



UNIVERSITAS
GADJAH MADA

Tugas 1

Computer Vision Lanjut

“An Implementation for Image Enhancement in Low-light Images”

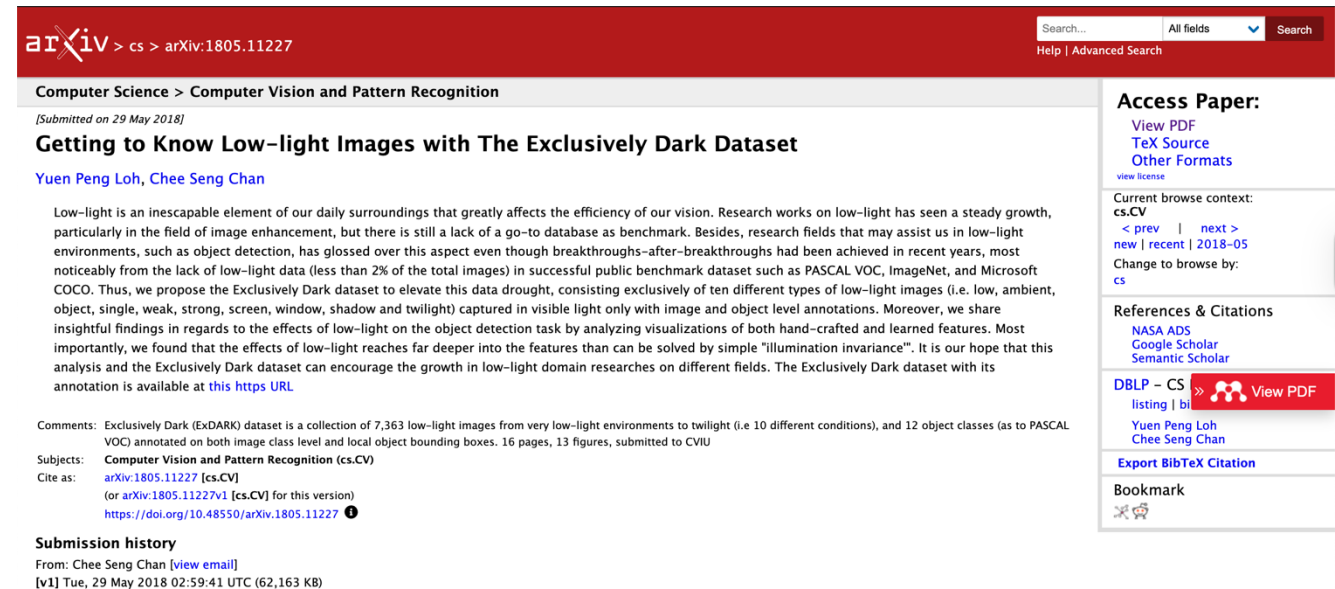
Herlina

25/571614/SPA/01154

Doktor Ilmu Komputer

Dataset Resources

- The dataset utilized in this task was acquired from Yuen Peng Loh and Chee Seng Chan. The relevant publication can be found at: <https://arxiv.org/abs/1805.11227>.
- This dataset pertains to object detection within low-light environments and image enhancement.
- This task utilizes only **five sample images** to demonstrate the effectiveness of the image enhancement in low-light images.
- Five sample images were randomly selected from the car class label, choosing 5 out of 638 images.



arXiv > cs > arXiv:1805.11227

Computer Science > Computer Vision and Pattern Recognition

[Submitted on 29 May 2018]

Getting to Know Low-light Images with The Exclusively Dark Dataset

Yuen Peng Loh, Chee Seng Chan

Low-light is an inescapable element of our daily surroundings that greatly affects the efficiency of our vision. Research works on low-light has seen a steady growth, particularly in the field of image enhancement, but there is still a lack of a go-to database as benchmark. Besides, research fields that may assist us in low-light environments, such as object detection, has glossed over this aspect even though breakthroughs—after-breakthroughs had been achieved in recent years, most noticeably from the lack of low-light data (less than 2% of the total images) in successful public benchmark dataset such as PASCAL VOC, ImageNet, and Microsoft COCO. Thus, we propose the Exclusively Dark dataset to elevate this data drought, consisting exclusively of ten different types of low-light images (i.e. low, ambient, object, single, weak, strong, screen, window, shadow and twilight) captured in visible light only with image and object level annotations. Moreover, we share insightful findings in regards to the effects of low-light on the object detection task by analyzing visualizations of both hand-crafted and learned features. Most importantly, we found that the effects of low-light reaches far deeper into the features than can be solved by simple "illumination invariance". It is our hope that this analysis and the Exclusively Dark dataset can encourage the growth in low-light domain researches on different fields. The Exclusively Dark dataset with its annotation is available at [this https URL](https://github.com/yuenpengloh/exclusively-dark).

Comments: Exclusively Dark (ExDARK) dataset is a collection of 7,363 low-light images from very low-light environments to twilight (i.e 10 different conditions), and 12 object classes (as to PASCAL VOC) annotated on both image class level and local object bounding boxes. 16 pages, 13 figures, submitted to CVIU

Subjects: Computer Vision and Pattern Recognition (cs.CV)

Cite as: [arXiv:1805.11227](https://arxiv.org/abs/1805.11227) [cs.CV]
(or [arXiv:1805.11227v1](https://arxiv.org/abs/1805.11227v1) [cs.CV] for this version)
<https://doi.org/10.48550/arXiv.1805.11227>

Submission history

From: Chee Seng Chan [[view email](#)]
[v1] Tue, 29 May 2018 02:59:41 UTC (62,163 KB)

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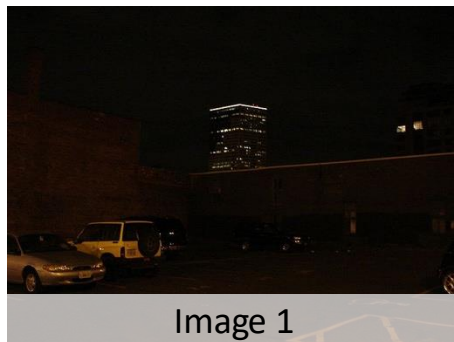
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[Yuen Peng Loh](#)
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CLAHE Implementation (Image 1)

Asli



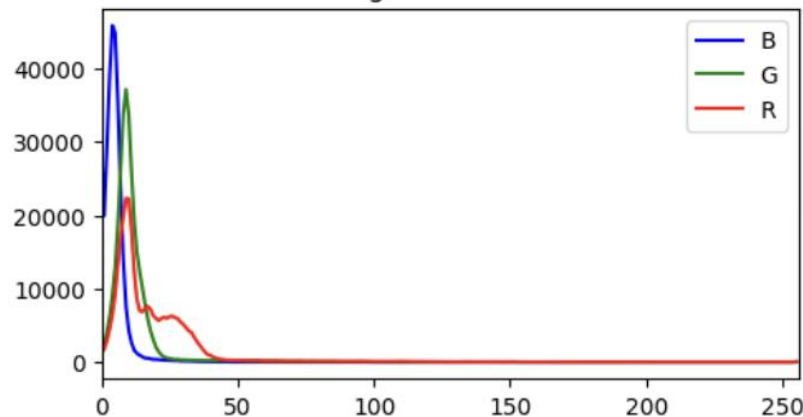
CLAHE (L-Channel)



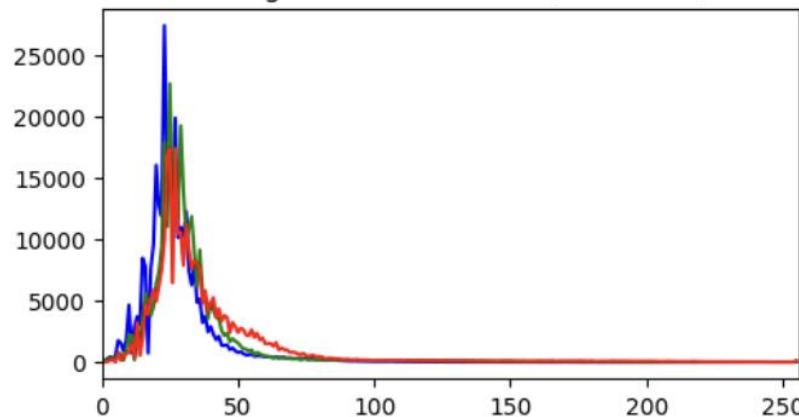
CLAHE (All Channels)



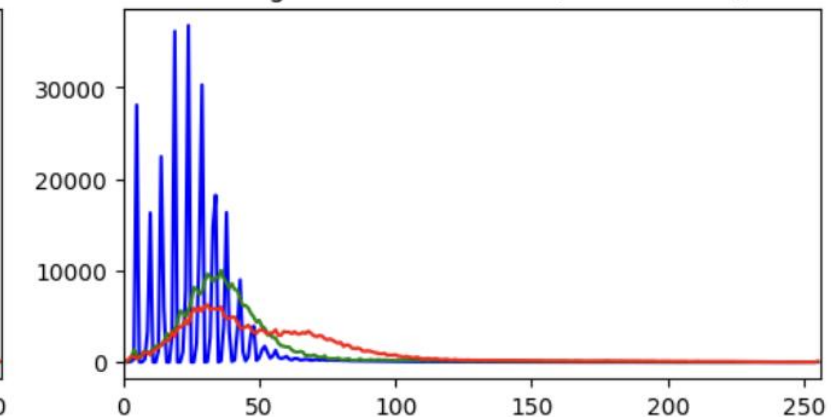
Histogram RGB — Asli



Histogram RGB — CLAHE (L-Channel)



Histogram RGB — CLAHE (All Channels)



- Many details lost in dark areas

- Building and car details start to appear
- Colors remain neutral

- Colors turn reddish
- Noise is amplified, especially on walls and sky

CLAHE Implementation (Image 2)

Asli



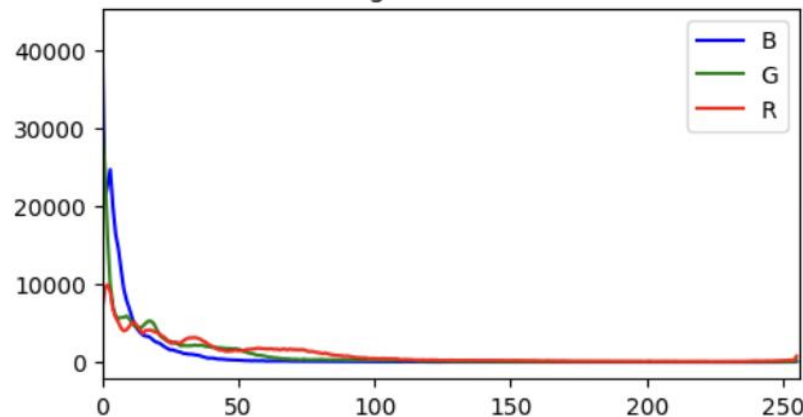
CLAHE (L-Channel)



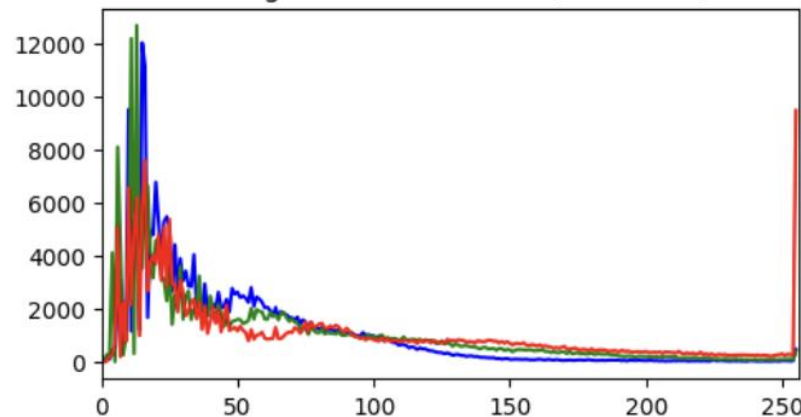
CLAHE (All Channels)



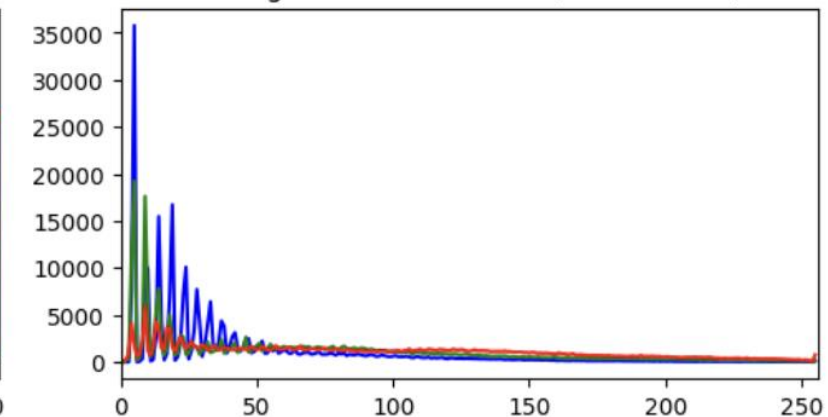
Histogram RGB — Asli



Histogram RGB — CLAHE (L-Channel)



Histogram RGB — CLAHE (All Channels)



- Lantern colors visible, but alley remains dark

- Natural colors, alley and car details become visible

- Colors are over-saturated
- Scene becomes overly vivid

CLAHE Implementation (Image 3)

Asli



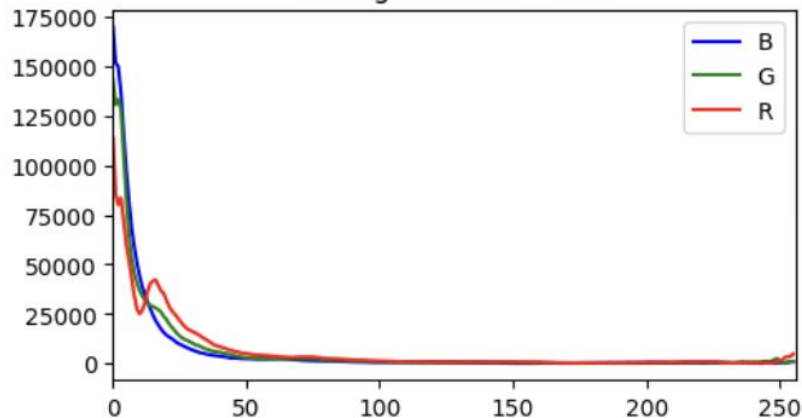
CLAHE (L-Channel)



CLAHE (All Channels)

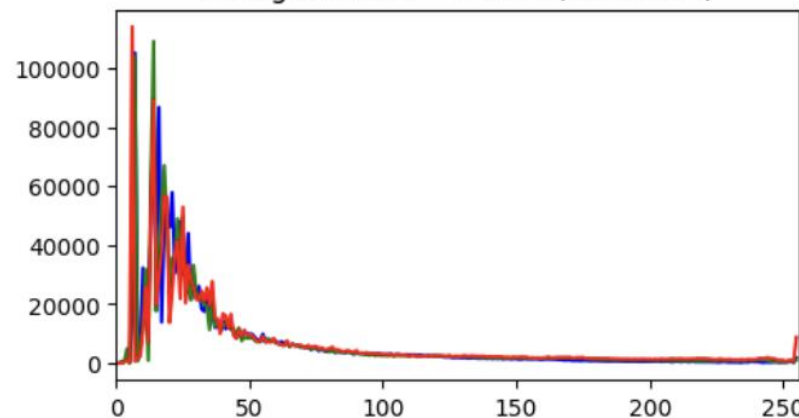


Histogram RGB — Asli



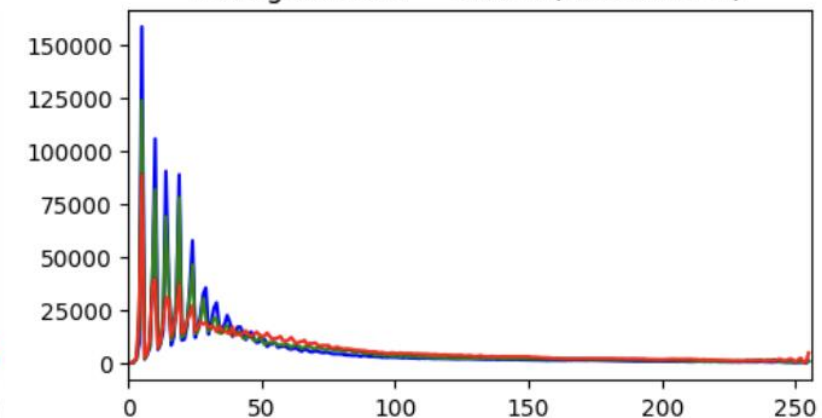
- Storefront and road too dark

Histogram RGB — CLAHE (L-Channel)



- Balanced result, colors look realistic

Histogram RGB — CLAHE (All Channels)



- Bright areas get overexposed
- Contrast is too high

CLAHE Implementation (Image 4)

Asli



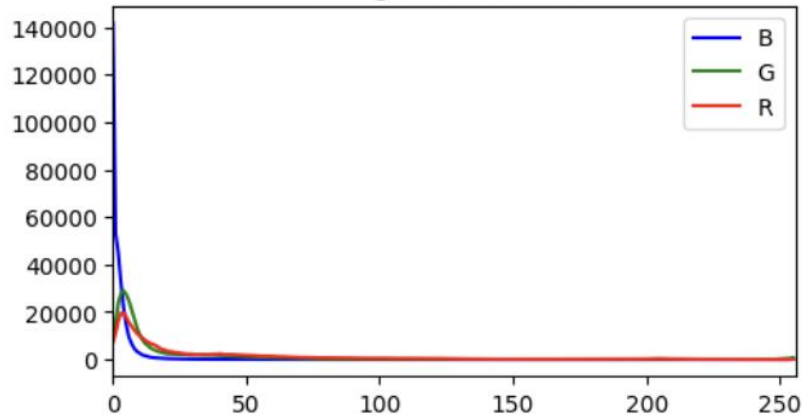
CLAHE (L-Channel)



CLAHE (All Channels)

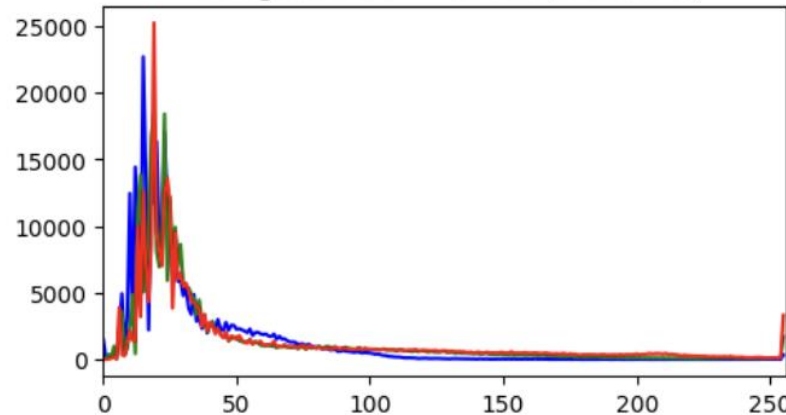


Histogram RGB — Asli



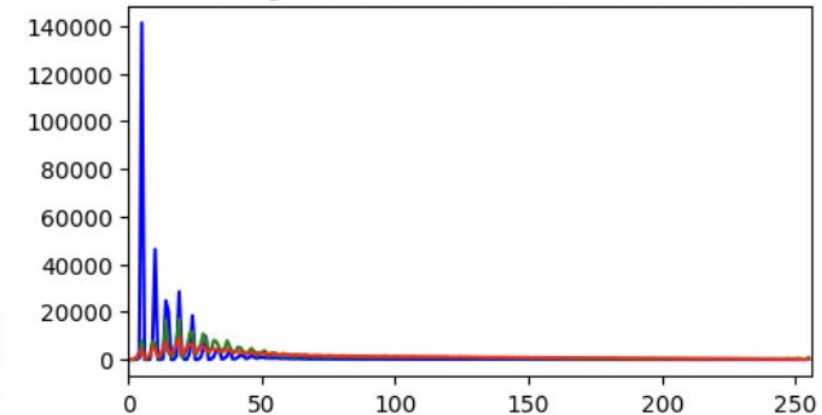
- Scene mostly dark

Histogram RGB — CLAHE (L-Channel)



- Street is more visible, trees start to show detail

Histogram RGB — CLAHE (All Channels)



- Grass/leaves colors look unnatural
- Noise significantly increased

CLAHE Implementation (Image 5)

Asli



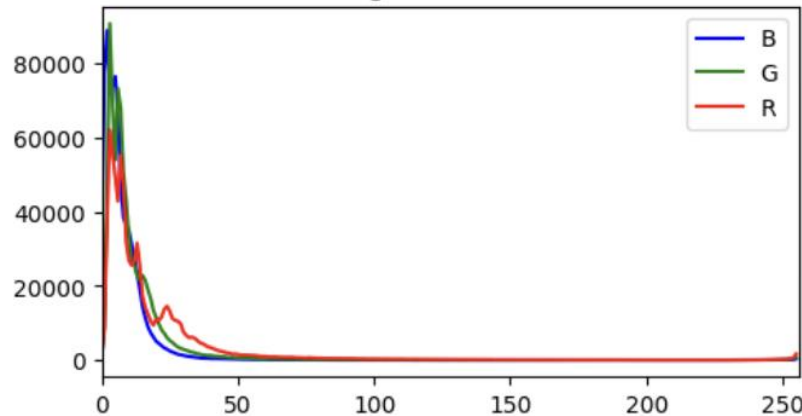
CLAHE (L-Channel)



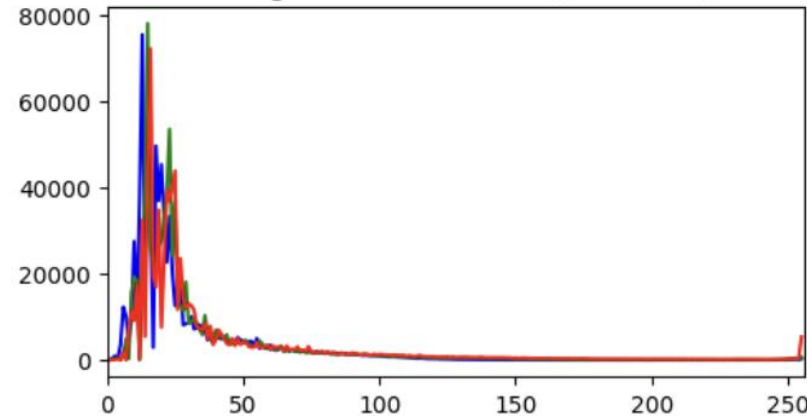
CLAHE (All Channels)



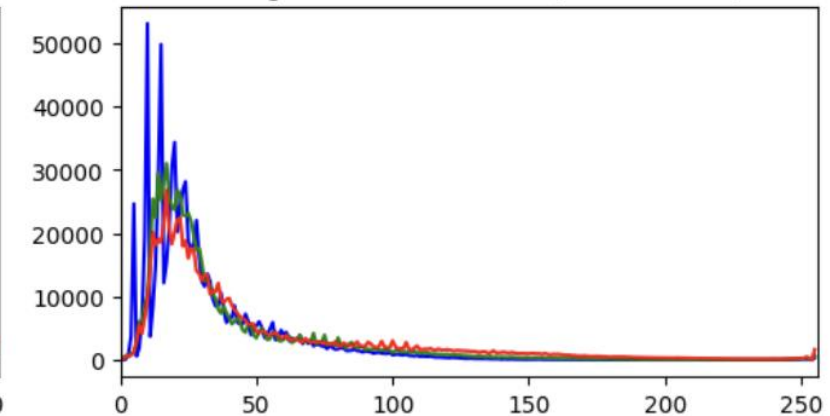
Histogram RGB — Asli



Histogram RGB — CLAHE (L-Channel)



Histogram RGB — CLAHE (All Channels)



- Only lamp posts clearly visible

- Street and cars become visible
- Noise remains manageable

- Scene becomes overly warm
- Noise more apparent

CLAHE Implementation Result Analysis

- **CLAHE L-Channel**
Offers an optimal balance between increasing brightness, enhancing contrast, and maintaining natural colors. There is a minor increase in noise, but it remains acceptable.
- **CLAHE All-Channels**
Being too aggressive with settings for low-light photos can cause color shifts, increased noise, and overexposure in bright regions.
- From these five images, we observe enhancements, but clarity remains insufficient. Therefore, this task will further enhance the image using a fusion-based approach, such as combining CLAHE with other methods.
- The final methods are:
 1. Gray-level transformation: contrast stretching and gamma correction
 2. White Balance (LAB neutralization)
 3. CLAHE (L-channel)
 4. Denoise (NLM + Bilateral)
 5. Sharpening (Unsharp Mask)



Image 1



Image 2



Image 3



Image 4



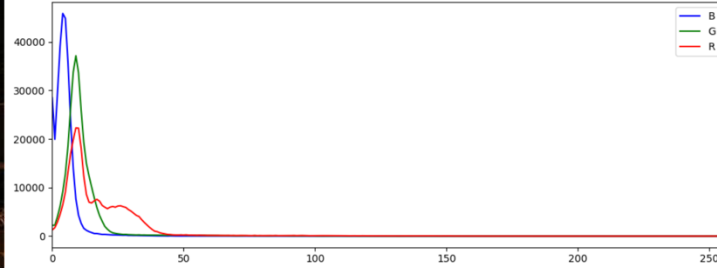
Image 5

Combining CLAHE with Other Methods

Original



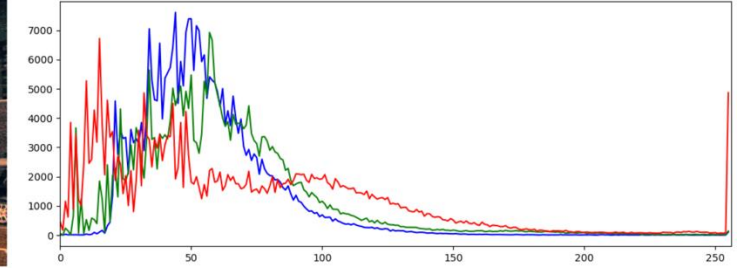
Histogram RGB — Original



CLAHE (L-channel)



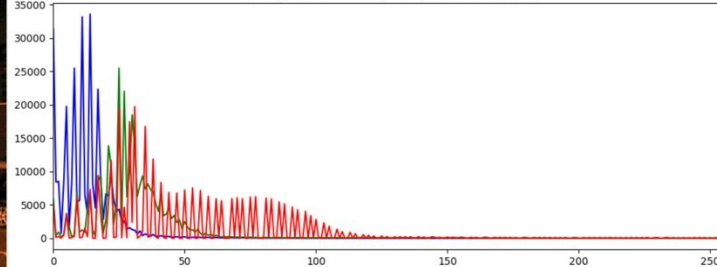
Histogram RGB — CLAHE (L-channel)



Gray-level (Stretch+Gamma)



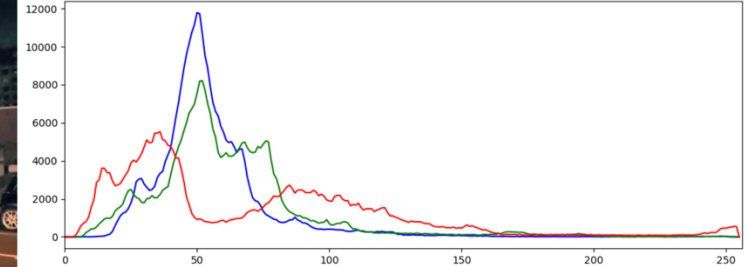
Histogram RGB — Gray-level (Stretch+Gamma)



Denoise (NLM + Bilateral)



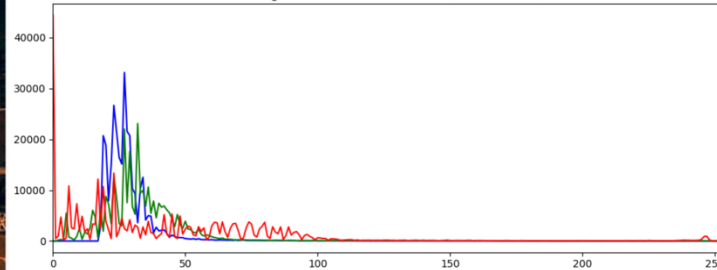
Histogram RGB — Denoise (NLM + Bilateral)



White Balance (LAB-neutralize)



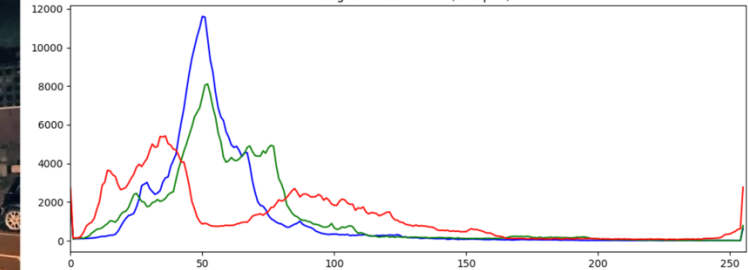
Histogram RGB — White Balance (LAB-neutralize)



Final (Sharpen)



Histogram RGB — Final (Sharpen)



Combining CLAHE with Other Methods

- **Visual Analysis**

- Image Brightness and Detail: Dark areas are more pronounced, and car and building details are highlighted.
- Colors: More neutral than the previous version (less warm).
- Sharpening: Edge details are sharper, but slight noise in the sky remains visible; this is still normal for low-light conditions.

Original



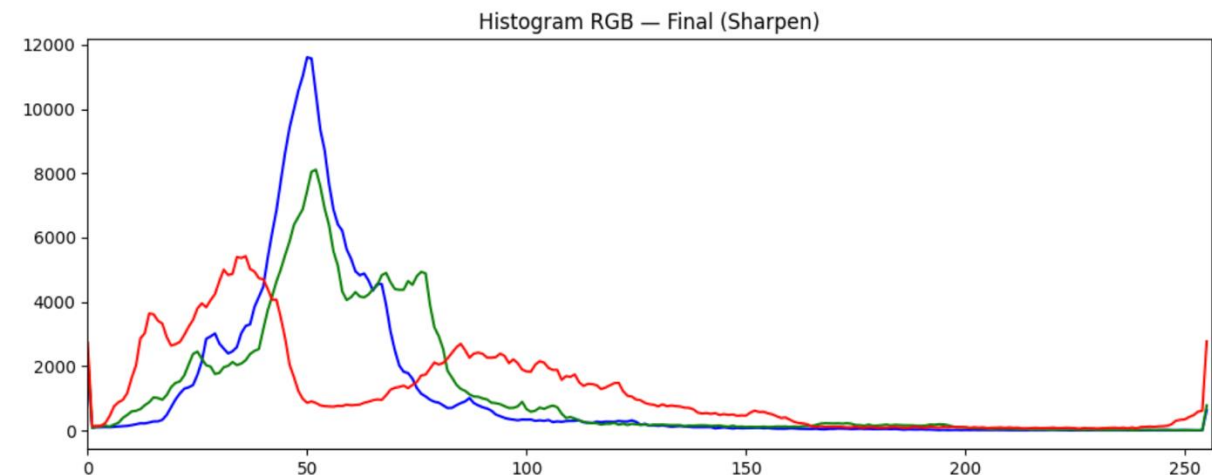
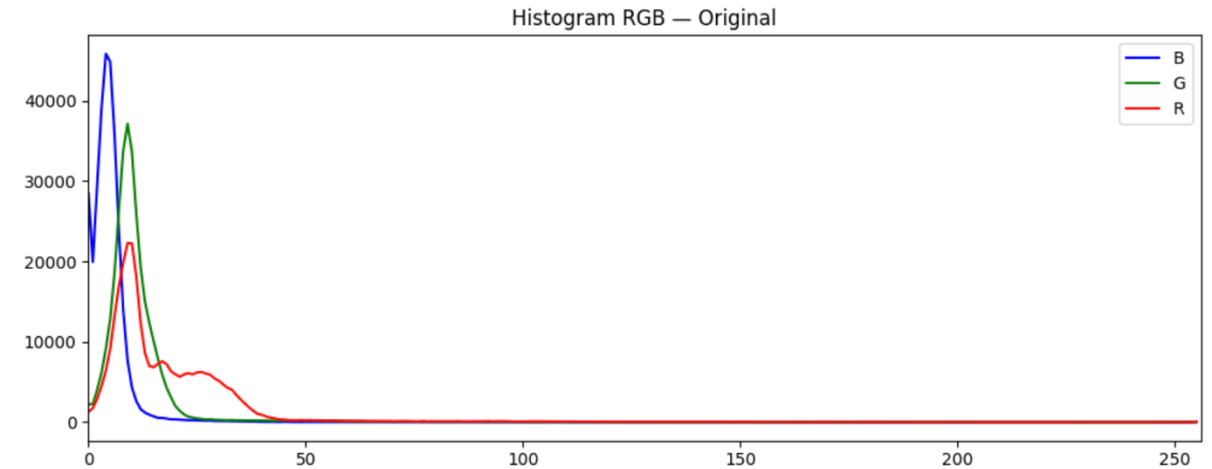
Final (Sharpen)



Combining CLAHE with Other Methods

- **Histogram Analysis**

- The histogram doesn't pile up on the left side, indicating that dark areas have been effectively highlighted.
- Blue and Green are dominant in the 40–80 range, while Red still peaks on the left and right, but they're still within reasonable limits. This indicates that the color isn't as orange-biased as before.
- The transition from midtones to highlights is smooth, so the contrast looks natural and isn't over-boosted.



URL GitHub

- Github :
<https://github.com/herlinalim-ugm/ComputerVision.git>

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