Enhancement of Videos Captured in Low-Light Conditions

Swaroop U A (01FE20BEC293), Ankit Raichur (01FE20BCS317), Vinod Patil (01FE20BEC143), Allabakash G (01FE20BEC261)

Under the Guidance of
Ujwala Patil and Uma Mudenagudi

KLE Technological University, Vidyanagar, Hubballi-580031, Karnataka, India

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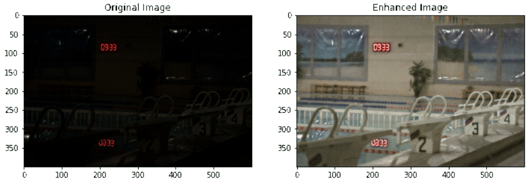
Introduction: Enhancement of Videos Captured in Low-light Conditions

- Videos captured under poor illumination conditions often exhibit poor characteristics which limits the performance of various machine vision.
- To counter this problem and enhance the videos which are captured in low-light conditions, we work on this problem statement.



Motivation for Enhancement of Videos Captured in Low-light Conditions

Figure: Autonomous vehicle's night driving scenario

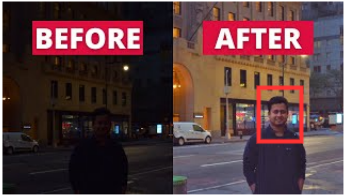


Figure: face detection in low light

- The above figure illustrates how difficult it is for autonomous vehicles to recognize lanes on the road, also how difficult it can be to detect objects and faces in low-light conditions.
- The low dynamic range and high noise levels of videos will impact how well computer vision algorithms work.
- To make computer vision algorithms reliable in low-light situations, Enhancing low-light footage is essential for making videos more visible.

LLCNN: A CNN for Lowlight Image Enhancement (Li Tao et al., CVPR 2017) [5]

They have used simple convolution network with residual network.

Inferences :

- Using multiple kernels
- Adaptively increases brightness and contrast

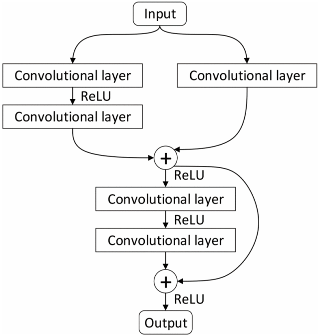


Figure: CNN architecture

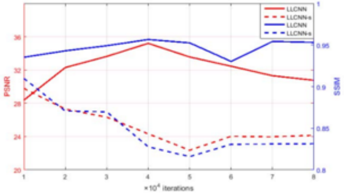


Figure: LLCNN and LLCNN-s PSNR and SSIM

Zero-Reference Deep Curve Estimation for Low-Light Image Enhancement (Chunle Guo et al., CVPR 2020) [2]

Unsupervised learning technique using unpaired data.

Inferences :

- Network decreases the danger of overfitting
- Creates an image-specific curve

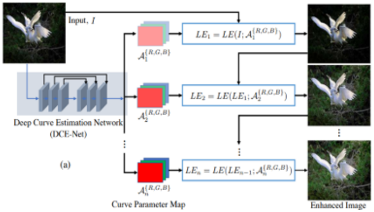


Figure: Framework of Zero-DCE

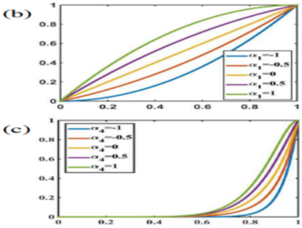


Figure: LE-curves with different adjustment parameters

From Fidelity to Perceptual Quality: A Semi-Supervised Approach for Low-Light Image Enhancement (Wenhan Yang et al., CVPR 2020) [7]

A semi-supervised learning approach using DRBN.

Interference :

- Deep recursive band representation
- Connect fully-supervised and unsupervised frameworks

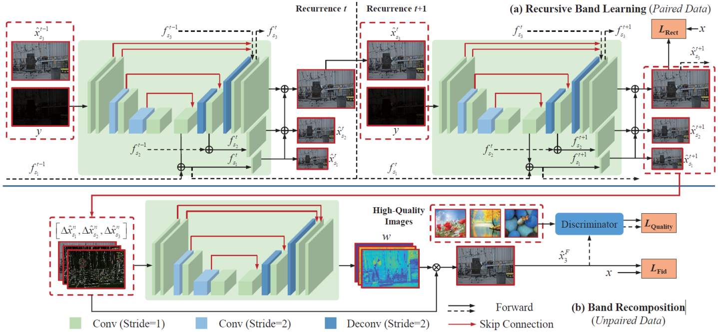


Figure: Framework of Fidelity to Perceptual Quality

Extremely Low-light Image Enhancement with Scene Text Restoration (Po-Hao Hsu et al., CVPR 2022)[3]

Simple U-NET architecture used to restore the text to complete the pipeline

Inference :

- Improving both the low-light image quality
- Annotate the texts in the real low-light dataset .

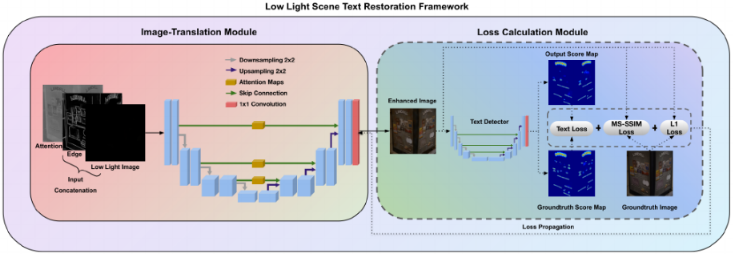


Figure: Framework of Low-light Image Enhancement with Scene Text Restoration

Problem Statement and Objectives

Problem Statement

To propose a learning-based technique for Enhancement of videos captured in Low-light conditions.

Objectives

- To Perform Extensive Literature Survey on Available SOTA Methods for Low-light Video Enhancement.
- To develop a learning-based algorithm for enhancement of video captured in low light conditions.
- To demonstrate the results of the proposed architecture using benchmark dataset in comparison with SOTA methods.

- Training Images : 2000
- Testing Images : 64
- The dataset is captured with multiple exposure levels

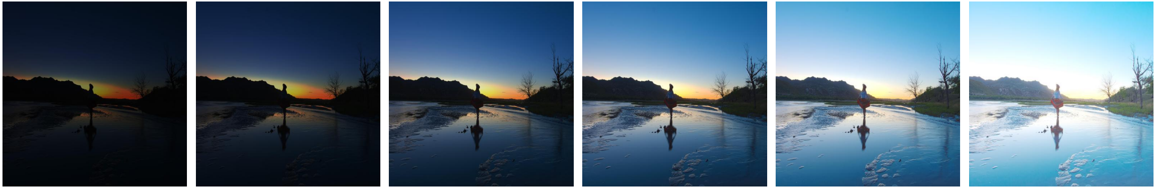


Figure: The above images depict low-contrast images with different exposure levels

Dataset Analysis: LOL [6]

- Training Images : 485
- Testing Images : 15

Figure: First row depicts low lit images, second row depicts ground truth images

Dataset Analysis: NTIRE [1]

- Training Images : 1220
- Testing Images : 50

Figure: First row depicts NTIRE input images, second row depicts NTIRE ground truth images

Existing Architecture of Zero-DCE

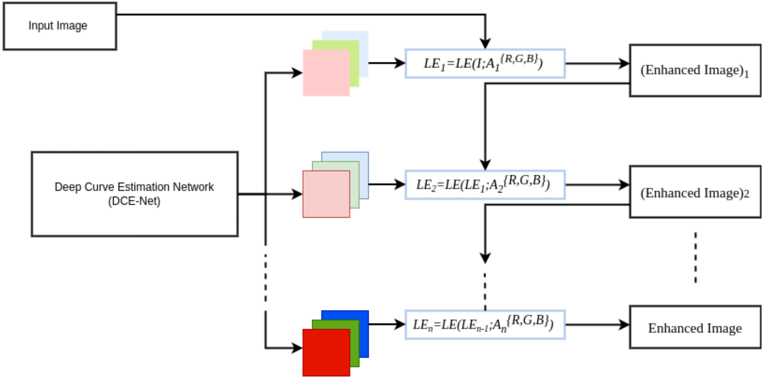


Figure: Framework of Zero-DCE

Proposed Block diagram: LLVE-Net

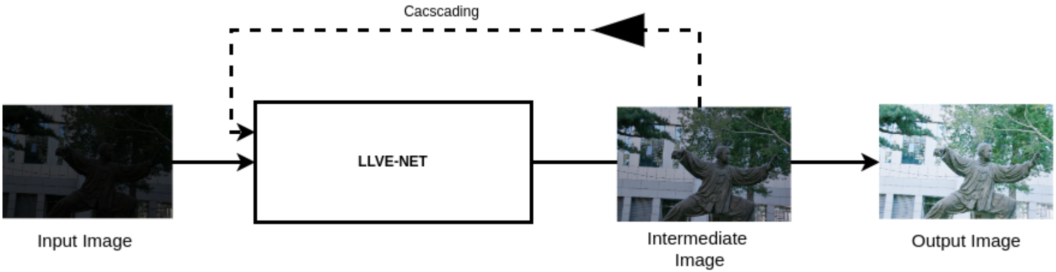


Figure: Block diagram of LLVE-Net

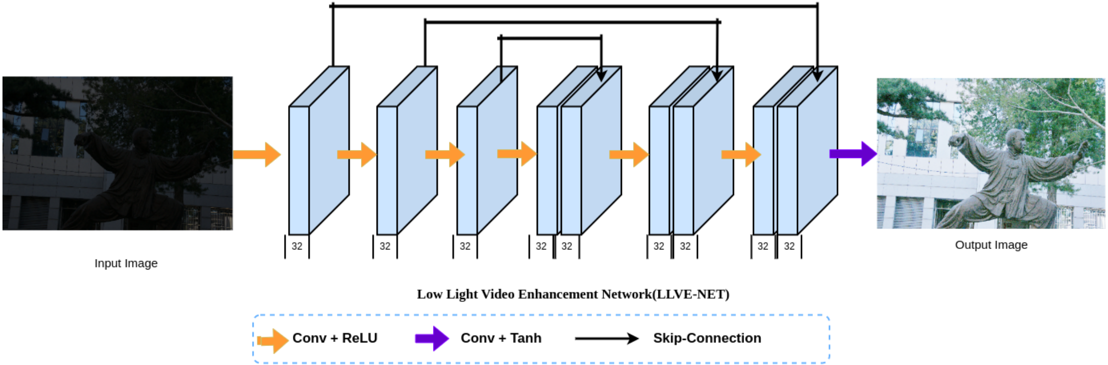


Figure: Architecture of LLVE-Net

Results of Zero-DCE

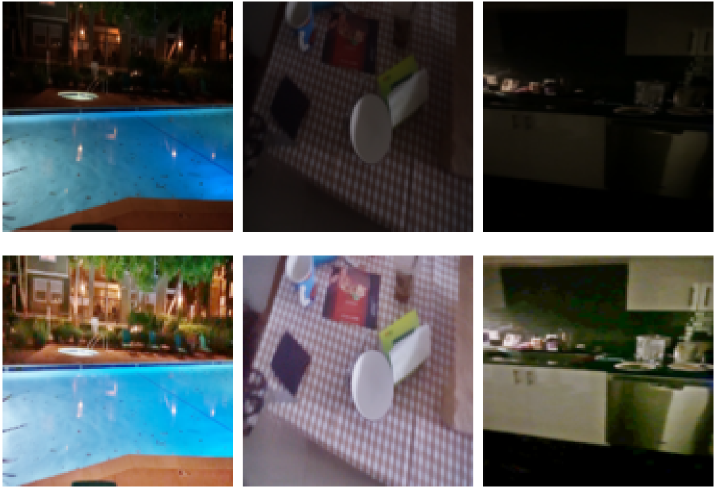


Figure: First row depicts input images of SICE dataset [4], second row depicts enhanced output images

Results of LLVE-Net

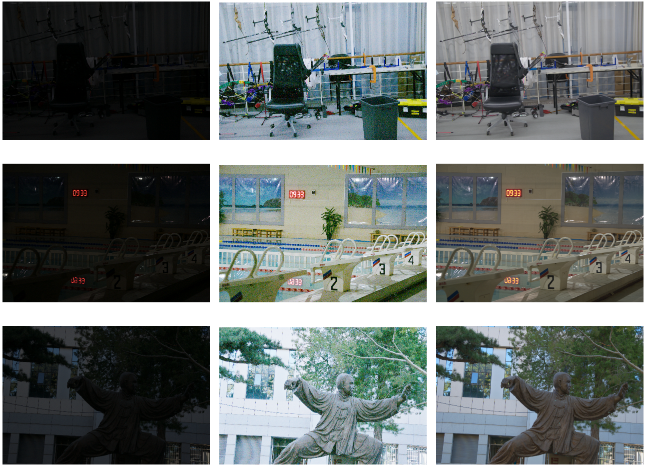


Figure: First column depicts low lit input images, the second column depicts output enhanced images, the third column depicts ground truth images

Results of Zero-DCE using NTIRE dataset

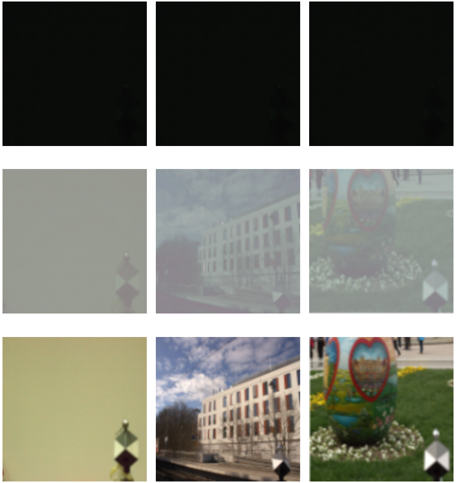


Figure: First row depicts NTIRE input images, the second row depicts output enhanced images, the third row depicts NTIRE ground truth images

Comparison of Evaluation Metrics

PSNR and SSIM Comparison		
MODEL	**PSNR**	**SSIM**
Zero-DCE	16.57	0.59
Zero-DCE(FEATURE LOSS)	19.64	0.59
LLVE-NET	**27.4**	**0.7**
Zero-DCE(NTIRE)	10.22	0.37

Figure: PSNR and SSIM Comparison

*Typical values for the PSNR in lossy image and video compression are between 30 and 50 dB and maximum value of SSIM is 1.

Obervations

- The output images of LLVE-Net consists of noise.
- The enhanced video generated from LLVE-Net consists of jitter.

Figure: Output image consisting noise

Future Work

- To develop a denoising algorithm as a plugin to our proposed architecture(LLVE-Net).
- To introduce a stopping criteria for the cascaded network.
- To introduce a method to reduce video jitter from the generated video.

Thank You

[1] Egor Ershov et al. "The Cube++ Illumination Estimation Dataset". In: *IEEE Access* 8 (2020), pp. 227511–227527.

[2] Chunle Guo et al. "Zero-reference deep curve estimation for low-light image enhancement". In: *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2020, pp. 1780–1789.

[3] Po-Hao Hsu et al. "Extremely low-light image enhancement with scene text restoration". In: *2022 26th International Conference on Pattern Recognition (ICPR)*. IEEE. 2022, pp. 317–323.

[4] Shahidul Islam Khan and Abu Sayed Md Latiful Hoque. "SICE: an improved missing data imputation technique". English. In: *Journal of Big Data* 7 (June 2020). Article. ISSN: 21961115. URL: https://link.gale.com/apps/doc/A626539838/AONE?u=anon~94a45a71&sid=googleScholar&xid=eebe0390.

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[5] Li Tao et al. "LLCNN: A convolutional neural network for low-light image enhancement". In: Dec. 2017, pp. 1–4. DOI: 10.1109/VCIP.2017.8305143.

[6] Chen Wei et al. "Deep retinex decomposition for low-light enhancement". In: *arXiv preprint arXiv:1808.04560* (2018).

[7] Wenhan Yang et al. "From fidelity to perceptual quality: A semi-supervised approach for low-light image enhancement". In: *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2020, pp. 3063–3072.