IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

Digital Image Defogging Using Dark Channel Prior and Histogram Stretching Method

Miss. Radhika P. Yawale[1] , Prof. A. S. Kapse[2]

M.E. Student, CSE, PRPCET, Amravati, Maharashtra, India[1]

Assistant Professor, CSE, PRPCET, Amravati, Maharashtra, India[2]

Abstract: In recent world scenario digital image processing is the most widely used application. Digital image processing is the method to perform some operations on the image, in order to get an enhanced image and extract some useful information from that image. Mostly in winter season the visibility of outdoor images captured in bad weather is often degraded due to the presence of fog. Because of this problem clear images are not obtained. In this paper, the proposed method uses the dark channel prior and histogram stretching methods for removing a fog from the images and obtaining a more clear images. Whereas dark channel prior is used to improve the quality of foggy images by removing a fog and histogram stretching method is used to improve the contrast of the image.

Keywords: Image processing, defogging, dark channel prior, histogram stretching etc.

I. INTRODUCTION

The image processing is the vast promising field in the era of technology of machine vision, machine intelligence and automation for real time processing of the image captured in different atmospheric conditions. The image captured in the outdoor scene are highly degraded due to the poor lighting condition or over lighting condition or due to the presence of various suspension particles like the water droplets or dust particles in the atmosphere.

Fog is kind of common natural phenomena. In the cloudy weather, muddy media of atmosphere such as modular and suspended particals can create a pollution of feedback images and make fidelity and contrast of the color for images reduce to a great extent. Fog removal is highly desired in both computational photography and computer vision applications. Removing fog can greatly increase the visibility of the scene and correct the color shift caused by the airlight. As we know that, poor visibility becomes a major crisis for most outdoor vision applications. Bad weather, such as haze or fog, can significantly degrade the visibility of the scene. Most computer vision applications, such as image segmentation and object tracking, usually suffer from the poor visibility of the foggy images. Because of this reason fog removal is highly desired in many practical applications. Therefore here using the dark channel prior and histogram stretching method for digital image defogging and improving the contrast of the image. [1].

The objectives of the proposed work are, to simulate the model for improving the quality of foggy images. Which not only remove the fog effectively but also enhance the details and color of scene from foggy image significantly. To degrade a fog which makes a great improvement in image visibility.

To develop a comprehensive solution to the foggy images. The proposed scheme uses great defogging technique and it is well adapted to any possible future technology in which clear images (fog free) are required.[1]\

II. LITERATURE REVIEW

Haze removal or dehazing is highly desired in both computational photography and computer vision applications. First, removing haze can significantly increase the visibility of the scene and correct the color shift caused by the airlight. Hongyu Zhao, Jing Yu, Chuangbai Xiao, and Xiujie Xu proposed a technique for single image fog removal based on Local extrema. The proposed method utilizes atmospheric scattering model to recognize the fog removal. It applies the local extrema method to figure out three pyramid levels to estimate the skylight and white balance, estimation of atmospheric veil, and image restoration by local extrema. The results on the experiments of comparison with traditional methods demonstrate that the projected method can achieve more precise restoration for the details and colors, resulting in a great improvement in image visibility.[1,2]

Wei Sun proposed a technique for single image fog removal which is based on the physical model of atmospheric scattering and the optical reflectance imaging model, mainly three major factors which are going to affect the effect of fog removal are discussed in detail, dark channel phenomenon is explained via the optical model, and an approach for solving the parameter in the atmospheric scattering model is severely derived from a new perspective.

Using fast joint bilateral filtering techniques and gray-scale opening operation, the proposed algorithm can efficiently obtain the global atmospheric light and significantly improve the speed and accuracy of atmospheric scattering function solving. Finally, the scene albedo is recovered by inverting this model. [1,3]

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

Tan's work is mainly based on the assumption that the clear-day images have higher contrast as compared to the input fog image, which has remove the haze by maximizing the local contrast of the foggy images. This method generates convincing images by enhancing the contrast, but it may also result in a physically-invalid extreme haze removal.[1,4]

Tarel et al. presented a method for fog removal based on median filter. He used the median filtering method to estimate the atmospheric veil. This method performs faster than above methods. But still it has the limitation that its detail restoration is not ideal. Yu J et al. used the bilateral filter for the estimation of atmospheric veil. It will improve the performance of defogging. This method used to handle the two types of fields of unknown variables scene albedo and depth which is having a higher complexity. Based on planner road constraints, he introduces another efficient approach to improve the restoration of road area, here it assuming an approximately flat road. [1,5,6,7,8]

Tripathi et al presented a technique for single image fog removal using bilateral filter. This filtering method is used to smooths the images without effecting the edges. In this proposed method, the given filter replaces every pixels of image by the weighted average of its neighbor pixel. This filter is used to get the quicker contrast. While using bilateral filter its uses the preprocessing and post transforming steps for the betterment. Histogram equalization is utilizes as a preprocessing and histogram stretching is utilizes as post preparing. [1,9]

The atmospheric scattering model is normally used for the formation of foggy or hazy image. This method is based on this physical model which is used to produce the better quality of defogging results. But in this work, under different atmospheric conditions some of these methods required the multiple images of the same scene. In practice, it is usually difficult to complete these type of special conditions. So, if enough additional information is not present in database then these types of methods are not able to perform. [1,10,11]

Fattal's approach is used for dehazing or defogging the image. This approach provides the impressive results. But it will not able to handle the heavy haze or heavy fog images when the assumption is not satisfied. Actually Fattal assumes that image albedo is a constant vector in local region and that the transmission is locally statistically uncorrelated. He proposed the dark channel prior to estimate the atmospheric veil by using the soft matting as a filter to refine it. But by using this method the space and time complexity is quite high. They further improve their method using some guided filter. [1,12,13]

III. PROPOSED WORK

Here the architecture for digital image defogging by using dark channel prior and histogram stretching method has been design. The atmospheric scattering model describes the formation of haze image by following equation:

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

where I is denotes the haze image, J is the scene radiance, A is the global atmospheric light, and t is the transmission medium. It describes the portion of the light that is not scattered and reaches the camera. The goal of haze removal is to recover A, t, and J from I. [14]

Following figure shows the data flow diagram for the proposed approach:

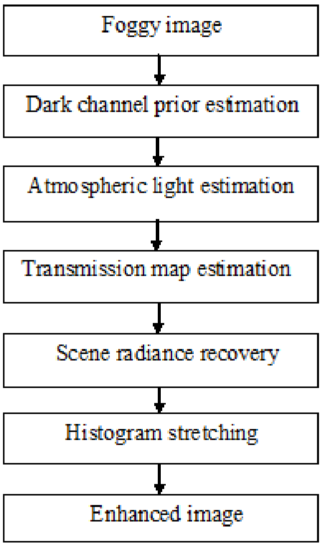

Fig 1: Data flow diagram for image defogging and enhancement

The above data flow diagram shows the various steps for obtaining defog and enhance image.

- **Improved Single Image Dehazing Algorithm**

In this section, the steps of the single image dehazing algorithm are explained in detailed. First we have to start with the dark channel prior.

1) Dark Channel Prior

The dark channel prior is based on the following observation on haze-free outdoor images. In most of the non-sky patches, at least one color channel has very low intensity at some pixels. In other words, the minimum intensity in such a patch should has a very low value. Formally, for an image J, we define dark channel as

$$J^{dark}(x) = \min_{c\in\{r,g,b\}}\left(\min_{y\in\Omega(x)}(J^{c}(y))\right) \qquad (2)$$

where J^c is a color channel of J and $\Omega(x)$ is a local patch centered at x. The observation says that except for the sky region, the intensity of J^{dark} is low and tends to be zero, if J is a haze-free outdoor image. Then call J^{dark} as the dark channel of J.[14]

The dark channel having the low intensities are mainly due to three factors: a) shadows. e.g., the shadows of cars, buildings, or the shadows of leaves, trees and rocks in landscape images. b) colorful objects or colorful surfaces. e.g., any object (for example, green grass/tree/plant, red or

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

yellow flower/leaf, and blue water surface. c) dark objects or surfaces. e.g. dark tree trunk and stone. As the natural outdoor images are usually full of shadows and colorful objects, the dark channels of these images are really dark. Due to the additive airlight in an atmosphere, the haze image is brighter than haze free image. So the dark channel of the haze image will have a higher intensity in region with denser haze.

2) Atmospheric Light Estimation

The atmospheric light is estimated from the foggy image by using dark channel prior. In most of the previous methods, the color of the most haze-opaque region is used as atmospheric light A. However, little attention has been paid to the detection of the "most haze-opaque" region. In Tan's work, he has assumed that the atmospheric light A is globally constant. And this global value can be obtained from the pixels that have the highest intensity in the input image. This will be true only when the weather is overcast and the sunlight can be ignored.[15]

In proposed work, we have to pick the brightest pixels from the estimated dark channel, since these are the most haze opaque. Then take the average of these pixel's intensity value. And finally atmospheric light has been estimated by using dark channel prior.

3) Transmission Estimation

For the transmission estimation, here it uses the above estimated atmospheric light. Here it assumed that the transmission in the local patch *Ω(x)* is constant. Here the patch's transmission is denoted by $t(x)$. The dark channel J^{dark} of J is defined by the equation (2), and since J^{dark} tends to be zero and as A^c, the corresponding channel of the atmospheric light is always positive, it will be written as:

$$J^{dark}(x) = \min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)}(J^c(y))) = 0 \quad (3)$$

This will be used to estimate the transmission for that patch *Ω(x)* by using equation (3) into the image formation model equation (1), however now in combination with the min operator:

$$\min_c(\min_{y\in\Omega(x)} I^c(y)) = t(x)\min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)}(J(y))) + (1-t(x)) \quad (4)$$

As $J^{dark}(x) \rightarrow 0$, equation (4) leads to:

$$t(x) = 1 - \min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)}(\frac{I^c(y)}{A^c})) \quad (5)$$

This is a direct estimation of the transmission for each local patch. As we know that dark channel prior is not a good for the sky regions, because the color of the sky in a hazy image is usually very similar to the atmospheric light *A*. So, in the sky region, we have

$$\min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)}(\frac{I^c(y)}{A^c})) = 1 \text{ and } t(x)\rightarrow 0 \quad (6)$$

Since the sky is at infinite and tends to have zero transmission, the Equation (5) kindly handles both sky regions and non-sky regions. There is no need to separate the sky regions. As we know that even on clear days atmosphere is not completely free from any particles. There always exist some haze when we look at distant objects. However, the presence of haze is an elementary key for human to perceive depth.

If the haze is removed thoroughly, then the image may seem unnatural and we may lose the feeling of depth. So, we can keep a very small amount of haze for the distant objects intentionally so that the image seems natural, by introducing a constant parameter $\omega(0 < \omega \leq 1)$) equation (5):

$$t(x) = 1 - \omega \min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)}(\frac{I^c(y)}{A^c})) \quad (7)$$

The value of ω is depends on application. As we decrease the patch size we can use slight lower value for ω (≈0.8) and for large patch size it can increase the ω value. Here we have to fix it as 0.95. The main problems with the transmission maps are that they suffer from some block and halos effects. This is all because the transmission is not always constant in a patch.[16]

4) Scene Radiance Recovery

With the atmospheric light and transmission map, the scene radiance according to equation (1) can be recovered. But the direct attenuation term *J*(*x*)*t*(*x*) can be very close to zero. So, the transmission is restricted to a lower bound t_0. since the scene radiance is typically not as bright as the atmospheric light *A*. The final scene radiance *J*(*x*) may then be recovered by:

$$J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A \quad (8)$$

Here we used a typical value of t_0 is 0.1. It usually needs to be increased when an image contains substantial sky regions, otherwise the sky region may wind up having artifacts. Which means the image will not look smoother and pleasant. [15]

- **Histogram Stretching**

There are two methods of enhancing contrast. The first one is called Histogram stretching and the second one is Histogram equalization. Here the proposed system uses the histogram stretching method. Where the histogram stretching is used to improve an image by stretching the range of intensity values it contains to make full use of possible values.

Where contrast is the difference between maximum and minimum pixel intensity. It is used to produced the histogram which is nothing but the plotting or a graph between the number of pixels and their intensity values. Here in 3-D histogram, axes representing the red, green and blue channels respectively

.

IV. SUMMARY AND DISCUSSION

First we have to see the flowchart for the proposed work. That is after loading the image for defogging then, what are the different steps through which an image will passes and get the fog free image

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

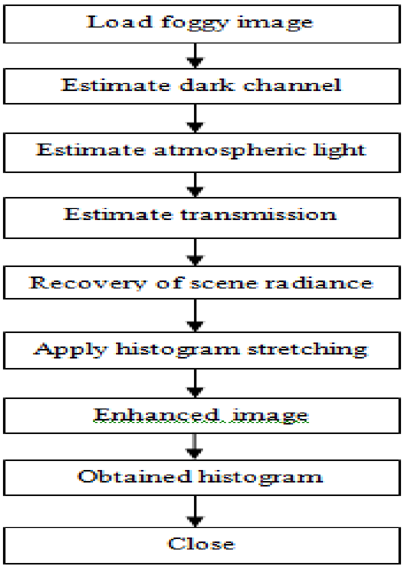

Fig 2: Flowchart for image enhancement

So, these are the various steps through which image will passes. The first step is load the image from database. In second step dark channel is estimated. In third step atmospheric light is estimated by using dark channel. In fourth step transmission map is estimated by using above estimated atmospheric light. The fifth step is the scene radiance recovery, with the atmospheric light and transmission map the scene radiance is recovered. In this step fog free image is obtained. In sixth step the fog free image is enhanced by improving contrast of the image using histogram stretching method. Finally enhance image has been obtained. In next step histogram of fog free image is obtained.

Now we have to see the output for given input image at different steps which is shown below:

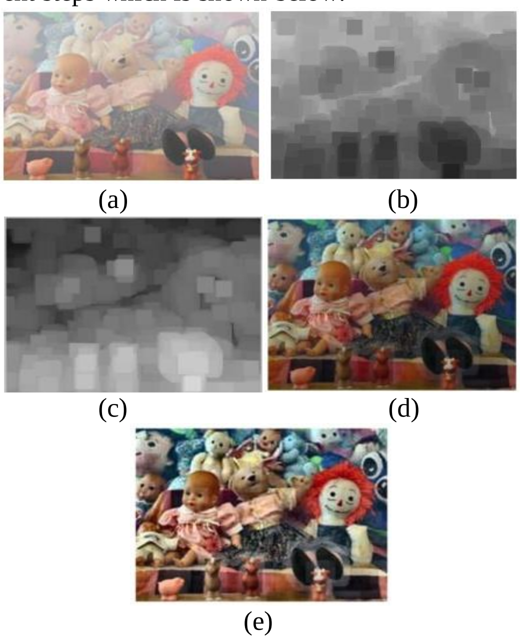

Fig 3: The “Toys” image: (a) Original foggy image, (b) It’s dark channel prior, (c) It’s transmission map, (d) Haze free image, (e) Enhanced image respectively.

The histogram for the above image is given as follow:

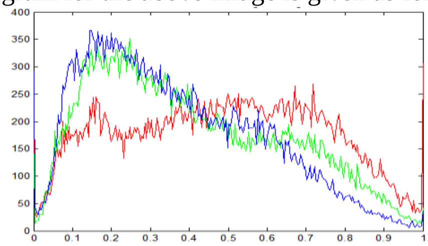

Fig 4: Histogram of Toys image.

In figure (3), we have to take the toys image for defogging. In that figure (a) represent the input foggy image. Figure (b) represent the dark channel of that image. In which we have to find the low intensity value pixel. Figure (c) represent the transmission map of image by using dark channel. Figure (d) represent the fog free image. Here with the atmospheric light and transmission map scene radiance can be recovered. Figure (e) represent the enhanced image. This image is enhanced by improving contrast of the intensity value of each pixel using histogram stretching. In figure(4) Histogram of the input image has been displayed. Here 3-D histogram is displayed because the three different axes are used for the red, green and blue color channels. Same process is done with the another input images. For the effectiveness of the defogging method, we will evaluate the proposed method on the foggy images. The experiments will be conducted on the matlab. Firstly, in the aspect of real world foggy images, our method will compare with other methods. In our proposed work we have to used the dark channel prior for fog removal and we have to enhanced the contrast of the image using histogram stretching method.

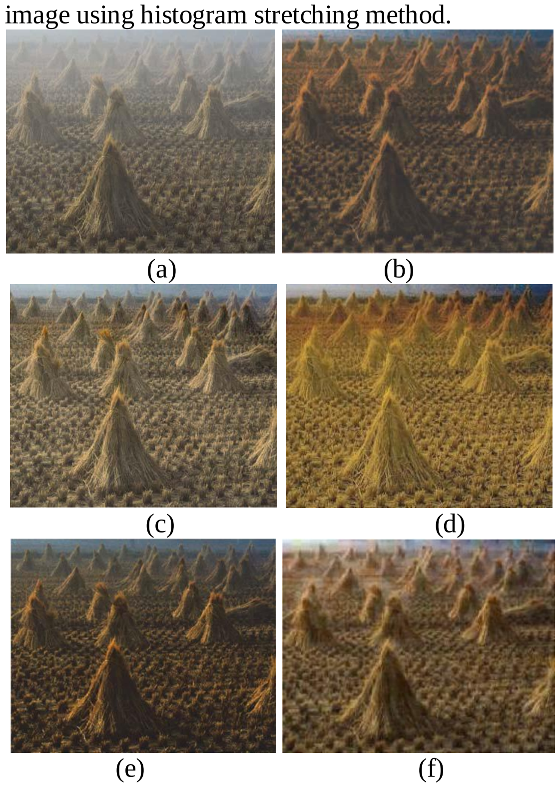

Fig 7: Haze removal. (a) Hazy image (b)-(f) Dehaze image obtained by [16], [17], [18], [19] and our method respectively.

Fig. 7 shows the comparisons with [16], [17], [18] and [19]. These methods achieve comparable results in haze-free images. but our method display the good result as compare to others. [16] In which haze is removed using dark channel prior followed by the soft matting. This system is proposed by He, Sun, Tang. [17] In figure (c) the result is displayed by the Fattal's approach. [18] In which Nishino's result has been given.

In addition to the visual analysis mentioned above, we conducted quantitative analysis, mainly from the perspective of mathematical statistics and the statistical parameters for the images. Now for the analysis of these images different parameters are used like digital image correlation (DIC), peak signal to noise ratio (PSNR), means square error (MSE), and elapsed time.

Digital image correlation and tracking is an optical method that employs tracking and image registration techniques for accurate 2D and 3D measurements of changes in images. The PSNR block computes the peak signal to noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The MSE represents the cumulative squared error between the compressed and the original image. The elapsed time is nothing but the processing time or execution time. Now we have to draw a table which contains these parameters for above input image(fig 3) which has been given above for the analysis of the result of the proposed system.

Table 1: Comparative parameters for given input images.

	Toy's
Elapsed time	0.744013
MSE	0.0752
RMSE	0.2742
PSNR	59.3693
DIC	0.7366

Now we have to compare the proposed scheme with the another existing systems with the help of these parameters. This analysis includes root means square error (RMSE). It is used for compare the quality of the image. Less value of RMSE better quality of the image.

	Average RMSE
[16]	0.2524
[20]	0.2135
[19]	0.1832
The proposed	0.1727

Table 2: Comparative analysis of different defogging methods.

Table 2 displays the average RMSE measured by the different existing systems and by the proposed method. As the average RMSE is minimum obtained by the proposed method which means the proposed method provides the better quality of the images as compare to the other methods. Here we have to compute the average value of RSME by using different input images. [19] this result is displays by the proposed work single-image dehazing via optimal transmission map under scene priors. [20] In this, the result is given by the Tarel's approach who proposed the Fast visibility restoration from a single color or gray level image.

V. CONCLUSION AND FUTURE SCOPE

In recent era, fog removal is very essential in the field of image processing. And there are different techniques are proposed for fog removal. But they are having their own advantages and disadvantages. Here in proposed system the dark channel prior and histogram stretching methods are used to improve the visual quality of foggy image and this produced the good results. But still in future work, there is need to investigate more optimal schemes for determining the better results.

The proposed scheme uses great defogging technique and it is well adapted to any possible future technology in which clear images (fog free) are required. Since haze removal is highly desired in computer vision applications, it is necessary to make a further effort to put the proposed method into real-time applications, such as the video-surveillance systems and the in-vehicle vision systems. In these situations, it is necessary to take into consideration the hardware environment of the real-time systems.

REFERENCES

[1]. Radhika P. Yawale, A. S. Kapse, "A Review Towards Digital Image Defogging Using Dark Channel Prior and Histogram Stretching Method", IJARCCE, vol. 4, December 2015.
[2]. Hongyu Zhao, Jing Yu, Chuangbai Xiao, and Xiujie Xu, "Single Image Fog Removal Based on Local Extrema", IEEE Journal of Automatica Sinica, vol. 2, 2015.
[3]. Wei Sun, "A new single-image fog removal algorithm based on physical model", elsevier, pp. 4770-4775, 2013.
[4]. Tan R T. "Visibility in bad weather from a single image", In: Proceedings of the 2008 IEEE Conference on Computer Vision and Pattern Recognition. Anchorage: IEEE Computer Society, pp. 1-8, 2008.
[5]. Tarel J P, Hauti N. "Fast visibility restoration from a single color or gray level image", In: Proceedings of the 12th International Conference on Computer Vision. Kyoto, Japan: IEEE, pp. 20-28, 2009.
[6]. Yu J, Li D P, Liao Q M. "Physics-based fast single image fog removal", Acta Automatica Sinica, 37(2): pp. 143-149,2011.
[7]. Nishino K, Kratz L, Lombardi S. "Bayesian defogging", International Journal of Computer Vision, 98(3): pp. 263-278, 2012.
[8]. Caraffa L, Tarel J P. "Markov random field model for single image defogging", In: Proceedings of the 2013 Intelligent Vehicles Symposium. Gold Coast, QLD: IEEE, pp. 994-999, 2013.
[9]. Tripathi, A. K., and S. Mukhopadhyay. "Single image fog removal using bilateral filter", Signal Processing, Computing and Control (ISPCC), 2012 IEEE International Conference on. IEEE, 2012.
[10]. Nayar S K, Narasimhan S G. "Contrast restoration of weather degraded images", IEEE Transactions on Pattern Analysis and Machine Intelligence, 25(6): pp.713-724,2003.
[11]. Schechner Y Y, Namer E, Shwartz S. "Blind haze separation", In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. New York, USA: IEEE Press, Pp.1984-1991, 2006.

[12]. He K M, Sun J, Tang X O. "Guided image filtering", In: Proceedings of the 2010 European Conference on Computer Vision (ECCV). Berlin, Germany: Springer-Verlag, pp.1-14,2010.
[13]. Fattal R."Single image dehazing", ACM Transactions on Graphics (TOG), 27(3): pp.1-9,2008.
[14]. Yan Wang, Bo Wu. "Improved Single Image Dehazing using dark Channel Prior", China, IEEE,2010.
[15]. Mohini Sharma, Virender. "Single Image Dehazing using Improved Dark Channel Prior",Haryana,ACEEE,2013.
[16]. K. He, J. Sun, and X. Tang, "Single image haze removal using dark channel prior," IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 12, pp. 2341–2353, Aug. 2010.
[17]. R. Fattal, "Single image dehazing," ACM Trans. Graph., vol. 27, no. 3, p. 72, 2008.
[18]. K. Nishino, L. Kratz, and S. Lombardi, "Bayesian defogging," Int. J. Comput. Vis., vol. 98, no. 3, pp. 1–16, 2011.
[19]. Yi-Hsuan Lai, Yi-Lei Chen, Chuan-Ju Chiou, Chiou-Ting Hsu,"Single-Image Dehazing via Optimal Transmission Map Under Scene Priors",IEEE, vol.25, no. 1, January 2015.
[20]. J. Tarel and N. Hautiere, "Fast visibility restoration from a single color or gray level image," in Proc. IEEE Conf. Comput. Vis., Oct. 2009, pp. 2201–2208.