Project page

Rethinking Generic Camera Models for Deep Single Image Camera Calibration to Recover Rotation and Fisheye Distortion

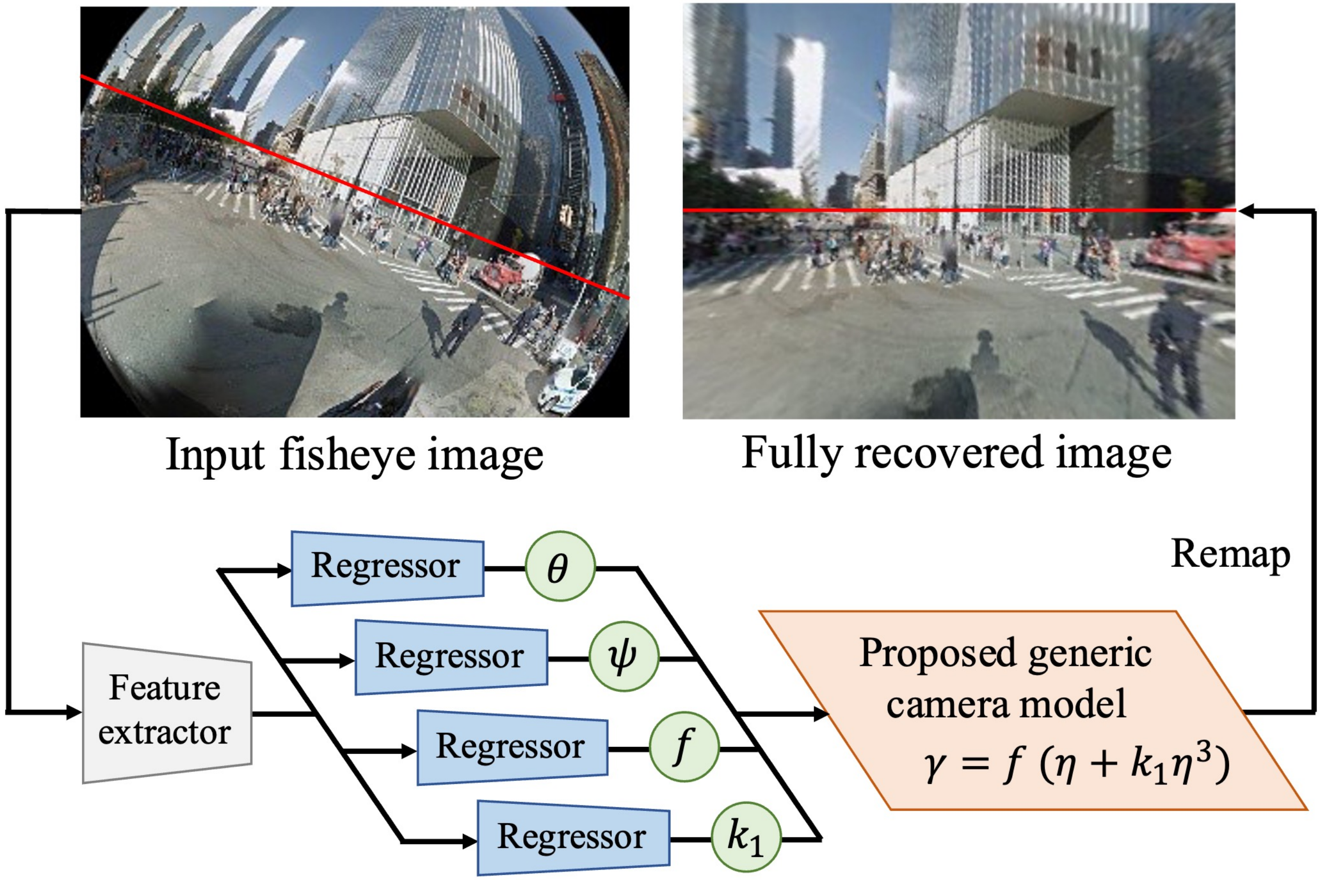
Nobuhiko Wakai [1] Satoshi Sato [1] Yasunori Ishii [1] Takayoshi Yamashita [2]

1 Panasonic Holdings 2 Chubu University

What is Deep Single Image Camera Calibration?

Camera calibration uses only a general scene image

Most computer vision tasks require undistorted images; however, fisheye images have the superiority of a large FOV. We do not need to set up calibration objects.



Red lines indicate horizontal lines in the images, for which we used [46].

Contributions

1. **Our learning-based method calibrates for recovering camera rotation and fisheye distortion using the proposed generic camera model**

2. **Our new loss function alleviates the bias of the magnitude of errors between the GT and predicted camera parameters to obtain accurate ones**

3. **We first analyze the performance of learning-based methods using off-the-shelf fisheye cameras consisting of four types of fisheye projection**

Our generic camera model

Conventional [30] $\gamma = \tilde{k}_1\eta + \tilde{k}_2\eta^3 + \cdots$

$[-\infty : +\infty]$

Our advantages

1. **Determinable parameter ranges**
2. **Close-form solutions for 3rd-order polynomial**

Proposed $\gamma = f(\eta + k_1\eta^3)$

$f\,[6:15]$ $k_1[-1/6 : 1/3]$

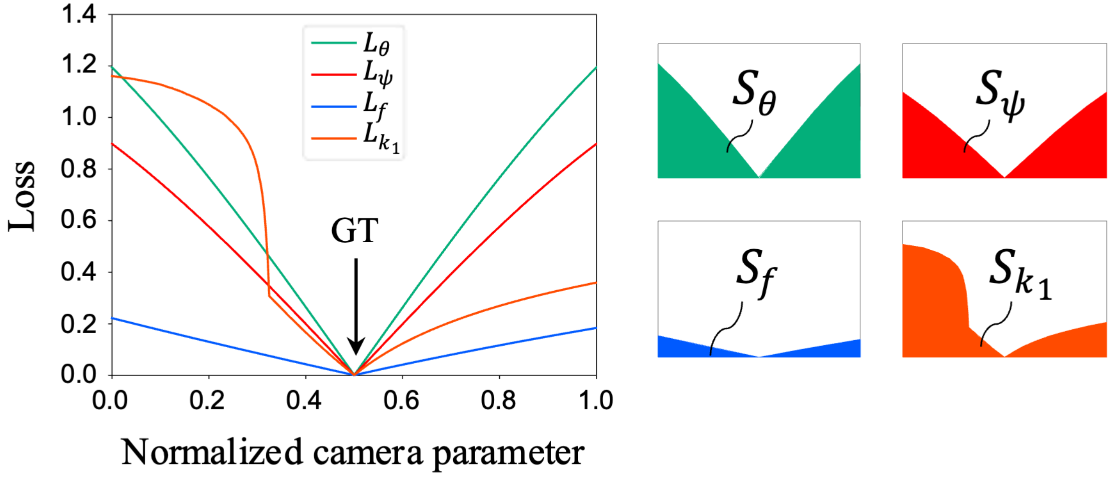
η **: incident angle**
f **: focal length**
k_1 **: distortion coefficient**

Our loss function: Harmonic non-grid bearing loss (HNGBL)

Remarkably, we determine the joint weights before training through the numerical calculation of S.

$$L = w_\theta L_\theta + w_\psi L_\psi + w_f L_f + w_{k_1} L_{k_1}$$
$$= S_\theta^{-1} L_\theta + S_\psi^{-1} L_\psi + S_f^{-1} L_f + S_{k_1}^{-1} L_{k_1}$$

To be exact, we normalize the weights.



(a) (b)

Experimental results on synthesis images

Comparison of PSNR ↑

Method	StreetLearn [46]				
	Stereo graphic	Equi distance	Equisolid angle	Ortho gonal	All
Almán-F. [2]	13.23	12.25	11.70	9.72	11.72
Santana-C. [55]	14.68	13.20	12.49	10.29	12.66
Liao [37]	13.63	13.53	13.53	13.74	13.60
Yin [66]	13.81	13.62	13.59	13.77	13.70
Chao [13]	15.86	15.12	14.87	14.52	15.09
Bogdan [8]	14.55	14.43	14.46	14.71	14.54
Li [34]	16.37	15.41	15.07	14.58	15.36
López-A. [45]	17.84	16.84	16.43	15.15	16.57
Wakai [60]	22.39	23.62	22.91	17.79	21.68
Ours w/o HNGBL	26.49	29.08	28.56	23.97	27.02
Ours	**26.84**	**30.01**	**29.69**	**23.70**	**27.58**

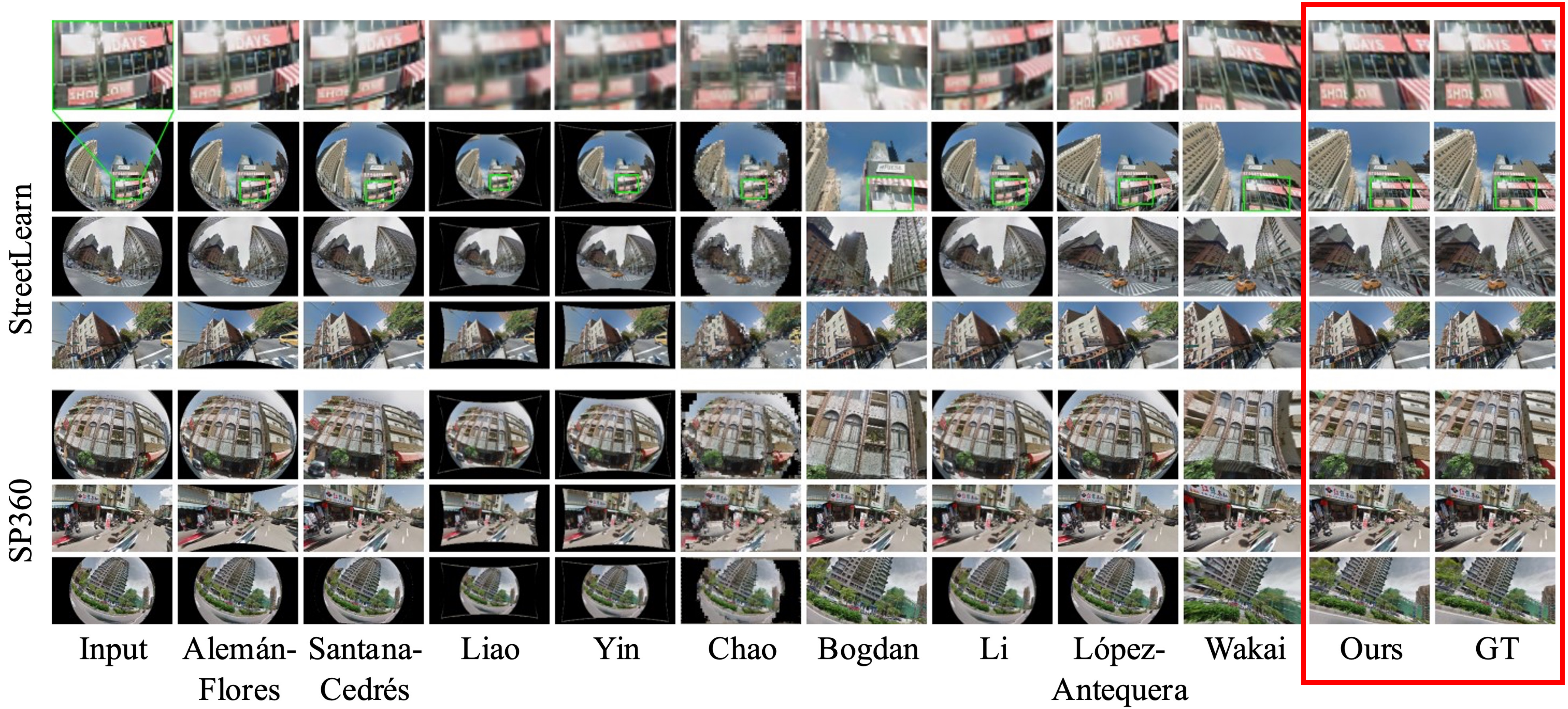
Comparison of MAE ↓ and REPE ↓

Method	StreetLearn [46]				
	Mean absolute error				REPE [pix]
	Tilt [deg]	Roll [deg]	f [mm]	k_1	
López-A. [45]	27.60	44.90	2.32	-	81.99
Wakai [60]	10.70	14.97	2.73	-	30.02
Ours w/o HNGBL	7.23	7.73	0.48	0.025	12.65
Ours	**4.13**	**5.21**	**0.34**	**0.021**	**7.39**

Ours outperforms [60]

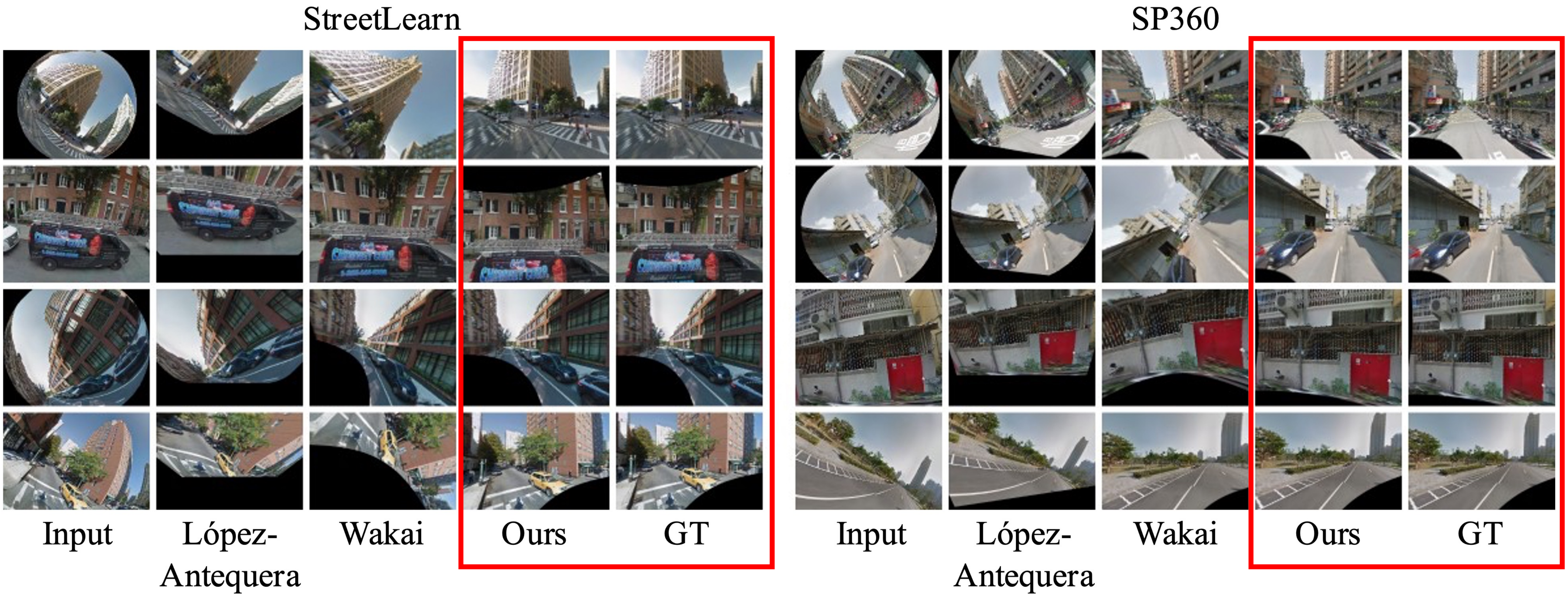
by +5.90 in PSNR
by −22.63 [pix] in reprojection errors (REPE)

Experimental results on synthesis images



(a) Only undistortion

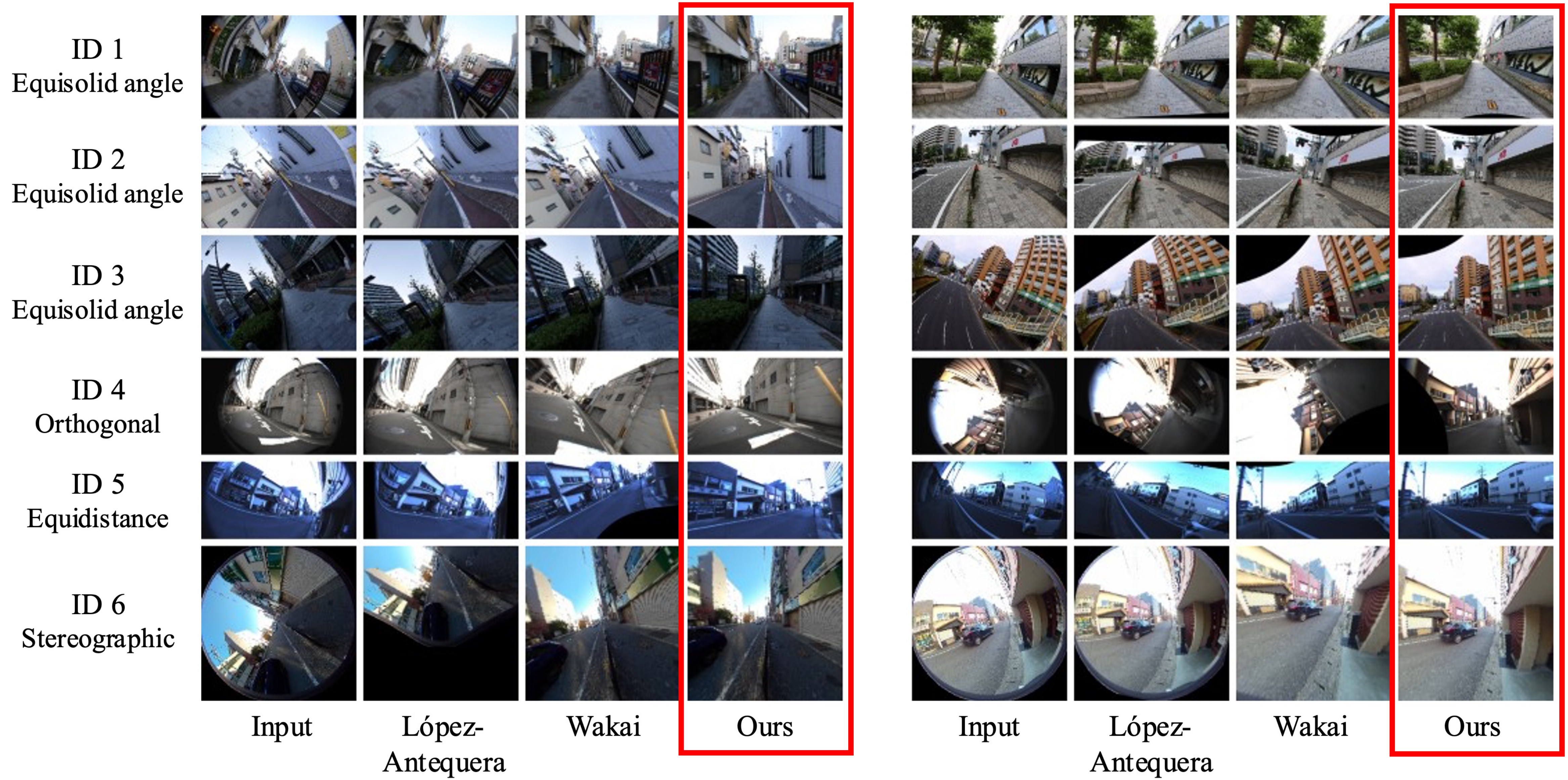
StreetLearn [46], SP360 [12]



(b) Fully recovered rotation and distortion

StreetLearn [46], SP360 [12]

Experimental results on off-the-shelf cameras



(a) Networks trained using StreetLearn

(b) Networks trained using SP360

StreetLearn [46], SP360 [12]

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These descriptions on this slide are referred to in our ECCV2022 paper.