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Image Enhancement Techniques for Different Atmospheric Conditions

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Abstract: The problem of image enhancement thereby enhancement of scene visibility in outdoor images is handled. The most important challenge related to visibility is the atmospheric haze, fog and poor lighting. An automatic degradation detection and restoration algorithm has been proposed, which detects the type of degradation using the distribution of the scene, then uses the hybrid dark channel prior based haze removal algorithm.

Keywords: Haze, fog, DCP,Visibility

I. INTRODUCTION

The ultimate aim of image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. Image Enhancement is the technique to improve the interpretability or perception of information in images for human viewers.

In most outdoor processing the images are degraded due to hazy, hence the input image is hazy image not the original radiance. If the haze can be removed then the scene will have proper brightness, contrast and the information contents in the image will be high. The haze removal process is very complicated because the haze depends upon the unknown depth of the object in the scene. The second problem which has been considered is enhancement of image when it is captured under night condition. In this case the object is rarely visible and hence the captured image has less amount of information.

II. IMAGE ENHANCEMENT BY DE-HAZE

Haze is term used in image analysis, which is a set of atmospheric effect that reduces the contrast of an image. Hazy images can be visible between 2 to 5 km from viewer. Haze can be removed by dark channel prior method.

Nayar and Narsimhan[10] have studied a simple color model for atmospheric scattering and verify it for fog and haze. Then, based on the physics of scattering, derive several geometric constraints on scene color changes, caused by varying atmospheric conditions. Finally, using these constraints develop algorithms for computing fog or haze color, depth segmentation, extracting three dimensional structure, and recovering “true” scene colors, from two or more images taken under different but unknown weather conditions.

Tan[9] observes that the haze-free image must have higher contrast compared with the input haze image and he removes the haze by maximizing the local contrast of the restored image. The results are visually compelling but may not be physically valid.

Fattal[8] estimates the albedo of the scene and then infers the medium transmission, under the assumption that the transmission and surface shading are locally uncorrelated. Fattal’s approach is physically sound and can produce impressive results. However, this approach cannot well handle heavy haze images and may fail in the cases that the assumption is broken.

a) Dark Channel Prior Method

He[7] proposed a method which uses a key assumption that most local patches for outdoor haze-free images exhibit very low intensity in at least one of color channel, which can be used to directly estimate haze density and recover colors. the method of He is generally considered to be the best single image haze removal approach. However, the efficacy of haze removal may change in response to varied scene objects in realistic environments.

$$I(x) = J(x)t(x) + A(1 - t(x)) \qquad \text{Eq. (1)}$$

Where I am the observed intensity, J is the scene radiance, A is the global atmospheric light, and t is the medium transmission describing the portion of the light that is not scattered and reaches the camera. The first term J(x)t(x)in Eq.(1) on the right-hand side is called direct attenuation and the second term A(1-t(x)) is called airlight . The direct attenuation describes the scene radiance and its decay in the medium, and the airlight results from previously scattered light and leads to the shift of the scene colors.

b) Estimating the Transmission

The sky is infinitely distant and its transmission is indeed close to zero gracefully handles both sky and nonsky regions. Optionally keep a very small amount of haze for the distant objects is given by Eq.(2) introducing a constant parameter ω ($0 < \omega < 1$) .

$$\tilde{t}(x) = 1 - \omega \min_{y \in \Omega(x)} \left(\min_c \frac{I^c(y)}{A^c} \right) \qquad \text{Eq.(2)}$$

c) Soft Matting

The image matting equation:

$$I = F\alpha + B(1-\alpha) \qquad \text{Eq. (3)}$$

where F and B are foreground and background colors, respectively, and α is the foreground opacity.The derivation of the matting is based on a color line assumption: The foreground/background colors in a small local patch lie on a single line in the RGB color space.

d) Estimating the Atmospheric Light

The atmospheric light is the only illumination source of the scene. So, the scene radiance of each color channel is given by eq.(4).

$$J(x) = R(x)A \qquad \text{Eq. (4)}$$

where R <1 is the reflectance of the scene points.

e) Recovering the Scene Radiance

To restrict the transmission t(x) by a lower bound t0, preserve a small amount of haze in very dense haze regions. The final scene radiance J(x) is recovered by

$$J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A \qquad \text{Eq. (5)}$$

III. IMAGE ENHANCEMENT BY DE-FOGGING

Blur is factor that is responsible for reducing the visibility of images. Foggy images can be visible less than 1 km from viewer. De-fog method for improving the quality of image using depth of the image using blur estimation. Gibson and Nguyen[4] have proposed fast single image defogging method that uses a novel approach to refining the estimate of amount of fog in an image with the Locally Adaptive Wiener Filter. They provide a solution for estimating noise parameters for the filter when the observation and noise are correlated by decorrelating with a naively estimated defogged image.

Atmospheric Dichromatic Model

Removing fog from a single image is an under constrained problem that requires an inference method or prior knowledge of the scene. The amount of fog observed in an image is dependent on the distance of the object to the camera, wavelength of the light, and the size of the scattering particles in the atmosphere.

Given a foggy image y_i at pixel location i, $y \in R^3$, the "defogged" version $x_i \in R^3$

$$y_i = t_i x_i + (1 - t_i)a, \qquad \text{Eq. (6)}$$

where the airlight is $a \in R^3$ and transmission is $t_i \in R$

IV. ENHANCEMENT OF NIGHT IMAGES

Xuesong Jiang[5] presents a real-time night video enhancement approach. As observed that a pixel-wise inversion of a night video has quite similar appearance with the video acquired at foggy days, use the similar idea of haze removal method to enhance the perceptual quality of the night videos. It present an improved dark channel prior model and integrate it with local smoothing and image Gaussian Pyramid operators.

$$I_{inv}^{c}(x) = 255 - I^{c}(x) \qquad \text{Eq. (7)}$$

The low-light images or the night images contain very less amount of visual information. So to extract information go for image negative. But when images are inverted then inverted images has very similar statistics as the hazy images.

V. COMPARISON OF METHODS

TABLE I

No	Methods	Limitations
1	Combining Semantic Scene Priors and Haze Removal for Single Image Depth Estimation	This method does not work in indoor scenes.
2	Fog Removal Techniques from Images: A Comparative Review and Future Directions	This method doesn't give any idea about frequency domain and it's also time consuming.
3	A Novel Visibility Restoration Algorithm for Single Hazy Images	This method is complex and slower.
4	Fast Single Image Fog Removal Using the Adaptive Wiener Filter	It is based on the Prior Knowledge that the scene contains fog.
5	Single Image Haze Removal Using Dark Channel Prior	It fails to enhance the sky regions where the sunlight is very influential. So in outdoor image case the dark channel prior method is inefficient to enhance the entire scene.

VI. CONCLUSION

A comprehensive review of image enhancement techniques for haze and fog removal as well as night image has been considered. These techniques offer a wide variety of approaches that depends on the specific task, image content, and observer characteristic and viewing conditions. Different atmospheric condition can be derived to get more precise image details.

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