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Review Paper: Day/Night Image Haze removal using modified Dark Channel Prior Technique

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ABSTRACT

Existence of aerosols in the atmosphere results in reduced visibility of images taken under fog or haze conditions. Effect of haze can be removed by image dehazing methods. The method we have used is for both day and night time captured images. This is obtained by using subsequent histogram equalization, Denoising and contrast enhancement for day time images. Further we used preprocessing step of fixing color bias by changing color statistics to the required image after this, modified dark color channel prior is used to dehaze the image. The results obtained on the day/night images show the effectiveness of this method.

***Keywords:*—** Image dehazing, unconstrained, dark channel prior.

I. INTRODUCTION

Aerosols present in atmosphere reduce the visibility of images captured. During hazy and foggy atmosphere images captured have reduced light transparency and hence the reduced visibility. Light gets reflected due to haze which has color of the ambient light. This color if constant over picture can be calculated and then we can remove that constant value from each pixel. Image dehazing methods helps recover the image visibility and obtain clearer images.

The various methods available can be used for either daytime images or night time images, but our proposed method can dehaze the day/night time image. It uses subsequent histogram equalization, denoising and contrast enhancement for daytime image and that for night time image pre-processing step of fixing color bias by changing color statistics to that of required image followed by the modified dark channel prior.

The dark channel prior method uses the approach of detecting low intensity pixels over the entire image. These pixels can directly provide estimation of haze's transmission. The proposed method uses a relaxed imaging equation to properly handle night-time haze images. Our method estimates atmospheric light with different colors and also their influence on different parts of the image. Though our relaxed model is similar to dehaze night-time images, our method dehazes daytime images also using the same model.

The methods used are discussed in the methodology section. The methods are explained through equations. All these methods assume that the atmospheric light is constant throughout the image. Day time images contains all colors, but during night time, artificial lights produce non uniform lightening. To deal with night time images, dark channel prior is introduced. The equations are given for the same.

II- LITERATURE SURVEY

[1] Fog and haze degrade the quality of preview and captured image by reducing the contrast and saturation. As a result the visibility of scene or object degrades. The objective of the present work is to enhance the visibility, saturation, contrast and reduce the noise in a foggy image. The method is fast and free from noise or artifacts that generally arise in such enhancement techniques.

[2] An advanced driving assistance system (ADAS) must also take into account the weather conditions. One of the most dangerous weather conditions for driving scenarios is the presence of fog. So an important task for a driving assistance system is to detect the presence of fog, estimate the fog's density and determine the visibility distance of the driver. It is based on a single in-vehicle camera and is actually an improvement over existing fog detection solutions, in terms of speed and accuracy. After detecting the presence of fog in the image and based on the fog's density we are able to compute the visibility distance and inform the driver about the environment's weather conditions.

[3] Limited visibility in haze weather strongly influences the accuracy and the general functions of almost outdoor video surveillance or driver assistance systems. Actual weather condition is valuable information to invoke corresponding approaches. Based on the atmospheric scattering model analysis and the statistics of various outdoor images, for most foggy images, we find that the lowest and highest value in color channels tends to be the same value of atmospheric light. A function for estimating the haze degree is developed for the automatic detection of the foggy image with different haze degrees. Experimental results show that our haze classification method achieves high performance.

[4] Under bad weather conditions, the light reaching a camera is severely scattered by the atmosphere. The resulting decay in contrast varies across the scene and is exponential in the depths of scene points. Therefore, traditional space invariant image processing techniques are not sufficient to remove weather effects from images. We present a physics-based model that describes the appearances of scenes in uniform bad weather conditions. Changes in intensities of scene points under different weather conditions provide simple constraints to detect depth discontinuities in the scene and also to compute scene structure. All the methods described are effective under a wide range of weather conditions including haze, mist, fog, and conditions arising due to other aerosols.

[5] The conventional dark channel prior method removes haze and thus restores colors of objects in the scene, but it does not consider the enhancement of image contrast. On the contrary, the image contrast method improves the local contrast of objects, but the colors are often distorted due to the over-stretching of contrast. The proposed algorithm combines the advantages of these two conventional approaches for keeping the color while dehazing. For this, an optimization function is proposed to balance between the contrast and colors distortion, where the contrast measure follows the conventional image statistics and the hue component is used to constrain the color changes.

[6] In computer vision, the absorption and scattering processes are commonly modelled by a linear combination of the direct attenuation and the airlight. This method is based on two basic observations: first, images with enhanced visibility (or clear-day images) have more contrast than images plagued by bad weather; second, airlight whose variation mainly depends on the distance of objects to the viewer, tends to be smooth.

[7] Atmospheric conditions induced by suspended particles, such as fog and haze, severely degrade image quality. Haze removal from a single image of a weather-degraded scene remains a challenging task, because the haze is dependent on the unknown depth information. Here, we introduce an improved single image dehazing algorithm which based on the atmospheric scattering physics-based models. We apply the local dark channel prior on selected region to estimate the atmospheric light, and obtain more accurate result. Experiments on real images validate our approach.

[8] Images captured in hazy or foggy weather conditions can be seriously degraded by scattering of atmospheric particles, which reduces the contrast, changes the color, and makes the object features difficult to identify by human vision and by some outdoor computer vision systems. Firstly, we innovatively divide a number of approaches into three categories: image enhancement based methods, image fusion based methods and image restoration based methods.

[9] Air particles, which present in atmosphere and affect the visibility level of any object, are called noise or unwanted signal between observer and object. For improving the visibility level of an image and reducing fog and noise various image enhancement methods are used. After enhancement is again restored the enhanced image by restoration methods. For improving the visibility level 4 major steps are used. First step is acquisition process of foggy images. Second is estimation p rocess (estimate scattering phenomena, visibility level). Third is enhancement process (improve visibility level, reduce fog or noise level). Last step is restoration process (restore enhanced image).

[10] Two approaches are used to evaluate these algorithms: one is computing the ratio between the gradient of the visible edges in the images before and after fog removal; another one is using a psychophysical method with human observers and a rank order protocol. Using both computing based and psychophysical based methods allows us to investigate whether they lead to comparable results.

III- METHODOLOGY

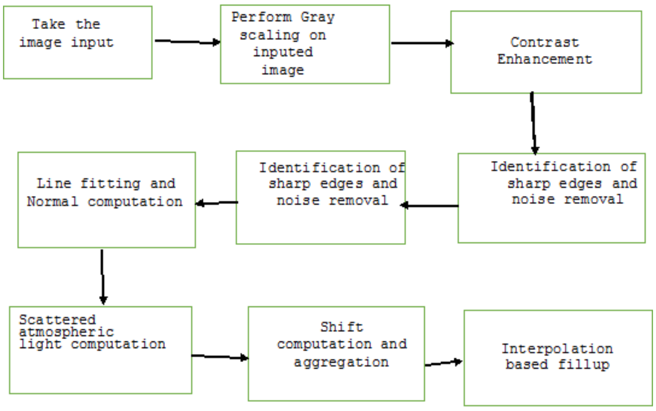

Fig:3.1 Process Overview of Methodology

From the fig. 3.1 we see that in this project, the input of program is an Image. This image contains atmospheric light which is distracted by dust particles and haze. The visibility of the image may not be clear due to the presence of aerosols in the atmosphere.

A. Gray Scaling:

Gray scaling is performed on the image so that manipulations can be performed on the captured image. It converts the image into range of pixels. Intensity of pixels is determined by same. Below given is the equation for gray scale(G) of image.

$$G = (\max(R, G, B) + \min(R, G, B)) / 2$$

Here, R denotes red, G denotes green,B denotes blue color respectively.

A discrete grayscale image {x} and let n_i be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$p_x(i) = p(x = i) = \frac{n_i}{n}, \quad 0 \le i < L$$

B. Contrast Enhancement:

Contrast Enhancement is a technique for adjusting image intensities to enhance contrast.

$$CE(v) = \text{round } cdf(v) - \text{cdfminx } /((M \times N) - cdfmin) * (L-1)$$

where cdf_{min} is the minimum non-zero value of the cumulative distribution function (in this case 1), M × N gives the image's number of pixels (for the example above 64, where M is width and N the height) and L is the number of grey levels used (in most cases, like this one, 256).The equalization formula for the example scaling data from 0 to 255, inclusive, is:

$$CE(v) = round (cdf(v) — 1 x 255) 63$$

C.Scattered atmospheric light computation:

Random Sample Consensus or RANSAC is iterative method to estimate a mathematical model from data set which contains outliers. It assumes two points (I_1,I_2) to define estimated line and set of inliner points. Normal to the plane containing color line and origin is also computed. Here parameters of line($L= \rho D+ P_0$) and normal computed as $P_0=I_1$,

$$A= \frac{I_2 - I_1}{|I_2 - I_1|} \quad , n= \frac{I_1 \times I_2}{|I_1 \times I_2|}$$

In this step, amount of shift of line from origin in direction if A is computed. This is achieved by minimizing the error,

$$E_{intersect}(\rho,\delta)=\min_{\rho,\delta}||P_0+\rho D-\delta A||^2 ,$$

here δ is the amount of shift of line. Estimated shift is validated using following tests:

Large intersection angle: Angle between A and D must be large enough otherwise there might be chances of error in shift estimation.

Low intersection error: If value of $E_{interest}$ is not close to zero, then line is still away from origin after being shifted. Hence we need this value to be small.

Valid range: Value of shift can't be arbitrary as t(x) is between 0 & 1 and m(x) is within known range. Shift should be between 0 and minimum intensity of patch.

D. Shift computation and aggregation:

We already computed A's and a(x) at each pixel in previous step, so we can compute airlight component (a(x)A^(x) = (1 - t(x))m(x)A^(x)) of an image. On subtracting these from original image we get airlight free original image:

$$J(x)t(x) = I(x) - (1 - t(x))m(x)A\hat{}(x).$$

Contrast enhancement of the image is based on intensity reduction caused by subtraction of airlight * component.

$$Rim = \frac{I(x) - (1 - t(x))m(x)A\hat{}(x)}{1 - Y((1 - t(x))m(x)A\hat{}(x))}$$

$$Y (I(x)) = 0.2989I_R(x)+0.5870I_G(x)+0.1140I_B(x)$$

E. Interpolation based fill-up:

The above computed values are required for every pixel to dehaze an image. The point should be kept in mind is that the image may or may not night time. So, we interpolate values of these pixels before dehazing the image. Here we need to interpolate two values i.e., A and a(x). We denote each one of A by a label and compute their influence at all the pixels. The influence of each label is obtained by minimizing the function given below:

$$Einfl(F) = (F - P)^T * (F - P) + \lambda/2 * F^TLF;$$

Where F is a matrix of size numpixel x numlabel with entry F(i , j) denoting the influence of j^{th} A on i^{th} pixel. P is also a numpixel x numlabel matrix with P(i, j) = 1 if j^{th} A is assigned to i^{th} pixel during aggregation. The scalar λ controls the smoothness of the influence. L is the Laplacian matrix of the graph constructed from the given image taking each pixel as a node and $1/|| I(x) - I(y)||^2$ as weight of the edge between pixels x and y. Neighbourhood of a pixel is also defined accordingly. The final interpolated A(x) is a normalized weighted sum of the A's where the weights are the influences.

This helps dehaze the image in a considerable extent and further modification can carried forward. The output image will be a dehazed image.

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