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Evolution of New Integrated Haze Removal Algorithm Based on Haze Line

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Abstract: Haze is a standout amongst the most essential factor that debases the outside pictures. Picture corruption relies upon the separation of the Object from the camera as the separation increment from the camera of the scene point haze additionally increases. This paper presents a haze removal technique which is relies on the Haze-line prior that is recently introduced. This prior is based on the observation that the pixel values of a hazy image can be modeled as lines in RGB space that intersect at the air-light proposed approach is known as haze line. In this paper we proposed Post processing CBMG (Contrast, Brightness, Midtone and Gama adjustment) followed by four stages: clustering the pixel into haze line, Estimation of Transmission map, Regularization, Dehazing, This method is implement by observation of two basic things first pixels in a given group are regularly non local . Second pictures with improved perceivability (or sunny morning picture) have more differentiation than the pictures stopped by terrible climate. Experimental result demonstrate that our method remove haze layer and provide qualitative result.

key words CBMG , Haze line , Non- local , RGB .

I. INTRODUCTION

Highlight The Image Quality of Outdoor scene usually degraded due to low contrast and limited Visibility affected by turbid/misty medium in the atmosphere. Degradation in image is due to bad weather is a major issue for many utilization of computer views. Haze, fog and smoke are such anomaly due to which small mites in the air that scatter the light in the atmosphere. The image captured by camera loses contrast and color fidelity caused by constrict the signal of the view scene and fluid light returned into the line of sight by atmospheric particles As the distance from the camera increases haze in the image increases since the radiance of the scene decrease with the increase of air light magnitude.

Most of the image Dehazing method removes the haze thickness by recuperating the direct scene radiance. These methods confide on a physical figure formation model. In order to courage this indeterminacy many approaches used different additional instructions about the scene such as different weather condition Narasiber and Nayer et al 2000 [11] or polarization angle [15]. In [13] estimation the albedo of sight and infrared the medium communication. [11], [19] need some depth information from user inputs or known 3D model .In this paper present an efficient algorithm for recovering a haze free image by adopting the Dana Berman et al 2016 [7] algorithm. And recover the lost color and contrast after removing haze layer from the image. We improve the algorithm by adding the CBMG post processing which leads a very well effective result. Experimental results are also compared with well known algorithm DCP (Dark channel prior based on local patch)[10] prior, Raanan Fattel (Color line based Dehazing 2016)[17], DCP shows effective results but his algorithm fails on sky region scene recoverance. As we already discuss the cause of weather degraded image for recovery this degradation from the image desire two main steps: first require determining transmission value at ever pixel Second recovery of loosed contrast and Brightness fig1

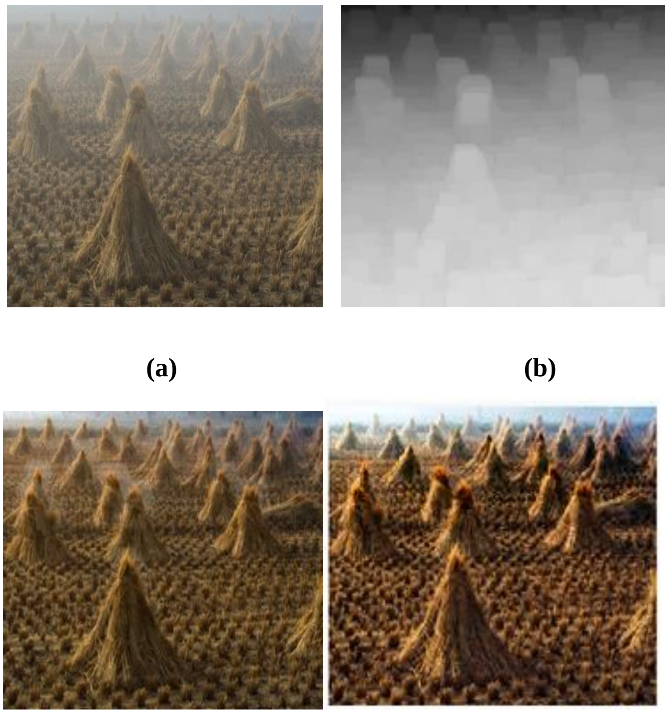

Fig1: (a) Haze image (b) Transmission image (c) Dehazed image (d) Recovered color and contrast in Dehazed image

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The remaining of the paper is organized as follows. In Section 2. We describe related previous Work on Dehazing. Section 3. Describe Background about the haze image formation. Section 4. Describe reference Haze removal algorithm .Section 5. Introduce our proposed method for Dehazing and restore the RGB value. Section 6. Shows experimental and comparison of results with well known algorithms. Section 7. Concludes the paper.

II. RELATED PREVIUS WORK

Various approaches have been proposed to clear haze / fog images. Dehazing image is a very challenging problem. In R. Fattal 2008 estimate the albrdo of scene and inferred the medium transmission. However this approach does not deal with heavy haze/ fog images and many fail to bring out that the assumption is wrong. Narasimhan and Nayar 2003 image defogging performed by modifying the distribution of the image histogram but the effect is limited. In [Y.Y Schechmer 2001 and [S.Shwartz 2000] based on polarization method remove haze effect through two or more images taken with different degree of polarization . In recent years there are many algorithms developed on DCP in [1][2][3][4][5][18][20] He at al 2011assume that will be at least one pixel with a dark channel and use this minimal value as an estimation of the presence of haze .Results are very effective and DCP was developed for air light estimation and it also transform to the transmission model via negative computation . But it fails to clear sky region in hazed image. Sulami et al. [25] severally estimate the air-light magnitude and direction. The direction is calculable by searching for little patches with a continuing transmission and surface reflective power . Every try of such patches provides a candidate air-light direction because the intersection of 2 planes in RGB space. The air-light magnitude is recovered by minimizing the dependence between the pixels' brightness and transmission. The assortment of priors has induce to the performance of [8] that explore different chunk features in a research framework. Rather of small chunks, in [9] the image is irregular into regions with Indistinguishable distances, and the contrast is Lengthen within each Section This may create artifacts at the Boundaries between segments. In [25,17] , color lines are fitted in RGB space per – patch , looking for small patches with constant transmission . This prior is based on the consideration [13] that pixel in a haze free image from color lines inn RGB space.

III. BACKGROUND

The haze image formation model in the computer vision and graphics proposed by Koschmieder [22] has been widely used in previous work. [11],[12],[13],[14],[17].

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

Where I stand f o observed hazy image corresponding at pixel **X** = (x,y) ,J is the true radiance of scene to be recovered at pixel **x**. and t is the transmission which is distance dependent of scene. Where A is the global atmospheric light. Fig [2] The problem of haze removal is based on mainly two parameters first **A** denotes the global atmosphere light and second is t(x) is the transmission matrix defined as

$$t(x)= e^{\beta d(x)} \qquad (2)$$

Where β is the scattering coefficient and d(x) is the scene depth at pixel x or can say distance between the object and camera.

Our research work is done till now on estimation of air light and transmission estimation. Also get efficient results on air light estimation. In early works the fore most haze-opaque element was accustomed estimate the air-light. for instance, Tan [13] selected the brightest element. Fattal [25] used it as associate degree initial guess for an improvement drawback. However, the element with the very best intensity would possibly correspond to a bright object instead of to the air-Light. He et al.[10] counsel choosing the brightest element among the pixels that have the highest brightest values of the dark channel (the bottom color channel during a tiny environment).

This technique is economical and

sually produces correct results; however it assumes that the sky or another space with no objects in line-of-sight is visible within the image

Sulamietal. [25] estimate the air-light magnitude and direction. The direction is calculable by read of tiny patches with a continuing transmission and surface ratio. Every try of comparable patches provides a candidate air-light direction because the intersection of 2 planes in RGB house. The air-light magnitude is improved by minimizing the dependence between the pixels' brightness and transmission.

In [23] proposed air light estimation using haze line[07] and Hough transform . The term haze line is defined by cluster of different colors in clear image forms a line in RGB space. Eq. 3 defined a line equation in 3D passing through air light coordinate. [07] Using Eq 1.

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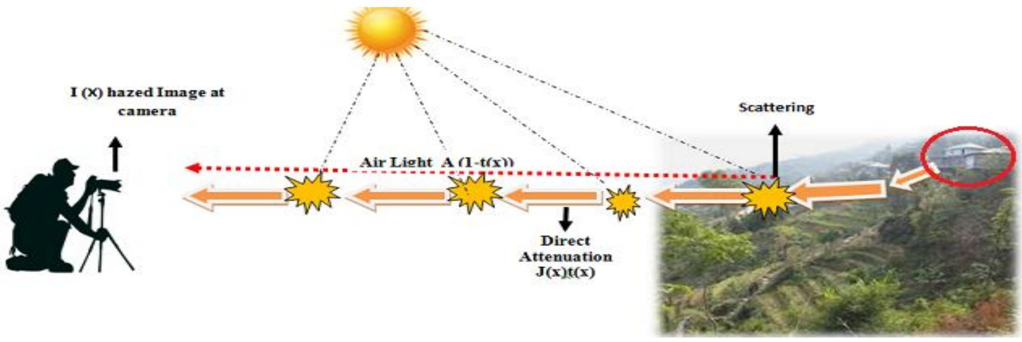

Fig 2: haze image obtained at the viewer side due to air light scattering

$$(x) = t(x).\ J\ ((x) - A) + A \quad (3)$$

Where J((x) – A) is the direction and t is the line parameter. Fig 3 sustains Haze line in both image plane and in RGB space.

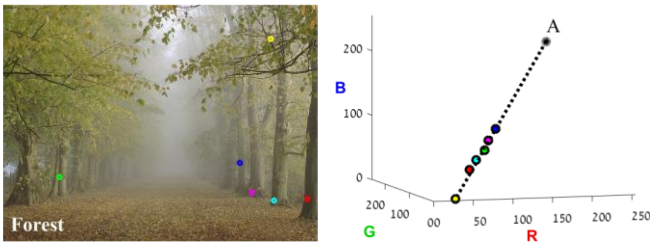

Figure 3. Haze-Lin Formation [07] Pixels of the Forest image were gather to haze-lines. Six pixels optimism to one haze line are marked each within the image plane and in RGB area, with individual colors.

IV. HAZE REMOVAL

As discussed above the concept of Haze and impressively describe the method to remove haze from the hazed image using haze line.

In our method use first this prior method to remove haze from the image [23]. For this apply the below algorithm to remove haze.

ALGORITHM FOR HAZE REMOVAL

"Input: $I(x)$,A
Output: $\hat{J}(x)$, $\hat{t}(x)$
Step 1: $I_A(x) = I(x) - A$
Step 2: Convert I_A to spherical coordinates to obtain $[r(x), \varphi(x), \theta(x)]$
Step3: Cluster the pixels according to $[\varphi(x), \theta(x)]$. Each cluster H is a *haze-line*.
Step4: For each cluster H do
Step5: Estimate maximum radius: $\hat{r}_{max}(x) = \max_{x \in H}\{r(x)\}$
Step6: For each pixel x do
Step7: Estimate transmission: $\tilde{t}(x) = \frac{r(x)}{\hat{r}_{max}}$
Step8: Perform regularization by calculating $\hat{t}(x)$
Step9: Calculate the dehazed image"

V. PROPOSED METHOD CBMG

Our Algorithm is based on the examination that a hazy image show low contrast generally. We restore the hazy image by enhancing its contrast and some other parameters. The proposed algorithm of image enhancement is composed of four major Steps **"C"(1) Contrast Enhancement "B" (2) Brightness setting. "M" (3) Midtone setting. "G" (4) Gamma correction. Followed by (non local Dehazing algorithm based on haze line proposed by Berman, Dana)[07] .**

PRPOSED ALGORITHM

Step 1: Input Raw image I_R
Step 2: INLD[x,y] result of non localDehazing $I_{NLD}[x,y]=NLD(I_R)$
Step 3: apply contrast enhancement equation from 4 to 8.
Step 4: For adaptive brightness enhancement Applyeq10 on EC[x,y].
Step 5: apply Midtone value adjustment eq 11 on EB[x,y]
Step 6 : Gamma correction apply eq .12 on M'enh[x,y]

A. *CONTRAST ENHANCEMENT*

The fuzzy image enhancement approach uses the HSV color territory where only the V-composing is stretched by preserving chromatic instructions such as hue (H) and saturation (S). The program designed completely increase low contrast color images. The stretching of composing V is controlled by the gain parameters M and K. this stretching converts the current intensity value x to the enhanced intensity value Xe.

The first step of the proposed method is to convert a given RGB image of size P × Q to HSV, and then calculate the histogram h(x), where x Є V. h(x) indicates the number of pixels in the image with the intensity value x. The proposed method uses two intensification parameters M and K, which control the degree at which the intensity value of x should be intensified. The control parameter M, the average value of the image intensity, can be calculated from the histogram as follows:

$$M = \frac{\sum_X X\, h(X)}{\sum_X h(X)} \quad (4)$$

The parameter M isolates the histogram h(X) into two classes. The top of the class C1contain pixel esteems in the range [0, M-1] and the second class C2 in the range [M, 255] and two fuzzy membership value µD1 and µD2 determined for pixel classes C1 and C2 separately. The M parameter assumes a critical job in ascertaining fuzzy membership values, µD1, and µD2.

The gain parameter K determines the intensity to calculate the increased intensity values for the two C1and C2 classes. The parameter K defines a point of stretching, which should be extended values of intensity of x based on the membership value values of µD1 and µD2 facilities. The value for K can be calculated empirically depending on the extent to which stretching is required. From experimental analysis, we set a value of 128 for K, which gives better results for low contrast and minimum bright color images.

The fuzzy membership value of µD1 for class C1 is based on the understanding of how far the intensity value of x is from parameter M. the fuzzy rule for class C1 can be represented as follows:

1) ***"If the difference between x and M is large, then the starching intensity must be small."***

The above rule specifies that pixel values closer to M will be higher, whereas values further from M will be extended lesser. The pixel values between them will expand proportionally. To implement the above fuzzy rule, use the following mathematical representation

$$\mu D1(X) = \frac{1-(M-X)}{M} \quad (5)$$

Where x Є C1. Once the membership value for x is obtained, the contrast enhanced or intensified value x_e for class C1can be computed as follows:

$$X_e = X + \mu D1(X)K \quad (6)$$

µD1(x) decides what amount of stretching parameter K has to be added to x to get the enhanced value x_e. The Fuzzy Membership value µD2 for class C2 is based on the concept Of how far the intensity value X is from the extreme value E For (8 bit image E = 255) the Fuzzy rule for class C2 can be represented as follows:

2) ***"If the difference between x and E is LARGE then the intensity of stretching should be LARGE."***

The rule number two implies that the pixels values closer to E will be protracted lesser whereas values farther from E will be extended higher. Pixel values in between will be extended correlatively. To implement the above fuzzy rule the following mathematical representation can be used:

$$\mu D2(X) = \frac{E-X}{E-M} \quad (7)$$

Where x Є C2. Once the membership value for x is obtained, the contrast enhanced or intensified value x_e for class C2can be computed as follows:

$$X_e = X\mu D2(X)) + (E - \mu D2(X)K) \quad (8)$$

µD2(x) decides what amount of stretching parameter K and the intensity value x has to be utilized to get the enhanced value x_e. The replacement of the old x values of the V component with the enhanced x_e values will cause the V component to be stretched resulting in contrast and brightness enhanced component V_e.

$$EC[x,y] = V_e \quad (9)$$

B. *BRIGHTNESS ENHANCEMENT*

After enhancement contrast in image our second main step is brightness enhancement which is done by applying below equation on the result of contrast enhanced image.

For each pixel Brightness value is extracted of Red, green and blue channel.

$$EB[x,y] = EC[x,y]+\{ (C_R C_G C_B)+B_i) \quad (10)$$

Where B_i is denoted for brightness "i" value lies between -255 to +255.EB is enhanced brightness in image at x, y coordinates of image.

C. *MIDTONE VALUE ADJUSTMENT*

Third main step of our algorithm is Midtone value adjustment. It has been observed that the luminance also contains the mid-tone and low frequency components of reflectance which has been degraded during the dynamic range compression. For the original image with low contrast or slow-varying reflectance map, the degradation of Midtone frequency features may be rather obvious in the output images.

$$M'_{enh}[x,y]= EB[x,y] + M_{sh}(x,y) \quad (11)$$

Where $M'_{enh}(x,y)$ is enhanced Midtone value where $M_{sh}(x,y)$value between -100 to +100.

D. *GAMMA VALUE ADJUSTMENT*

Fourth and final step of our algorithm is Gamma correction adjusts an image's brightness non-uniformly very bright areas are not as washed out and dark areas aren't as dark.

$\Upsilon_R[C_R] + \Upsilon_i$ (a)

$\Upsilon_G[C_B] + \Upsilon_i$ (b)

$\Upsilon_B[C_G] + \Upsilon_i$ (c)

$$\mathbf{F_{DH}[x,y]} = M'_{enh}[x,y] + \mathbf{\Upsilon_{RGB}} + \Upsilon_i \quad (12)$$

Where ϒi is denoted for Gama "i" value lies between 0.2 to 5. For each gamma array of Red, Green and Blue. $F_{DH}[x,y]$ (eq by merging (a),(b),(c)) is final result of haze free and restored image after apply CBMG .

VI. RESULT COMPARISION

In Fig4 we have compared our results among the existing methods and measure is result quantitatively.

We have generated PSNR value with multiple original as well as processes images (which also contains natural as well as syntactic images) . We have compared our result with DCP , Color line and haze based algorithm.

Our result is much better by the visual censored images. We also compared all images with Universal Image Quality Index which is proposed by ZhouWang [24] and get better results

Table1: compression of the root mean square error

	RMSE				
	Orignal	**R.Fattel**	**K.He**	**D.Berman**	**Our Algo**
1	29.1873	33.99867	31.65386	31.7641	33.42428
2	31.9494	33.278	35.06817	37.15754	34.66123
3	29.3855	31.30878	31.55587	31.95217	32.82924
4	29.8271	31.44631	30.96927	32.84191	33.05836

Table2: compare the quality Index value

	Universal Image Quality Index				
	orignal	**R.Fattel**	**K.He**	**D.Berman**	**Our Algo**
1	0.10669	0.20397	0.33063	0.43646	0.46719
2	0.24622	0.48628	0.45092	0.37265	0.49606
3	0.20333	0.35019	0.26049	0.42319	0.58198
4	0.26846	0.39767	0.48024	0.54471	0.74377

1 (a) Original Image 1(b) R.Fattel (color line) 1 (c)He.K (DCP) 1(d)D.Berman (non-Local) 1(e)Our Result

2 (a) Original Image 2(b) R.Fattel(color line) 2 (c)He.K(DCP) 2(d)D.Berman(non-Local) 2(e)Our Result

3 (a) Original Image 3(b) R.Fattel(color line) 3(c)He.K(DCP) 3 (d) D.Berman (non-Local) 3(e)Our Result

4 (a) Original Image 4(b) R.Fattel(color line) 4 (c)He.K(DCP) 4(d)D.Berman (non-Local) 4(e)Our Result

Fig :4 figure shows compression of result with benchmark images in 1 (a,b,c,d,e) , 3(a,b,c,d,e) ,4 (a,b,c,d,e) and 2(a) image is natural clicked by camera and result is compared with well known algorithms

VII. CONCLUTION

Many vision applications can be more effective and efficient after using Haze and Fog algorithm. Proposed algorithm is based on CBMG technique for nonlinear enrichment of color images on illuminance-reflectance. In this paper we have demonstrated that after processing proposed algorithm image have more descriptive, clear and robust enrich result, by the algorithm we can improve the accuracy in hazed and foggy images.

We estimates the color probability in the proposed technique by selected candidates of the representative haze pixels For air light computation.

By the different table and images data set we find a better and Descriptive result.

REFRENCES

1. Hsieh, C. H., Lin, Y. S., & Chang, C. H. (2014, July). “Haze removal without transmission map refinement based on dual dark channels. In 2014 International Conference on Machine Learning and Cybernetics” (Vol. 2, pp. 512-516). IEEE...
2. Kim, Jin-Hwan, et al. "Optimized contrast enhancement for real-time image and video dehazing." Journal of Visual Communication and Image Representation 24.3 (2013): 410-425.
3. Wen, Kai, Bin Sun, and Jing Yang. "NSCT-Based Image Enhancement Combing Homomorphic Filtering With Fuzzy theory." Advanced Materials Research. Vol. 989. Trans Tech Publications, 2014.
4. Pei, Soo-Chang, and Tzu-Yen Lee. "Effective image haze removal using dark channel prior and post-processing." 2012 IEEE International Symposium on Circuits and Systems. IEEE, 2012.
5. Song, Yingchao, et al. "An improved image dehazing and enhancing method using dark channel prior." The 27th Chinese Control and Decision Conference (2015 CCDC). IEEE, 2015.
6. Ullah, Ehsan, R. Nawaz, and Jamshed Iqbal. "Single image haze removal using improved dark channel prior." 2013 5th International Conference on Modelling, Identification and Control (ICMIC). IEEE, 2013.
7. Berman, Dana, and Shai A. "Non-local image dehazing." Proceedings of the IEEE conference on computer vision and pattern recognition. 2016.
8. Tang, Ketan, Jianchao Yang, and Jue Wang. "Investigating haze-relevant features in a learning framework for image dehazing." Proceedings of the IEEE conference on computer vision and pattern recognition. 2014.
9. L-González, Raúl, Juan L. Nieves, and Javier Romero. "Recovering of weather degraded images based on RGB response ratio constancy." Applied optics 54.4 (2015): B222-B231
10. He, Kaiming, Jian Sun, and Xiaoou Tang. "Single image haze removal using dark channel prior." IEEE transactions on pattern analysis and machine intelligence 33.12 (2010): 2341-2353.
11. Narasimhan, Srinivasa G., and Shree K. Nayar. "Chromatic framework for vision in bad weather." Proceedings IEEE Conference on Computer Vision and Pattern Recognition. CVPR 2000 (Cat. No. PR00662). Vol. 1. IEEE, 2000.
12. Schechner, Yoav Y., Srinivasa G. Narasimhan, and Shree K. Nayar. "Instant dehazing of images using polarization." CVPR (1). 2001.
13. Tan, Robby T. "Visibility in bad weather from a single image." 2008 IEEE Conference on Computer Vision and Pattern Recognition. IEEE, 2008
14. Fattal, Raanan. "Single image dehazing." ACM transactions on graphics (TOG) 27.3 (2008): 72.
15. Shwartz, Sarit, EinavNamer, and Yoav Y. Schechner. "Blind haze separation." 2006 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'06). Vol. 2. IEEE, 2006.
16. Kopf, Johannes, et al. “Deep photo: Model-based photograph enhancement and viewing.” Vol. 27. No. 5. ACM, 2008
17. Fattal, Raanan. "Dehazing using color-lines." ACM transactions on graphics (TOG) 34.1 (2014): 13.
18. Kil, Tae Ho, Sang Hwa Lee, and Nam Ik Cho. "A dehazing algorithm using dark channel prior and contrast enhancement." 2013 IEEE International Conference on Acoustics, Speech and Signal Processing. IEEE, 2013.
19. Kopf, Johannes, et al. “Deep photo: Model-based photograph enhancement and viewing.” Vol. 27. No. 5. ACM, 2008.
20. Zhang, Qiang, and Xiaorun Li. "Fast image dehazing using guided filter." 2015 IEEE 16th International Conference on Communication Technology (ICCT). IEEE, 2015.
21. McCartney, Earl J. "Optics of the atmosphere: scattering by molecules and particles." New York, John Wiley and Sons, Inc., 1976. 421 p. (1976).
22. Choi, Lark Kwon, Jaehee You, and Alan C. Bovik. "Referenceless perceptual image defogging." 2014 Southwest Symposium on Image Analysis and Interpretation. IEEE, 2014.
23. Berman, Dana, TaliTreibitz, and Shai Avidan. "Air-light estimation using haze-lines." 2017 IEEE International Conference on Computational Photography (ICCP). IEEE, 2017.
24. Wang, Zhou, and Alan C. Bovik. "A universal image quality index." *IEEE signal processing letters* 9.3 (2002): 81-84.
25. Sulami, Matan, et al. "Automatic recovery of the atmospheric light in hazy images." *2014 IEEE International Conference on Computational Photography (ICCP)*. IEEE, 2014.
26. Kumar Sandeep ,Rajeev Kumar and Meenu kansal “Image Resolution enhancement Object captured by satellite” 4th International “Conference on System Modeling & Advancement in Research Trends (SMART)College of Computing Sciences and Information Technology (CCSIT) ,TeerthankerMahaveer University , Moradabad”.
27. Panchal, Vinod Kumar. "Taxonomy Of Nature Inspired Computational Intelligence In Digital Image PROCESSING FOR HARSH WEATHER." *IJAR of Computer Science* 8.8 (2017).
28. Hanmandlu, Madasu, and DevendraJha. "An optimal fuzzy system for color image enhancement." *IEEE Transactions on image processing* 15.10 (2006): 2956-2966.
29. Nair, Madhu S., et al. "Fuzzy logic-based automatic contrast enhancement of satellite images of ocean." *Signal, Image and Video Processing* 5.1 (2011): 69-80.
30. Chen, Soong-D, and Abd Rahman . "Minimum mean brightness error bi-histogram equalization in contrast enhancement." *IEEE transactions on Consumer Electronics*49.4 (2003): 1310-1319.

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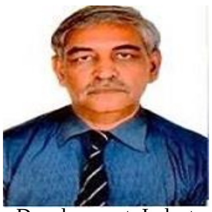

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