# Image De-hazing Based on Improved Dark Channel Prior and Contrast Enhancement

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**ABSTRACT**

*Quality of pictures caught by sensors of the camera are degraded by haze. The haze evacuation, called dehazing, is ordinarily done under the physical degradation model, which requires a solution for an ill-posed inverse problem. To soothe the trouble of the reverse issue, a novel method called Dark channel Prior (DCP) was as of late proposed and has received a lot of consideration. Environmental factors, such as haze and cloudiness influence the picture quality and make it unacceptable for real time applications such as environment surveillance, which require pictures with clear perceivability. By and large, reproduction of mist free picture from a solitary info picture is very testing. Proposed DCP based picture defogging technique with enhanced map to abstain from artifacts, TM's are obtained for RGB and YCbCr colour spaces. Three transmission maps for the R, G, and B channels are used to process a mean transmission map. In the YCbCr space, Y channel is utilized to figure the map. The two transmission maps are refined by protecting edge data for developing two middle pictures, which are given with weights to obtain dehazed yield. Dehazed image thus obtained suffers from low contrast and dimness. To overcome this, we go for contrast enhancement method. The RGB image is converted to HSV space. The luminance component, 'v' alone is considered for enhancement. Compute the illumination component and calculate the reflectance of the image. The illumination of the image is adjusted and it is multiplied by the reflectance image to get the adjusted luminance, which can be rescaled to 0 to 255 to obtain the enhanced luminance.*

**Keyword**: *Dark channel prior, Image de-hazing, Image construction, Contrast enhancement*

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## 1. INTRODUCTION

The perceptive nature of open-air pictures is imperative for comprehension and dissecting the environment to perform automatic tasks, for example, navigation, object location and recognition. Scattering or assimilation of light in unfavorable climate because of haze and fog can enormously limit the perceivability of open-air scenes. Along these lines, pictures taken in such climate conditions experience the ill effects of lower differentiate, blurred hues and luminance unevenness, bringing about items a long way from camera practically imperceptible. Fig.1 represents the impact of haze which lessens the perceivability in gained pictures. It very well may be seen that picture debasement in such situation is because of the reflection and ingestion of light by the haze particles. Since diminished perceivability enormously impacts the imaging frameworks, mechanized strategies to upgrade perceivability in foggy pictures have turned into a territory of enthusiasm for specialists. The mist impact relies upon the profundity of the article in a scene, i.e., the items more remote from the camera are affected more.

The paper is organized as follows. In section 2 contains the proposed system, Section 3 tells about the results and comparisons. Section 4 gives the conclusion, while section 5 contains the reference.

## 2. PROPOSED SYSTEM

### 2.1 Dark channel prior

The Dark Channel Prior (DCP) based strategy to re-establish haze free pictures is given as follows. Fig.2 shows the square outline strategy. Dark Channel Prior is determined for two distinctive shading spaces, i.e., RGB and YCbCr. A window size of 31 x 31 is utilized to apply the minimum filter on the RGB pictures to acquire DCP.

Initially, the minimum filter is applied on the three shading channels and then on the local patch of the yield picture from the filtered RGB picture. A larger patch size is utilized for this reason on the grounds that small patch may yield a mistaken estimation of the air light. DCP for the RGB shading space is given as,

$$I_{Dark} = \min_{y\in\Omega(x)}\left(\min_{c\in\{r,g,b\}}(I^c)\right)$$

Assuming Ω=31 for the local patch size. DCP is also applied on the Y channel of YCbCr color space, which is given as,

$$I_{Dark-Y} = \min_{y\in\Omega(x)}(I_Y)$$

Where $I_y$ is the Y channel of the hazy input image and Ω=31 is the local patch size.

**2.2 Estimation of Atmospheric Light**

Subsequent to the DCP from RGB and YCbCr shading spaces, the air light A and Ay are evaluated from dark channels Dark I dark and I $_{dark-y}$, respectively 0.1% brightest pixels are chosen and the largest intensity value in each RGB shading channels is acquired independently from these pixel areas. These three intensity values from the RGB channels are taken as atmospheric light A, subsequently 'A' will be a 3x1vector where each value represents the largest intensity value in the individual R, G, and B channel. A similar procedure is done for I $_{dark-y}$ to get $A_y$.

**2.3 Calculation of Transmission Map**

The TM is processed utilizing the air light A from the input picture. Each channel of hazy picture is divided by its respective 'A' value to process three transmission channels. The mean channel for RGB shading space is figured as t'(x),

$$t'(x) = 1 - \omega\frac{1}{3}\left(\sum_{c=1}^{3}\left(\frac{I^c}{A^c}\right)\right)$$

Next step is to calculate $t_y$'(x), which is as follows,

$$t_Y'(x) = 1 - \omega\left(\frac{I_Y}{\max(A_Y)}\right)$$

Where $t_y$'(x) is the TM for the intensity channel.

**2.4 Transmission Map Refinement**

The TM is refined by saving the information of the gradients. To begin with, Laplacian filter is applied on the transmission map, and the yield is subtracted from the original TM to expel the undesirable noise. Then, a mean filter is applied for smoothening. The previously mentioned procedure is connected to both the TM's i.e., the mean TM for the RGB shading space and, the transmission map for the intensity channel of YCbCr shading space.

**2.5 Haze free image reconstruction**

Subsequent to processing all the parameters, the last step is to reproduce the upgraded picture with limited haze impact. The picture reproduction process is given by,

$$J(x) = \frac{I - A}{\max(t(x), t_0)} + A \qquad J_Y(x) = \frac{I - A_Y}{\max(t_Y(x), t_0)} + A_Y$$

$t_o$ is a constant value which is used to avoid divide by zero error.

Image re-established using the RGB shading space is given by J(x) and J y (x) gives there constructed image using the YCbCr colour space. This intermediate image is used to obtain the reconstructed image using the equation,

$$R(x) = \alpha\, J(x) + (1-\alpha)\, J_y(x)$$

Where R(X) is the re-established image, 'α' is set as 0.5.

### 2.5 Contrast enhancement

Contrast loss in the DCP enhanced image due to incorrect estimation. Contrast enhancement here is retinex inspired, based on visual system of human beings. Decomposition of the image into low frequency component illumination and a high frequency component reflectance. Image at the end of DCP is converted to HSV colour space. The illumination component L(x,y) of the image Luminance S(x,y) is estimated .Reflectance image R(x,y) is obtained by dividing S(x,y) by L(x,y) with small value δ.

$$R(x,y) = \frac{S(x,y)}{L(x,y) + \delta}$$

Illumination image L(x,y) is adjusted by a mapping function,

$$L_a(x,y) = log_2(L(x,y) + 1)$$

Adjusted La(x,y) is then multiplied by the reflectance image to obtain the adjusted luminance Sa(x,y)

$$S_a(x,y) = R(x,y) \cdot L_a(x,y)$$

Rescaling the image to the dynamic range of 0 to 255 gives the enhanced luminance. The image can be converted back to the RGB colour space.

**Fig.1 Block diagram of proposed system**

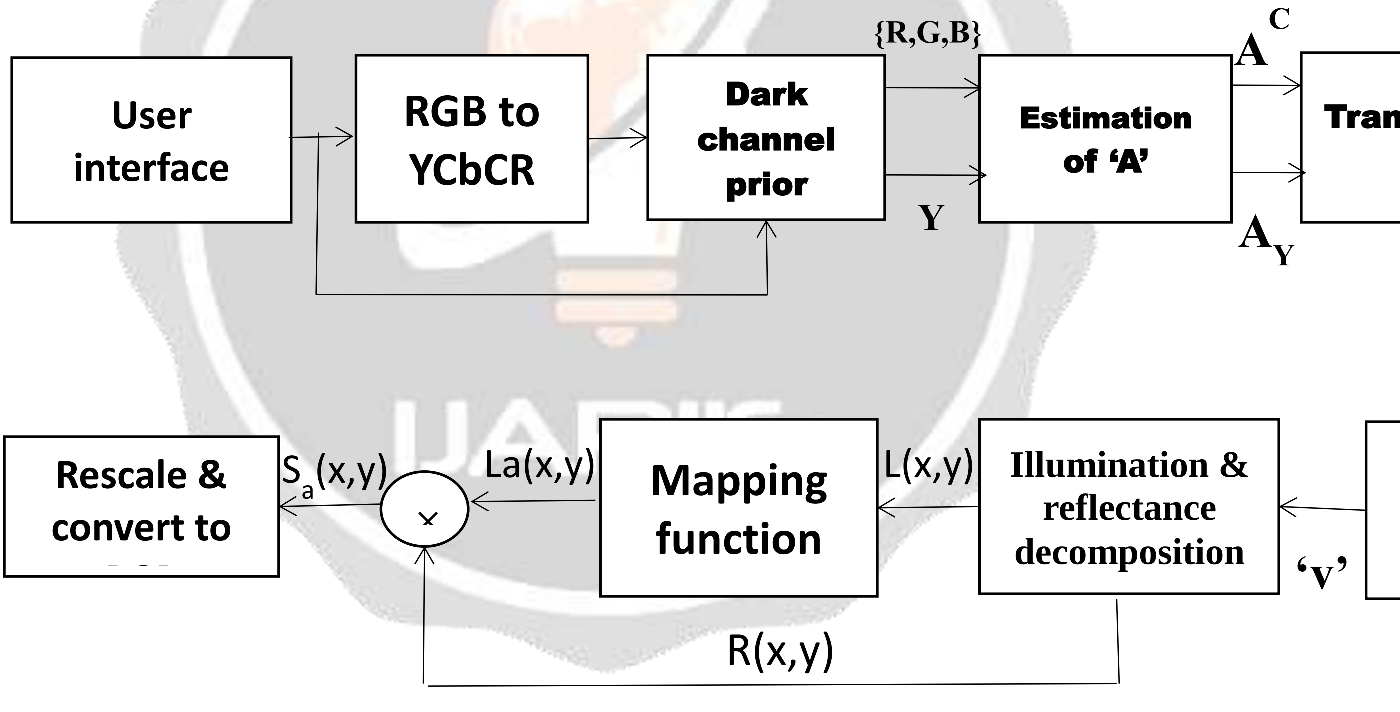


**Fig.2 Input hazy image**

**Fig.3 Input foggy image in YCbCr colour space.**

**Fig.4 'Y' channel of the YCbCr colour space**

**Fig.5 Extracted Dark channel of the RGB image**

**Fig.6 Extracted dark channel of the YCbCr image**

**Fig.7 Mean transmission map of RGB**

**Fig.8 Transmission map of YCbCr**

**Fig.9 Intermediate image reconstructed from the RGB space**

**Fig.10 Intermediate image reconstructed from the YCbCr space**

**Fig.11 Constructed image**

## 3. EXPERIMENTAL RESULTS

Trials are done on an assortment of pictures and the results are contrasted with existing picture defogging methods. Quantitative and subjective examination on two kinds of pictures which incorporate pictures with even depth and the other with cluttered depth [7]. Pictures with bright objects, for example, structures, cloud, vehicles and, small sky locale may cause incorrect estimation of air light and may prompt wrong estimation of depth. Such pictures are delegated smooth depth picture class. Indifferentiate, pictures with small foreground items, for example, leaf & decorative objects present discontinuities in forefront objects that produce complex depth. Diverse creators utilize diverse parameters, to assess their outcome's, a few normal parameters are SSIM and FE. SSIM, FE, DS and AQI are determined to think about obtained results with existing picture defogging calculations.

$$Fog\ Effect = 10 \cdot \log_{10}\left(\frac{MAX^2}{MSE}\right)$$

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left[ I(i,j) - K(i,j) \right]^2$$

SSIM quantifies image quality degradation caused by processing using the visual perception.

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

AQI measures image quality without any reference image. Not at all like different measures, no reference picture, is needed to process AQI. Higher the estimation of AQI implies better the nature of picture. The model used to evaluate the degradation score has a yield going from 0 to 100. The estimation of 0 implies a flawless picture and an estimation of 100 implies a most misshaped picture.

**Table 3.1 Comparison of SSIM, FE, AQI& DS**

| Technique | SSIM | FE | AQI | DS |
|---|---|---|---|---|
| He | 0.8541 | 14.641 | 0.0011 | 7.5 |
| Tan | 0.6515 | 11.7306 | 0.0026 | 10.41 |
| Tar el | 0.9119 | 17.8932 | 0.0005 | 17.29 |
| Wang | 0.6893 | 12.4586 | 0.0020 | 12.5 |
| Sal | 0.6265 | 11.5254 | 0.0028 | 2.5 |
| Proposed | 0.3817 | 3.817343 | 0.0031 | 1.512 |

**Table 3.2 Comparison of Image Quality parameters**

| PARAMETER | EXISTING | PROPOSED |
|---|---|---|
| Contrast | 49.713 | 67.284 |
| Sharpness | 5.132 | 7.445 |
| Naturalness | 28.215 | 38.105 |
| PSNR | 27.53 | 27.88 |
| MSE | 114.79 | 105.87 |
| SSIM | 0.6265 | 0.3817 |
| FE | 11.5254 | 3.817 |
| AQI | 0.0028 | 0.0031 |
| DS | 2.5 | 1.512 |

## 4. CONCLUSION

In our work, picture de-hazing technique has been proposed dependent on the dark channel prior (DCP). Existing best in class picture defogging strategies utilizing DCP neglect to demonstrate ideal execution for the errand of picture defogging. Their outcomes are compromised with low contrast & artifacts. We have proposed another strategy to ascertain the transmission map and used a Laplacian filter to refine the transmission map. Contrast enhancement procedure followed by the DCP overcomes the disadvantage of the DCP that is low contrast & provides enhanced contrast to the image. Trial results demonstrate that the proposed technique gauges haze more precisely and the recreated pictures have better shading difference. Defogged pictures are seen with halo effects and thin mist layer that expelled utilizing our strategy. Besides, the improvement percentage of the parameters compared to existing system, FE-66%, SSIM-39.07%, DS-39.52%, AQI-10.71%, MSE-7.77%, PSNR-1.27%, Naturalness-35.9%, Sharpness-45.07% & Contrast-35.3%, demonstrates that the pictures remade by proposed technique show higher perceptual quality. In future proposed method can be improved by providing improvised contrast enhancement algorithm and also by improving the conventional procedure of the dark channel prior.

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