Dynamic Low-Light Image Enhancement for Object Detection via End-to-End Training

Haifeng Guo [1], *Tong Lu* [1,*], *Yirui Wu* [2]

[1] *Department of Computer Science and Technology, Nanjing University*
[2] *College of Computer and Information, Hohai University*

Speaker: Haifeng Guo

Motivation

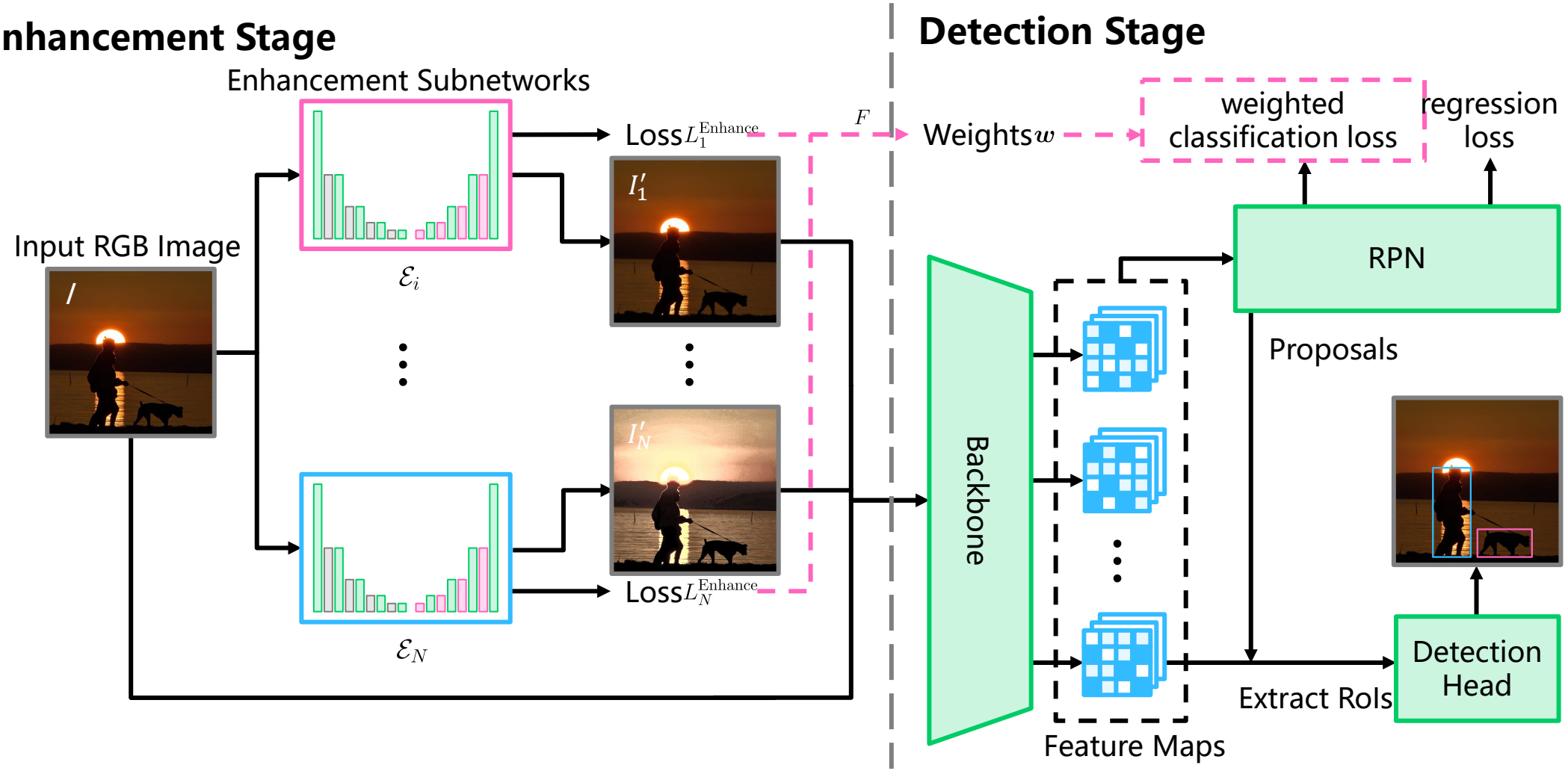
"enhancement first, detection later"

1. Methods which perform well on visual quality may not significantly improve the performance of the object detection task

2. The diversity of low-light environments makes it difficult for many enhancement methods to cover all situations

3. Quality problems in low-light images are interrelated

End-to-End Training Framework



End-to-End Training Framework

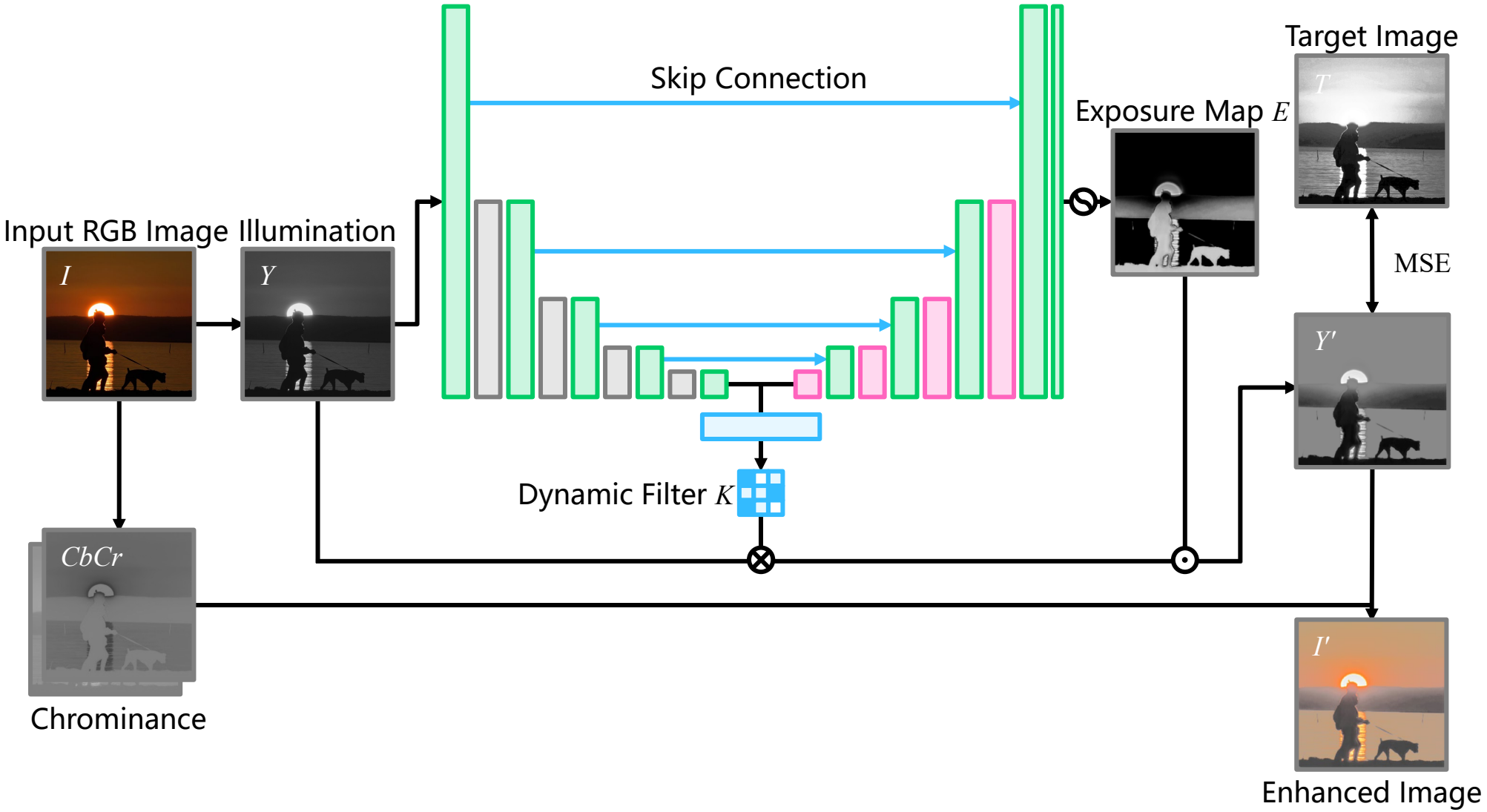
Enhancement Stage:

1. Generate sample-specific convolution kernels and exposure maps
2. Constrain the output of each enhancement subnetwork

Detection Stage:

1. Detect objects based on the enhanced images
2. Assign weights to the classification losses of RPN to improve the classification performance

Enhancement Network



Enhancement Network

Dynamic Filter Generator:

- Designed to simulate a specific enhancement method

Adaptive Exposure Module (AEM):

- Further activate areas in the image that are critical to improve detection performance

Experimental Results

Significantly improves detection performance on ExDark* dataset

	Enhanced Channel(s)*	AP	AP_{50}	AP_{75}	AP_S	AP_M	AP_L
RetinaNet	-	27.6	52.7	25.9	4.5	16.0	31.8
Faster R-CNN w FPN	-	30.4	61.0	27.3	4.3	**18.8**	35.2
Bilateral Filter (BF)	Y	27.8	57.6	23.2	2.2	17.3	32.0
Guided Filter (GF)	Y	25.8	53.9	21.7	1.9	14.6	30.2
Histogram Equalization (HE)	Y	28.4	57.4	25.6	2.6	17.6	32.7
Image Sharpening (IS)	Y	29.0	59.2	25.7	2.9	17.2	34.0
Loh *et al.*	Y	29.0	58.4	25.4	5.2	17.4	33.2
EnlightenGAN (EGAN)	Y	29.2	59.7	25.5	4.5	18.1	33.6
Loh *et al.*	RGB	27.5	55.8	23.3	4.3	16.6	31.6
EnlightenGAN (EGAN)	RGB	29.4	58.8	26.1	6.8	18.6	33.8
Proposed Method (based on Loh *et al.*'s & EGAN)	Y	31.6	61.7	28.8	**7.4**	18.5	36.3
Proposed Method (based on HE & IS)	Y	**32.1**	**62.1**	**29.9**	5.4	**18.8**	**36.4**

* Enhanced channel means which channel we apply enhancement methods. Y denotes the illumination component in YCbCr color space and RGB indicates all the channels in RGB color space.

* Y. P. Loh and C. S. Chan, *Getting to Know Low-Light Images with the Exclusively Dark Dataset*, Computer Vision and Image Understanding, vol. 178, pp. 30–42, 2019.

Summary

- Propose a novel framework for the end-to-end training of low-light image enhancement and object detection

- Introduce dynamic filter networks and adaptive exposure module in enhancement stage

THANKS