A Well-aligned Dataset for Learning Image Signal Processing on Smartphones from a High-end Camera

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We collect a sub-pixel aligned dataset with raw and RGB data pairs captured by two popular smartphones and one high-end camera. Our dataset can be used for learning ISPs to replace the sub-optimal built-in ISPs of smartphones. Our dataset complements the existing ISP dataset [Ignatov et al. 2020] with more types of smartphone images.

PROBLEM

Not every camera is equipped with an excellent image signal processing (ISP) pipeline that converts raw sensor data into color images.

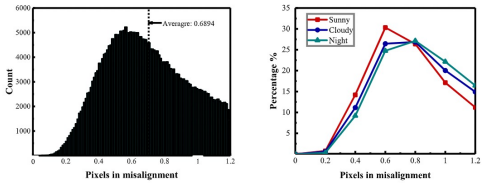
It is labor-intensive and challenging to design an ISP pipeline with many independent modules. and thus the ISP on most smartphones is sub-optimal, even for the highly-rated ones such as iPhone.

DATA COLLECTION

Over 2000 pairs of aligned images from iPhone 6S & Xiaomi

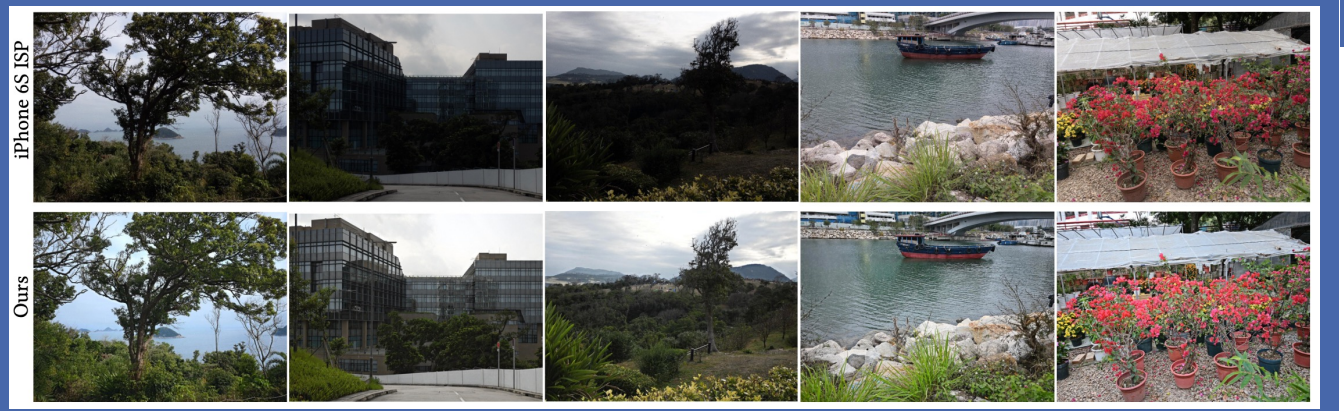
iPhone 6S | Nikon Z6 | Camera Rig

DATA ANALYSIS



(a) Misalignment distribution (b) Dependence on illumination

SID [Chen et al. 2018] DPED [Ignatov et al. 2017] PAC [Su et al. 2019] iPhone 6S Ours



APPROACH

Given a raw image captured by a small sensor camera, our goal is to render a high-quality RGB image. The high dynamic range of raw sensor images imposes a great challenge using a conventional CNN architecture that relies on spatially invariant convolutions, which are considered antithetical to localize edge discontinuities. Thus, directly applying standard convolution can cause apparent artifacts such as halos, which has been identified in previous non-learning-based image filtering methods. We propose a novel edge-aware conditional convolutional network architecture based on the kernel prediction method.

RESULTS

We provide the quantitative results with baselines. Overall, all perceptual metrics show that our proposed ISP model outperforms the baselines.

	Mi 3			iPhone 6S		
Method	LPIPS ↓	PSNR ↑	SSIM ↑	LPIPS ↓	PSNR ↑	SSIM ↑
Built-in ISP	0.261	18.82	0.632	0.262	19.65	0.626
DPED	0.474	18.71	0.665	0.453	18.46	0.667
PAC	**0.182**	20.18	0.699	0.204	18.50	0.650
SID	0.264	20.56	0.690	0.295	**21.23**	0.731
Ours	**0.182**	**21.22**	**0.725**	**0.134**	21.09	**0.733**

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Download the Dataset

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