# Explore National Parks at home: Generate Haze-Free Images

Jiaqi Jiang (jiangjq@stanford.edu), Kaiwen Wang(kaiwenw@stanford.edu), Lijing Wang (lijing52@stanford.edu)

## Abstract

Dense haze caused by air pollution may block the view of the National Parks. In this project, we take outdoor images as inputs to

1) **estimate their air pollution levels**
2) **generate haze-free images**.

We compare the performance of deep learning method with the Dark Channel Priors algorithm which is a traditional dehaze method. The deep nets show better performance at haze level prediction while producing satisfactory dehazed images.

## Atmospheric Scattering Model

Each haze image consist 2 parts:

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

Dark Channel:

$$J_{dark} = \min_{\Omega}(\min_{r.g.b} I)$$

Dark Channel Prior: $J_{dark} \rightarrow 0$

## Dataset

- FRIDA2: 66 synthetic road scenes, each associated with 4 haze images.
- National Parks: 145,803 images from 11 national parks with fixed cameras. Labels come from hourly Ozone level on CASTNET.

FRIDA2 National Parks

## Neural Style Transfer


- Pre-trained VGG network
- Content image: the haze image
- Content cost: ‘conv1_2’ and ‘input’ layers.

$$J_{content}(C,G) = \sum_{layers} \frac{1}{4 * n_H * n_W * n_C} \sum_{all\ entries} (a^{(C)} - a^{(G)})^2$$

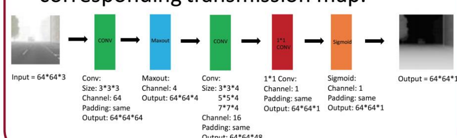
- Style image: Dark Channel Prior with adjusted histogram
- Style cost: ‘input’, ’conv1_1’, ’conv2_1’, and ’conv3 1’ layers

$$J_{style}(S,G) = \sum_{layers} \frac{1}{4 * n_C * n_H * n_W} \sum_{i=1}^{n_C} \sum_{j=1}^{n_C} (DC_{ij}^{(S)} - DC_{ij}^{(G)})^2$$

## Dehaze Deep Nets

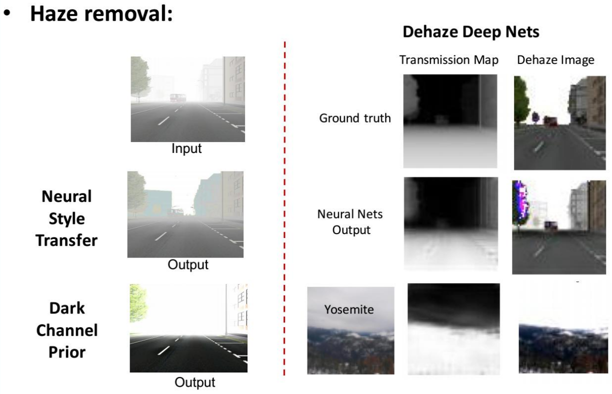
- Data augmentation by physically simulated fog on images. 100 images for each scene, in total 6264 images.

- Training : Dev : Test = 9:1:1.
- Input haze images and output corresponding transmission map.




## Results and discussion

- **Haze level prediction:**
  Dark Channel Prior + Linear Regression has 64% accuracy FRIDA2;
  CNN gives 95% accuracy on FRIDA2 over 4 haze levels and
  85 % accuracy on National Park dataset over 6 haze levels.
- **Haze removal:**




- **Discussions:**
  - Neural Style Transfer works well on reveal details, while not preserving the original color.
  - Dehaze Deep Net is a more end-to-end model and can be successfully transferred to the National Park dataset.

## Future works

- Try to dehaze with different air lights in outdoor scenes
- Try GANs to generate images on requested weather conditions.

## References

- He and Tang, Single image haze removal using dark channel prior, 2010
- Tarel et al, Vision enhancement in homogeneous and heterogeneous fog, 2012
- Cai et al, Dehazenet: An end-to-end system for single image haze removal, 2016
- Kahraman and Charette, Influence of Fog on Computer Vision Algorithms,2017