A. Implementation details

Our model consists of three γCRG and each CRG has five γCRB. All the convolutional layers are implemented with a kernel size of 3, a stride of 1, and padding of 1. All the channels of intermediate feature maps are maintained as 48, and only input and output convolution of CRG changes the channels as 3 to 48 and 48 to 3, respectively. We randomly crop 30 patches of 100×100 pixels from each training image. λ_1, λ_2 for loss function are set to 1. The model is trained for 100 epochs. We use Adam [14] optimizer with default parameters. The learning rate is set as 0.001 at first and is halved at [20, 40, 60, 90] epochs. Please refer to the code for more detailed settings. We train our model on NVIDIA Titan Xp, V, and RTX A6000 GPUs.

B. Kernel functions

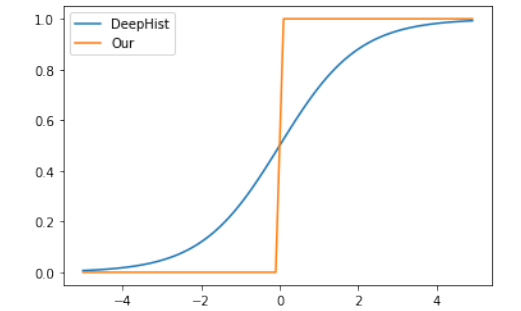
We hypothesized that using the derivative of a step-like function as a kernel will be more suitable for estimation of color histograms. Figure 8 shows the graphs of our step-like function, the logistic regression function used by [2], and their corresponding derivatives. Along with our motivation, our estimation yields much smaller estimation errors (Figure 4).

C. Quantitative comparison on LOL* dataset

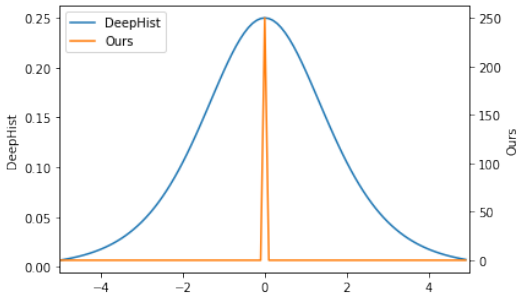
LOL* [29] denotes the original dataset with 15 test samples and 485 training images. For a fair comparison, we experimented with more test samples than the original LOL* dataset (Table 1). Table 3 shows the quantitative results with the original 15 test images. Similarly, in this experiment, the proposed CCM achieves the best performance.

D. More qualitative comparison results

Figures 9-11 illustrate the qualitative results of the CCM and the state-of-the-art comparison methods on the real-world dataset. Figures 12-14 show the qualitative results on the synthetic dataset. The proposed CCM achieved superior perceptual quality while recovering the original illumination and color distribution.



(a) $s(z)$

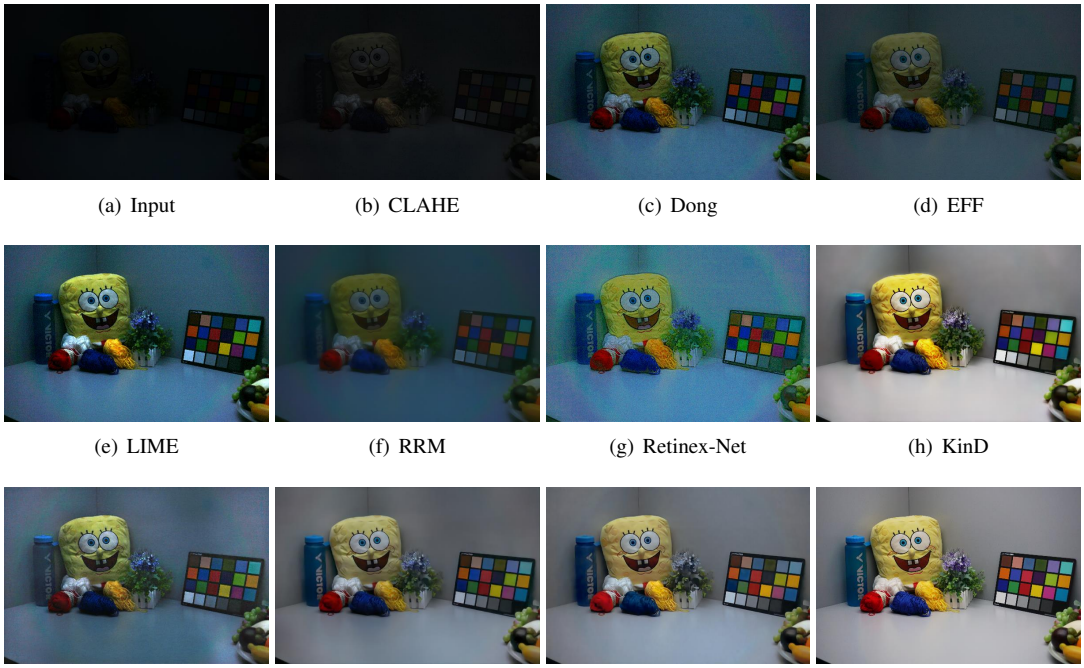


(b) $\kappa(z)$

Figure 8. $\kappa(z)$ and $s(z)$ for the differentiable histogram estimation.

	CLAHE	BPDHE	Dong	SRIE	DHECE	MF	EFF	CRM
PSNR	9.46	12.1	17.38	12.21	17.97	18.03	14.91	18.08
SSIM	0.3854	0.3559	0.5895	0.5793	0.5187	0.6292	0.6866	0.7318
WD	2301.4	1844.8	843.2	1370.2	1309.2	808.8	1578.9	3073.9
	LIME	JED	RRM	Retinex-Net	KinD	EG	DRBN	**CCM**
PSNR	18.10	14.17	14.24	17.73	21.56	19.61	<u>22.27</u>	**26.97**
SSIM	0.6007	0.7127	0.7150	0.7742	0.8870	0.7271	<u>0.8903</u>	**0.9405**
WD	864.6	1591.7	1555.8	1143.9	704.8	781.8	<u>564.4</u>	**463.6**

Table 3. The quantitative comparison results with other state-of-the-art methods on the LOL datasets[29]. The proposed method achieved the new state-of-the-art performance on the LOL datasets. **Bold** and <u>underline</u> indicate the best and the second best score, respectively.

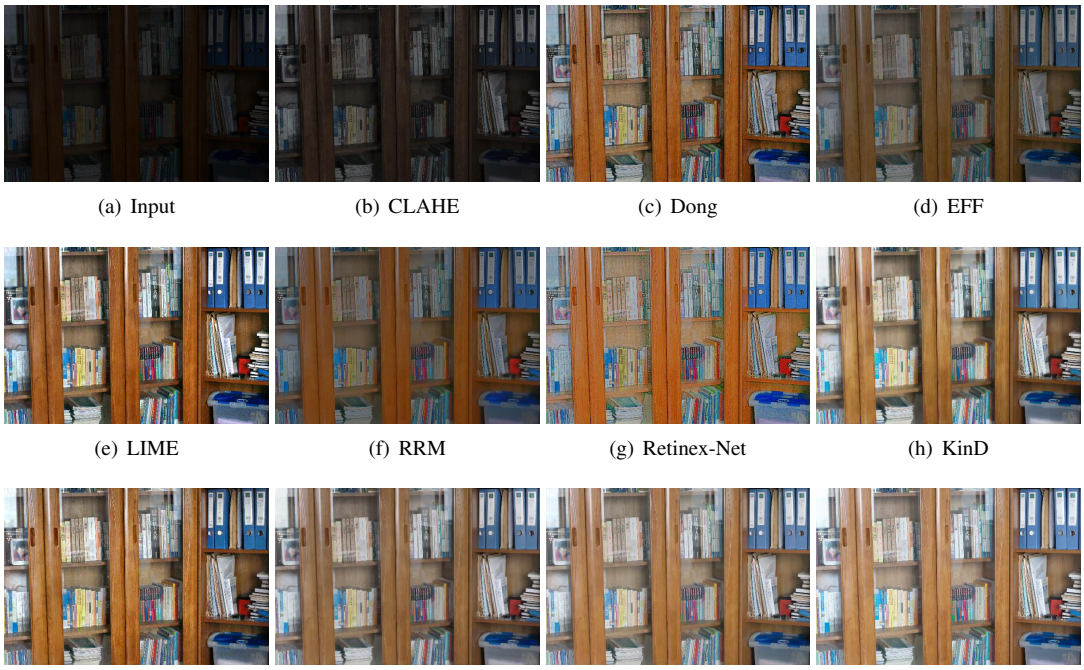


(a) Input (b) CLAHE (c) Dong (d) EFF

(e) LIME (f) RRM (g) Retinex-Net (h) KinD

(i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 9. Qualitative evaluation results on the real-world dataset [29].

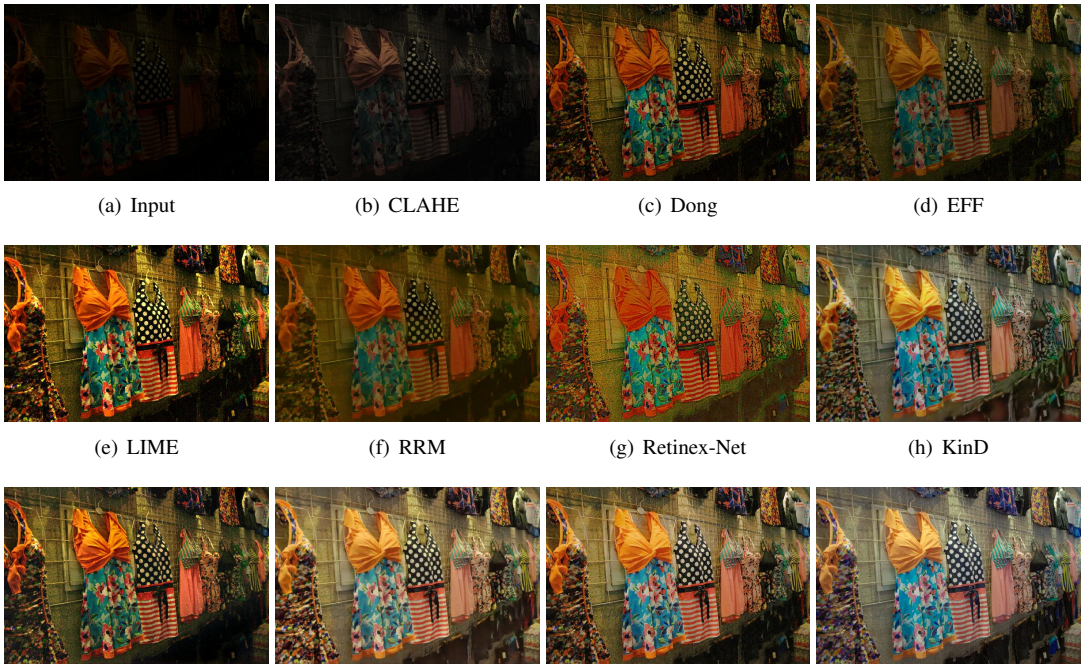


(a) Input (b) CLAHE (c) Dong (d) EFF

(e) LIME (f) RRM (g) Retinex-Net (h) KinD

(i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 10. Qualitative evaluation results on the real-world dataset [29].



(a) Input (b) CLAHE (c) Dong (d) EFF

(e) LIME (f) RRM (g) Retinex-Net (h) KinD

(i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 11. Qualitative evaluation results on the real-world dataset [29].

(a) Input (b) CLAHE (c) Dong (d) EFF (e) LIME (f) RRM

(g) Retinex-Net (h) KinD (i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 12. Qualitative evaluation results on the synthetic dataset [29].

(a) Input (b) CLAHE (c) Dong (d) EFF (e) LIME (f) RRM

(g) Retinex-Net (h) KinD (i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 13. Qualitative evaluation results on the synthetic dataset [29].

(a) Input (b) CLAHE (c) Dong (d) EFF (e) LIME (f) RRM

(g) Retinex-Net (h) KinD (i) EG (j) DRBN (k) **CCM** (l) Ground-truth

Figure 14. Qualitative evaluation results on the synthetic dataset [29].