ISCAS 中国科学院软件研究所学术年会'2023 暨计算机科学国家重点实验室开放周
学术论文

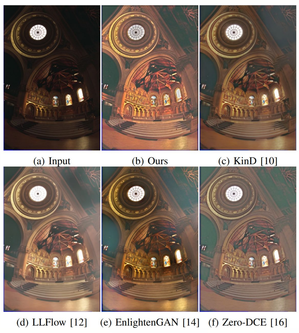
利用 Retinex 分解和混合曲线估计进行零样本自适应低光增强

Zero-shot Adaptive Low Light Enhancement with Retinex Decomposition and Hybrid Curve Estimation

夏玉萍，徐帆江，郑权 Email: {xiayuping2022, fanjiang, zhengquan} @iscas.ac.cn
联系人：夏玉萍 联系电话：18298239479

Motivation

- Due to the suboptimal environment and equipment, the obtained low-light images often have problems such as low brightness, insufficient contrast, and noise, which also affect the performance of high-level vision tasks. **Low-light image enhancement** can improve the visual quality of images and improve the accuracy of high-level vision tasks.
- However, existing methods often do not consider **noise** or **uneven illumination** in low-light images.

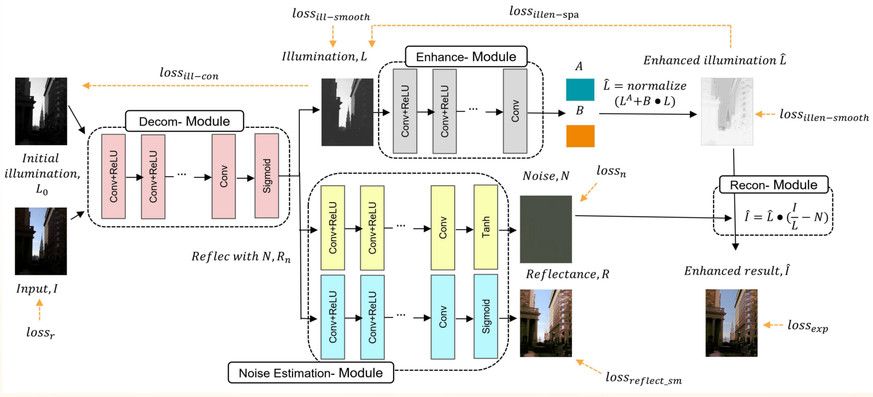


(a) Input (b) Ours (c) KinD [10]

(d) LLFlow [12] (e) EnlightenGAN [14] (f) Zero-DCE [16]

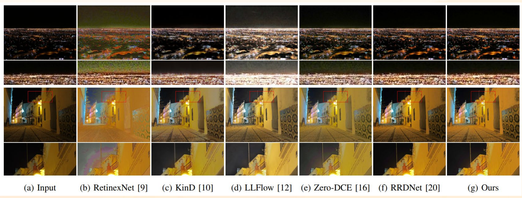
Method

- Our method mainly consists of four modules: **(1) retinex decomposition, (2) noise estimation, (3) illumination enhancement and (4) reconstruction.**
- **Retinex decomposition:** This module decomposes the low-light image into illumination and reflectance.
- **Noise estimation:** We estimate the noise in the reflectance component, and then remove it to obtain a clean reflectance component.
- **Illumination enhancement:** This module uses the hybrid curve to enhance the illumination.
- **Reconstruction:** This module is the product of the denoised reflectance and the enhanced illumination.

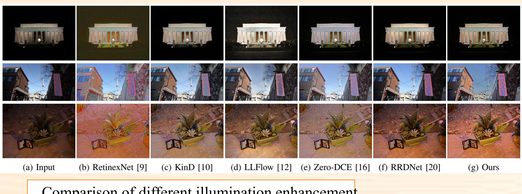


Evaluation & Results

- We conduct ablation experiments to validate the illumination adjustment module.
- We perform ablation experiments on the loss functions.
- Extensive experiments demonstrate that the proposed method outperforms state-of-the-art methods qualitatively and quantitatively on the popular public datasets.



(a) Input (b) RetinexNet [9] (c) KinD [10] (d) LLFlow [12] (e) Zero-DCE [16] (f) RRDNet [20] (g) Ours



(a) Input (b) RetinexNet [9] (c) KinD [10] (d) LLFlow [12] (e) Zero-DCE [16] (f) RRDNet [20] (g) Ours

Comparison of the effects of different loss functions on NIQE the best result is in bold.

Settings	Average
w.o. $loss_{ill-con}$	nan
w.o. $loss_{ill-smooth}$	4.62
w.o. $loss_n$	3.77
w.o. $loss_{reflect\_sm}$	3.61
w.o. $loss_r$	nan
w.o. $loss_{illen-smooth}$	3.61
w.o. $loss_{illen-spa}$	3.67
w.o. $loss_{exp}$	4.32
Ours	**3.59**

Comparison of our and other methods on NIQE, the best results are in bold.

Method	LIME	DICM	NPE	MEF	Average
RetinexNet [9]	4.59	4.46	4.59	4.41	4.51
KinD [10]	4.40	4.21	4.12	4.05	4.19
LLFlow [12]	4.35	4.25	4.32	4.26	4.29
ZeroDCE [16]	3.80	3.56	**3.94**	3.30	3.65
RRDNet [20]	3.95	3.60	4.07	3.47	3.77
Ours	**3.65**	**3.50**	3.96	**3.26**	**3.59**

Comparison of different illumination enhancement modules on NIQE, the best results are in bold.

Settings	LIME	DICM	NPE	MEF	Average
Only Gamma	3.74	3.51	4.01	**3.26**	3.63
Only Liner	3.68	3.51	3.96	3.31	3.61
S-curve [29]	3.77	3.55	**3.94**	3.36	3.65
Ours	**3.65**	**3.50**	3.96	**3.26**	**3.59**