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Haze Removal using Optical Transmission Map and Adaptive Atmospheric Light

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ABSTRACT

Haze removal is a very common problem that we face in photography and other fields; existing models are not very accurate in removing yellow dust and other disturbances caused by light scattering and reflection. We are attempting to reduce noise and haze in the image by using optical transmission mapping and adoptive atmospheric light. We are also attempting to increase image quality by using image enhancement techniques. Several studies are being conducted.

Using a variety of techniques, remove the haze and improve the image's quality and resolution. Existing methods are typically founded on various priors; as a result, they perform poorly in situations where the priors do not hold. By investigating hazy

Keywords: Transmission Mapping,Adoptive atmospheric light, Image processing techniques, Dehazing

1.INTRODUCTION

Haze is an atmospheric phenomenon caused by dust, smoke, and other dry particulates that obscure the purity of the sky. In the World Meteorological Organization's manual of codes, fog, ice fog, steam fog, mist, haze, smoke, volcanic ash, dust, sand, and snow are all classified as horizontal obscuration. Haze particles are produced by agriculture (plowing in dry weather), traffic, industry, and wildfires. When viewed from a distance (for example, from an approaching airplane), haze may appear brownish or bluish, depending on the angle of view concerning the Sun, whereas mist is bluish-grey. Mist formation is a humid air phenomenon, whereas haze is commonly thought of as a dry air phenomenon. Haze particles, on the other hand, could be useful. when warmer air over water collides with the cooler surface of the land.

Mist can also form when warm air from the land collides with cooler air over the ocean. Summer fog in San Francisco, California is caused by this. You can even make mist by exhaling warm air from your body into the cold air, as you're probably aware.

Mist is similar to its cousin, fog. The distinction between the two is determined by your ability to see. Mist has a lower density than fog. If you can't see more than one kilometer (two-thirds of a mile) ahead of you, fog is obscuring your vision. If you can see beyond that, it's mist.

The term haze is commonly used in meteorological literature to refer to wet aerosols that reduce visibility. Such aerosols are frequently formed as a result of complex chemical reactions that occur when sulfur dioxide gases emitted during combustion are converted into small droplets of sulfuric acid. In the presence of sunlight, high relative humidity, and stagnant airflow, the reactions are accelerated. Wet-haze aerosols appear to contain a small number of compounds released by trees, such as terpenes. For all of these reasons, wet haze is primarily a summer phenomenon.Large areas of haze covering many thousands of kilometers mMist produced by volcanic activity is simply hot water vapor expelled by a volcano along with gases and, occasionally, lava. Steam vents or cracks in the Earth's surface around volcanoes and geysers emit volcanic mists. Volcanic mists are sometimes watery clouds that you can walkthrough. Steam vents are popular tourist attractions at Hawaii's Volcanoes National Park.

These techniques become important since the world war-1 & world war-2 they majorly use these techniques fora better understanding of their territoryinthe late ’80s and become 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), X. Zhao, "Single Image Dehazing Using Bounded Channel Difference Prior," 2021. This paper estimates the transmission map of weather-degraded images. They provided a basic understanding of how haze is formed, the characteristics of haze formation, and how to reduce haze more effectively using transmission mapping. As a result, we can develop more effective methods to reduce atmospheric scattering and yellow dust formation in the atmosphere.

Dat ngo and Seungmin Lee from Dong-A

2.LITERATURE SURVEY

X. Zhao, "Single Image Dehazing Using Bounded Channel Difference Prior," 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW),. This paper estimates the transmission map of weather-degraded images. They provided a basic understanding of how haze is formed, the characteristics of haze formation, and how to reduce haze more effectively using transmission mapping. As a result, we can develop more effective methods to reduce atmospheric scattering and yellow dust formation in the atmosphere.

Dat ngo and Seungmin Lee from Dong-A University's Department of Electronics Engineering, Busan 49315, Korea, This paper employs transmission mapping and haze removal from digital images. They provided a basic understanding of how to use image processing techniques in adverse weather conditions.

One of the most well-known single-image dehazing methods in image processing is the dark channel prior (DCP) proposed by He et al. DCP assumes that an extremely dark pixel exists in every color channecolorhe local non-sky patch surrounding all pixels. This is a strong prior that leads to excellent indoor dehazing performance. However, DCP works in the sky region in an unpredictable and time-consuming manner. DCP has since been improved in a variety of ways. Kim et al. used an edge-preserving filter called the modified hybrid median filter to accelerate the processing speed, albeit with slight background noise, after observing that the computationally expensive drawback of DCP is largely due to the use of the soft-matting method. Furthermore, their algorithm

In this paper, we present a machine-learning-based method for removing haze from single images using an optimal transmission map and adaptive atmospheric light (OTM-AAL). The following are the main contributions of this method:

Because haze reduces the contrast, sharpness, and thus the information conveyed by an image, an objective function quantifying this type of adverse effect is developed and then optimized to achieve an accurate estimate of the atmospheric extinction coefficient. For the sake of simplicity, locally homogeneous

2.**Atmospheric scattering model-**

McCartney proposed the atmospheric scattering model, which is as follows and provides basic information about atmospheric scattering:

$I(x,y)=J(x,y)\cdot t(x,y)+A\cdot[1-t(x,y)]$

The two-dimensional coordinates' image pixels are denoted by (x,y).

It represents the hazed image (x,y).

The letter J denotes a haze-free image.

The total amount of light in the atmosphere is represented by A.

J(x,y)t describes the direct attenuation of scene radiance in the transmission medium (x,y).

A[1t] represents the amount of scattered light entering the aperture and causing additive distortion of the scene radiance (x,y).

By rewriting the above equation, we can obtain a haze-free image:

J(x,y)=I(x,y) −A^(x,y) +A^(x,y)

max[t(x,y),tmin] A(x,y),

Here t^ and A^ are estimates of t and A.

3. PROPOSED ALGORITHM:

Haze Features:

Due todirect attenuation and additive,e The loss of contrast and image details is primarily caused by the distortion of the scene radiance, which is normally represented by transmission mapping, in which the values near zero represent the degraded haze image and the values near one represent the clear image captured by the camera or lens or undegraded part of the image, and in which we are using a few techniques to increentropyophy and sharpen the image.

The following are some of the characteristics of haze:

(1)**Contrast Energy**(CE):The contrast of an image is defined as the energy required to increase or improve the quality of the input image by increasing the intensity of the image by adjusting the intensity values from minimum to maximum. (CE). To increase the contrast of the image, we use a second-order derivative filter in this process.

The following is the contrast energy equation:

$$CE(\mathbf{I}_c) = \frac{\gamma \cdot Z(\mathbf{I}_c)}{Z(\mathbf{I}_c) + \gamma \cdot \kappa} - \tau_c$$

$$Z(\mathbf{I}_c) = \sqrt{(\mathbf{I}_c * h_h)^2 + (\mathbf{I}_c * h_v)^2}$$

I, γ denotes the maximum value of Z(Ic)

κ denotes the constant gain

τc denotes the noise threshold of individual color channels

hh and hv are kernels of the horizontal and vertical Gaussian second-order derivative filters

2.**Image Entropy**:(IE)

Image entropy tells us how much uncertainty is in an image (or) how much information is provided by the image. information about the image and less entropy contains less information about the image. image intensity levels in the grayscale channel Igray can be given as follows:

$$IE(\mathbf{I}_{gray}) = -\sum_{\forall i} p_i \cdot log_2(p_i)$$

3.**Statistical Image:**

. . In this process, we represent the image in a two-dimensional array with rows and columns, and we use local standard deviation (σ) and normalized dispersion (η) to quantify image details.

$$\mu(x,y) = \sum_{i,j} \omega(i,j) \cdot \mathbf{I}_{gray}(x+i, y+j)$$

$$\sigma(x,y) = \sqrt{\sum_{i,j} \omega(i,j) \cdot [\mathbf{I}_{gray}(x+i, y+j) - \mu(x,y)]^2}$$

$$\eta(x,y) = \frac{\sigma(x,y)}{\mu(x,y)+1}$$

μ is the local mean

ω denotes the local Gaussian weighting kernel

(i,j) denotes the coordinates in ω.

Optical transmission map estimation:

estimation of the optimal transmission map is as follows:

$$t(x,y) = e^{-\beta \cdot d(x,y)}$$

β is a positive constant representing the extinction coefficient of the atmosphere

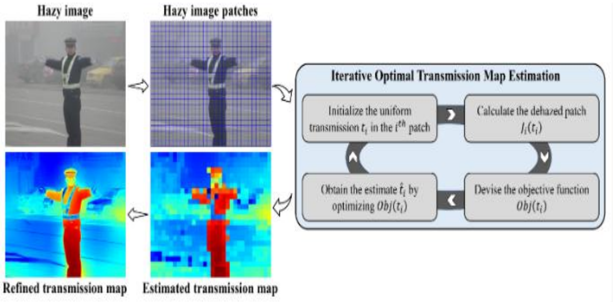
d is the scene depth.

. The above relationship shows that the haze distribution is proportional to depth. In this estimation, we divide the haze image into non-overlapping square patches, then use a four-step algorithm to estimate the optical transmission in each patch, and its expression is as follows.:

$$Obj(t_i) = CE[\mathbf{J}_i(t_i)] \cdot IE[\mathbf{J}_i(t_i)] \cdot \sigma[\mathbf{J}_i(t_i)] \cdot \eta[\mathbf{J}_i(t_i)]$$

CE[Ji(ti)]=∏cCE[Jic(ti)] represents the contrast energy over three opponent color channels

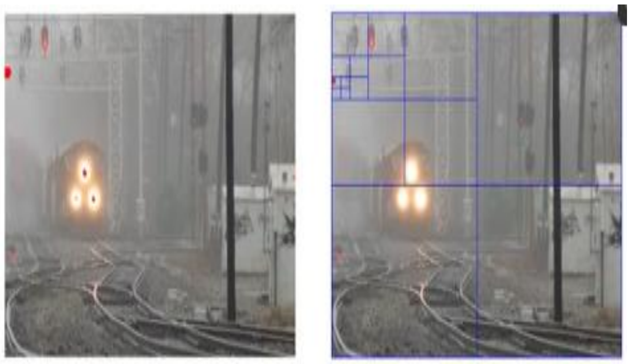
each patch for IE[Ji(ti)], σ[Ji(ti)], and η[Ji(ti)]. Because the adverse effects of haze include contrast reduction and loss of image details, maximizing the objective function Obj(ti) results in the optimal transmission map value t^



Adaptive Atmospheric Light Estimation:

. Atmospheric light estimation-based dehazing algorithm to obtain high visual-quality remote and high-quality images, in this atmospheric light estimation we use quad decomposition technique to de haze the image, there are two major challenges that we are facing in the atmospheric light estimation high computational cost and functional defects in scenes containing large white objects, An atmospheric light pixel is the brightest of a predetermined percentage of pixels in the most haze-opaque region. This method of identifying atmospheric light necessitates sorting all pixels and searching over the ones that have been chosen. Furthermore, if the percentage is not carefully calculated, the estimated atmospheric light may belong to a white object, such as a light bulb.

. The quad-decomposition algorithm can prevent these undesirable effects. The minimum filter is used to reduce the intensity of white objects in the input image. The image is then divided into quarters, and the quarter with the highest average luminance value is chosen. The decomposition process is repeated on the chosen quarter until its size is less than a predetermined value. As the atmospheric light, the pixel with the smallest Euclidean norm to the white point in the RGB color space is chosen within the chosen quarter.



The atmospheric light returned by the quad-decomposition algorithm is used as an initial estimate for determining adaptive lightness, which is generally assumed to be smooth except in special image regions such as dar

k areas. The objective function (ObjA) is designed with the following two constraints: I the recovered image's luminance must not decrease significantly to prevent detail loss in low-light regions, and (ii) the adaptive atmospheric light (A) must vary around the initial estimate (A0), LI and LJ denote the luminance channels of the input hazy image and recovered image, respectively; is the regularisation parameter, and () is the smoothness regularisation function.

$$Obj_{\mathbf{A}}(x,y) = [L_{\mathbf{J}}(x,y) - L_{\mathbf{I}}(x,y)]^2 + \lambda[\mathbf{A}(x,y) - \mathbf{A}_0]^2 + \mathbf{\Psi}[\mathbf{A}(x,y)]$$

The presence of (causes the function ObjA to become nonlinear, making direct optimization difficult. As a result, it is more convenient to approximate the optimization by leaving out the term (). The remaining linear function (ObjA) is easily optimized, and the guided image filter is applied to the discovered minimum to achieve the smoothness regularisation effect. The linear function ObjA and its corresponding derivatives are expressed using the linearity of the atmospheric scattering model as follows:

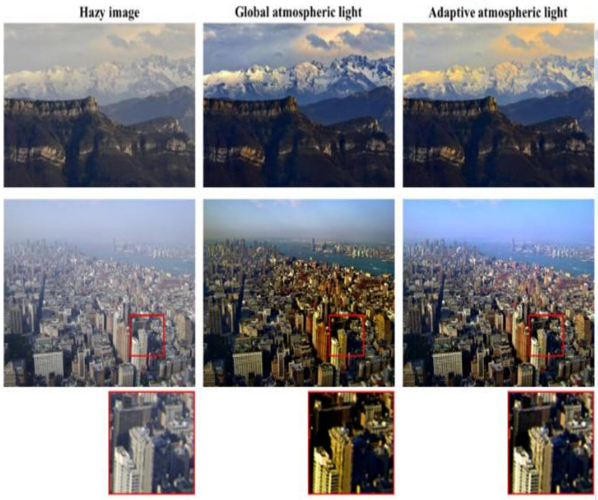
$$\hat{Obj}_{\mathbf{A}}(x,y) = \{\alpha(x,y)\cdot[L_{\mathbf{I}}(x,y) - \mathbf{A}(x,y)]\}^2 + \lambda[\mathbf{A}(x,y) - \mathbf{A}_0]^2,$$

$$\frac{d\hat{Obj}_{\mathbf{A}}}{d\mathbf{A}}(x,y) = -2\alpha^2(x,y)\cdot[L_{\mathbf{I}}(x,y) - \mathbf{A}(x,y)] + 2\lambda[\mathbf{A}(x,y) - \mathbf{A}_0],$$

$$\frac{d^2\hat{Obj}_{\mathbf{A}}}{d\mathbf{A}^2}(x,y) = 2\alpha^2(x,y) + 2\lambda,$$

in which (x,y)=1t(x,y)/1. Because the second derivative is always positive, setting Equation (14) to zero yields the minimum of ObjA. The equation represents the adaptive atmospheric light A by denoting the guided image filter as GF().

$$\hat{\mathbf{A}}(x,y) = GF\left[\frac{\alpha^2(x,y)\cdot L_{\mathbf{I}}(x,y)+\lambda\mathbf{A}_0}{\alpha^2(x,y)+\lambda}\right]$$



4.RESULTS:

In this paper, we are using an algorithm that is more accurate than that of the existing techniques because the strong algorithm approach is due to transmission mapping and adoptive atmospheric light techniques we are comparing the average or the mean value of the transmission mapping and increasing the pixel clarity or the resolution of the image.

In the below pictures we can see the solely measurable FADE scores show that a large amount of yellow dust has been removed (i.e., approximately 54.2As a result, the recovered image is clearer, which is advantageous for other algorithms.OUTPUT:

Figure 1:

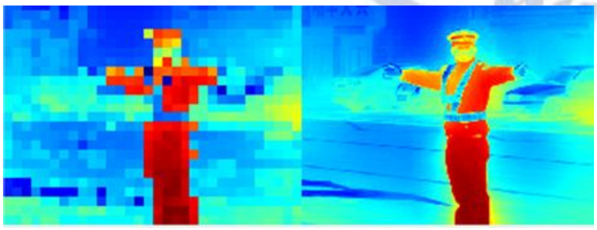


Figure 2:

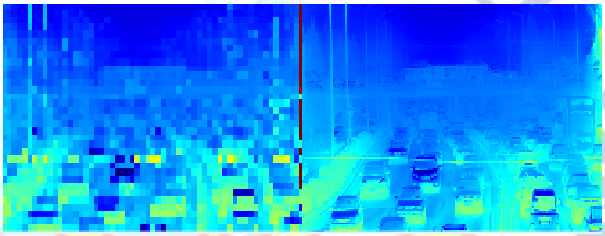
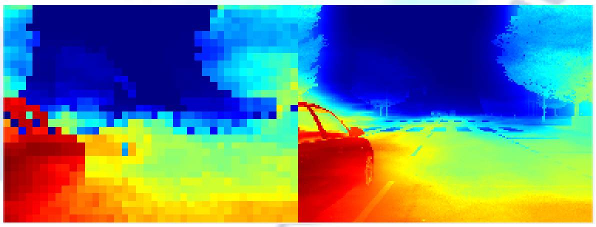


Figure 3:



5. CONCLUSION:

In this paper, we are using an effective way to Decrease haze and some other scattering of light which decreases the image quality and a better way of viewing the objects near to us clearly in an image. maximizing the objective function that multiplicatively combines all of these features results in an accurately estimated transmission map, which is then refined by a guided image filter to produce the optimal transmission. Another unknown quantity, atmospheric light, is predicted adaptively using the simple quad-decomposition algorithm and a different objective function. The adaptive atmospheric light and optimal transmission map are then swapped into the atmospheric scattering model to generate clear visibility.

6.FUTURE SCOPE:

Our algorithm's high computational cost is a significant disadvantage. Even though the proposed algorithm is optimized on non-overlapping patches, it is relatively slow in comparison to the four benchmark approaches. Furthermore, the lack of a closed-form solution for the first optimization problem involving the optimal transmission map makes applying the proposed algorithm to real-time processing systems difficult.

If we eliminate this drawback it will give more efficient outputs.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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