Zero-DCE for low-light image enhancement

-Vedanti Kale

INTRODUCTION

Zero-Reference Deep Curve Estimation or Zero-DCE formulates low-light image enhancement as the task of estimating an image-specific tonal curve with a deep neural network. Zero-DCE takes a low-light image as input and produces high-order tonal curves as its output. These curves are then used for pixel-wise adjustment on the dynamic range of the input to obtain an enhanced image. This curve estimation is inspired by curves adjustment used in photo editing software such as Adobe Photoshop where users can adjust points throughout an image's tonal range.

METHODOLOGY

Data Loading and Processing

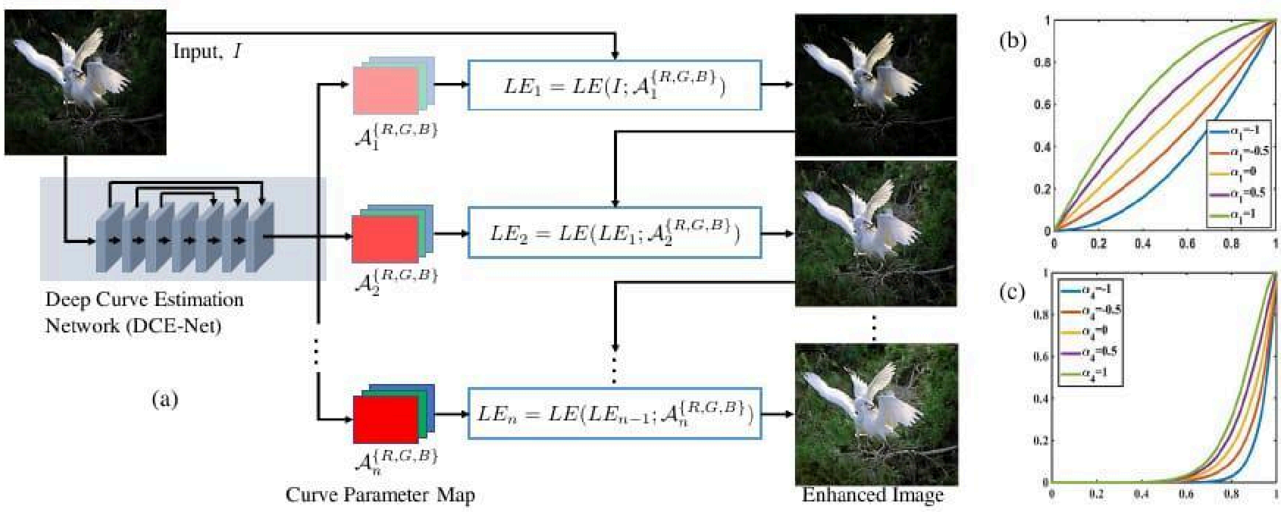
The LOL Dataset has been created for low-light image enhancement. It provides 485 images for training and 15 for testing. Each image pair in the dataset consists of a low-light input image and its corresponding well-exposed reference image. We resize the images to size 256 x 256 to be used for both training and validation.

Note:- Although the model has been trained and validated over the LOL dataset. The model has been tested over the dataset provided by VLG

The Zero-DCE Framework

The goal of DCE-Net is to estimate a set of best-fitting light-enhancement curves (LE-curves) given an input image

Understanding light-enhancement curves



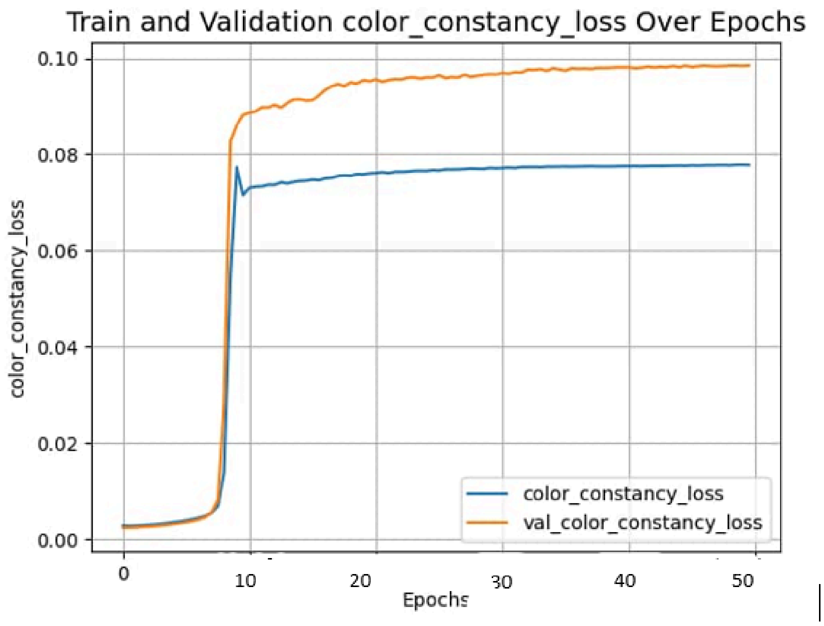
Model architecture

The input to the DCE-Net is a low-light image while the outputs are a set of pixel-wise curve parameter maps for corresponding higher-order curves. It is a plain CNN of seven convolutional layers with symmetrical concatenation. Each layer consists of 32 convolutional kernels of size 3×3 and stride 1 followed by the ReLU activation function. The last convolutional layer is followed by the Tanh activation function, which produces 24 parameter maps for 8 iterations, where each iteration requires three curve parameter maps for the three channels.

LOSS FUNCTION

❖Color constancy loss

The color constancy loss is used to correct the potential color deviations in the enhanced image.



❖Exposure loss

To restrain under-/over-exposed regions, we use the exposure control loss. It measures the distance between the average intensity value of a local region and a preset well-exposedness level (set to 0.6).

❖Illumination smoothness loss

To preserve the monotonicity relations between neighboring pixels, the illumination smoothness loss is added to each curve parameter map.

Quantitative Results

The final losses and PSNR values achieved after 50 epochs of training are summarized in Table.

PSNR calculated over the dataset given by VLG - `27.940903998170302`

Metric	Training Loss	Validation Loss
Total Loss	0.9176	0.842
Illumination Smoothness	0.1821	0.2319
Color Constancy	0.0933	0.0933
Exposure Control	0.06422	0.4556

Qualitative Results

References

https://arxiv.org/abs/2001.06826

https://helpx.adobe.com/photoshop/using/curves-adjustment.html

https://www.researchgate.net/publication/378796725_Rethinking_Zero-DCE_for_Low-Light_Image_Enhancement