Project Report

# Image Dehazing Using Dark Channel Prior

Group - 2
Ayushi Anand (IS201401006)
Chaitanya Nagpal (IS201401011
Randhir Prakash (IS201401037)
Ambuj Tiwari (IS201411004)
Chandrakant Ojha (IS201411010)

## Introduction

Images of outdoor scenes are usually degraded by atmospheric particles. Haze, fog, and smoke are such phenomena due to atmospheric absorption and scattering. The irradiance received by the camera from the scene point is attenuated along the line of sight. Since the amount of scattering depends on the distances of the scene points from the camera, the degradation varies with space.

Haze removal (or dehazing) is highly desired in both photography and computer vision applications. First, removing haze can significantly increase the visibility of the scene. In general, the haze-free image is more visually appealing. Second, most computer vision algorithms, from low-level image analysis to high-level object recognition, usually assume that the input image is the scene radiance.

## Background

In computer vision and graphics, the hazed image model can be described as:

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

where $I(x)$ : observed intensity

$J(x)$ : scene radiance

$t(x)$ : medium transmission

$A(x)$ : global atmospheric light

## Related Work

In the field of image dehazing, different researchers have contributed in various ways and devised their own methods for image analysis. Some of previous work done on this field includes:

- Tan's method (visibility in bad weather from a single image)
    - Able to greatly unveil details and structures from the haze image, but large saturation values
    - Contain halo effects near the depth discontinuities

- Fattal et al's method (single image dehazing)
    - Independent component analysis
    - Any lack of variation or low SNR will make the statistics unreliable
    - Invalid for grayscale images

Before

After

## Proposed Method - Dark Channel Prior

The dark channel prior is based on the following observation on haze-free outdoor images: in most of the non-sky patches, at least one color channel has very low intensity at some pixels.

$$J^{dark}(x) = \min(\min(J^{c}(y)))$$

where $c \in \{r, g, b\}$, $y \in \Omega(x)$

There are several reasons for low intensities in the dark channel. These include shadows, colorful objects and dark objects. As the natural outdoor images are usually full of shadows and colorful, the dark channels of these images are very dark.
Here we compute the average intensity of each dark channel and plot the corresponding histogram in Figure 2.

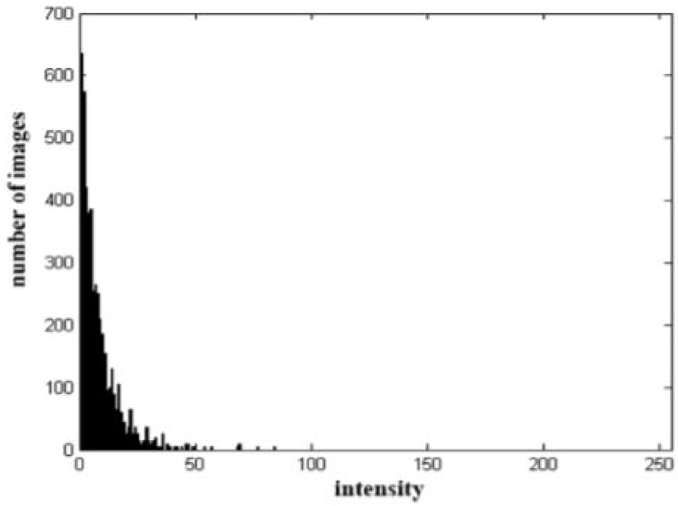



Figure 2 : Histogram of the average intensity of each dark channel

## Haze Removal Process :

Normalize the hazing image model, we get :

$$\frac{I}{A} = \frac{J}{A}t + (1 - t)$$

Calculating the dark channel, we get :

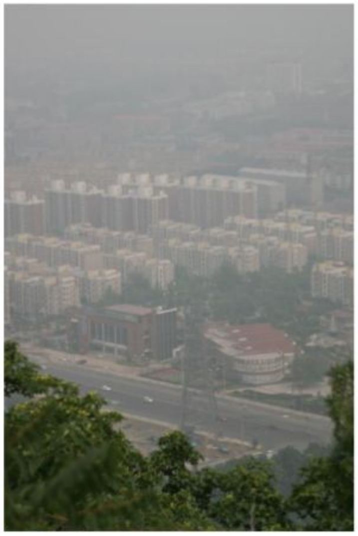
$$\min(\min\left(\frac{I}{A}\right)) \;=\; \min\left(\min\left(\frac{J}{A}\right)\right)t + (1 - t)$$

The medium transmission is defined as :

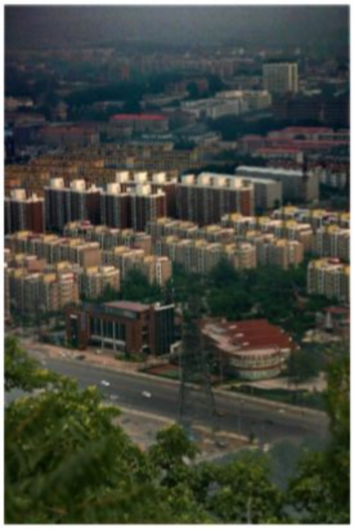
$$\mathbf{t = 1 - \mathit{min}(\mathit{min}\left(\frac{\mathit{I}}{\mathit{A}}\right))}$$

Applying Transmission Optimization and estimating the atmospheric light, we finally recover the scene radiance to obtain dehazed image using dark channel prior method.

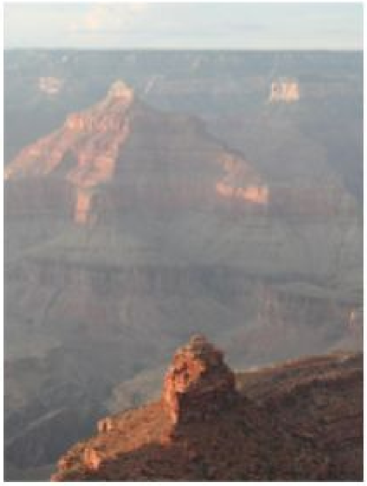
## Results



Original image



Dehazed image



Original image

Dehazed image

## Algorithm

1. Initiate and read the image
2. Calculate the gray scale
3. Calculate the atmospheric light A
4. Calculate dark channel using the gray scale and atmospheric light A
5. Get rough transmission using the dark channel
6. Soft matting to get real transmission
7. Solve the linear equation using PCG
8. Get the dehazed image

## Advantages

- Simple but powerful
- Bad haze image can be put to good use

## Disadvantages

- Invalid when the scene objects are inherently similar to the atmospheric light and no shadow is cast on them
- Invalid when non-constant A

## References


1. TAN, R. T. 2008. Visibility in bad weather from a single image. Proceedings of IEEE CVPR.
2. HYVRINEN, A., AND OJA, E. 2000. Independent component analysis: Algorithms and applications
3. NARASIMHAN, S. G., AND NAYAR, S. K. 2003. Interactive (De)weathering of an Image using Physical Models. In ICCV Workshop on Color and Photometric Methods in Computer Vision (CPMCV).
4. OAKLEY, J. P., AND BU, H. 2007. Correction of simple contrast loss in color images. IEEE Transactions on Image Processing 16
5. YUAN, L., SUN, J., QUAN, L., AND SHUM, H.-Y. 2007. Image deblurring with blurred/noisy image pairs. ACM Transactions on Graphics
6. OAKLEY, J. P., AND BU, H. 2007. Correction of simple contrast loss in color images. IEEE Transactions on Image Processing 16, 2, 511–522.