Removing Atmospheric Noise Using Channel Selective Processing For Visual Correction

Rajbeer Kaur
M.tech(ECE)
Chandigarh Engineering College(Landran)
Mohali, India
buttar.143@gmail.com

Er.Aman Saini
Assistant Professor(ECE)
Chandigarh Engineering College(Landran)
Mohali, India
cecm.ece.aman@gmail.com

Abstract— In the presented paper; we propose an effective image fog removal technique with a color stabilization technique which is a total 2-level process for image restoration with a HSI (Hue Saturation Intensity) based evaluation process. The approach uses extraction of suppressed pixels from an RGB image affected by smoke, steam, fog which is form of white and Gaussian noise. From our observation of most images in fog environment contain some pixels which have low values of luminescence in every color channel (considering RGB image).Using this model, we can directly estimate the effective density of fog and recover the most affected parts in the image. The parameter of calculating the effective luminescence which is a form of intensity, and also gives the scattering estimates of the light, the combined Laplace of the luminescence-light and suppressed pixels values gives us the basic map of light spread which is further used in the restoration of intensity. The transmission of intensity between the calculated fog values in the image give the estimate for the local transition between the intensity values and color values. This factor helps in the color restoration of the affected image and estimates the proper restoration of image after removal of dense fog particles. After the removal of fog particles, we then restore the color balance in the image using an auto-color-contrast stabilization technique. This is the 2-level fog restoration method. The visibility is highly dependent on the saturation of color values and not over saturation, which accounts for image quality improvements. In order to evaluate in-depth the effectiveness, we have also introduced the HSI mapping of the images, as this will show the true restoration of intensity and saturation in the fog image. Results on various images demonstrate the power of the proposed algorithm. To measure the efficiency of the algorithm the parameter of visual index is also estimated which further evaluates the robustness of the proposed algorithm for the HVS (Human Visual System) for the de-fogged images.

Keywords- *HVS, HSI, fogging, defogging, luminous, radiance.*

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INTRODUCTION

Images of natural scenes are usually degraded by the various turbulences in the atmosphere. Fog, steam and smoke are such forms of atmospheric noises caused due to atmospheric absorption and scattering. The visual data received by the camera from the target point is attenuated along the line of sight. The degraded images lose the contrast and color. Since the amount of light deflection depends on the distances of the projected points from the camera, the degradation is spatial-variant. Fog removal is highly desired in both consumer and computational photography and far vision applications. First, removing fog can significantly increase the visibility of the scene and correct the color shift caused by the luminescence. The fog-free image is more visually pleasuring. Most computer vision algorithms, from low-level image analysis to High-level usually assume that the input image is the Radiance. The fog removal can produce depth information and benefit many vision algorithms and advanced image editing. The bad fog image can be put to good use. Improving the quality of foggy or fog image falls into two broad categories: 1) Adjusting contrast related to visibility of the image, 2) Enhancing local contrast representing details of the image. For improving visibility of a foggy image, defogging methods exist for color images [1, 2]. The defogging also reduces the details in an image. To reduce the loss of details, we propose a method to defog fog or smog in the spatial domain first and then enhance the local contrast in the transform domain; the truth evaluation is done through the HSI modeling of the resultant images of the algorithms.

BACKGROUND

Recently, image fog removal [3, 4] has made significant progress. The success of these methods lies in using a stronger prior or assumption. Tan [5] observes that the fog-free image must have higher contrast compared with the input fog image and he removes the fog by using the local contrast of the foggy image. In general de-hazing is formulated as:

$$I(x) = J(x)\, t(x) + A(1 - t(x)) \quad (1)$$

Where I is 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 goal of haze removal is to recover J, A, and t from I. The results are visually compelling but may not be physically valid. Estimations of the scene and transmission are done under the assumption that the surface shading is locally uncorrelated. The approach is physically sound and can produce impressive results [6]. The proposed method also significantly reduces ringing artifact by increasing the local contrast along edge directions. Moreover, the proposed method adjusts the local contrast in each frequency component, whereas the conventional methods adjust the contrast in frequency bands. Consequently, the enhancement performance of the proposed method yields high quality images and is more robust compared to the conventional methods.

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Our approach is color and intensity of objects even in the heavy fog image. We do not rely on significant variance on transmission or surface shading in the input image. Like any approach using a strong assumption, our approach also has its own limitation. The suppressed pixels of all three channels (RGB channels) may be invalid when the scene object is inherently similar to the air luminescence over a large local region.

SUPPRESSED PIXELS FROM RGB CHANNELS

The suppressed pixel extraction is based on the following observation on fog affected images: in most, at least one color channel has very low values at some pixels. But most of the times all the color channels are affected depending upon the scene of the image. The low intensities in the given channels are mainly due to the light scattering and attenuation done by the fog particles, which as a result account for color dilation in the image and reduced saturation, this effect can be easily depicted with the help of HSI model on an image, where all the properties can be seen in the images.

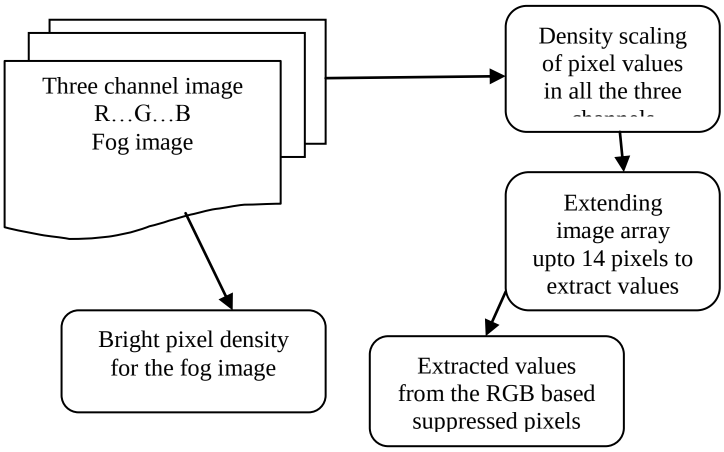

Fig.1 Minimization and luminous pixel extraction

CALCULATING LUMINESCENCE INTENSITY

Here, we first assume that the luminescence L is given. We will present an automatic method to estimate the atmospheric luminescence. We further assume that the transmission in a local patch is constant. We denote the luminescence as Lx.

$$Sup(I(y))=Lx*sup(J(y))+(1-t(x))*L \quad (1)$$

The above equation estimates luminescence for the fog particles and hence a nice property of this modification is that we adaptively estimate the density of fog more for the distant objects. It is roughly good but contains some block effects since the transmission is not always constant in a patch. In the next subsection, we refine this map using a patting method.

ALPHA STABILIZATION

It is seen that the fog image after knowing the luminescence also tells about the intensity of light alpha particles. The luminescence map is exactly an alpha estimation. Therefore, we will apply the alpha stabilization algorithm to filter the luminescence. Alpha Stabilization method will also deal with the white balance issue aroused in restoration process.

SCENE RADIANCE

We recover the scene radiance by calculating filtering the image using patch processing by using window filtering. We have to look for attenuation constants which can be zero when the luminescence is close to zero. The recovered radiance R can contain other noises from the atmosphere. Therefore, some amount of mist or fog is evidently present in some regions of the image. The total scene radiance with use of windowing process is recovered as Rx by:

$$Rx = I - L(x) \quad (2)$$

The value of x is 0.1%.Since scene radiance is not as bright as luminescence; the image after defogging removal looks less vivid as the process causes loss of color information and a decrease in saturation of contents of the image this is due to window process smoothing, which we have corrected in the next section of the fog image restoration.

HSI COLOUR MODEL

The HSI (Hue, Saturation and Intensity) color model describes a color showing how it is perceived by the human eye.

HUE

The "attribute of a visual sensation according to which an area appears to be similar to one of the perceived colors: red, yellow, green, and blue, or to a combination of two of them".

INTENSITY

The total amount of light passing through a particular area is the intensity relative to its corresponding areas.

SATURATION

Brightness and colorfulness are absolute measures, which usually describe the spectral distribution of light entering the eye, while lightness and chroma are measured relative to some white point, and are thus often used for descriptions of surface colors, remaining roughly constant even as brightness and colorfulness change with different illumination. Saturation can be defined as either the ratio of colorfulness to brightness or of chroma to lightness.

The HSI model is useful when processing images to compare two colors, or for changing a color from one to another.

COLOUR RESTORATION USING AUTO-CONTRAST SETTING

The color optimization is an algorithm that takes in a sequence of images of a constant scene taken over time and recovers the scene radiance in the absence of the visual effect of fog and a transmittance map which can be easily converted into a depth map. In this section we will see the results of this algorithm from the perspective of defogging. To account for an inaccurate assumption as movement of the direction of illumination which causes a change in the intensity of the scene radiance, we normalized each image by dividing by the average irradiance over a patch of the scene in the foreground. The reason we chose a patch of the scene in the foreground is that foreground objects are least affected by fog and therefore give us more accurate information on how the scene radiance intensity varies with changes in illumination. Further away objects would be affected greatly by fog and would therefore give inaccurate variations of scene radiance intensity.

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BLOCK DIAGRAM OF ALGORITHM

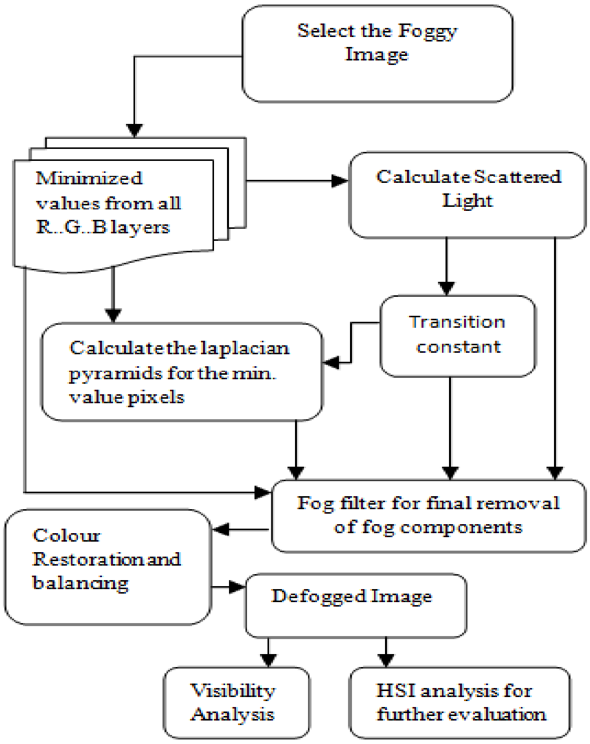

Fig.2 Defogging process block diagram

PROCESS FOR DEFOGGING OF IMAGES

1. Select the image to be processed and calculate min. values of pixels from all three layers.
2. Using the calculated min. values and a constant luminosity, we determine the amount of scattering given to the natural light.
3. Then we calculate Laplace using the RGB values and a transition constant derived from the scattered light calculation.
4. Using the above processed values we recover the defogged image.
5. Further the image is processed and colour balance is maintained in the image using a restoration process utilizing the contrast values of the restored image.
6. In order to prove the effectiveness of the algorithm we calculate the visibility and mean HSI values for the defogged image.

RESULTS AND ANALYSIS

A. Base Defogging HSI Result

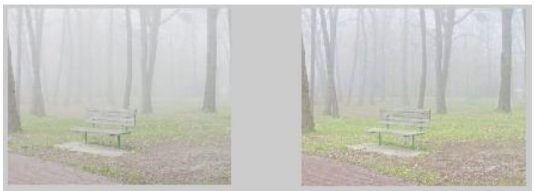

Fig.3 shows input image (left) and output image (right).

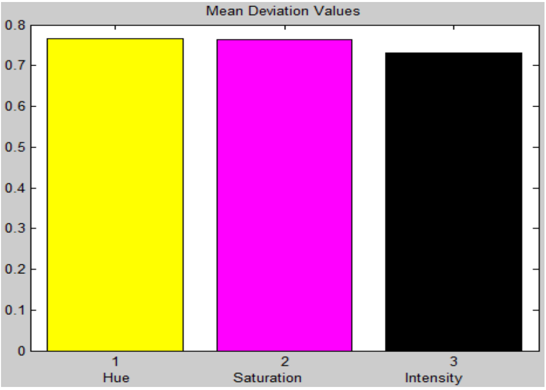

Fig.4 shows the Hue, Saturation and Intensity values for defogged image.

B. Proposed Defogging HSI Result

Fig.5 shows input image (left) and output image (right).

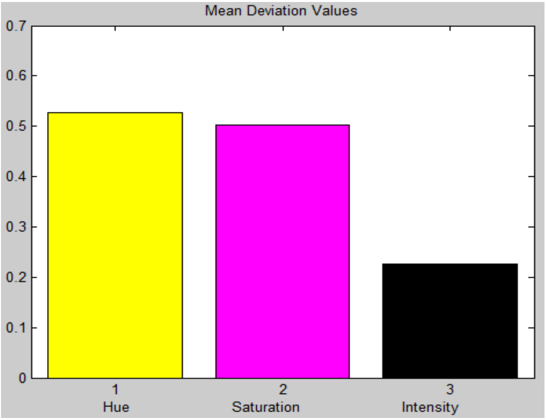

Fig.6 shows the Hue, Saturation and Intensity values for defogged image.

C. Base Defogging HSI Result

Fig.7 shows input image (left)and output image (right)

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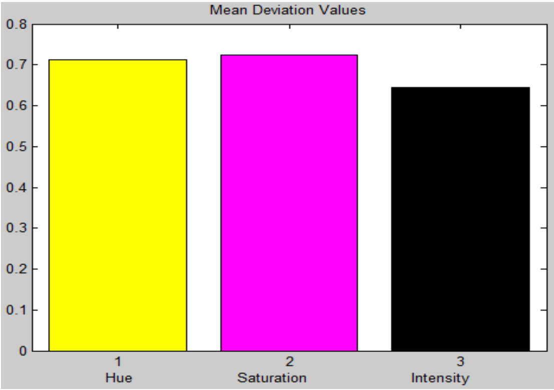

Fig.8 shows the Hue, Saturation and Intensity values for defogged image.

D. Proposed Defogging HSI Result

Fig.9 shows input image (left) and output image (right)

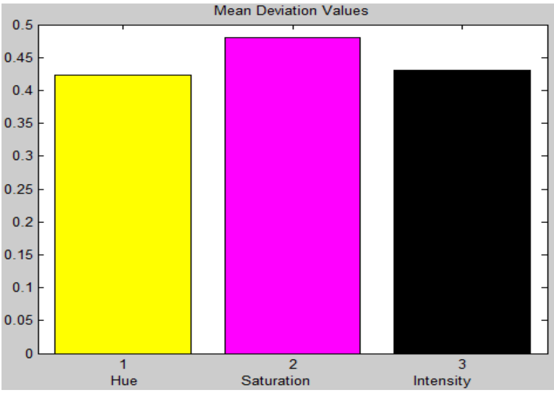

Fig.10 shows the Hue, Saturation and Intensity values for defogged image.

The above figures (from fig.3 to 10) show the results for the defogging process and also evaluate the efficiency of the algorithm numerically with HSI analysis to predict its visual efficiency.

Below given tables 1 & 2 which show the comparison between the visibility index of the base and proposed approach and also that of the HSI value means.

Table .1 shows Comparison of Visibility Index for defogged images.

Image Name	**Visibility Fogged**	**Visibility Base Defogged**	**Visibility Proposed Defogged**
Bench	50.57	66.76	97.62
Fisher	18.06	26.05	32.86
Street	56.11	70.11	54.73
City	39.25	40.51	42.63
Forest	40.24	49.66	91.56

Table.2 shows the comparison of the Hue, Intensity and Saturation values for defogged images

Image Name	**Hue Mean values**	
	Base	Proposed
Bench	0.76	0.52
Boat	0.71	0.42
Street	0.53	0.30
City	0.78	0.43
Forest	0.71	0.68
Image Name	**Saturation Mean values**	
	Base	Proposed
Bench	0.76	0.50
Boat	0.72	0.47
Street	0.55	0.34
City	0.80	0.43
Forest	0.69	0.46
Image Name	**Intensity Mean values**	
	Base	Proposed
Bench	0.73	0.22
Boat	0.64	0.43
Street	0.58	0.43
City	0.69	0.28
Forest	0.62	0.15

CONCLUSION

In this work, we have presented an image defogging process which does not require any substitutive information like multiple images, hardware, etc. Our approach is simple and involves a forward approach. Based on a minimized pixel values, their light scattering and transition in the observed image and its Laplace, we are able to identify the foggy regions of the image. After we have identified these regions, we are able to produce a fog-free image using a filter designed by using above calculated parameters. The processing time of our technique is dependent upon the image size, but the results when compared to previous methods which were designed and optimized for speed, our approach show exceptional results with minor difference in speed. In the future, we will be investigating a more comprehensive optical model, as well as extending our work to the problem of live image defogging and with much faster speed.

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