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A Scheme for Increasing Visibility of Single Hazy Image under Night Condition

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Abstract

This paper proposes an approach for Increasing visibility of single hazy image under night condition which utilizes a combination of histogram equalization, gamma correction, and dark channel prior with soft matting technique, refined transmission procedure to avoid the generation of block artifacts in the restored image, and effective transmission map estimation by adjusting its intensity via an enhanced transmission procedure based on the adaptive gamma correction technique. Our result shows better contrast noise ratio and peak signal to noise ratio values over existing methods based on dark channel prior.

Keywords: Haze, Histogram Equalization, Gamma Correction, Low Light, Visibility

1. Introduction

The image is captured in the outdoor scene are highly despoiled due to the reduced lighting situation or due to the soil particles. So due to these particles the irradiation coming from the objects is scattered or absorbed and hence the phenomena of haze and fog occurs. The dark channel prior [5] method is extremely helpful to dehaze the foggy images but fails to remove halo effects, to be more precise, it fails to estimate the correct transmission map for hazy low light images. So in outside low light image case the dark channel prior scheme is incompetent to improve the whole scene.

The optical model has been widely used in the computer vision research field, particularly to describe the formation of hazy images captured by digital cameras. It is based on the physical properties of light transmission through atmospheric conditions, and can be described as [10].

$$P(x) = Q(x)\,t(x) + A_t(1 - t(x)) \tag{1}$$

Where P(x) is the intensity of the observed hazy image, Q (x) is the scene radiance, A_t is the universal atmospheric light, and t(x) is the medium transmission representing the portion of light, which is not scattered and subsequently is received by the camera. On the right-hand side of (1), the first term Q(x)t(x) is called the Direct reduction; the second term A_t (1−t(x)) is called atmosphere light. The optical model can be described by direct attenuation and air light. Direct attenuation describes the decay of scene radiance and is dependent upon medium and scene depth, while air light represents the scattering of light that leads to color shifts in the scene.

2. Haze Removal Using Dark Channel Prior

2.1 Dark Channel Prior

In order to restore image visibility degraded by haze, He et al.[5] provide a DCP method to estimate scene depth in a single image. The method is based on the key observation that a haze-free outdoor image exhibits at least one color channel with a very low intensity value in regard to patches of the image, which do not contain sky[5]. Thus, the dark channel J dark of the outdoor haze-free image J can be expressed as

$$J^{dark}(X) = \min_{y \in \Omega(x)}\left(\min_{c \in \Omega\{r,g,b\}} J^{c}(y)\right) \tag{2}$$

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Where J^c is a color channel of the RGB image is the minimum value of the RGB channel, Ω(x) is a local square centered at location x, and is a minimum filter. According to [5], if J is an outside fog-free image, the corresponding intensity of dark channel J^{dark} is low and close to zero.

2.2 Estimating the Transmission

In [10], the dark channel prior provides a method by which to estimate transmission in a hazy image.

$$\tilde{t}(X) = 1 - \omega \min_{y \in \Omega(x)} \left(\min_{c \in \Omega\{r,g,b\}} \frac{J^c(y)}{A^c} \right) \quad (3)$$

Where ω is set to 0.95.

2.3 Atmospheric Light Estimation

As discussed in[5], for estimation of the atmospheric light A in the outdoor image, the brightest 0.1% of pixels are chosen from within the dark channel prior. From among these, the pixels with the highest intensity in the input image are determined to be the atmospheric light A.

2.4 Soft Matting

The restored image may contain some block artifacts after haze is removed by employing the transmission produced via (3). To resolve this, the transmission can be refined as optimal transmission t(x) through soft matting, as described in [5].

3. Proposed Algorithm to Detect the Type of Images and Enhancement of Hazy Night Images

In order to detect, whether the image is during day light or it is degraded due to fog and insufficient lighting during night time, the following algorithm has been proposed.

Algorithm Steps

- Determine the mean intensity distribution of input images (let it be 'm')
- If (m <s) then the image is night image otherwise day light image.
- Invert night image. Then set threshold value for clear image and haze night image (let td).
- If (haze>td) then the image is called haze night image otherwise low light image.
- Apply dark channel prior method for transmission and atmospheric light estimation.
- Apply soft matting technique for estimating refined transmission and recover image.
- Apply adaptive gamma correction technique for enhanced transmission estimation.
- Recovered haze free night image and invert the image to recover scene radiance.
- If amount of haze is less than $t_{d,}$ then apply histogram equalization on invert image.
- Apply inverted function and then recovered scene radiance of haze free night image.

4. Proposed Approach Description

Our propose approach involves two important modules:

- Transmission Estimation Module
- Recover Scene Radiance Module

4.1 Transmission Estimation Module

The propose TE module is based primarily on the dark channel technique and is used to estimate the transmission map of a hazy image. However, two prominent problems exist in regard to the dark channel prior technique:

- Generation of halo effects
- Insufficient transmission map estimation.

The TE module circumvents these problems using a enhance transmission procedure. Because the primary operation of the dark channel prior depends on the minimum filter, the transmission map will usually experience a loss of edge information when estimation occurs. For this reason, we propose a enhance transmission procedure that uses an adaptive gamma correction technique to preserve edge information of input hazy images and there by avoid generation of halo effects. We apply an adaptive gamma correction technique to adjust the intensity of the transmission map to achieve optimum haze removal result that can effectively hold back impulsive noise components while preserve edge information and estimating sufficient transmission map. The enhanced transmission form Et (q) is derived via the adaptive gamma correction operate as

$$Et(q) = (D_{max}) \, (R_t(x) / D_{max})^\wedge\gamma \quad (4)$$

Where Et(q) is the maximum intensity of the input image, R_t is the transmission map after performing equation (3), Υ is a varying adaptive parameter, is equal to 0.60

4.2 Recover Scene Radiance

Using the small amount of natural low light and transmission map, the scene radiance quality can be improved according to equation one. The direct reduction expression can be extremely close up to zero when the transmission t(x) is close to zero. So, we limit the transmission map t(x) by the lower limit t_o and maintain a little fog in low light regions.

The image radiance J(x) is recovered as: [16]

$$J(x) = \frac{P(x) - A}{max(Et(q), t_0)} + A \tag{5}$$

Where t_o be 0.1.

5. Experimental Observations

The proposed algorithm is implemented in MATLAB version R2010b running on Windows 7 operating system with 4GB RAM. Refer to Table 1. sample input images. The peak to signal ratio (PSNR) and contrast to noise ratio (CNR) has been calculated for first output images of different authors using matlab code refer to Table 2 ; PSNR and CNR has been calculated for second output image using matla code refer to Table 3. *Graphical Analysis of Different Methods refer to Table 4.*

Table 1. Sample input images

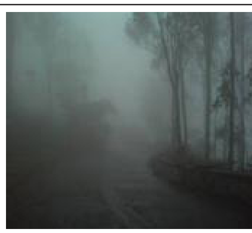
Sample Input Image			
S.No	**Image Name**	**Image**	**Original CNR**
1	Input1.jpg		216.1294
2	Input2.jpg		158.1688

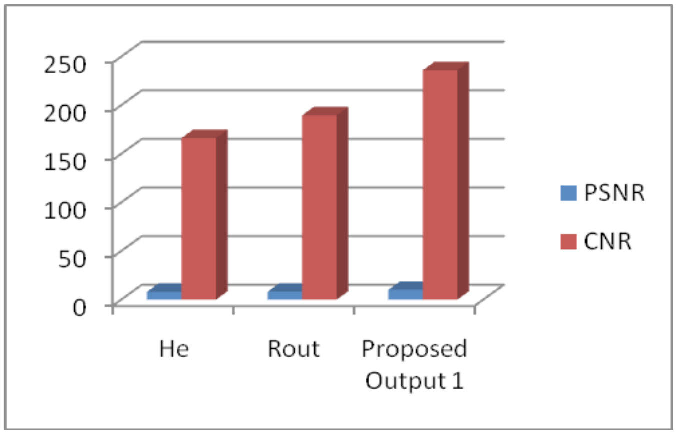
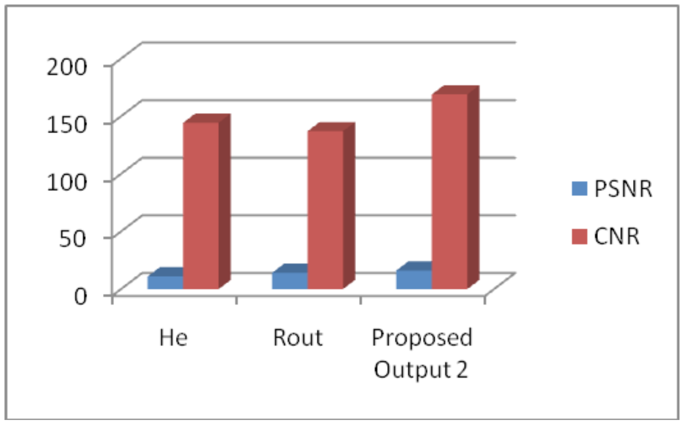
Table 2. Comparative Analysis of Different Methods on Image 1

RGB Input Image 1				
S.N	**Image**	**Author**	**PSNR**	**CNR**
1		He	8.104	166.300
2		Rout	8.240	189.714
3		Proposed Output 1	10.163	236.097

Table 3. Comparative Analysis of Different Methods on Image 2

RGB Input Image 2				
S. No	**Image**	**Author**	**PSNR**	**CNR**
1		He	10.9937	144.4179
2		Rout	14.0828	137.0335
3		Proposed Output 2	16.1394	168.9823

Table 4. Graphical Analysis of Different Methods

S.No	Image	Graph/Chart
1	RGB Input Image 1	
2	RGB Input Image 2	

6. Conclusion and Future Scope

The propose work applies a refined transmission procedure to avoid the generation of block artifacts in the restored output image using the DCP. Subsequently, an effective transmission is estimated by adjusting its intensity via an enhanced transmission procedure based on the adaptive gamma correction technique.

Since the weight parameter "w" generally varies from scene to scene, it becomes very important parameter to deal with the night haze image. Therefore our proposed model fails to make the parameter "w" adaptive for all night climate conditions

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