

Reversed Image Signal Processing and RAW Reconstruction. AIM 2022 Challenge Report

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Project page : <https://github.com/mv-lab/AISP>



AIM 2022 Reversed ISP Challenge

Related work: “*Learned smartphone ISP*” Challenges at AIM and Mobile AI
FlexISP (Heide et al.), *DeepISP* (Schwartz et al.), *PyNET* (Ignatov et al.)

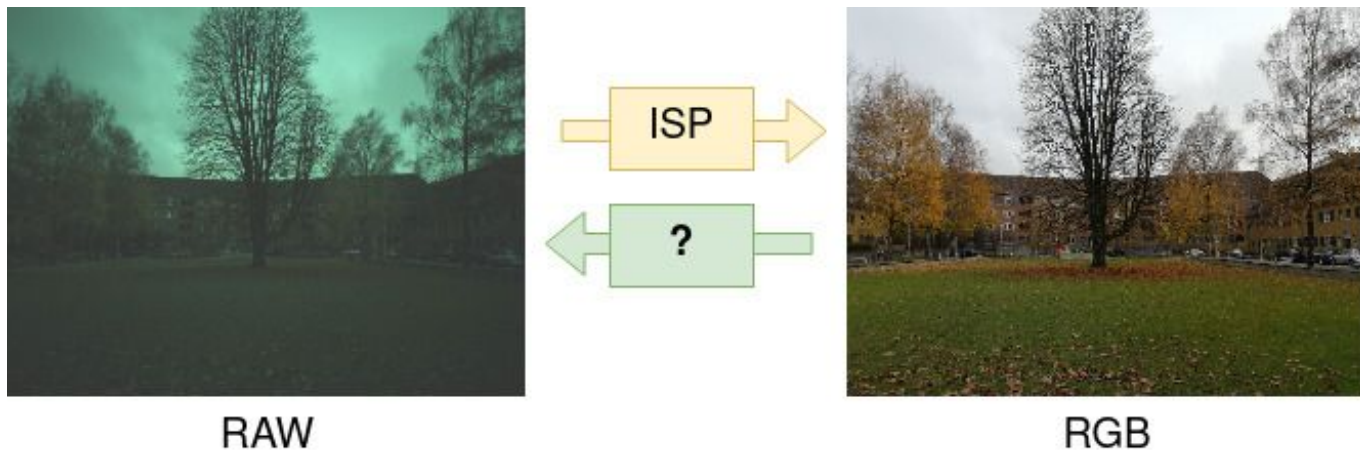
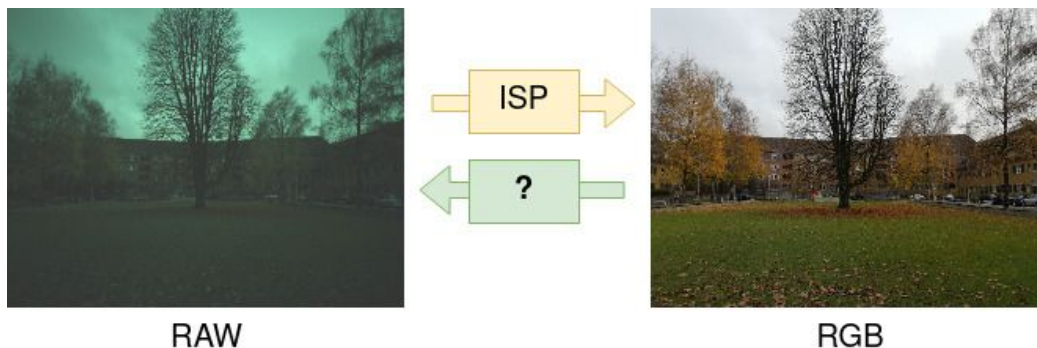


Fig. 1. Images Source “PyNet”, Andrey Ignatov, ETH

Motivation

- RAW camera sensor data is scarce
- RAW images collection is expensive
- Numerous low-level vision tasks operate in the RAW domain
- NTIRE 2020/2022 Challenge on Spectral Reconstruction from an RGB Image
- Establish a benchmark for this inverse problem



Objective

- Recover RAW sensor images from the corresponding RGBs **without metadata** and, by doing this, “**reverse**” the ISP transformation.
- No camera parameters.

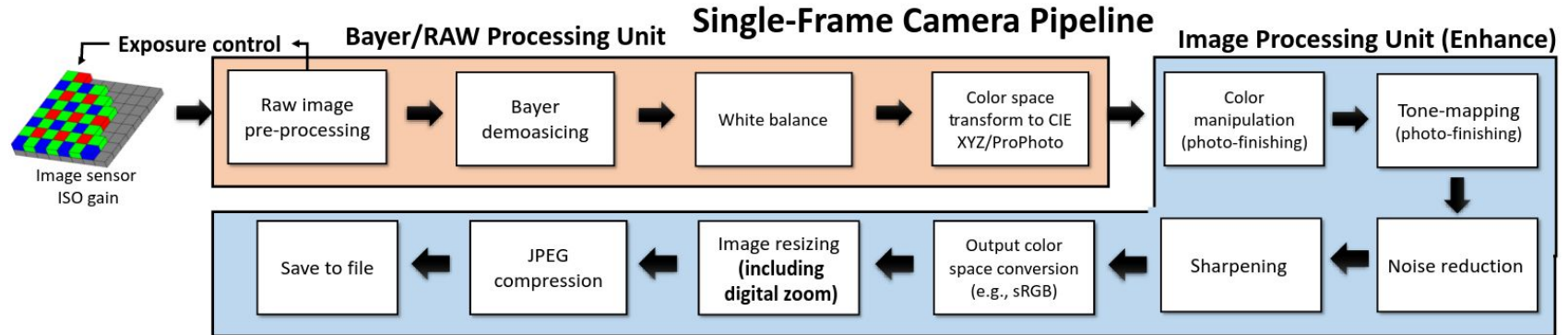


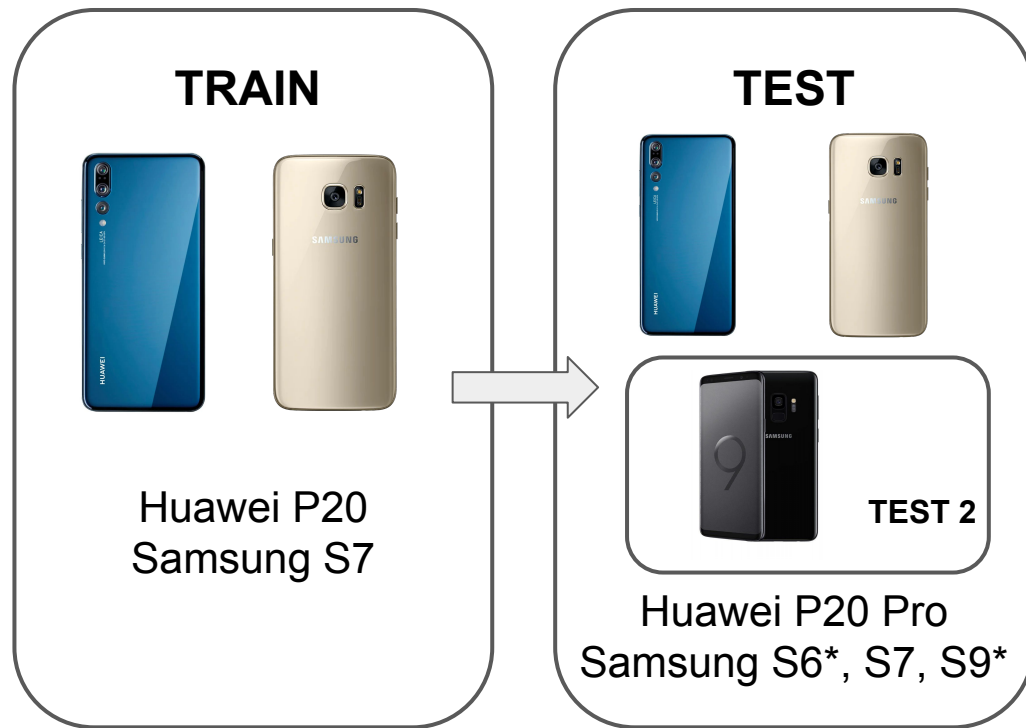
Fig. 2. Image from Delbracio et al. “Mobile Computational Photography: A Tour”

Datasets

- **Samsung S7*** (12MP Sony IMX260)
Dataset from “DeepISP”, Schwartz et al. IEEE TIP 2018
- **Huawei P20*** (12.3 MP Sony Exmor IMX380) Pro ETH
Dataset by “PyNET”, Ignatov et al. CVPRW 2020
- **Samsung S6 Edge** (16MP Sony IMX240)
Dataset “SSID” by Abdelhamed et al. CVPR 2018
- **Samsung Galaxy S9** (Sony IMX345)
Dataset “RAW-to-RAW” by Afifi et al. BMVC 2021.



Datasets

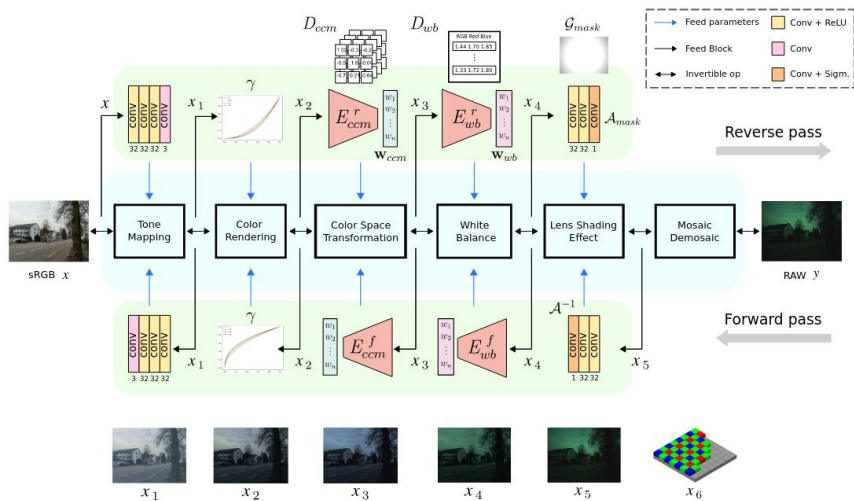


Benchmark

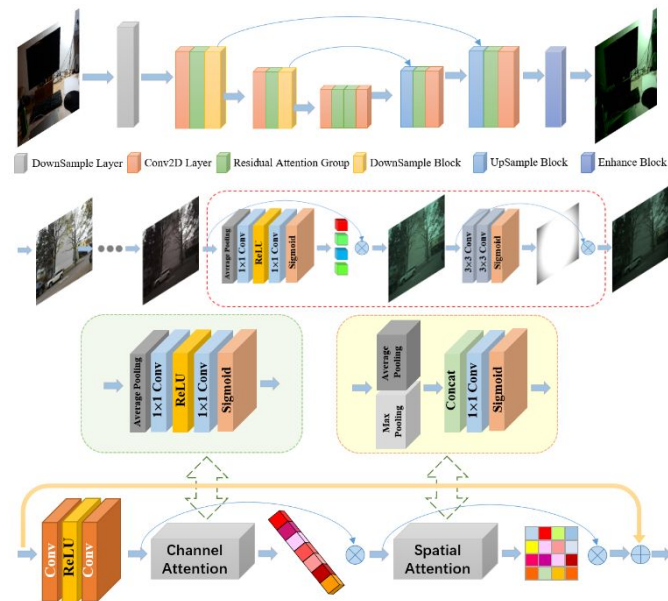
Team name	Track 1 (Samsung S7)				Track 2 (Huawei P20)			
	Test1		Test2		Test1		Test2	
	PSNR \uparrow	SSIM \uparrow	PSNR \uparrow	SSIM \uparrow	PSNR \uparrow	SSIM \uparrow	PSNR \uparrow	SSIM \uparrow
NOAHTCV	31.86	0.83	32.69	0.88	38.38	0.93	35.77	0.92
MiAlgo	31.39	0.82	30.73	0.80	40.06	0.93	37.09	0.92
CASIA LCVG (*)	30.19	0.81	31.47	0.86	37.58	0.93	33.99	0.92
HIT-IIL	29.12	0.80	30.22	0.87	36.53	0.91	34.25	0.90
SenseBrains	28.36	0.80	30.08	0.86	35.47	0.92	32.63	0.91
CS ² U (*)	29.13	0.79	29.95	0.84	-	-	-	-
HiImage	27.96	0.79	-	-	34.40	0.94	32.13	0.90
Onoise	27.67	0.79	29.81	0.87	33.68	0.90	31.83	0.89
OzU VGL	27.89	0.79	28.83	0.83	32.72	0.87	30.69	0.86
PixelJump	28.15	0.80	-	-	-	-	-	-
CVIP	27.85	0.80	29.50	0.86	-	-	-	-
CycleISP [47]	26.75	0.78	-	-	32.70	0.85	-	-
UPI [8]	26.90	0.78	-	-	-	-	-	-
U-Net Base	26.30	0.77	-	-	30.01	0.80	-	-

Tab. 1. AIM 2022 Reversed ISP Challenge Benchmark

Top Solutions



Model-Based Image Signal Processors via Learnable Dictionaries by Conde et al.



MiAlgo, Xiaomi Team Solution by Bai and Liu et al.

Visual Results



Ground-truth RGB-RAW Scene 1



NOAHTCV

MiAlgo

CASIA LCVG

HIT-IIL



SenseBrains

CS²U

HiImage

0noise

Samsung S7 Comparison



Ground-truth RGB-RAW Scene 5

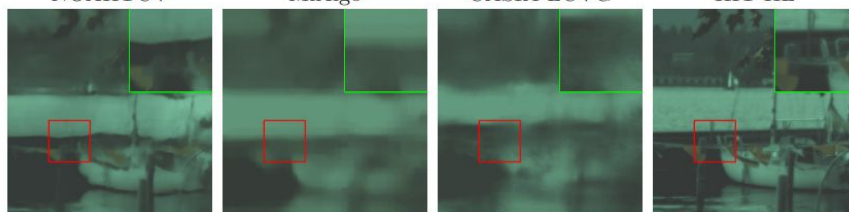


NOAHTCV

MiAlgo

CASIA LCVG

HIT-IIL



SenseBrains

OzU VGL

HiImage

0noise

Huawei P20 Comparison

Conclusions

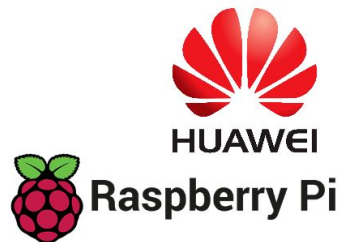
- Efficient solutions - Offline/Online use.
- Great RAW reconstruction results, even when learning from “non-aligned” image pairs. Model-agnostic methods.
- Approximate inverse functions of real-world ISPs is hard!

Team	Input	Epochs	ED	ENS	FR	# Params. (M)	Runtime (ms)
NOAHTCV	(504,504)	500	✗	✗	✓	5.6	25
MiAlgo	(3024,4032)	3000	✗	✗	✓	4.5	18
CASIA LCVG	(504,504)	300K it.	✓	✓	✓	464	219
CS ² U	(504,504)	276K it.	✓	✓	✓	105	1300
HIT-IIL	(1536,1536)	1000	✗	✗	✓	9/116	19818 (cpu)
SenseBrains	(504,504)	220	✗	✓	✓	69	50
PixelJump	(504,504)	400	✗	✓	✓	6.64	40
HiImage	(256, 256)	600	✗	✗	✓	11	200
OzU VGL	(496, 496)	52	✗	✗	✓	86	6
CVIP	(504,504)	75	✗	✗	✓	2.8	400
0noise	(504,504)	200	✗	✗	✓	0.17	19

Challenge Papers

- ***“Learned Reverse ISP with Soft Supervision”***
by Beiji Zou and Yue Zhang (Central South University)
- ***“RISPNet: A Network for Reversed Image Signal Processing”***
by Xiaoyi Dong, Yu Zhu, Chenghua Li, Peisong Wang Jian Cheng
(Institute of Automation, Chinese Academy of Sciences; MAICRO; AiRiA)
- ***“Reversing Image Signal Processors by Reverse Style Transferring”***
by Furkan Osman Kınlı, Barış Özcan and Furkan Kirac (Ozyegin University)
- ***“Overexposure Mask Fusion: Generalizable Reverse ISP Multi-step Refinement”*** by Jinha Kim (MIT), Jun Jiang and Jinwei Gu (SenseBrain)

Thank you!



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