Deep Learning and its Applications
Project Presentation on Dehazing Images
Group-04

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Introduction - Haze

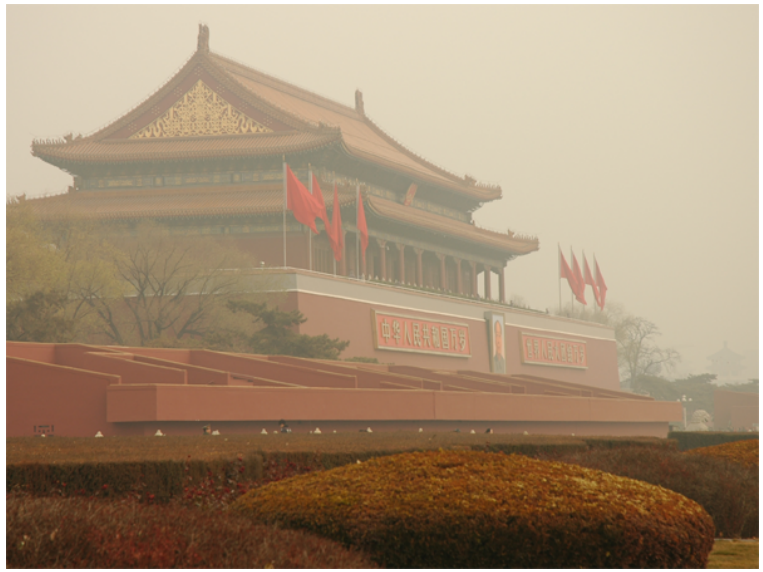

Figure: Hazy Image

Haze is traditionally an atmospheric phenomenon in which dust, smoke, and other dry particulates obscure the clarity of the sky.
[1] [2]

[1] https://en.wikipedia.org/wiki/Haze
[2] http://kaiminghe.com/cvpr09/

Removing Haze

Many editors like Photoshop come with an inbuilt dehaze filter.

Figure: Before and After

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[3] https://blogs.adobe.com/jkost/2015/06/adobe-announces-camera-raw-9-1-for-photoshop-cc-and-lightroom-cc.html

Motivation

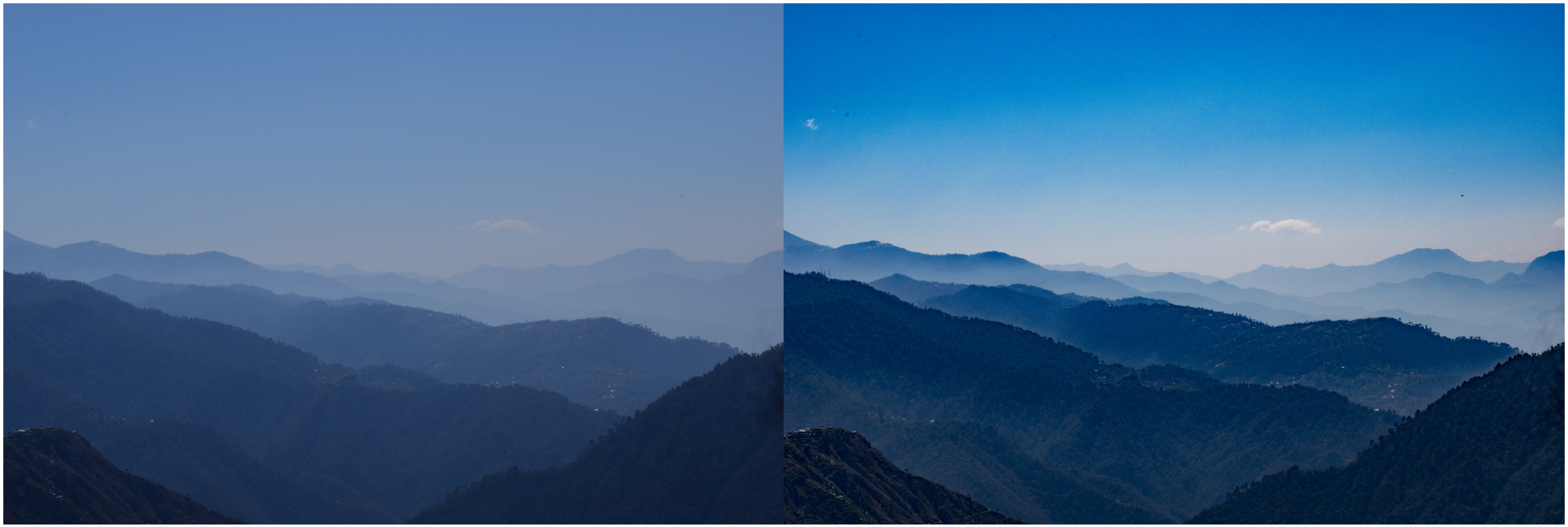
Inbuilt dehaze filter is not enough. For example, consider the images below:

(a) Raw (b) Dehaze using Photoshop

Picture Credits: Nikhil T R

This is the best quality image that was possible using the inbuilt filter. We can see clearly that second picture still has a lot of haze.

Challenges



(c) Raw (d) Photoshop Dehaze

Picture Credits: Nikhil T R

Challenges

1. Recognise Transmission map
2. Understand Edges
3. Artificial Dataset - Depth Map
4. Maintain Resolution

Problem Statement

To remove haze from single image, while making it appear as natural as possible.

Methods Explored

- DehazeNet (2016)
  https://arxiv.org/pdf/1601.07661.pdf
- Cycle-Consistent Adversarial Networks(2018)
  https://arxiv.org/pdf/1703.10593.pdf
- AOD-Net (2017)
  http://openaccess.thecvf.com/content_ICCV_2017/papers/Li_AOD-Net_All-In-One_Dehazing_ICCV_2017_paper.pdf

DehazeNet - Introduction

- Assumes an atmospheric scattering based model for haze. This is taken from another paper.

$$I(x) = J(x)t(x) + \alpha(1 - t(x))$$

- Emphasis on calculating the medium transmission map $t(x)$ of a given hazy image $I(x)$. The original image $J(x)$ can then be recovered using it.
- Use of a new activation function - BReLu (Bilateral Rectified Linear Unit)

Model's Task: Hazy Image $\rightarrow$ Transmission Map.
α is estimated from $I(x)$ itself.

Architecture

Layers:

1. Feature Extraction using Convolution and Maxout.
2. Multi Scale Mapping using Convolution.
3. Local Extremum using MaxPool.
4. Non Linear Regression using Convolution and BRelu

Is “end to end trainable”.

AOD(All-in-One Dehazing)-Net - Introduction

- Based on a re-formulated atmospheric scattering model.
- Generates the clean image through a light-weight CNN,rather than estimating the transmission matrix and the atmospheric light separately as previous model.
- Easy model allows AOD-Net into other deep models, e.g., Faster R-CNN, for improving high-level tasks on hazy images.
- The key to achieve haze removal is to recover a transmission matrix.However, the estimation is not always accurate, and some common pre-processing such as guild filtering or softmatting further distort the hazy image generation process

Transformation Formulas I(x) =J(x)t(x) +A(1-t(x))
$t(x) = e^{-\beta * d(x)}$
minimizing J (x)=K(x)I(x) - K(x)+b

Model Details

Model Architecture

Composed of two parts

1.K-estimation module that uses five convolutional layers to estimate K (x)

2.Clean image generation module.

RELU used,momentum and the decay parameter set to 0.9 and 0.0001.

Loss function - Simple Mean Square Error (MSE).

Model's Pros

- Improved PSNR(Peak signal-to-noise ratio),SSIM(Structure similarity index),quality of image
- Very fast processing speed.
- Can be embeded with other deep models.

Dataset

Created synthesized hazy images by using the ground-truth images from depth Indoor NYU2 Depth Database.

Qualitative Visual Results

- Does good job on highly cluttered objects, fine textures, or illumination variations where other model blur or darken some portion
- AOD-Net results are almost artifact-free on white objects where the transmission value is close to zero.
- Image Anti-Halation. Halation is a spreading of light beyond proper boundaries, forming an undesirable fog effect in the bright areas of photos. The anti-halation results by AODNet are decent too.

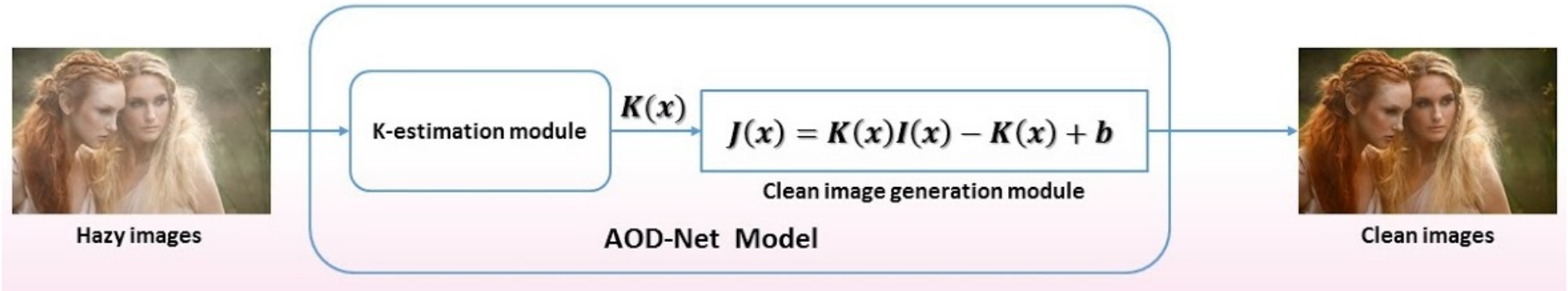


Figure: AOD model and observaion

CycleGAN - Introduction

- Generative Adversarial Networks(GANs) : Generating fake images indistinguishable from the original images on the targeted domain.
- Earlier Single Image Dehazing, require hazy input image and its ground truth in a paired manner.
- CycleGAN– Need of Paired data is removed after the introduction of cycle-consistency loss.
- CycleGAN can be used for image to image translation.
- Single Image Dehazing : Single image dehazing methods are mainly based on estimating parameters of the physical model like Atmospheric scattering.However using GAN's we are don't have to consider these parameters.

Proposed Model

- Proposed model implements modifications on Cycle GAN model.
- We introduce another loss in form of perceptual loss on Cycle GAN model, the idea being that perceptual loss compares images in a feature space rather than in a pixel space and preserves the sharpness of the image.
- Cycle GAN takes low resolution input image and generates low resolution output.
- We aim at taking high resolution input hazed image and generate high resolution dehazed image.
- For generating low resolution to feed the model from high resolution image we will use methods such as bicubic downscaling.
- For upscaling low resolution output image we will either use Laplacian pyramid or another GAN model such as SISR.
- To improve the results we might make the model end-to-end which can generate high resolution output from hazed image and includes a GAN model for upscaling as part of a single model.

Datasets

- RESIDE https://sites.google.com/view/reside-dehaze-datasets/reside-v0
- NYU V2 Depth - haze to be synthesized https://cs.nyu.edu/~silberman/datasets/nyu_depth_v2.html