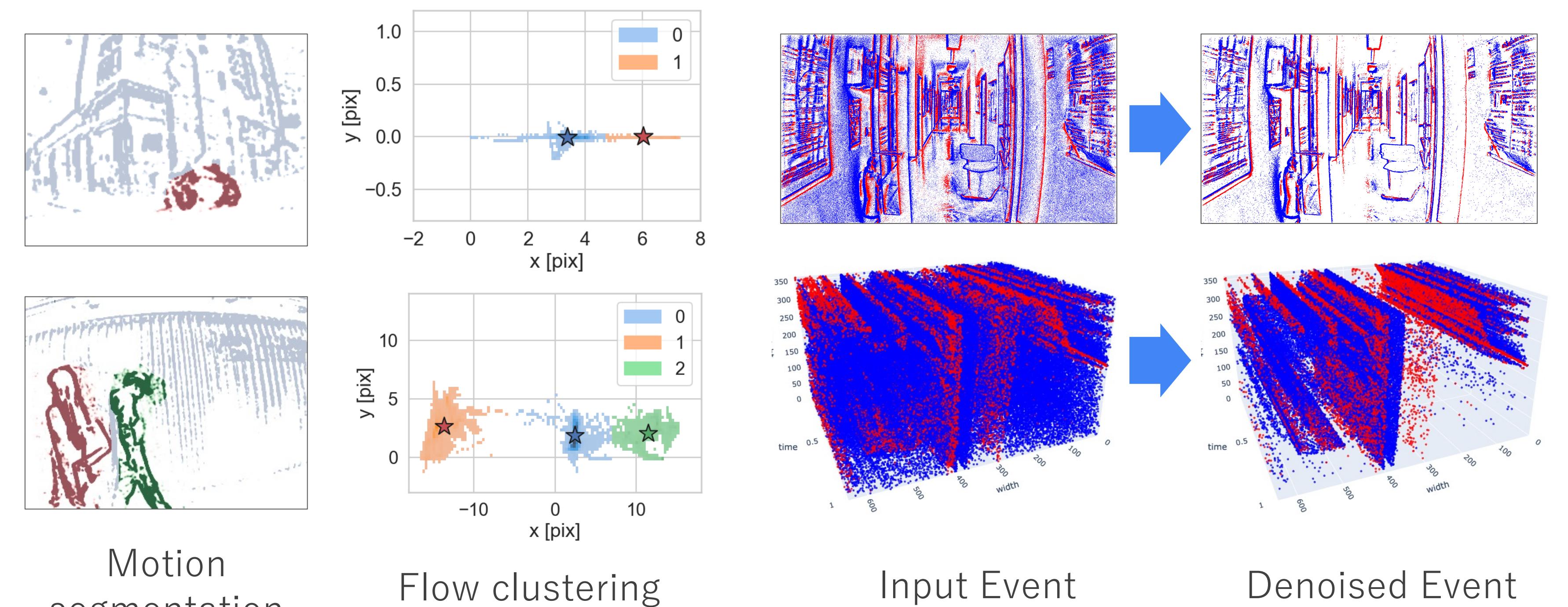


Applications

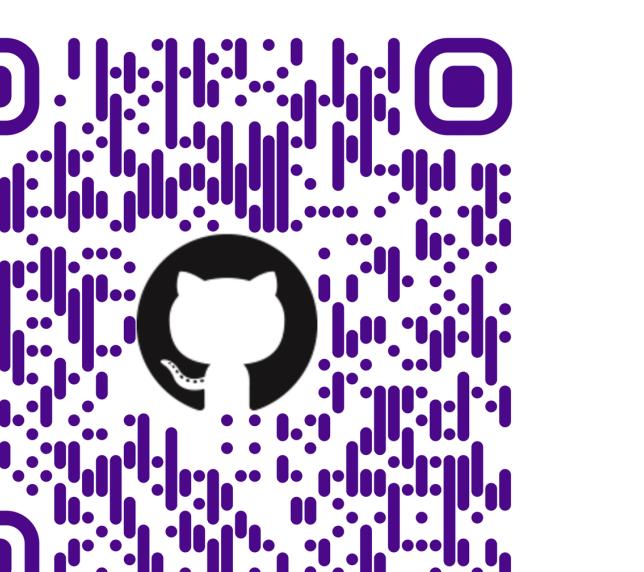
Intensity reconstruction using flow and IWE (Zhang et al. TPAMI 2023)



Motion segmentation



Code



Paper

