Exploring the Common Appearance-Boundary Adaptation for Nighttime Optical Flow

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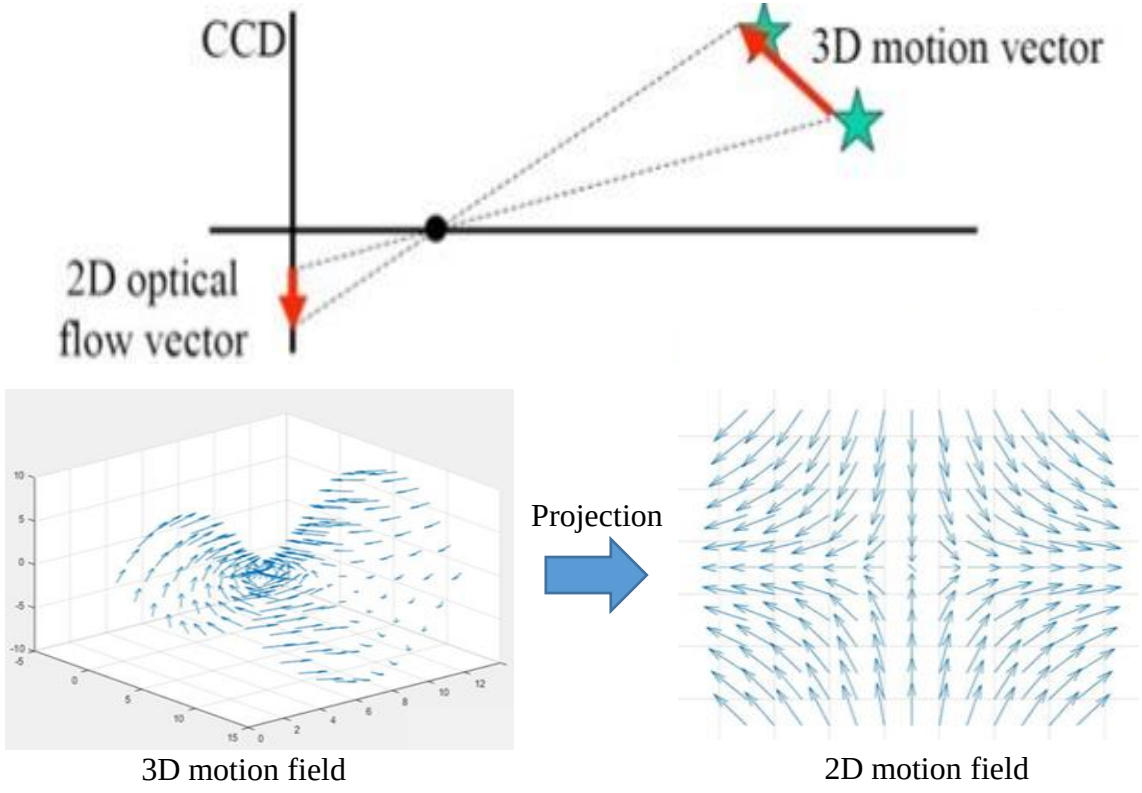
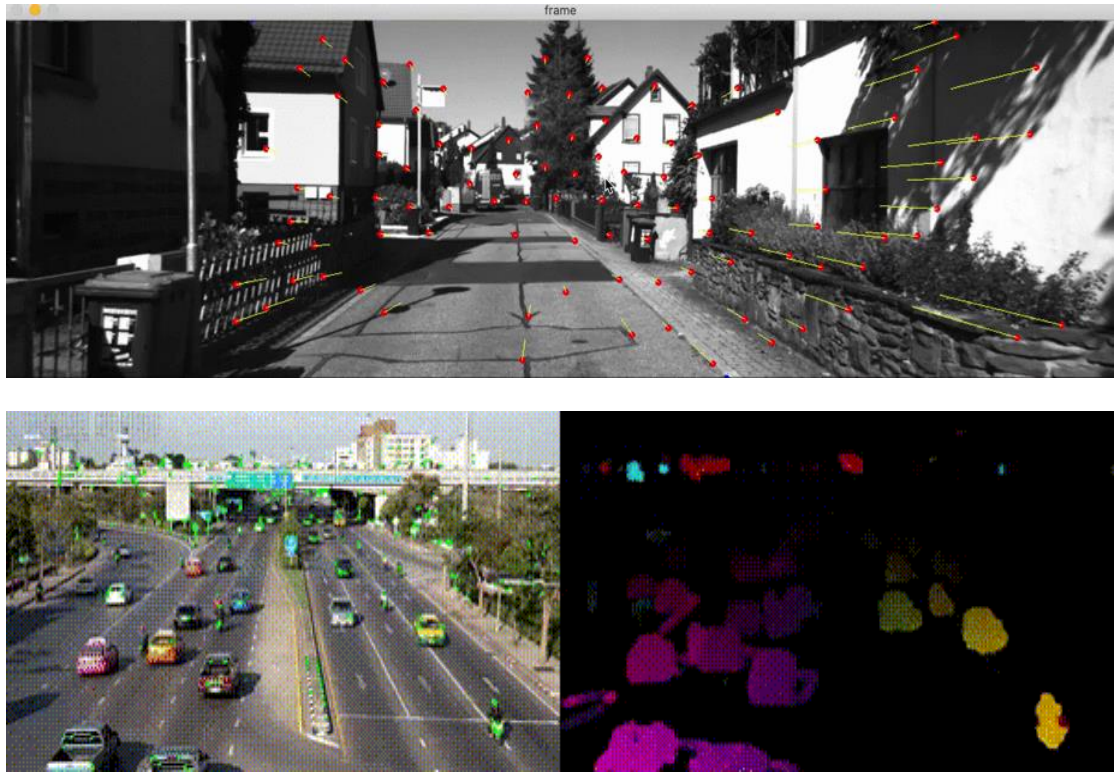
Optical Flow: Motion Estimation Tool



Optical Flow Schematic



Optical Flow Visualization

Problem

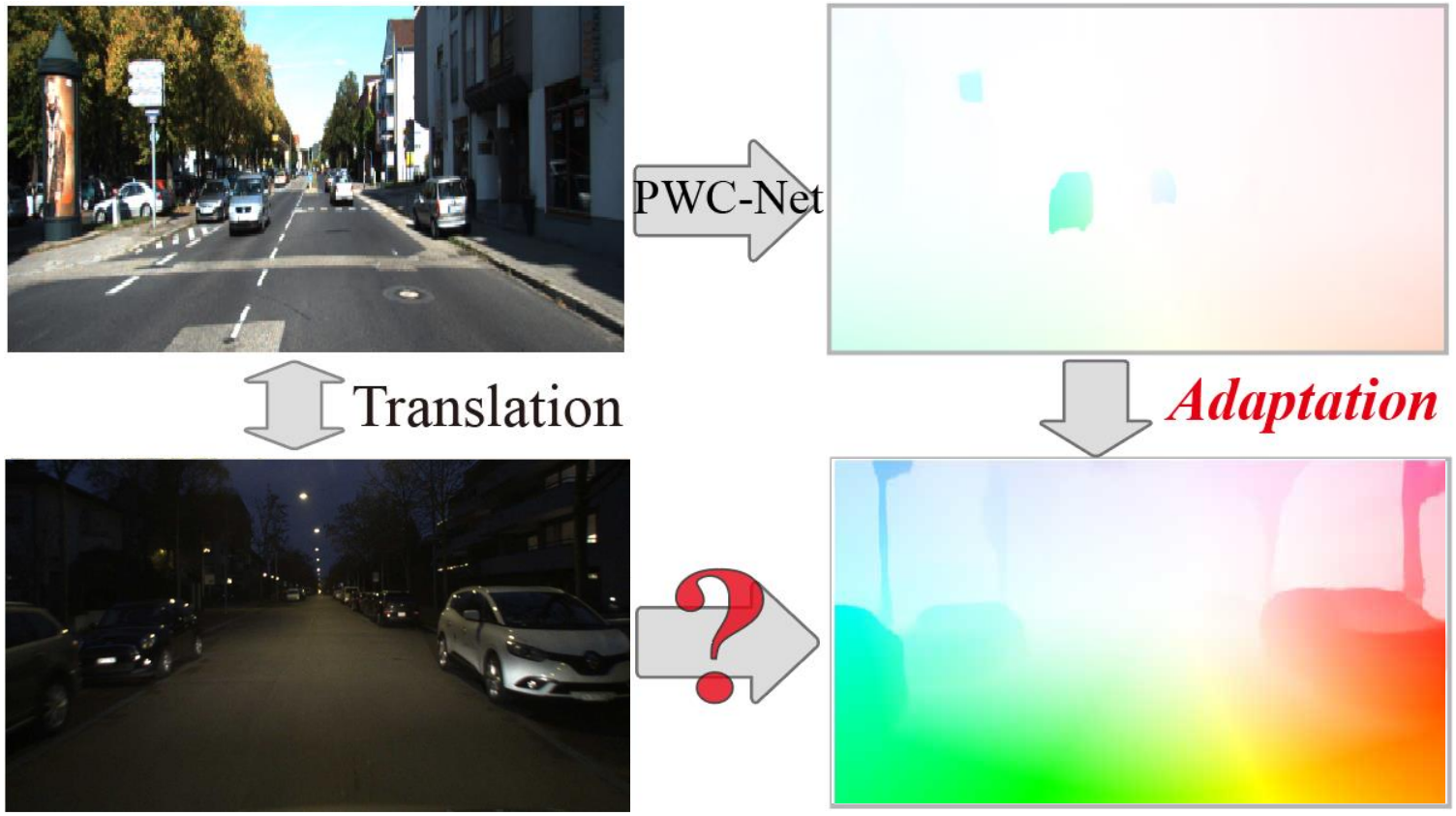
Clean Scene

Nighttime Scene

Enhanced Nighttime Scene

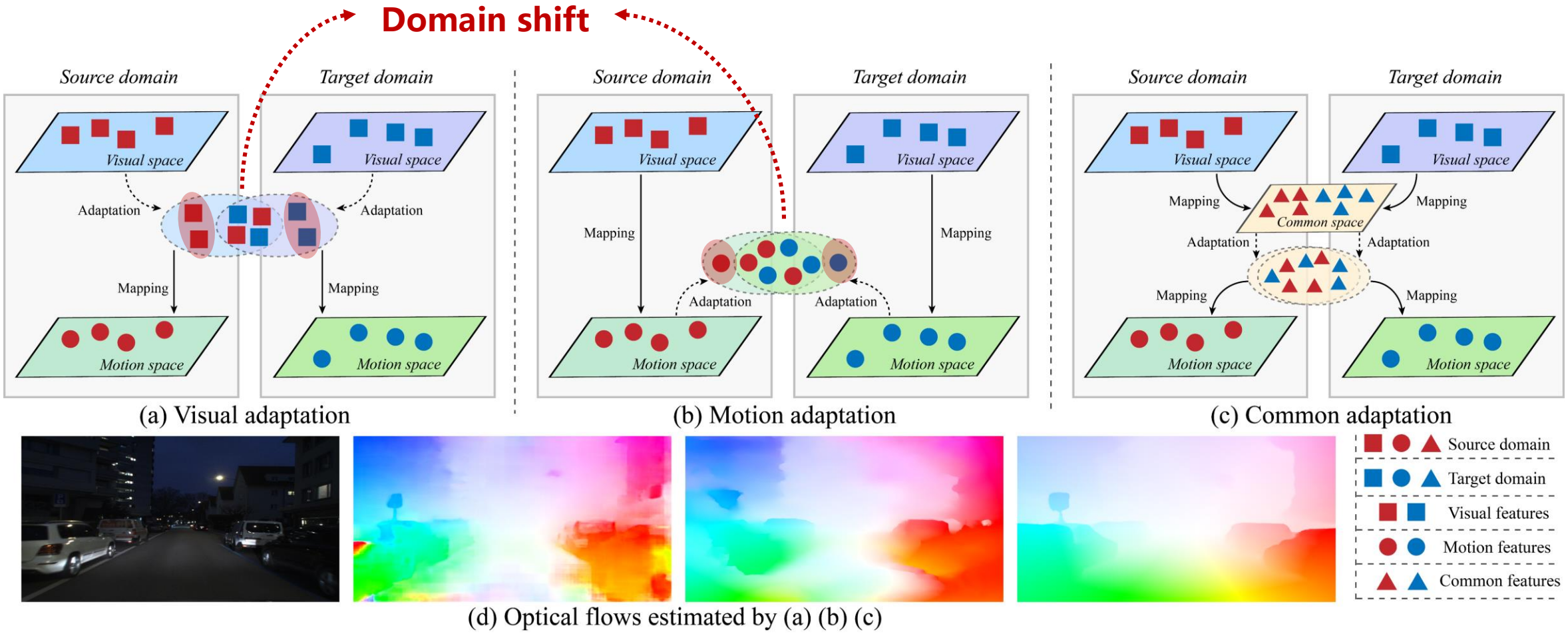
Optical flow suffers degradation under nighttime scenes

Domain Adaptation



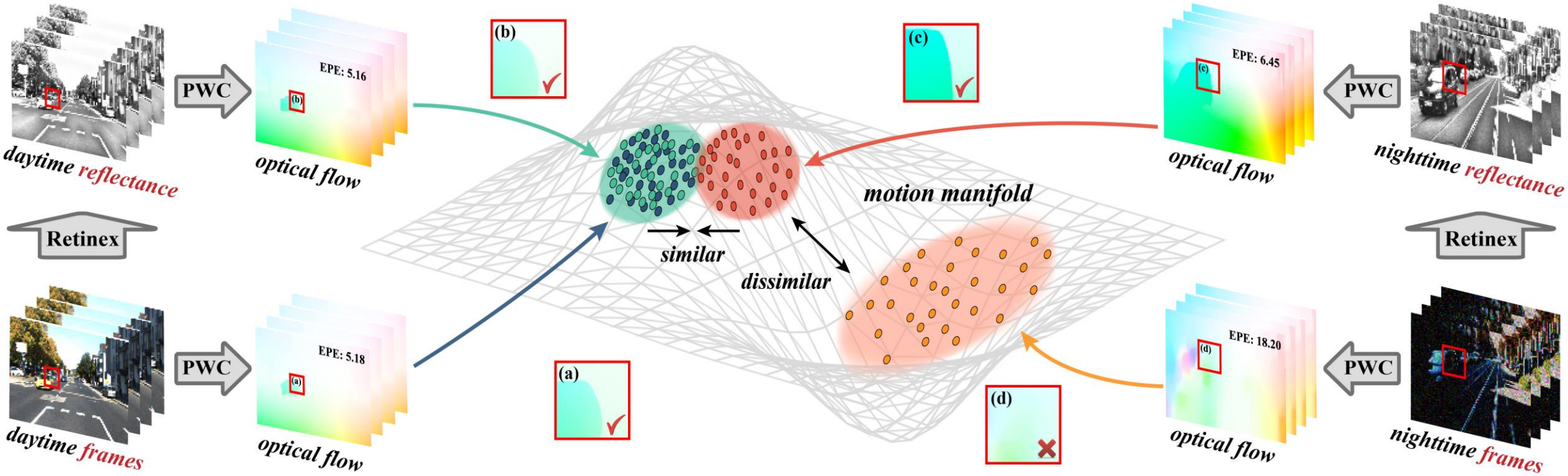
- Solution: Transfer the knowledge from source clean domain to target nighttime domain.

Adaptation Paradigms on Optical Flow



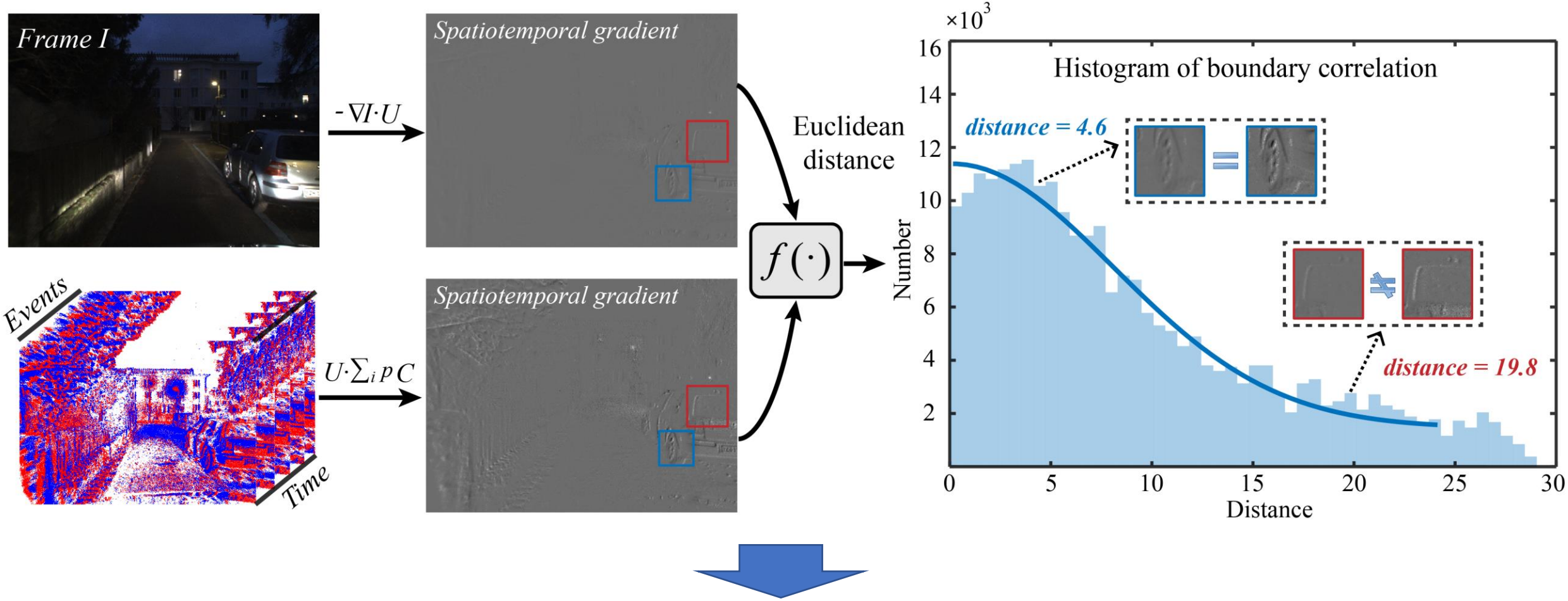
Exploring a common space to reinforce feature distribution alignment

Common space: Reflectance Space



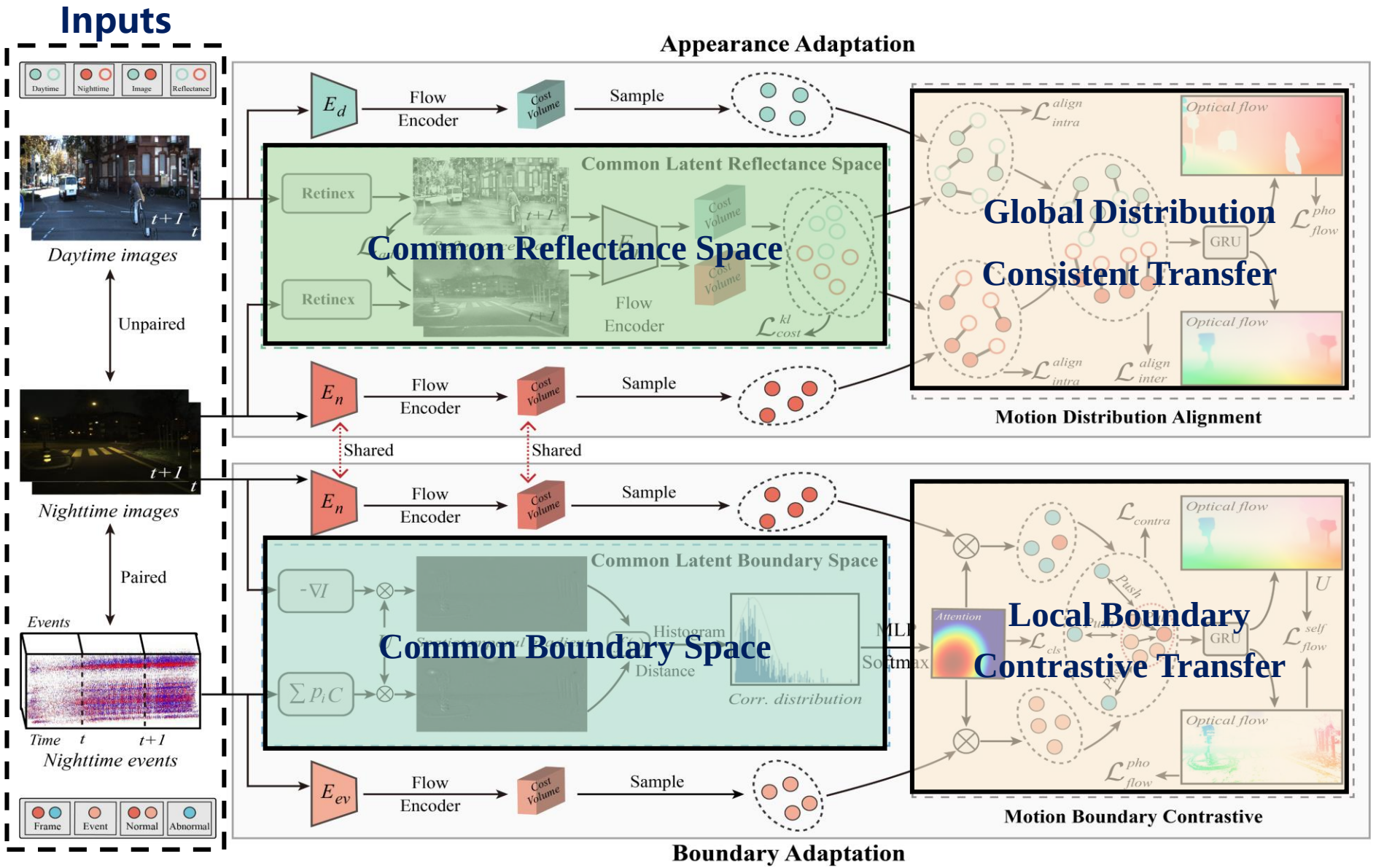
Motion distributions of daytime/nighttime reflectance are similar

Common space: Boundary Space



Correlation discrepancy makes up boundary similarity of frame/event domains

Appearance-Boundary Motion Adaptation



Comparison on Synthetic/Real datasets

Method		DarkFlow-PWC	Selflow			SMURF			ABDA
			–	(KinD++) +	AGLLNet +	–	(KinD++) +	AGLLNet +	
D-KITTI	EPE	7.56	14.22	12.58	11.70	11.36	10.03	8.42	**3.47**
	Fl-all	35.75%	55.87%	48.69%	46.31%	45.88%	44.65%	39.25%	**16.13%**
ND-KITTI	EPE	8.56	18.01	16.75	14.54	13.40	11.95	10.26	**4.35**
	Fl-all	41.28%	65.43%	59.55%	55.26%	54.21%	45.91%	45.60%	**23.86%**

(a) Nighttime Images (b) SMURF (c) DarkFlow-PWC (d) GMA (e) ABDA-Flow

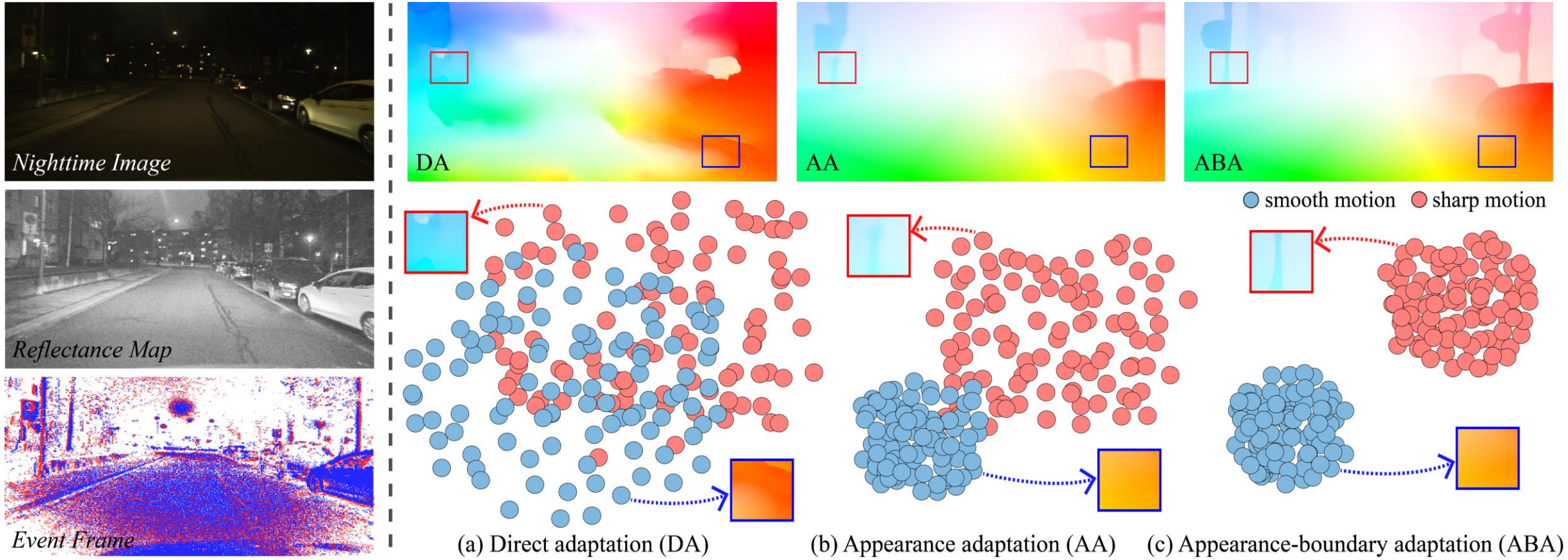
Comparison on Unseen Nighttime Scenes

(a) Nighttime images (b) DarkFlow-PWC (c) GMA (d) ABDA-Flow

ABDA-Flow could generalize well for various illumination

Nighttime images | DarkFlow | ABDA-Flow (Ours)

Direct Adaptation v.s. Common Adaptation



Common adaptation transfers global and local motion

Discussion

Table 3: Discussion on effect of common space.

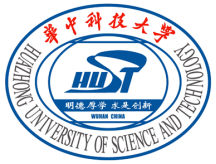
Strategy	EPE
w/o motion/reflect./bound.	1.51
w/ motion, w/o reflect./bound.	1.09
w/ motion/reflect., w/o bound.	0.87
w/ motion/bound., w/o reflect.	0.95
w/ motion/reflect./bound.	**0.74**

Table 4: Ablation study on adaptation losses.

$\mathcal{L}_{intra}^{align}$	$\mathcal{L}_{inter}^{align}$	$\mathcal{L}_{contra}$	$\mathcal{L}_{flow}^{self}$	EPE
×	×	×	×	1.45
√	×	×	×	1.24
√	√	×	×	1.05
√	√	√	×	0.85
√	√	√	√	**0.74**

Table 5: Discussion on training data and optical flow backbone.

Training data	Method	EPE
daytime, nighttime	CycleGAN + our baseline	1.41
	Our appearance adaptation	0.87
daytime, nighttime, event	CycleGAN + our baseline + E-RAFT	1.33
	Ours w/ CNN backbone	0.77
	Ours w/ Transformer backbone	**0.74**




Thanks