Computer Vision Project Report

Topic: Image Dehazing

GROUP: 20		
Name	**Roll No**	**Contribution**
Dara Deepak	**S20190010037**	**Dataset Collection, Estimation of atmospheric light, Comparison with Histogram Equalization**
Chandi Guru Nithin Reddy	**S20190010028**	**Calculation of Dark Channel, Color correction, Parameter tuning**
Paindla Yashwanth Kumar	**S20190010130**	**Transmission refinement, Estimation of Transmission, Parameter Tuning**
Kona Pavan Kumar	**S20190010095**	**Image Recovery, Depth map**

Abstract: A simple but effective image prior - dark channel prior to remove haze from a single input image. The dark channel prior is a kind of statistics of the haze-free outdoor images. It is based on a key observation - most local patches in haze-free outdoor images contain some pixels which have very low intensities in at least one-color channel. Using this prior with the haze imaging model, we can directly estimate the thickness of the haze and recover a high-quality haze-free image. Results on a variety of outdoor haze images demonstrate the power of the proposed prior. Moreover, a high-quality depth map can also be obtained as a by-product of haze removal.

Literature Survey:

Paper 1:

Hybrid Single Image Dehazing with Bright Channel and Dark Channel Priors" "Jehoiada Jackson[1], Oluwasanmi Ariyo[1], Kingsley Acheampong[1], Maxwell Boakye[2], Enoch Frimpong[2], Eric Ashalley[3], Younbo Rao[1*]

- Dark channel prior (DCP) and Bright channel prior (BCP) for single image dehazing is used.
- This method achieves air light approximations by implementing numerical proximity of atmospheric light, which uses the average value of the DCP and BCP.

Paper 2:

"Fast Single Image Dehazing with Robust Sky Detection" sebastian salazar.ulises moya-sanchez 2,3 (2020)

- The DARK CHANNEL PRIOR(DCP) has shown remarkable results in image dehazing with three main limitations: high time consumption, artifact generation, and sky region oversaturation.
- Therefore current work has focused on improving processing time without losing restoring quality and avoiding image artifacts during image dehazing.

Paper 3::

"Haze Removal using the Difference-Structure-Preservation Prior" Linyuan He, Jizhong Zhao Associate Member, IEEE, Nanning Zheng Fellow, IEEE, and Duyan Bi.

- To solve the problem, we meticulously analyze the optical model and recast the initial transmission map under an additional boundary prior.
- For better preservation of the results, the difference-structure-preservation dictionary could be learned such that the local consistency features of the transmission map could be well preserved after coefficient shrinkage.

Challenges:

- To find a way to solve the ambiguity problem between images color and depth in dehazing.
- To create a more robust model for dehazing in an inhomogeneous atmosphere.
- Develop a reliable image quality assessment mechanism to evaluate the quality of dehazing algorithms.

Motivation:

Under bad weather conditions, such as fog and haze, the quality of images degrades severely due to the influence of particles in the atmosphere. Suspended particles scatter light and result in attenuation of reflected light from the scene and the scattered atmospheric light mixes with the light received by the camera and changes the image contrast and color.

. It is therefore necessary for computer vision systems to improve the visual effects of the image and highlight image features. The development of image dehazing methods has been beneficial to many real-world applications, including outdoor video surveillance, analysis of remote sensing imagery, and driver assistance systems. These techniques can also be transferred to underwater image enhancement and enhancement of images acquired in rain or snow.

Methodology:

Preprocessing of a Hazy Input Image:

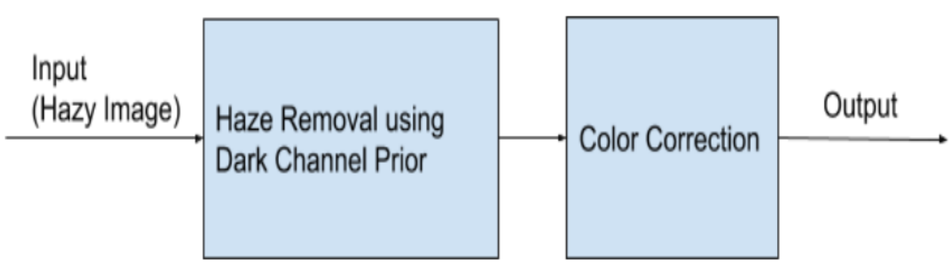
In the preprocessing stage, colored hazy images are used as an input. The haze imaging equation is normalized as follows:

$$I(x)_{\text{normalized}} = t(x)\frac{K^C(x)}{A^C} + 1 - t(x),$$

Dark Channel Computation:

The computational criteria of dark channel prior are based on an observation in RGB images.Considering a normalized image from equation, its dark channel is mathematically defined as follows:

$$I^{\text{dark}}(x) = \min_{y\in\Omega(x)}\left(\min_{C\in R,G,B} I(y)_{\text{normalized}}\right),$$



Estimating the Transmission Map:

The transmission map is estimated by assuming the atmospheric light *A* is known.Assuming transmission to be constant for the small local patch we apply the dark channel on the equation on both sides.

$$I^{\text{dark}}(x) = t(x) \min_{y \in \Omega(x)} \left(\min_{C} \frac{K^C(y)}{A^C} \right) + 1 - t(x).$$

We will find dark channel prior k by using

$$K^{\text{dark}}(x) = \min_{y \in \Omega(x)} \left(\min_{C \in R,G,B} K^C(y) \right) = 0.$$

Probability-Weighted Moments:

While recovering the contrast of a hazy image, it is very important to preserve the true edges in an image. Majorly, two types of estimations are used, PWM and maximum likelihood estimation (MLE). It is a proven fact that PWM has a better capability to restore and estimate the contrast in an image

$$\text{PWM} = \frac{\sqrt{\pi}}{n} \sum_{i=1}^{n} \left[\tilde{t}_i - 2\left(1 - \frac{i - 0.5}{n}\right) \tilde{t}_i \right].$$

Dataset:

- For hazed images we have used our own dataset.
- The total number of images used are 500, for training we have used 400 images and for testing we have used 100 images.
- Compared to other widely used datasets, this dataset contains high quality images with high resolution.
- In our dataset we have both Indoor and outdoor image dataset.

Results:


Original Hazy Image


Haze Removed Image


Original Hazy Image


Haze Removed Image

Analysis of Results:

The algorithm seems to perform really well on most outdoor images. It removes most of the haze from the images, only leaving out some when the haze is extremely Thick.

Since the dark channel prior assumption only works when haze is the brightest object in the dark channel, the algorithm fails if there is a prominent white object/light in the picture that is brighter than the haze.

It also fails to perform when the haze is tinted, for example, from a beam of sunlight. This is because the color makes the haze part black in the dark channel prior.

Conclusion:

- This work provides good performance for the task of obtaining a haze-less image in both qualitative and quantitative manner.
- Experimental results show the proposed methods estimates haze accurately, the reconstructed images are more realistic and detailed information is restored.

References:

[1] He, Kaiming, Jian Sun, and Xiaoou Tang. "Single image haze removal using dark channel prior." IEEE transactions on pattern analysis and machine intelligence 33.12 (2010): 2341-2353.”

[2] Salazar-Colores, Sebastián, et al. "Fast single image defogging with robust sky detection." IEEE access 8 (2020): 149176-149189.

[3]Ancuti, Codruta O., et al. "O-haze: a dehazing benchmark with real hazy and haze-free outdoor images." Proceedings of the IEEE conference on computer vision and pattern recognition workshops. 2018.

[4] Ancuti, Cosmin, et al. "I-HAZE: a dehazing benchmark with real hazy and haze-free indoor images." International Conference on Advanced Concepts for Intelligent Vision Systems. *Springer, Cham, 2018.*

[5] Jackson, Jehoiada, et al. "Hybrid single image dehazing with bright channel and dark channel priors." 2017 2nd International Conference on Image, Vision and Computing (ICIVC). IEEE, 2017.