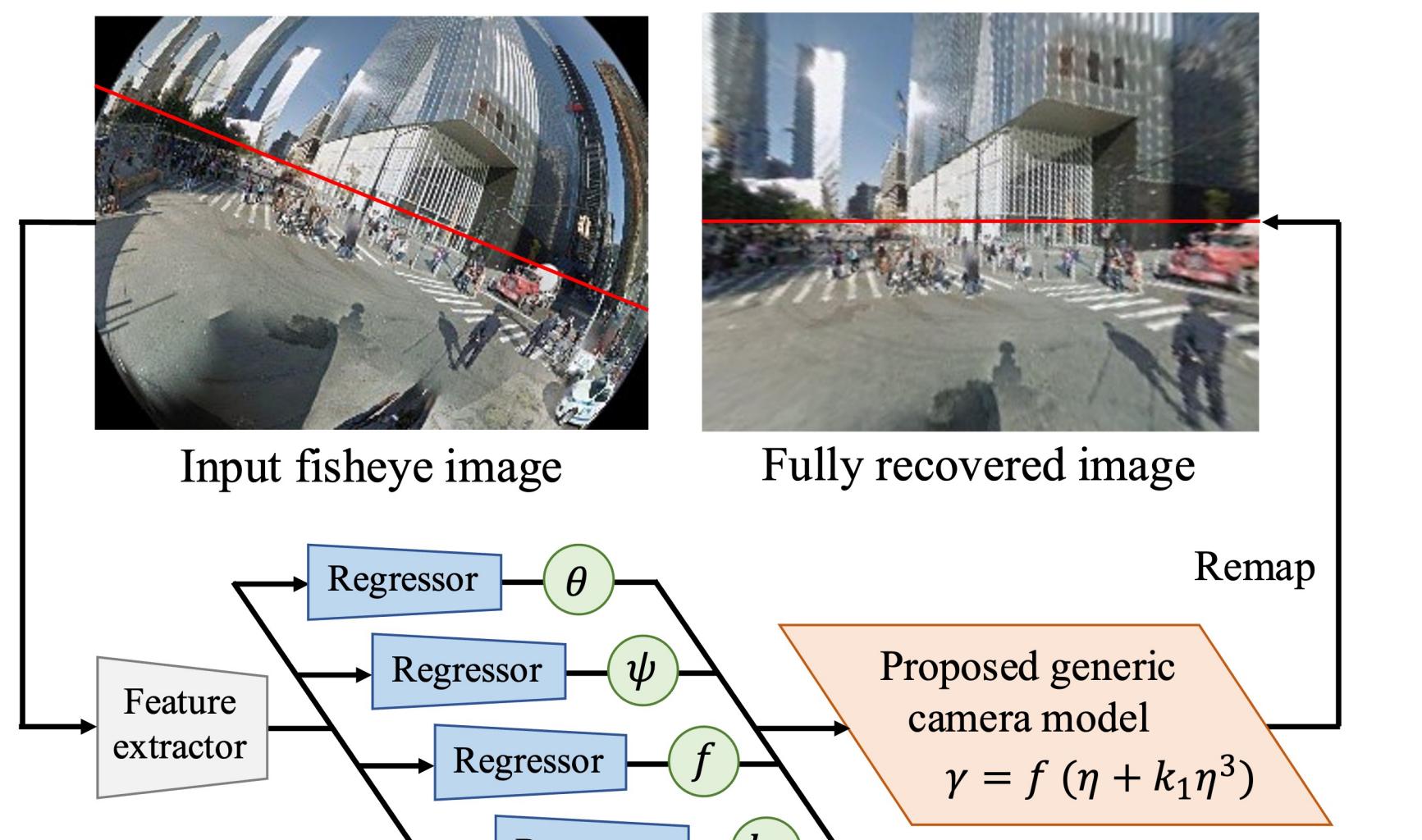




Introduction

Background

Most computer vision tasks require undistorted images; however, fisheye images have the superiority of a large FOV.



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

Contributions

- Our learning-based method calibrates for recovering camera rotation and fisheye distortion using the proposed generic camera model
- Our new loss function alleviates the bias of the magnitude of errors between the GT and predicted camera parameters to obtain accurate camera parameters
- We first analyze the performance of learning-based methods using off-the-shelf fisheye cameras consisting of four types of fisheye projection

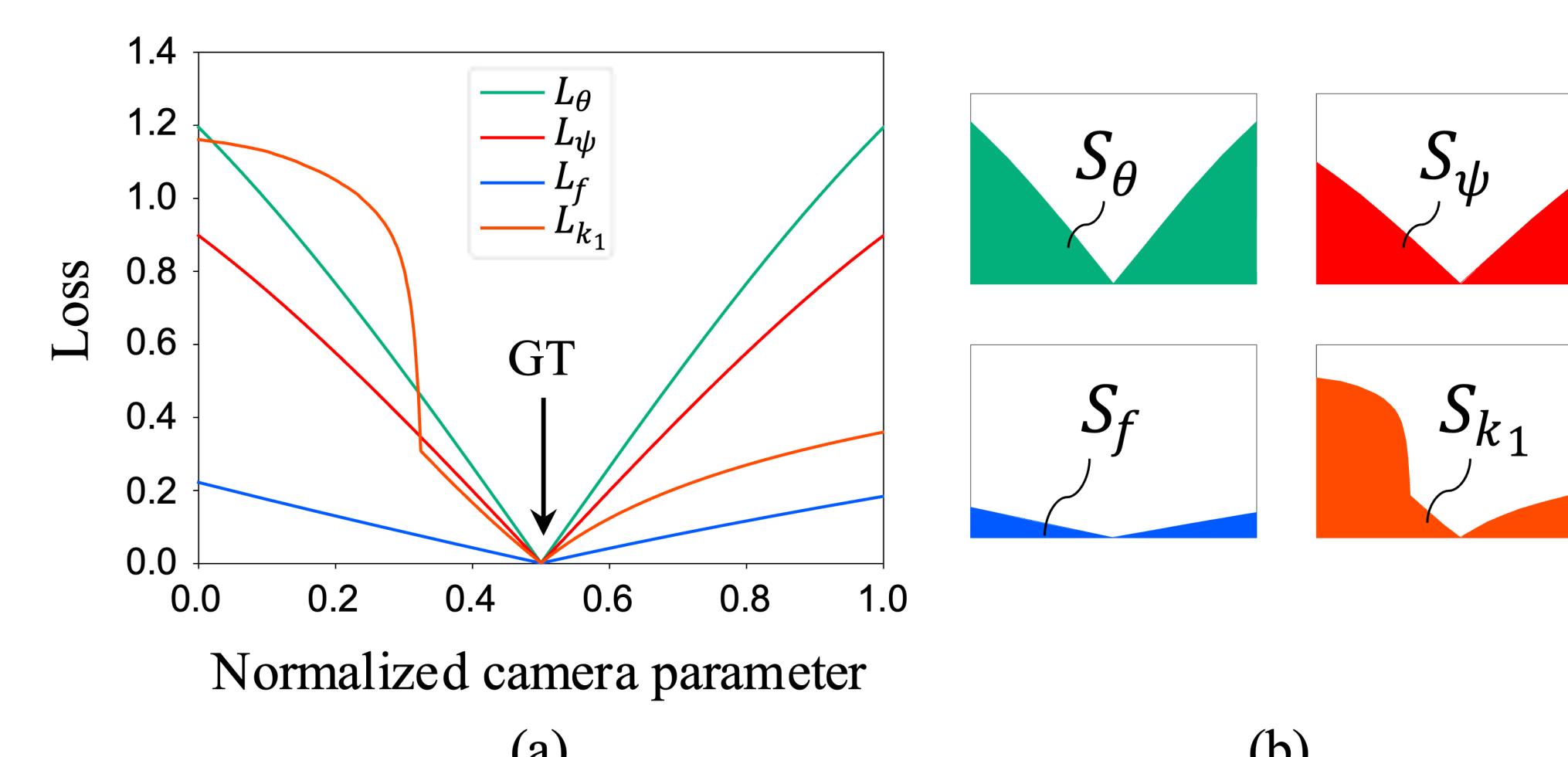
Our generic camera model

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

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

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

- Our advantages
- Determinable parameter ranges
 - Close-form solutions for 3rd-order polynomial



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

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

$$\begin{aligned} L &= w_\theta L_\theta + w_\psi L_\psi + w_f L_f + w_{k_1} L_{k_1} \\ &= S_\theta^{-1} L_\theta + S_\psi^{-1} L_\psi + S_f^{-1} L_f + S_{k_1}^{-1} L_{k_1} \quad \text{HNGBL} \end{aligned}$$

To be exact, we normalize the weights.

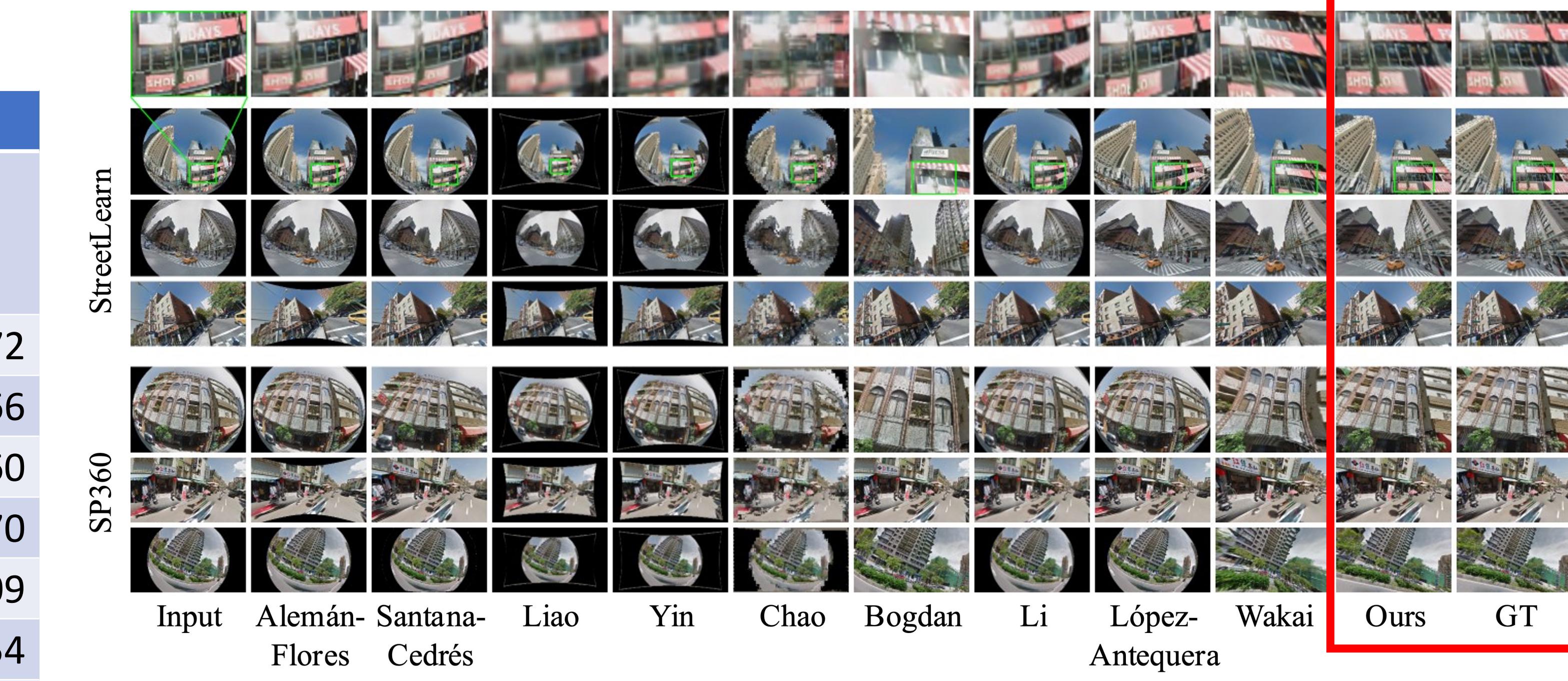
Experimental results on synthesis images

Comparison of PSNR ↑

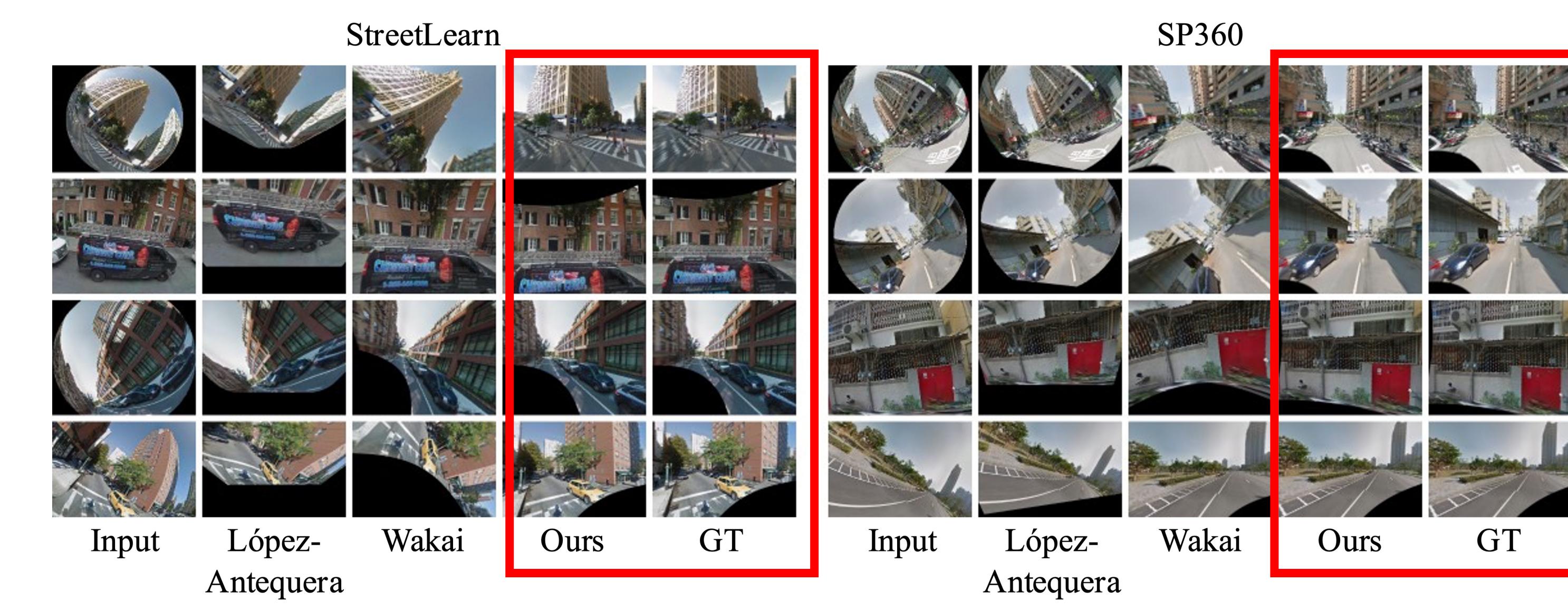
Method	StreetLearn [46]				
	Stereographic	Equidistance	Equisolid angle	Orthogonal	All
Almán-F. [2]	13.23	12.25	11.70	9.72	11.72
Santana-C. [55]	14.68	13.20	12.49	10.29	12.66
Liao [37]	13.63	13.53	13.53	13.74	13.60
Yin [66]	13.81	13.62	13.59	13.77	13.70
Chao [13]	15.86	15.12	14.87	14.52	15.09
Bogdan [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	
	Tilt [deg]	Roll [deg]	f [mm]	k_1	[pix]
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



(a) Only undistortion



(b) Fully recovered rotation and distortion

Ours outperforms [60]
by +5.90 in PSNR
by -22.63 [pix] in reprojection errors (REPE)

Experimental results on off-the-shelf cameras

Off-the-shelf cameras:
single lens reflex cameras, compact cameras, and machine vision cameras

Ours can address four types of fisheye projection in off-the-shelf cameras, unlike conventional methods.

