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.)

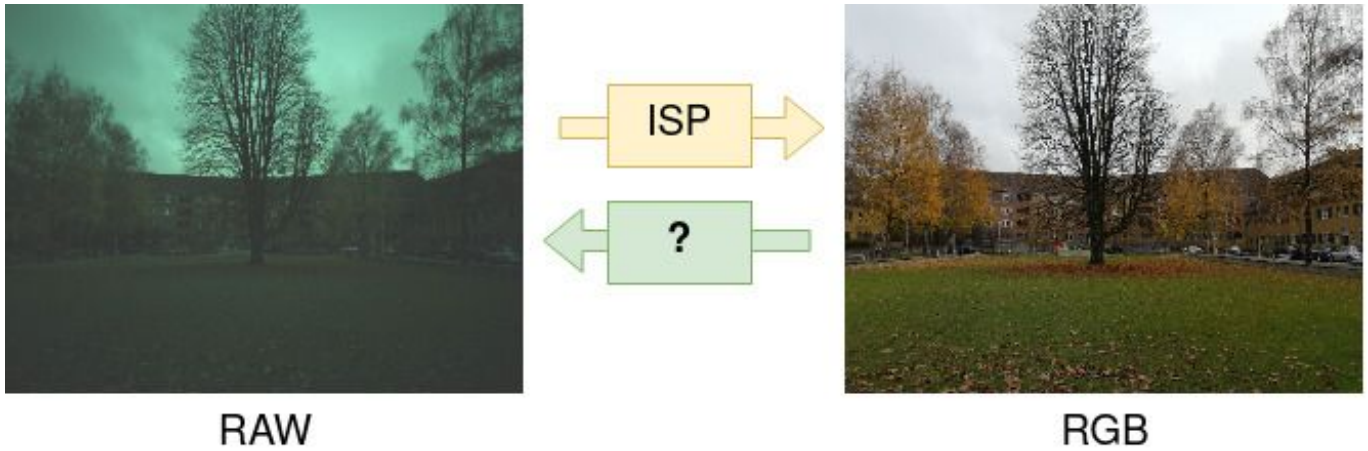
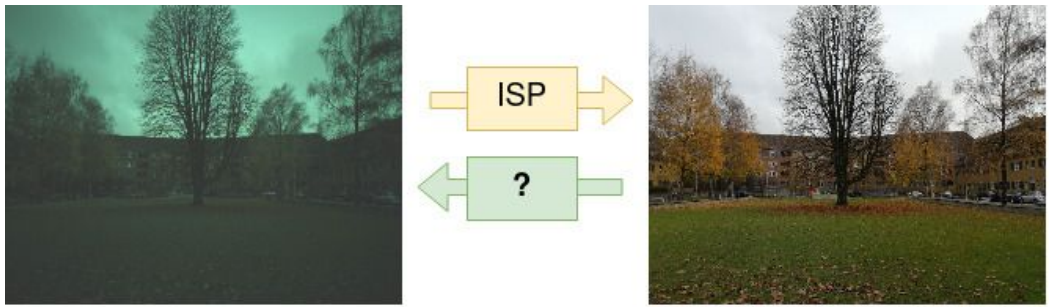


Fig. 1. Images Source “PyNet”, Andrey Ignatov, ETH

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

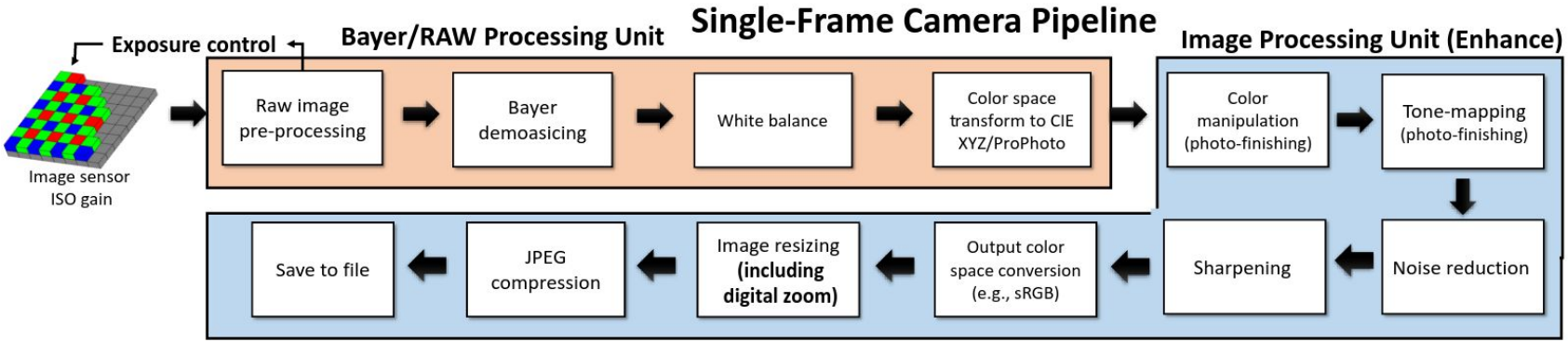


Fig. 2. Image from Delbracio et al. "Mobile Computational Photography: A Tour"

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

TRAIN

Huawei P20
Samsung S7

TEST

TEST 2

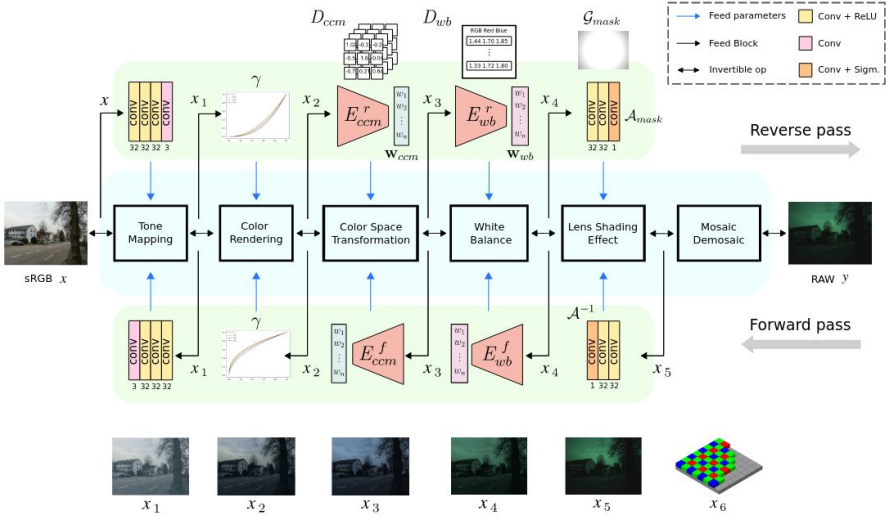
Huawei P20 Pro
Samsung S6*, S7, S9*

Benchmark

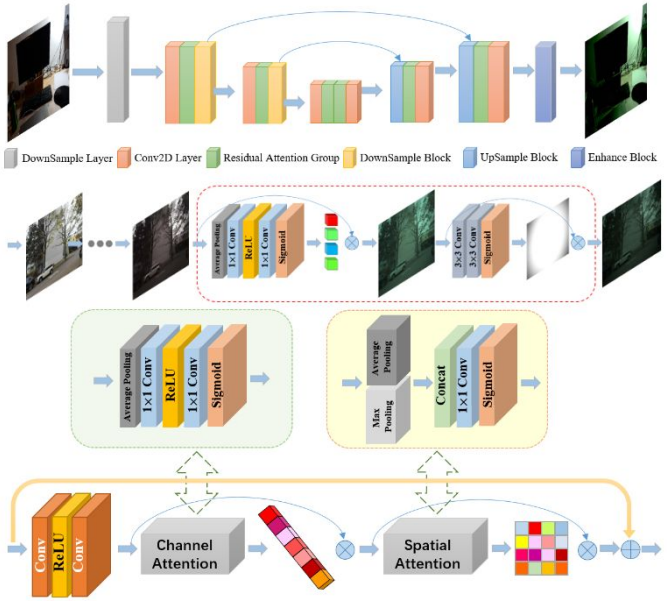
Team name	Track 1 (Samsung S7) Test1 PSNR ↑	Track 1 (Samsung S7) Test1 SSIM ↑	Track 1 (Samsung S7) Test2 PSNR ↑	Track 1 (Samsung S7) Test2 SSIM ↑	Track 2 (Huawei P20) Test1 PSNR ↑	Track 2 (Huawei P20) Test1 SSIM ↑	Track 2 (Huawei P20) Test2 PSNR ↑	Track 2 (Huawei P20) Test2 SSIM ↑
NOAHTCV	31.86	0.83	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
CSˆ2U (*)	29.13	0.79	29.95	0.84	-	-	-	-
HiImage	27.96	0.79	-	-	34.40	0.94	32.13	0.90
0noise	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.

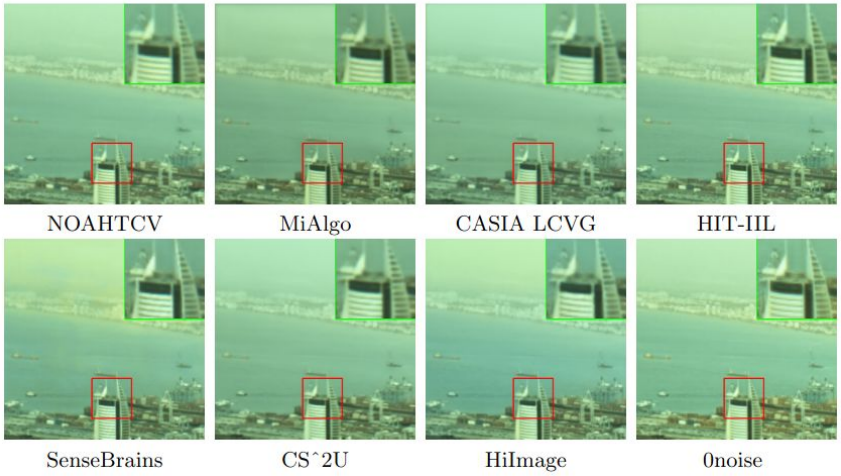


*MiAlgo, **End-to-End Deep Learning** Solution* by Bai and Liu et al. (*Xiaomi*)

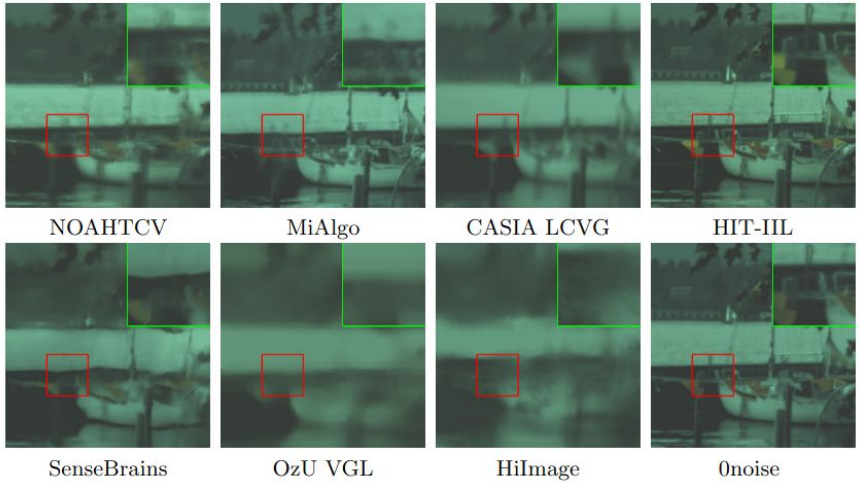
Visual Results

Ground-truth RGB-RAW Scene 1

Ground-truth RGB-RAW Scene 5



Samsung S7 Comparison



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
CSˆ2U	(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)

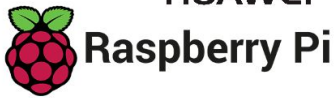
- ***"Reversing Image Signal Processors by Reverse Style Transferring"***
  by Furkan Osman Kınlı, Barış Özcan and Furkan Kirac (Ozyegin University)

- ***"Overexposure Mask Fusion: Generalizable Reverse ISP Multi-step Refinement"*** by Jinha Kim (MIT), Jun Jiang and Jinwei Gu (SenseBrain)

AIM 2022

ECCV TEL AVIV 2022

Thank you!



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