An Image Dehazing Technique Using Perona-Malik Diffusion

Anjali V Nair[1], Bibin Varghese[2], Smita C Thomas[3]
[1, 2, 3] Dept of Computer Science & Engineering
[1, 2, 3] Mount Zion College of Engineering Kadammanitta ,Pathanamthitta ,India

Abstract- *Haze is mainly occurred due to light scattering and absorption.Light scattering lowers the visibility and contrast ofCaptured image. Absorption substantially reduces the light energy. In this study a novel algorithm is proposed for removing the fog in an image.Anisotropic diffusion is a technique that reduces haze without removing image partssuch as edges, lines or other details that are essential for the understanding of the image. Its flexibility licenses to combine smoothing things with image enhancement qualities. It can grip colour as well as greyimages. Laterally with the RGB (red, blue and green) colour model.. Proposed algorithm has a wide application in tracing and navigation, consumer electronics.*

Keywords- RGB(red, blue and green);Haze

I. INTRODUCTION

Haze is traditionally an atmospheric phenomenon in which dust, smoke, and other dry particulates unclear the clearness of the sky. The World Meteorological Organization manual of codes contains a classification of horizontal obscuration into categories of fog, ice fog, steam fog, mist, haze, smoke, volcanic ash, dust, sand, and snow.[1] Sources for haze particles contain farming (ploughing in dry weather), traffic, industry, and wildfires.Haze also happens when there is too much pollution in the air while there is also dust.Some haze-causing pollutants are directly emitted into the air; while others are formed when gases emitted into the air undergo a chemical reaction to form pollution. ... During the summer months, haze is often caused by smoke from fires caused by wildfires, prescribed burning, and agricultural burning.Anything above 300 is considered 'Hazardous'. When the air quality spreads 'Unhealthy' levels, it is more likely to trigger mild aggravation of respiratory illness symptoms among those suffering from chronic lung or heart ailments. For others, it may distress you by generating coughs, eye irritation and sneezing. In this paper, we present a new method for removing the haze from an image. The technique is anisotropic diffusion process. ThisIn image processing and computer vision, anisotropic diffusion, also called Perona–Malik diffusion, is a technique aiming at reducing image noise without removing significant parts of the image content, typically edges, lines or other particulars that are important for the interpretation of the image.[1][2][3] Anisotropic diffusion resembles the process that creates a scale space, where an image creates a parameterized family of continuously more and more blurred images based on a diffusion process. Each of the consequential images in this family are given as a convolution between the image and a 2D isotropic Gaussian filter, where the width of the filter increases with the parameter. This diffusion process is a linear and space-invariant alteration of the original image. Anisotropic diffusion is a generalization of this diffusion process: it harvests a family of parameterized images, but each resulting image is a combination between the original image and a filter that be contingent on the local comfortable of the original image. As a significance, anisotropic diffusion is a non-linear and space-variant transformation of the original image.

II. LITERATURE SURVEY

Several researchers proposed many techniques for explaining the dehazing techniques for haze removal.

Nayar, Shree K. and Srinivasa G. Narasimhan [1] has proposed a solution named multiple image dehazing method.In this haze elimination, two or more images or multiple images of the same scene are taken. This method attains known variables and avoids the unknowns.

Narasimhan, Srinivasa G. and Shree K. Nayar, [2] also proposed an idea named method based on different weather condition.This method is to use multiple images [2] taken from different weather condition.The undeveloped method is to take the differences of two or more images of the similar scene. Thesemultiple images have dissimilarthings of the contributing medium. This approach canexpressively improve visibility, but its drawback is to wait until the properties of the medium change. So, this method is impotent to deliver the results promptly for scenes that have never been metbefore. Moreover, this method also cannot handle dynamic scene.

Schechner, Yoav Y., Srinivasa G. Narasimhan and Shree K. Nayar[3]has proposed polarization.In this method two or more images of the same scene are taken with dissimilar polarization filters The basic method is to take multiple images of the same scene that have dissimilar degrees of polarization, which are acquired by rotating a polarizing filter attached to the camera,but the treatment effect of dynamic scene is not very good. The deficiency of this method is thatit cannot be applied to dynamic scenes for which the changes are more rapid than the filter rotationand require special equipment like polarizers and not necessarily produce better results.

Kopf, Johannes, Boris Neubert, Billy Chen, Michael Cohen [4] has proposed depth map based methodThis method uses depth information for haze removal. This method uses a single image and assumes that 3D geometrical modelof the scene is provided by some databases such asfrom Google Maps and also assumes the texture of the scene is specified (from satellite or aerialphotos). This 3D model then aligns with hazy image and provides the scene depth [18]. This method requires user interaction to align 3D model [19] with the scene and it gives accurate results.

Tan, Robby T [5], proposed contrast maximization method Haze diminishes the contrast. Eliminating the haze enhance the contrast of the image. Contrast maximization is a method that enhances the contrast under the constraint. But, the resultantimages have larger saturation values because this method does not physically improve thebrightness or depth but somewhat just enhance the visibility.

III. EXISTING SYSTEM

A novel approach to remove the haze in underwater images based on a single imagecaptured with a conventional camera. As illustrated in Fig. 1, approach builds on the fusion of multiple inputs, butderives the two inputs to combine by correcting the contrastand by sharpening a white-balanced version of a single nativeinput image. The white balancing stage aims at removingthe color cast induced by underwater light scattering, so asto produce a natural appearance of the sub-sea images. Themulti-scale implementation of the fusion process results in anartifact-free blending.

A. *White Balancing Method*

White balance (WB) is the process of removing unrealistic color casts, so that objects which appear white in person are rendered white in your photo. Correct camera white balance has to take into account the "color temperature" of a light source, which refers to the relative warmth or coolness of white light.White balance is a scenery on your camera which is used to control how colors are captured in different types of light. ... Color temperatures series from cool (blue tint) to warm (orange tint). Using the right white balance setting will eliminate unwanted color casts that can ruin your image and make it appear unnatural.

B. *White Balance : The Problem*

Quite simply, the brain adjusts the color that we see. The vast majority of the time, we are not even aware that this is happening. For instance, when you walk from a parking lot into a building, you are probably not even aware that the color of the light has changed significantly. For photographers, this creates a problem: the brain monkeys with the color we see. Thus, we do not always see color correctly. In particular, when dealing with warm or cool colored light, the brain functions on a principle of constancy. It imagines the colors of objects to remain fairly constant throughout the day. If the color of objects changes during the day because the light that is illuminating them changes, the brain tends to filter out at least part of that color change. As a consequence, the color that we see during times of strong warm or cool light tends to be less intense than the color of the actual light and, possibly, less intense than what the camera will see and record. For instance, a casual photographer may not be aware that the light has become warm toned in the afternoon until he gets his film back and discovers that his wife's skin has an odd yellow tone.

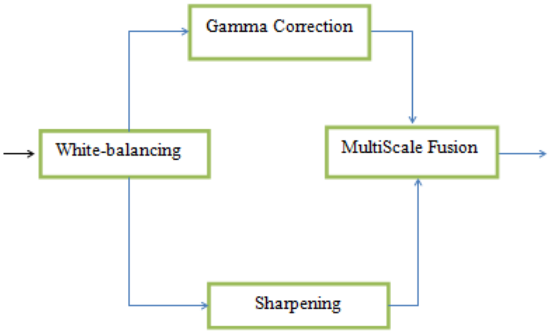

Figure 1. Method Overview Of Existing System

C. *Naïve Fusion Process*

In the existing system they proposed naïve fusion process for merging the two normalized images.The normalization can be done through this naïve process and merging of this image can be done through multiscale fusion process.In practice, the naive approach introduces undesirable halos . A common solution to overcomethis limitation is to employ multi-scale linear ornon-linear filters.The main limitations are related to the fact that: colorcan not always be fully restored, and (ii) some haze ismaintained, especially in the scene regions that are far fromthe camera.

D. Multi Scale Fusion Process

In this process, first they perform white balancing to the input image. Then create two input image from white balanced version. The first input is get after the gamma correction. Second input is from sharpening version of the white balanced image. Then we found the weight map of this image. Then this image is normalized and after that this two image is fusioned using naïve fusion process.

Image fusion has shown utility in several applications such as imagecompositing, multispectral video enhancement,defogging and HDR imaging. Here, we aimfor a simple and fast approach that is able to increase thescene visibility in a wide range of underwater videos andimages. This assumption is generally valid for underwater scenes decently illuminated by natural light, butfails in more challenging illumination scenarios.

IV. PROPOSED SYSTEM

In this section we propose Anisotropic diffusion is known to: - smooth the signal; - preserve strong edges; - enhance the contrast of edges which tries to cover the challenges presented in Existing system.

A. Procedure of Anisotropic Diffusion

Perona& Malik introduce the flux function as a means to constrain the diffusion process to contiguous homogeneous regions, but not cross region boundaries. The heat equation (after appropriate expansion of terms) is thus adaptedto:where c is the proposed flux function which controls the rate of diffusion at any point in the image. A choice of c such that it tracks the gradient magnitude at the point enables us to restrain the diffusion process as we approach region boundaries. As we approach edges in the image, the flux function may generate inverse diffusion and actually enhance the edges !Perona& Malik advise the following two flux functions:

The flux functions offer a trade-off between edge-preservation and blurring (smoothing) homogeneous regions. Both the functions are ruled by the free parameter κ which determines the edge-strength to consider as a valid region boundary. Automatically, a large value of κ will lead back into an isotropic-like solution.We will experiment with both the flux functions in this report.A discrete numerical solution can be derived for the anisotropic case using the FTCS method as follows:

where {N,S,W,E} correspond to the pixel above, below, left and right of the pixel under consideration (i,j). Another nice property is that c is based on the gradient magnitude, thus it does not matter if we take forward or backward gradients ! The following table displays the results of th anisotropic diffusion process for the same example image as above. κ=0.35 was used for both flux functions.

Quadratic t=2 t=8 t=64 t=128 t=2
t=8 t=64 t=128
Exponential t=2 t=8 t=64 t=128t=2
t=8 t=64 t=128
t = 2 t = 8 t = 64 t = 128

As seen in the above table, the flux functions behave differently as the diffusion progresses and can lead to interesting choices based on the application at hand.

B. Anisotropicscale space

Similar to the intuition that isotropic diffusion is akin to Gaussian blurring, we can imagine that anisotropic diffusion is similar to blurring by a weighted kernel. However, this kernel is not as straightforward as the Gaussian due to the free parameter κ. We can think of creating a nonlinear scale space based on such a kernel, but the ideal The gradient magnitude images display the effect of the lux function more clearly. As we traverse along the scale-space, gradient magnitude decays faster due to the isotropic diffusion process. This is evidence of the fact that this process has no information about the edges present. On the other hand, the edges are preserved upto much higher scales in the anisotropic process. Also noticeable is the fact that stronger edges last longer than weaker edges. The effect of inverse diffusion is seen at higher scales. Specially in the case of the exponential flux function which favours edge preservation over smoothing. This is evident in the progressive sharpening of the vertical edges along the minarets.

C. Methods

Anisotropic diffusion filter (Perona and Malik [1990]) has been successfully employed in the context of image processing to remove high frequency noise while conserving the main edges of existing objects.

In its discrete form, ADF is an iterative algorithm thatsimulates the diffusion process by:

$$I_s^{t+1} \approx I_s^t + \frac{\lambda}{|\eta_s|} \sum_{p\in\eta_s} g(|\nabla I_{s,p}^t|, \gamma)\nabla I_{s,p}^t, \qquad (1)$$

Noise pixels are filtered faster than edge pixels for two main reasons. First, opposite direction gradients attenuate or cancel their effects, according to Equation 1. That usually happens to edge pixels, but not to noise pixels. Second, ADF has a cumulative effect by the number of neighbors with high gradient magnitude with the same direction. As noise pixels are randomly spread through the image, mostly their intensity are distinct from their surrounding neighbors. Edge pixels, on the contrary, have a similar intensity to a considerable part of their adjacency.

D. Parameter Selection

The ADF requires an edge-stopping function and three parameters: the smoothing constant γ, the number ofiterations tmax, and the size of the adjacency relationηs. The size of the adjacency relation reflects a trade-off between precision and computational effort. The other two parameters determine the results in terms of image underand over-smoothing. In this paper, we are more concerned about the smoothing degree the ADF and hence, we will focus on tmax and γ. With respect to γ, Perona and Malik [1990] suggested to use a noise estimator based on Canny [1986], i.e., 90% of the accumulated histogram of the absolute values of the gradient. Black et al. [1998] proposed the use of the median absolute deviation of the image gradient since it is more robust to the influence of outliers. After that, Voci et al.[2004] reinforced the importance of the idea of estimating γ at each iteration. This strategy reduces the effect of ADF over edges with higher gradient intensity. More recently, Tsiotsios and Petrou [2013] proposed a stopping criteriafor the number of I terations based on the contrast of the edges at each iteration, and a novel gradient threshold estimation for parameter γ utilizing the most uniform block of pixels in the image.All the proposed methods compute γ and tmax parameters based on either the gradient of the image, or on the standard deviationof anon-edge region requiring empirical tuning (Kim et al. [2005]).

E. Edge-Stopping Function

The edge-stopping function can assume several forms.

At first, Perona and Malik [1990] initially proposed the functions:

$$g(x,\gamma) = exp\left(-x^2/2\gamma^2\right), \qquad (2)$$

$$g(x,\gamma) = \left[1 + (x/\gamma)^2\right]^{-1}, \qquad (3)$$

Black et al. [1998] proposed a nice improvement using Tukeysbiweight ESF in Equation 4.

$$g(x,\gamma) = \begin{cases} \left[1 - (x^2/5\gamma^2)\right]^2 & |x| \leq \gamma\sqrt{5}, \\ 0, & \text{otherwise.} \end{cases} \qquad (4)$$

After a number of iterations of the diffusion filter using the ESF of Equation 4, the filter will stop changing pixel’s intensities. Using Equation 3, on the other hand, causes the filter to smooth the image indefinitely. Even though both functions start rejecting gradient intensities greater than a given threshold, the function described by Equation 4 reaches zero for |x| > γ.

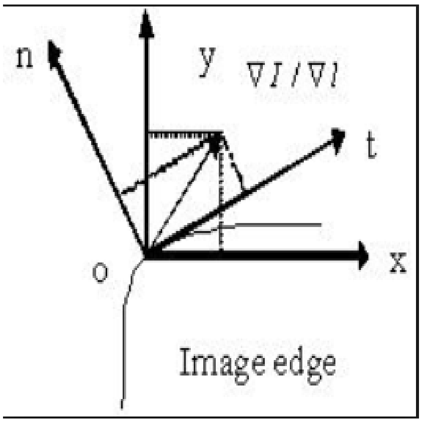

Figure 2 Anisotropic Diffusion

We have found that an edge stopping function which stopsdiffusion from low image gradient onwards well preserves the sharp edges and fine details. This property of an edge stopping function will also result in lower evolution in case of level set methods. But an edge stopping function which stops diffusion from high image gradient onwards will not preserve sharp edges and fine details, since they are blurred due to diffusion. We have also found that low values of gradient threshold parameter used in edge stopping function well preserves the sharp edges and fine details than high values of threshold parameter. By utilizing an edge stopping function which stops diffusion from low image gradient onwards or which has zero or insignificant value at low image gradient, we can wellpreserve the sharp edges and fine details in the denoised image.

V. CONCLUSION

Various experiments with nonlinear scale-space suggest that it can be a powerful tool for various applications. However, linear (Gaussian) scale-spaces are not far behind. The inherent properties of the Gaussian kernel make it convenient to use and easy to understand. On the other hand, nonlinear scale-spaces allow for the inclusion of knowledge about local criteria such as edge-strength to smooth homogeneous regions, while preserving the boundaries. One way to improve the process of anisotropic diffusion would be to automate the process of computing κ values. Since this value is related to the edge-strength, the obvious choice seems to be to examine the density function of the image gradient. We could look at peaks in this function to identify regions at various levels of coarseness to be preserved, in some sense a level-of-detail (LOD) type approach. Another naive, yet probably effective method would be to simply look at the histogram and choose the value of κ based on the edge-strength we wish to preserve. Nonetheless, even without these improvements, it is clear that anisotropic diffusion and nonlinear scale-space is a valuable tool in the image processing toolkit.: High-frequency noise is present in magnetic resonance images and it is usually removed by a filtering process. The anisotropic diffusion filter (ADF) was proposed to adaptivelyremove the noise, maintaining the image edges.

VI. ACKNOWLEDGMENT

We would like to thank, first and foremost, Almighty God, without his support this work would not have been possible. We would also like to thank all the faculty members of Mount Zion college of engineering, for their immense support.

REFERENCES

[1] Narasimhan, S.G., Nayar, S.K.: ‘Chromatic framework for vision in badweather’. IEEE Conf. on Computer Vision and Pattern Recognition,2000, vol. 1, pp. 598–605

[2] Schechner, Y.Y., Narasimhan, S.G., Nayar, S.K.: ‘Instant dehazing of images using polarization’. IEEE Computer Society Conf. onComputer Vision and Pattern Recognition, 2001, pp. 325–332

[3] Kopf, J., Neubert, B., Chen, B., et al.: ‘Deep photo: model-basedphotograph enhancement and viewing’, ACM Trans. Graph., 2008,27, (5), p. 116:1–116:10

[4] Tan, R.T.: ‘Visibility in bad weather from a single image’. IEEE Conf. on Computer Vision and Pattern Recognition, 2008, pp. 1–8

[5] Hautiere, N., Tarel, J.P., Aubert, D., Dumont, E.: ‘Blind contrast enhancement assessment by gradient ratioing at visible edges’,J. Image Anal. Stereology, 2008, 27, (2), pp. 87–95

[6] Gonzaless, R.C., Woods, R.E.: ‘Digital image processing’ (Addison- Wesley, Reading, MA, 1992, 2nd edn.)

[7] Economopoulosa, T.L., Asvestasa, P.A., Matsopoulos, G.K.: ‘Contrast enhancement of images using partitioned iterated function systems’,Image Vis. Comput., 2010, 28, (1), pp. 45–54