







Our Neural ISP + Pre-Trained Detector



- We propose a neural ISP, named GenISP, that can be trained under the guidance of a pre-trained object detector.
- This method eliminates the need of collecting paired low- and normallight images, and can generalize to unseen camera sensors and object detectors.
- We focus on machine perception rather than human perception.
- We contribute a dataset of 7K raw images collected using two cameras, Sony RX100 and Nikon D750, and bounding box annotations of people, *bicycles* and *cars*.
- The dataset is publicly available for task-based benchmarking of future low-light image restoration and low-light object detection.

### GenISP: Neural ISP for Low-Light Machine Cognition Yu-An Chen<sup>1</sup> Yu-Sheng Lin<sup>1</sup> Shusil Dangi<sup>3</sup> Kai He<sup>3</sup> Winston H. Hsu<sup>12</sup> Igor Morawski<sup>1</sup> <sup>1</sup> National Taiwan University <sup>2</sup> Mobile Drive Technology <sup>3</sup> Qualcomm Inc.





# GenISP

- A framework for training a neural ISP model for low-light image restoration and enhancement with an object detection dataset.
- Our minimal ISP pre-processing pipeline explicitly incorporates **Color Space Transformation (CST)** matrices available with raw files, instead of encoding CST implicitly.
- This helps **improving the capability to generalize** to unseen sensors and eliminate the need for re-training for each camera model.
- •We propose a two-stage color processing implemented by two imageto-parameter modules: **ConvWB** and **ConvCC**.
- The two modules introduce expert knowledge about ISP and improve the detection results both when CST matrices are available and unavailable.
- We validate in an extensive experimental study that once trained, the proposed model, GenISP, generalizes well to unseen datasets, camera sensors, brightness levels and object detectors.

### Results

Tested on	Input	Method	Trained on	Parameters (M)	GMACs	AP
	JPEG	Baseline (Traditional Minimal ISP)		-	-	22.2%
Our Nikon		SID [CVPR 2018]	SID Sony	7.7	562	22.9%
Our Mikon	RAW	Lamba and Mitra [CVPR 2021]	SID Sony	0.78	60	23.0%
		Our	Our Sony	0.12	<u>61</u>	24.5%

object detectors.

## **RAW Object Detection Dataset**

Dataset	Camera Sensor	# classes	# annotated images	# instances
Sony	Sony RX100 VII		3.2k	18.7k
Nikon	Nikon D750	3	4.0k	28.0k
In total	Sony & Nikon		7.2k	46.7k

# **Summary/Conclusion**

- $\succ$  We propose a minimal neural ISP, named GenISP, trained under the guidance of a pretrained object detector.
- $\succ$  GenISP can generalize to unseen camera sensors and object detectors.
- $\succ$  We contribute a raw low-light object detection (QR code) consisting of 7K images.



• Extensive experimental results to validate that GenISP generalizes well to unseen datasets, camera sensors, brightness levels and

