Image Dehazing

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BTP code : HS05

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Introduction

- The existence of haze dramatically degrades the visibility of outdoor images captured in inclement weather conditions.
- This affects many high level computer vision tasks such as object detection and recognition.

Problem Statement

- The goal is to generate a completely dehazed image from a hazy image through an application.
- The model should be end to end and should be easy to embed into other deep models.
- This enables us to integrate the model with any other applications as well as making it easy to use.

Literature

- AOD-NET: We used this model as a reference for our implementation. It generates a simple dehazed image using an end to end convolution neural network[3].
- YOLO: We used this model for our implementation of object detection in dehazed images[4].
- SSD: We used this model for our implementation of object detection in dehazed images[5].

Dataset

- The dataset we used for training is a synthetic dataset consisting of 27,257 images.
- The dataset also has 1,449 test set images.
- Besides we also collected a set of natural hazy images to evaluate our model performance.
- The data is taken from New York University[3].
- They are resizing, normalizing the data and then giving it to the model.

Methodology

It contains two modules:

1. K - estimation module

2. Clean image generation module

1. K-Estimation

The transformed formula for obtaining the clean image by the atmospheric scattering model is :

$$J(x) = (I(x)/t(x)) - (A * (1/t(x))) + A$$

- Where t(x) is transmission matrix
- A is the Atmospheric light and
- I is the hazy image

Formulation of K(x)

J (x) = K (x) I (x) − K (x) + b

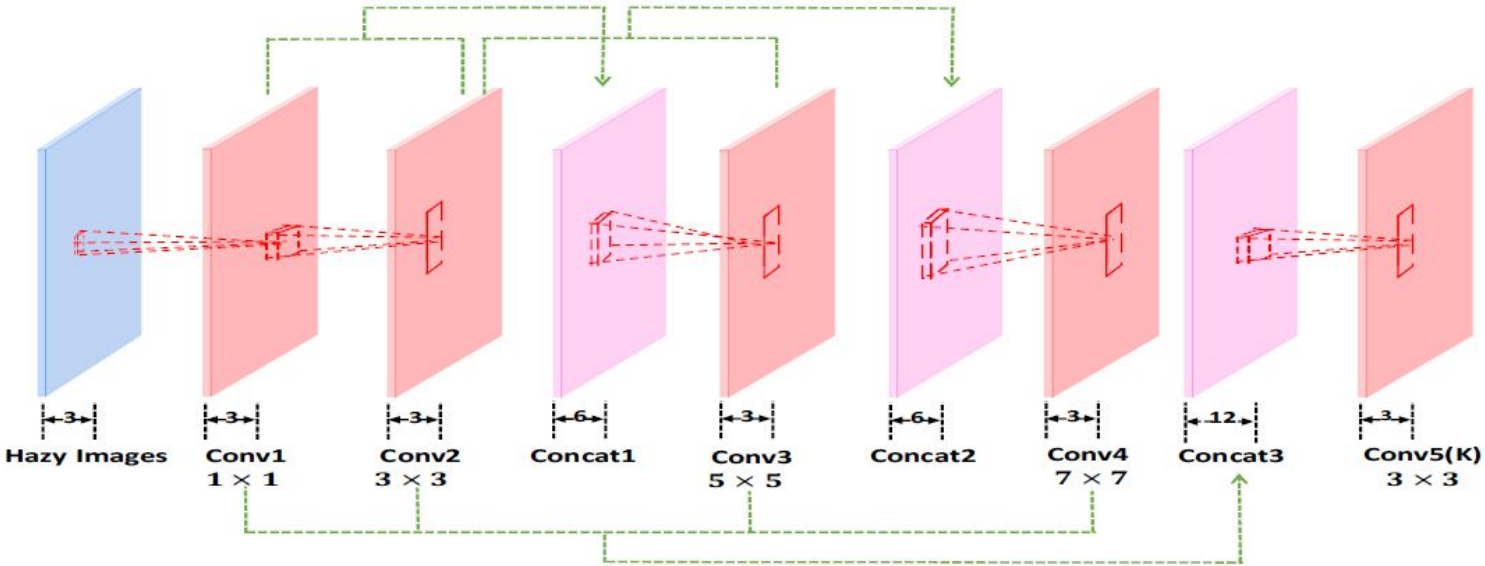
$$K\left(x\right)=\frac{\frac{1}{t(x)}\left(I\left(x\right)-A\right)+\left(A-b\right)}{I\left(x\right)-1}.$$

- Here both t(x) and A are integrated in to a new variable K(x), where b is constant.

Necessity and design of K-estimation

- The K-estimation model is a critical component in this model.
- It is responsible for estimating depth and relative haze level .
- This model uses five convolutional layers with three concat layers.
- “concat1” layer concatenates features from the layers “conv1” and “conv2”.
- Similarly, “concat2” concatenates those from “conv2” and “conv3”;
- “concat3” concatenates those from “conv1”, “conv2”, “conv3”, and “conv4”.

Network design of K-estimation module



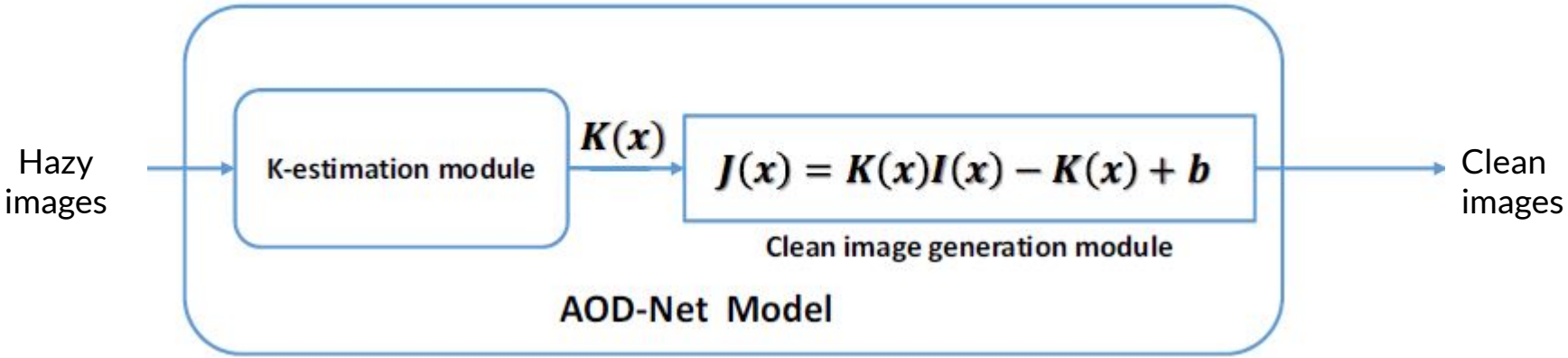
Source: AOD-Net: All-in-One Dehazing Network

2. Clean Image Generation

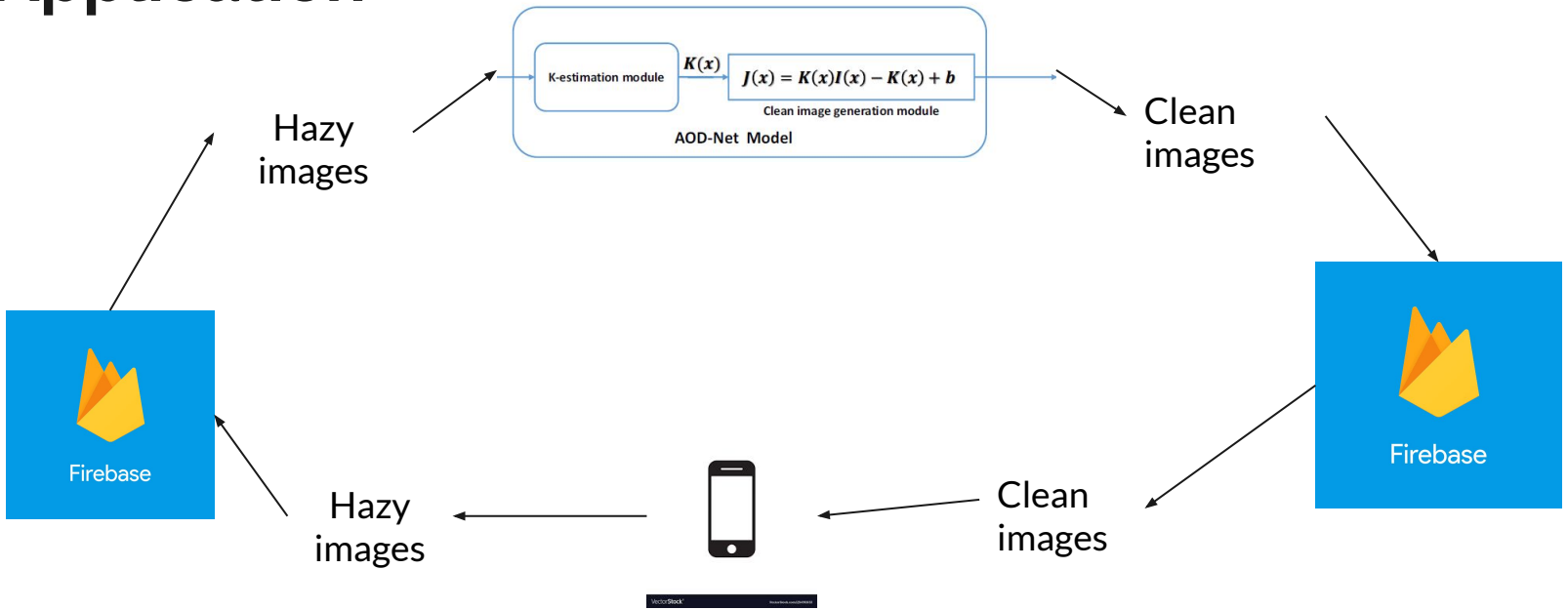
It consists of an element wise multiplication layer and several addition layers.

$$J(x) = K(x) I(x) - K(x) + b$$

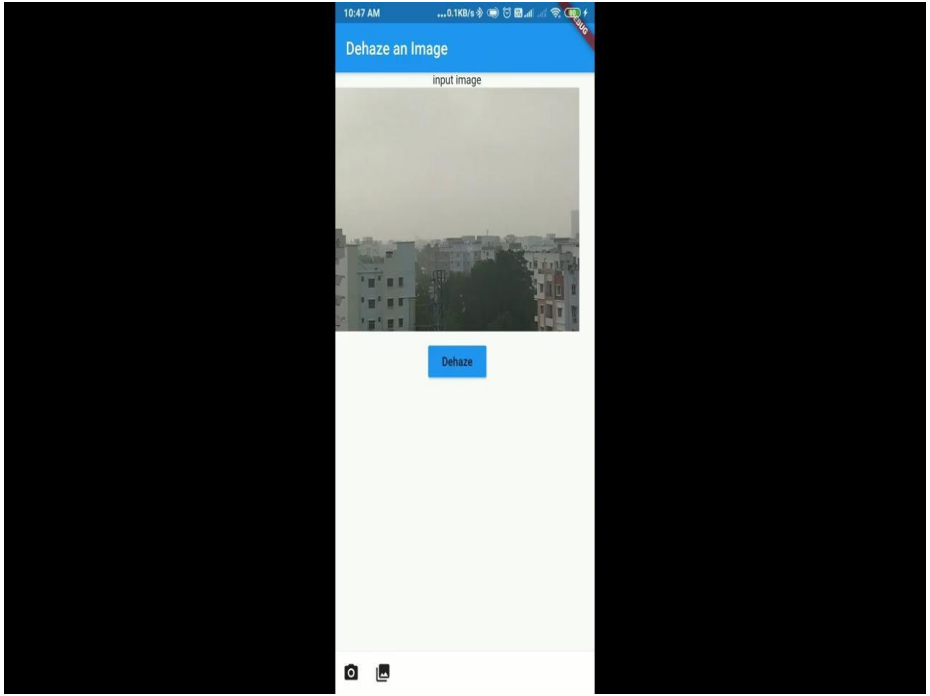
The diagram of AOD-NET



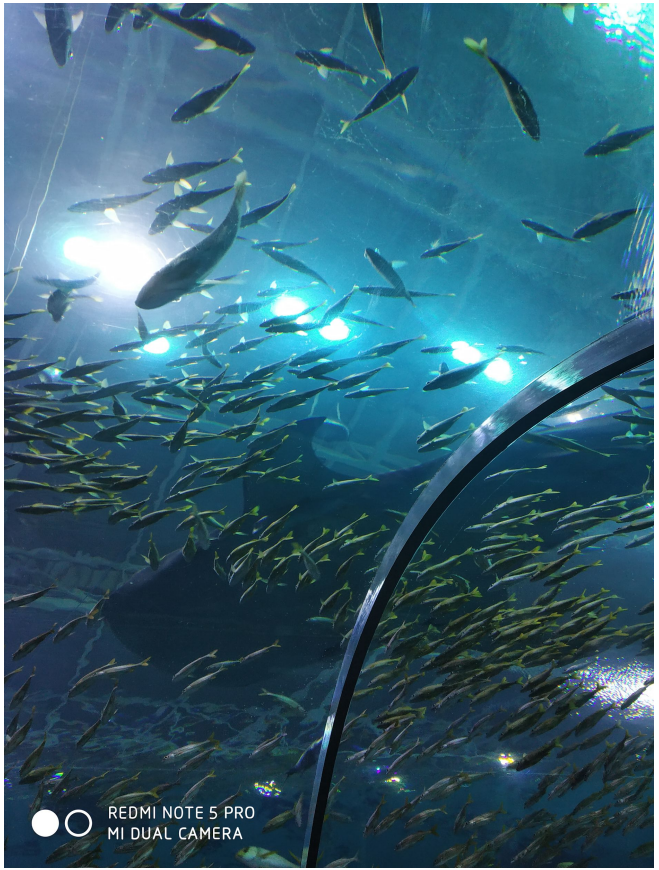
Application



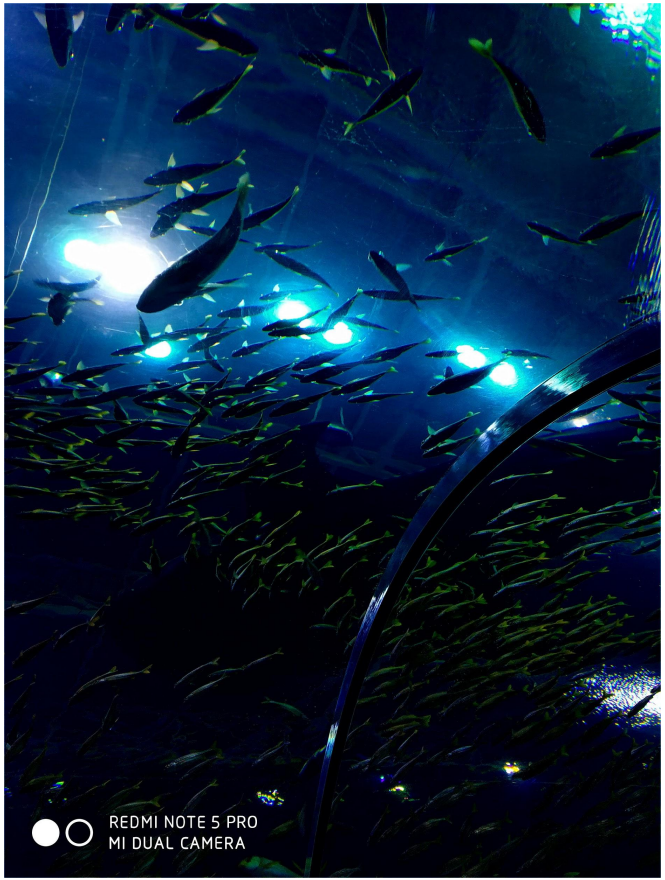
Demonstration



Results



Input



Output

Results

Input

Output

Source: NatureTTL

Results

Input

Output

Results

Input image

Input image yolo object detection

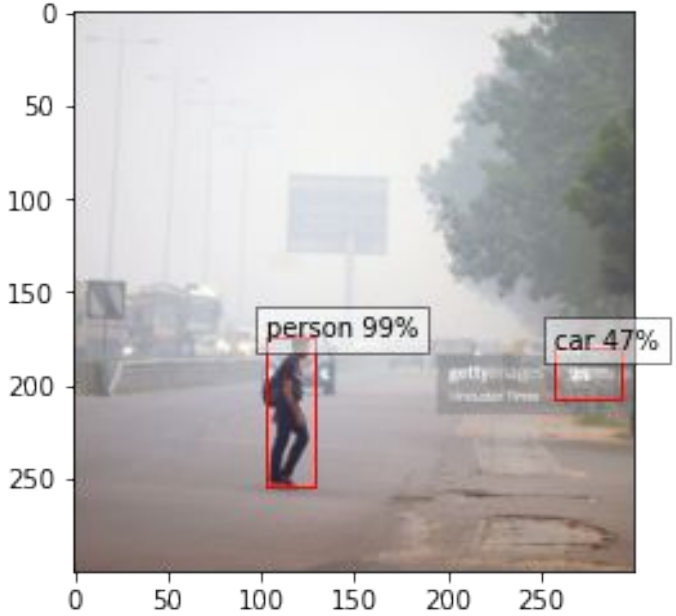
Source: getty images

Results

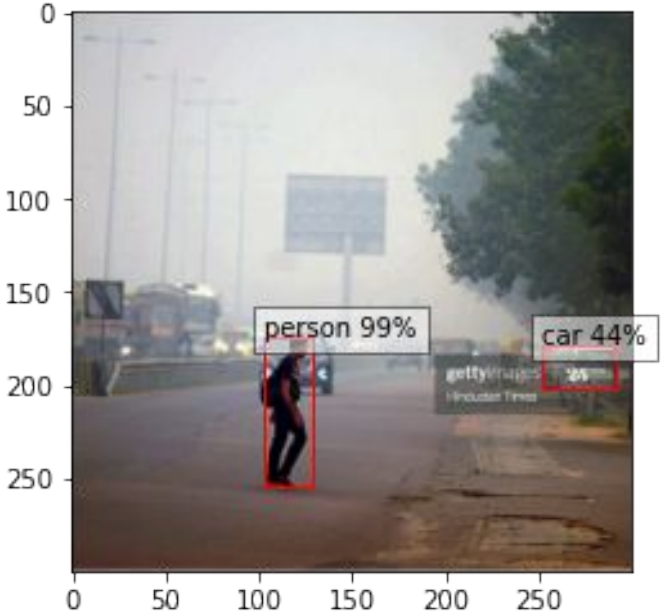
Dehazed image

Dehazed image yolo object detection

Source: getty images



Input image SSD object detection



Dehazed image SSD object detection

Source: getty images

Set 1 - Indoor Images

Hazed		Dehazed	
Yolo	SSD	Yolo	SSD
376	241	399	270

We have taken 500 images in each set and the results are the Number of Images in which the objects are being detected in Hazed and Dehazed form of same image

Set 2 - Outdoor Images

Hazed		Dehazed	
Yolo	SSD	Yolo	SSD
417	331	443	338

We have taken 500 images in each set and the results are the Number of Images in which the objects are being detected in Hazed and Dehazed form of same image

Set 3

Hazed		Dehazed	
Yolo	SSD	Yolo	SSD
406	309	425	335

We have taken 500 images in each set and the results are the Number of Images in which the objects are being detected in Hazed and Dehazed form of same image

Average PSNR and SSIM for natural Hazy images and Dehazed images

Average PSNR value: 19.246682 db (28.49db max value)

Average SSIM : 0.71232333251 (0.84 max value)

We have collected hazy images(500)[6] and dehazed using our net and calculated the average psnr and ssim for those.

Pipeline

- 1st Quartile: Underwater Image dehazing techniques and later realized that dataset is not available.
- 2nd Quartile: Understanding multiple Image dehazing Technique and implementing AODNET.
- 3rd Quartile: Implementing the entire application and implementing Yolo Algorithm
- 4th Quartile: Implementing and checking the algorithm on multiple datasets and comparison between Yolo and SSD

References

1. K. He, J. Sun, and X. Tang. Single image haze removal using dark channel prior. IEEE transactions on pattern analysis and machine intelligence
2. W. Ren, S. Liu, H. Zhang, J. Pan, X. Cao, and M-H. Yang Single image dehazing via multi-scale convolutional neural networks. In European Conference on Computer Vision,pages 154–169. Springer, 2016.

References

3. B. Li, X. Peng, Z. Wang, J. Xu, and D. Feng, “AOD-Net: All-in-One Dehazing Network”, In Proceedings of IEEE International Conference on Computer Vision (ICCV), 2017.

4. Yolo real time object detection by Joseph Redmon, Ali Farhadi

References

5. Implementation of SSD using Pytorch by nvidia deeplearning examples

6. Synthetic Objective Testing set

Thank You...