Image Enhancement Of Foggy Images Using Hybrid Method Based On Dark Channel Prior

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Abstract: The movement of atmospheric particles, which decreases contrast, changes color as well as atmospheric particles difficult to identify by human vision as well as some outdoor computer vision devices, will be used in images captured in hazy or foggy weather conditions. Image dehazing is thus an important issue and has been widely explored in computer vision. The task of image dehazing is to remove weather factors' impact to enhance the image's visual effects and to gain post-processing. We were using a pre-method of dark channels to dehaze images and NPEA to increase the image's naturalness or edge detection to detect edges.

Keywords: Dark Channel Prior, Image Dehazing, Biliteral Filter, Image Reconstruction, Transmission Image, Homomorphic Filter, Canny Edge Detection, NPEA.

1. INTRODUCTION

In the era of machine vision technology, machine intelligence, and automation for the in-post processing or processing of the picture captured in different atmospheric conditions, Image processing is encouraging. The outdoor images are highly spoiled by the presence of various deflective objects such as water droplets, particles of dust, poor lighting, etc. Image sequences taken under low visibility conditions especially in foggy weather have a significant role to play on the picture scene due to the light dispersal behavior of water droplets and air pollution, which affects many computer vision applications such as remote sensing, smart vehicle detection, or object detection and tracking [1]. It is also essential for a simple scene to be found in the nebulous picture sequence. An external display device is essential to enhance workability and reliability by learning an intelligent defogging mechanism, which can auto-identify foggy pictures and explain foggy images.. [2]. The two common phenomena of land and ocean depletion were fog or haze. Many atmospheric particles with large measurements are present in foggy or hazy weather. We not only reflect or scatter the scene's reflected light but disperse any ambient light through the camera. The image obtained by the sensor is then distorted or are typically poorly contrasting. In particular, this will have a serious influence on the visual system [3]. Computer vision applications, therefore, need to improve the image's visual impact or highlight the texture features. ID method, related to as "removal or defogging of haze " is essentially a procedure to eliminate or completely extract contamination from haze using different techniques, to obtain more usable details or visual results. ID reduces potential visual artifacts technologically and is often used as a way to improve the image. Nevertheless, deterioration to image pixels caused by haze depends on the distance between material, acquisition system, and regional density. This varies from standard approaches for reducing noise or enhancing contrast. The haze effect on pixels also reduces the vibrant color spectrum [4]. The defogging algorithms for images are split into two categories: one is the approach for image restoration, and The other method is the atmospheric diffusion model-based restore images. The technique of imagery improvements simply increases the image's optical appearance by which the sensitivity of the picture that does not have the real image loss pattern in the fog. [5]. Defogging of image based on dark channel prior (DCP) is found in 'dark pixels' with at least one color channel rather low strength, excluding for sky area. The bulk of new dehazing methods have followed the DCP owing to their success in dehazing. The DCP-based dehazing method consists of four major stages: estimation of ambient illumination, an approximation of the map, the refining of the chart, and the repositioning of images[6]. The Gaussian or bilateral filter DCP provides better performance than the average or bilateral filter. [7]. The following section of this paper is organized II defines a Literature review done in the field of image defogging method to the enhancement of images. Section III defines the problem domain in existing work and section IV defines the proposed methodology, in these various methods that applied in our proposed methodology are defined. Section V defines experimental analysis and section VI defines the conclusion.

2. LITERATURE SURVEY

Z. Tufail et al. [2019] To estimate atmospheric light that also describes the value of light intensity in a scene in the absence of fog, the author proposes a DC-based single ID method. This atmospheric light is used for reconstruction of a transmitting map for fog-free pictures. The fog effect concerning image depth is reflected in the transmission map. Within this analysis, four maps are suggested to reconstruct the photos with a specific color difference. To order to reconstruct images with maximum color intensity, the suggested approach selects a transmission map based on the fog density Apply Laplacian filter followed by the guide filter to process the transmission map. Previously, approaches focused on DC were considered less effective for images with wide sky areas, but for these images, the proposed procedure consistently reconstructs better results independent of the fog intensity. The test results indicate that the images reconstructed using the approach suggested are qualitatively better than the methods presented above. [8]. Z. Tufail et al. [2018] This paper introduces a DCP-based defogging approach with enhanced map transmitting to avoid objects from being obscured. The maps are determined for the color spaces RGB or YCbCr. Three charts are used to determine the overall transmission map for the R, G & B networks. In-area of the YCbCr color field, the transmission map is determined. Both maps are optimized by the protection of edge details for two intermediate images, with specific weights applied to achieve a better-defogged efficiency. This procedure is focused on the current methods and the tests are determined depending on the structural similarities indexes, fog effect, anisotropic index, or degrees, which demonstrate that better outcomes are obtained with a lower fog influence, similarity indices, deterioration score, and higher classification by using the defogged images recovered using the proposed process. The reconstructed picture has better contrast as well as light, which is more attractive to the human visual system [9]. V. K. Trivedi et al. [2018] A DCP with a contrast extension is used for removing fog and improving the image free of fog. With the DCP process, a high-quality haze image can be effectively removed from the thickness layer. The resultant image of the DCP process is used to enhance picture contrast. The noise affecting abstract images may also be made possible by medium low-pass filters. Visual as well as color accuracy of the foggy image will easily be accurate by using this technique. PSNR and RMSE parameters experiment. Experimental results show that among other approaches the proposed method includes lower average RMSE values but higher PSNR values. [10]. R. Li and U. Kintak [2018] To resolve the issues, Fog Aware Density Evaluator (FADE) has been developed to obtain a more accurate measurement of ambient light A & medium transmission in the light regions, to prevent changing colors in the sky area. The issue lies in the reference-less calculation of the perceptual fog intensity model. This paper is often used to optimize the medium transmission with quickly directed filtering. The findings indicate that the restored picture of the enhanced algorithm proposed in this paper has no significant color distortion issue in the sky area & algo is more successful than DC before the de-fog algo. [11]. A. Li & X. Li [2017] We propose a modern simple defogging method from a gray or color image to get an image of fog. Next, before we explain the contrasting relationship of the dark channel with the image of fog, we use dark channel numbers. Then we proposed a new filter algorithm to address the weaknesses of the estimating methods of fog concentration. The abrupt shift in the intensity of a picture can be immensely preserved on the edge of the mist concentration through bilateral filtering. By smoothing the corner by partial median filters, a certain amount of fog is avoided around small objects as well as the edge of the corner of the building is kept more robust [12]. Changli Li et al. [2017] The main focus of this essay is on image restoration. This investigates first and foremost DCP defogging algo as well as improves based on this theory. This paper proposes improving atmospheric light or transmission estimates to fix deficiencies of an inaccurate atmospheric light estimation and long-term usage of He's algorithm. Implement a benefit multiplier rather than a soft matting method over a longer time for a better calculation transmittance. Four binary tree subdivision approaches simultaneously are used to estimate the light environment that decreases running time, avoids halo effects, and produces a better defogging effect. [13]. H. Yu and C. Cai [2016] The DCP algorithm was considered an efficient dehazing tool utilizing only one constant factor for the overall image, irrespective of scene type. This imprudent method leads to a lighter image color which does not yield fantastic performance. We propose a factor-based solution to improve DC before dehazing. In this paper. the foggy image in our methods is divided into sky & non-sky regions in Otsu, and the essential parameters are defined by various variables, i.e. light strength and transmission ratio Several experiments to confirm the dehazing efficiency of this method have been performed [14].

3. PROPOSED FRAMEWORK

a) Problem Statement

There are some problems associated with an existing technique. These are:

1) The color of the sky affects the atmospheric light
2) During extreme weather, outdoor images are vulnerable to low visibility,
3) Result dependent on image quality.

b) Propose Methodology

First, we are going to load the hazed image and then apply a dark channel filter after that we estimate the atmospheric light after that we find the scene radiance and improve it and next, we find the transition image and reconstruct the image we get the reconstructed image with a low quality that why to improve the naturalness of the image we will enhance it using our filters like bilateral and in our propose, we used NPEA for increasing the image quality. The proposed methodology has the following phases:

c) Dark channel prior (DCP)

DCP[15] is focused on core findings from outdoor haze-free photos, which shows that a minimum color channel contains pixels of very low intensity or near to null, indicating that a minimum intensity is similar to zero in such an area. The commonly used pattern of computer vision or computer graphics for the creation of hazy images is:

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

J is scene radiance, where I are experiential intensity, A is global atmospheric light, as well as t medium is a light portion that is not distributed into the camera. The goal is to eliminate haze from I, J, and A. The transmitting t can be represented when the atmosphere is homogeneous.

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

Where β is the atmosphere's scattering coefficient, as well as d, is the scale of the picture. eq. (2), it is found that after the transmission is reached, depth must be restored to an unknown scale such that transmission t can be utilized to recover all scene radiance J or scene depth d.

DC J_{dark} is given for an arbitrary image J

$$J_{dark}(X) = \min_{y \epsilon \Omega(x)} (\min_{C \epsilon \{r,g,b\}} J^{C}(y)) \qquad (3)$$

If J_{dark} (X) is a J or Ω(x)color channel, it's a local patch centering on x. Two operators minimum are commutative.

During outdoor image J, the intensity of J's DC is small or near to zero based on the main observation on non-high areas:

$$J_{dark} \rightarrow 0 \qquad (4)$$

This analysis, which is influenced by a well-known technique of dark object subtraction[16], is considered a

DCP. The depth d as well as the radiance J can be measured in the basic sequence.

- Estimate atmospheric light
- Estimate transmission
- Recover scene radiance

d) Bilateral Filter

BF [17] is a nonlinear filter that does not smooth the edges of a spatial say. This has proved to be an important technique of image denoising. This may also be used to reduce blocking tools. The specification of the filter parameters, which have a major effect on the performance, is critical for the implementation of the bilateral filter. In comparison, the SUSAN filter and the neighborhood filter introduced the definition of the BF. The Beltrami flow algorithm is the theoretical origin of the BF [18], which produces a variety of image improvement algorithms from linear L2 through non-linear L1 flows. In a local district, the BF takes a weighted sum of pixels; weights are dependent on both their spatial as well as intensity distances. It retains the outlines when integrating static. The output of a BF is calculated mathematically at a pixel x,

$$\tilde{I}(x) = \frac{1}{C}\sum_{y\in N(x)} e^{\frac{-||y-x||^2}{2\sigma_d^2}} e^{\frac{-|I(y)-I(x)|^2}{2\sigma_r^2}} I(y) \quad (5)$$

Where σ_d & σ_r are parameters which control weight fall in space or intensity areas, N(x) is an area of PixelI(x), but C is a constant of normalization:

$$C = \sum_{y\in N(x)} e^{\frac{-||y-x||^2}{2\sigma_d^2}} e^{\frac{-|I(y)-I(x)|^2}{2\sigma_r^2}} \quad (6)$$

e) Homomorphic Filtering

HF[19] is a technique for improving & correcting images. the amplitude of the whole image is normalized as well as the intensity decreases when the lighting and reflectance components can not be isolated. To improve image appearance, which is light & contrast at the same time, two elements will be used. In concept, illumination and reflection can be mathematically modeled as follows:

$$F(x,y) = I(x,y)\, R(x,y) \quad (7)$$

Attach the model to the normal log domain & then perform the transformation of Fourier.

$$Z(x, y) = \ln\{ F(x, y)\} = \ln\{I(x, y)\}+ \ln\{R(x, y)\} \quad (8)$$

The reverse Fourier process is implemented next, as mentioned below:

$$S (x, y) = F^{-1} \{H (u ,v) I(u ,v)\}+ F^{-1} \{ H (u ,v) R(u ,v)\} \quad (9)$$

Where, I(u, v) is Illumination images, R(u,v) is Reflectance images and H(u,v) is the Type of filter (Spatial Filter).

Inverse transformation of a natural log is now used to obtain an exponential spatial domain,

$$S (x, y) = i(x, y) + r(x, y) \quad (10)$$

$$G (x, y) = \exp[i(x ,y)] \times \exp[r(x ,y)] \quad (11)$$

f) Canny Edge Detection

Edges define boundaries yet are an important issue for the processing of images. Imagery edges are regions of clear differences in the strength-a leap from pixel to pixel. Edge image detection greatly decreases the volume of data, removes unnecessary data, and retains the structural features of a file. Also considered to be the best edge detector, the CED [20] algo. Canny's plans were already to develop multiple edge detectors when he started his research. A list of criteria for improving current edge detection methods. Low error rates are the first and most obvious. It is important not to lose the edges of images or to not respond to the non-edges. This is important. The second requirement is the correct positioning of the edge points. In other terms, there is a minimal gap from the detector between both the side pixels as well as the actual edge. A third requirement is to have a single edge solution. CED smoothes image for exclusion or noise dependent upon these parameters. The gradient of the image is found to show high-space regions. The algorithm then tracks the regions or deletes every not maximally excluded pixel [21]. The algorithm tracks these regions. Several precautions will be done to introduce CED algo.

- Step 1: The first step is to filter all noise from the original image before attempting to find all borders. Gaussian smoothing can be done by standard convolution methods once an appropriate mask is calculated.
- Step 2: The next step is to find edge strength after smoothing the image and filter noise. By taking the image gradient. A 2D spatial gradient measurement is carried out on an image by the Sobel operator. In this scenario, users can find at each point approximate absolute gradient (edge strength).
- Step 3: Once the gradient in x & y directions is known, the direction of the edge is trivial. Every time gradient in direction of x is zero, the edge of the path must be 90 degrees or 0 degrees, depending on the value of the path in the y-direction. If GY's value is negative, it is 0 degrees in edge direction. When not, it is 90 degrees in edge position. The method to determine the position of the edge is:

$$\text{Theta} = \text{invtan}\, (Gy / Gx) \quad (12)$$

- Step 4: Once knowing the direction of the edge, the next move is to transmit the direction of the edge direction of the image.

g) NPEA Method

NPEAfor non-uniform lighting pictures. Consequently, in sort to improve facts with NP, the proposed algorithm intends to recover local variation of picture & conserve the global trend of intensity at a similar time. The lightness-order-error (LOE) calculates for NP is projected to evaluate improved pictures. LOE calculates that execute well following objective evaluation on NP. Consequently, physics position of sight, here 2 methods are constraints. The 1st detail constraint, that reflectance may bind to proper range via considering the property of reflectance. The 2nd is NP constraint, that relative sort of lighting in diverse local locations ought not to be altered considerably [22]. Naturalist maintained improvement for non-uniform pictures of enlightenment that only improve picture information but also maintains naturalness [23].

A. Proposed Algorithm

Step 1: Start
Step 2: Browse the hazed Images
Step 3: Use Dark channel prior
Step 4: Estimate atmospheric light
Step 5: DC consider the radiance of the scene
Step 6: Scene radiance by radiation boost
Step 7: Consider the transformative visual scene radiance
Step 8: Perform Images reconstruction and dehaze the image
Step 9: Apply Bifilter2
Step 10: Apply Propose method

1) Resize the image
2) improved dehaze image by clahe
3) improved image by the homomorphic filter
4) Canny edge detection
5) final improvement by NPEA method

Step 11: Evaluate the Performance
Step 12: End

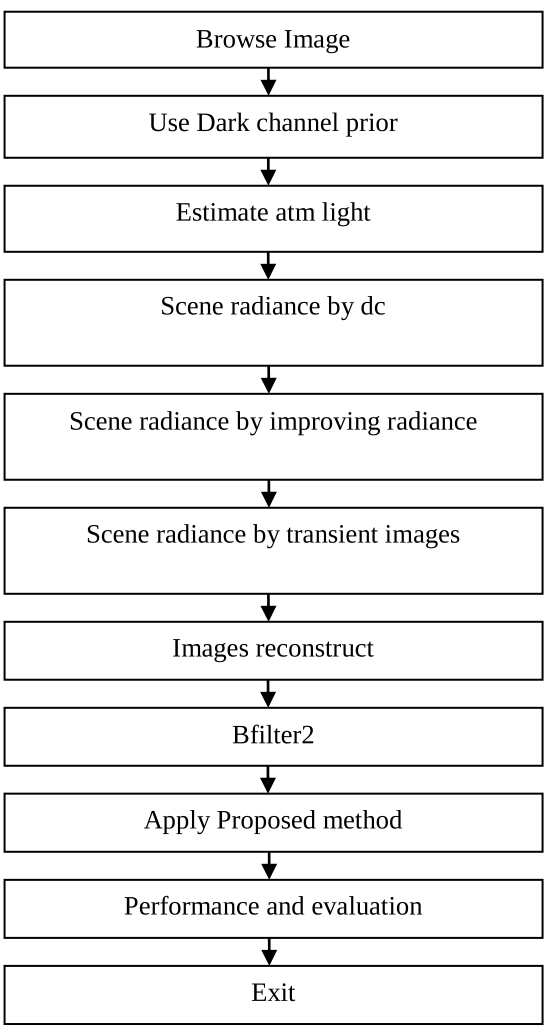


Fig.1. The Flow Chart of Proposed Methodology

4. EXPERIMENTAL ANALYSIS

In performance evaluation, the experimental study utilizes model enhancement images. Color images are needed for evaluation. The PSNR or SSIM importance are approximate. On the Image Processing toolbox, the algorithm is based on MATLABR18. This algorithm is compared to the current algorithm in this application. When we saw the examination results.

The output of the existing technology is evaluated based on their corresponding PSNR & SSIM values & the next figures and table show output.

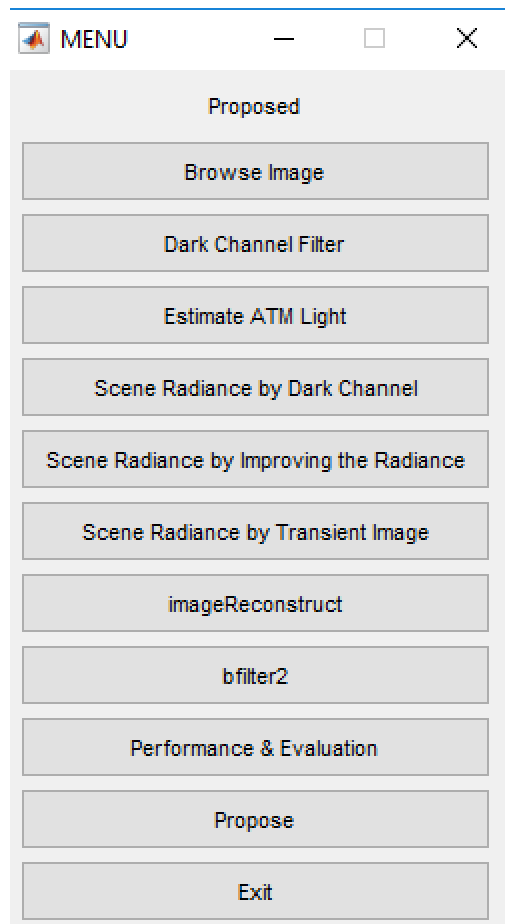


***Fig.2**. Initially, we "run" our application or get the menu bar of this form.*

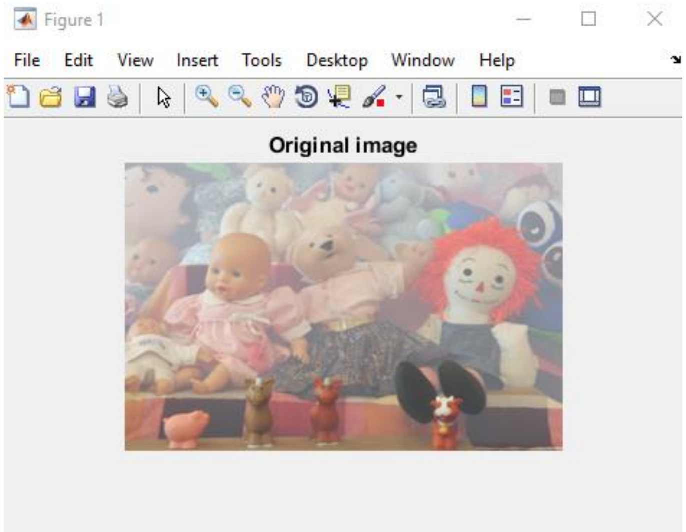


***Fig.3**. Browse the image*

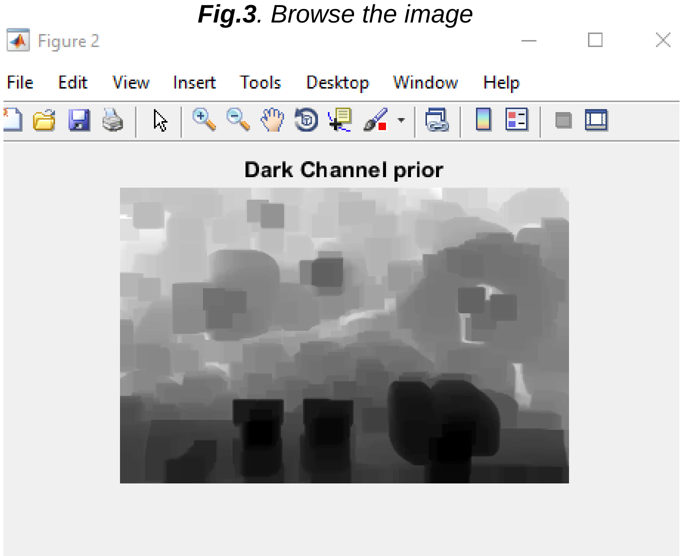


***Fig.4**. Applying the dark channel prior*

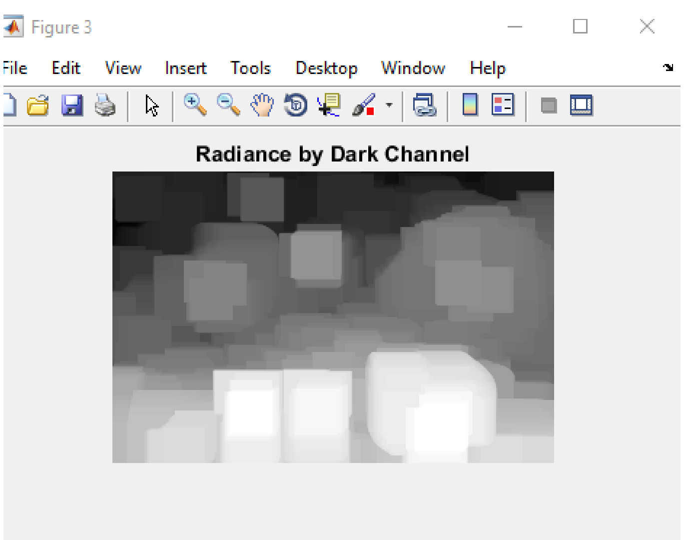


***Fig.5**. Radiance by Dark channel*

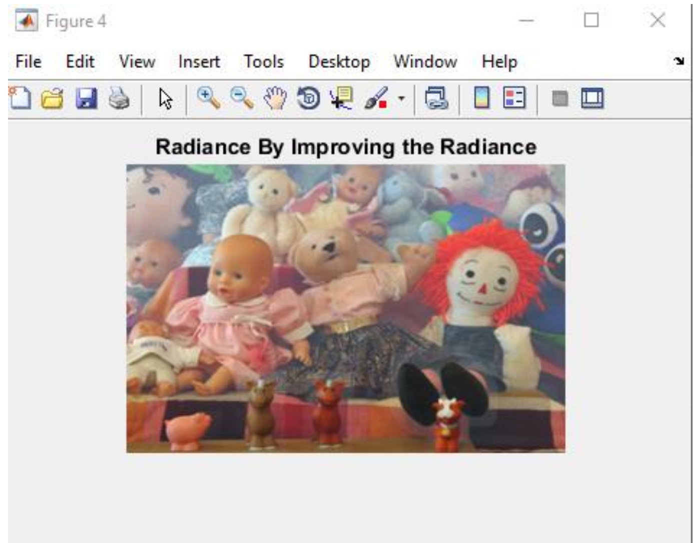


***Fig.6**. improved scene radiance*

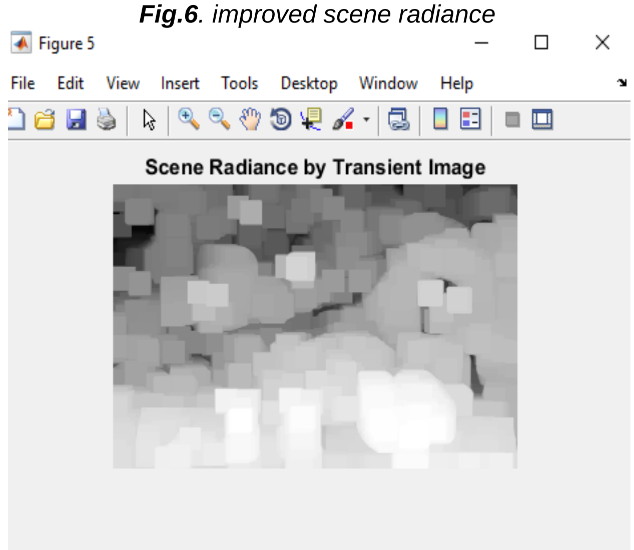


***Fig.7**. scene radiance by transient image*

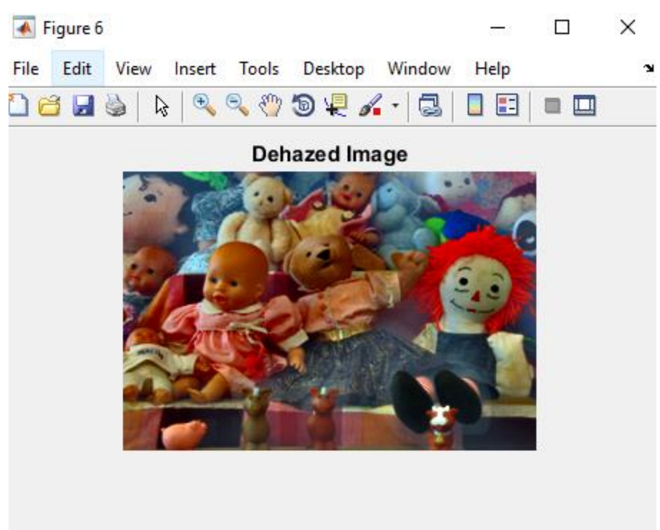


***Fig.8**. Dehazed Image*

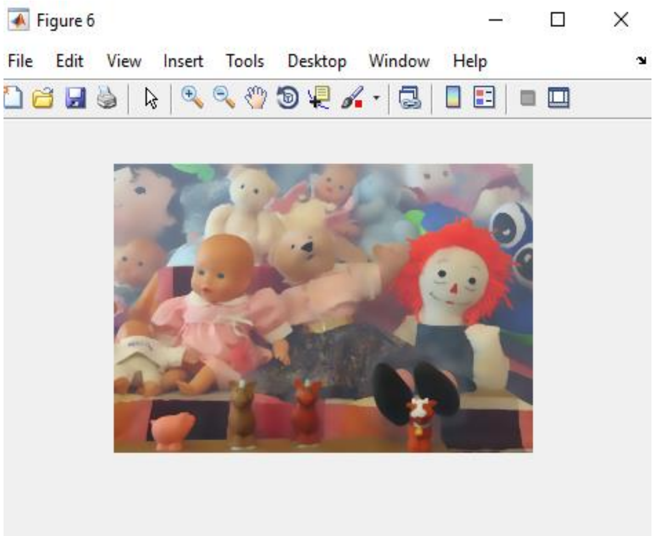


Fig.9. *Improved by the bilateral filter*

Fig.10. *Menu bar for the proposed method*

The proposed techniques start here:

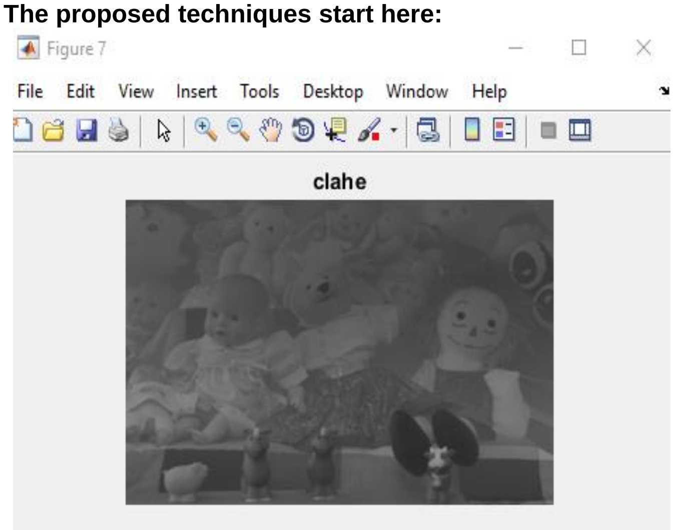


Fig.11. *improved dehaze image by clahe*

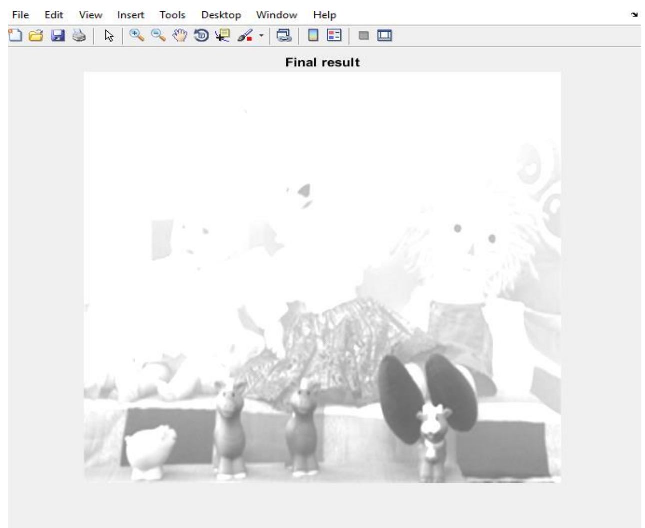


Fig.12. *improve by the homomorphic filter*

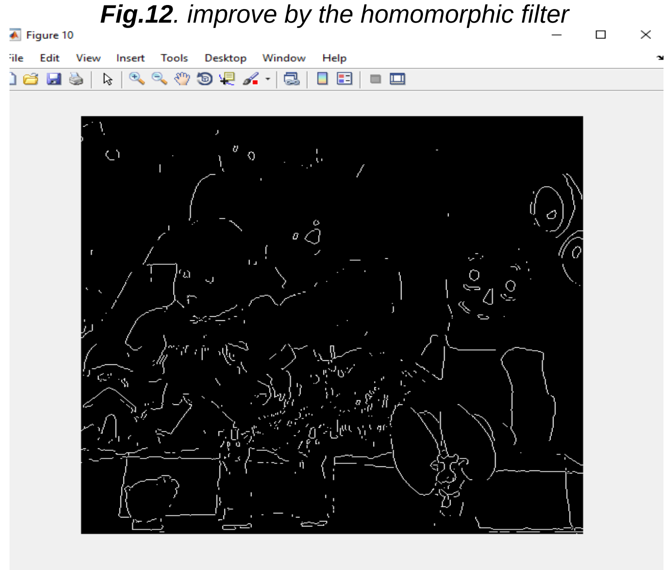


Fig.13. *Canny edge detection*

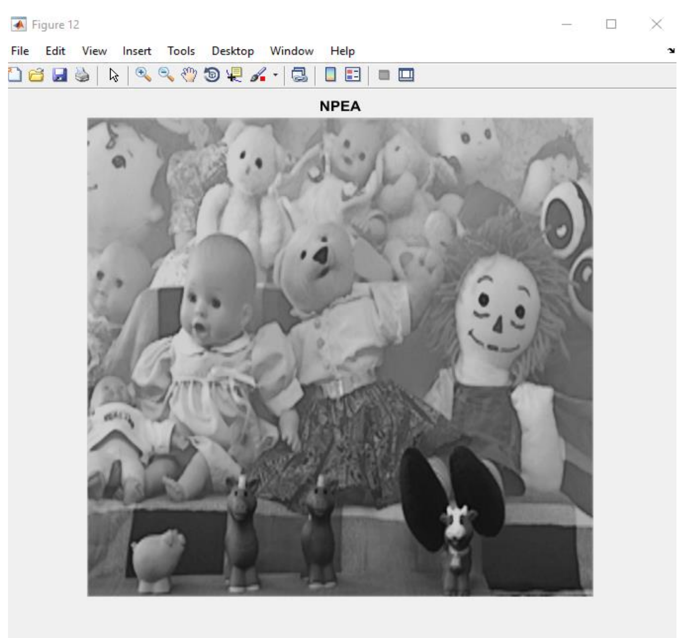


Fig.14. *final improvement by NPEA*

A. Performance Parameters

PSNR (Peak Signal to noise ratio): Sometimes PSNR is the proportion of intensity of mutilating clamor that determines the essence of its portrayal at the most intense possible confidence of a sound. The words of the logarithmic decibel scale are normally conveyed to PSNR. The PSNR numerical articulation is

$$PSNR = 20log_{10}\left(\frac{max_f}{\sqrt{MSE}}\right) \tag{13}$$

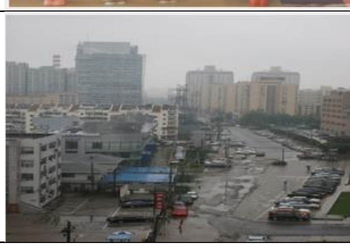
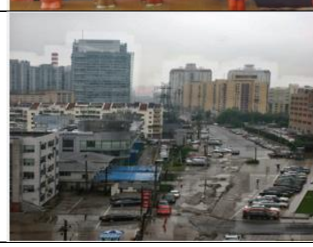
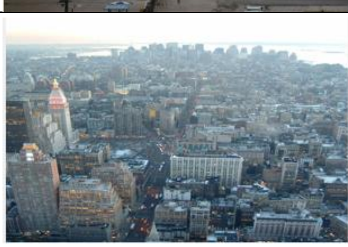
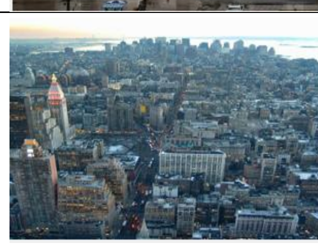
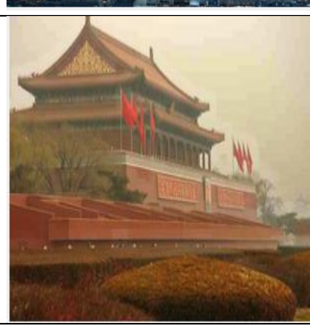
SSIM: The SSIM Index9 tests a function X with a reference picture Y to determine its optical similarity. It's an SKE business in that way. SSIM assesses the existence of X and Y by creating a spatial file defined as a neighborhood.

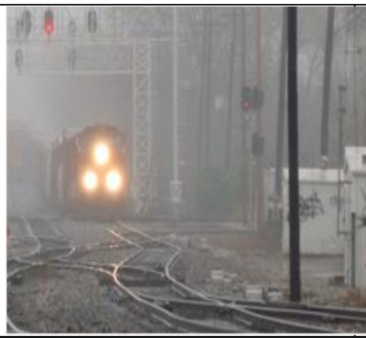
$$SSIM(x,y) = [I(x,y)]^{\alpha} * [c(x,y)]^{\beta} * [r(x,y)]^{\gamma} \tag{14}$$

Where α, β, & γ are parameters that determine each component's relative importance. Y differs from 0 (completely different) to 1 (the same patches). SSIMðx; yÞ differs. Finally, to determine the global image similarity, a mean SSIM index is estimated

B. Comparison of Results

Table I. *shows the PSNR and SSIM values between base & Propose*

Hazed Image	Dehaze Image	PSNR		SSIM	
		Base	Propose	Base	Propose
		52.7306	72.2333	0.9831	0.8569
		55.2529	82.7194	0.9953	0.9341
		54.5832	75.2340	0.9942	0.8533
		54.2589	73.5812	0.9915	0.9440

		54.9194	76.8098	0.9941	0.8662

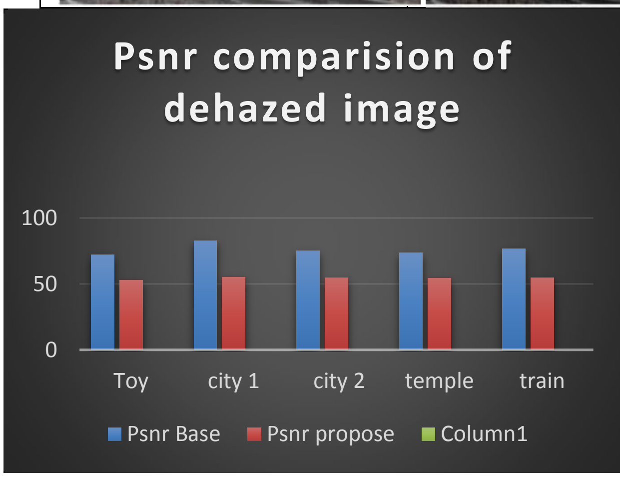


***Fig.15**. Comparison Graph of PSNR*

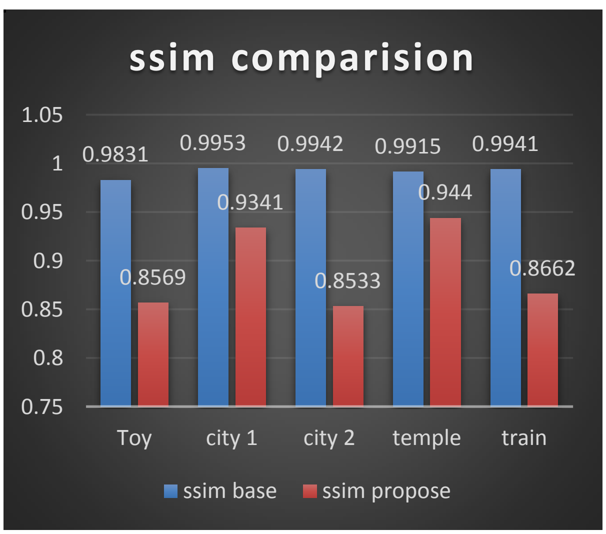


***Fig.16**. Comparison Graph of SSIM*

5. CONCLUSION

The scattering of ambient components that decrease contrast, change color, or render the object's visual or outdoor computer structures difficult to identify will dramatically impact captured images in foggy or hazy conditions. Thus image dehazing is an important issue that has been extensively examined in the computer vision sector. This work proposes a DCP-based method of image defogging. Existing advanced defogging approaches utilizing DCP do not demonstrate optimal performance for the defogging image function. We have either low contrast performance or artifacts compromised. To measure the transmission map, we have introduced a new hybrid system, so a Homomorphic filter has been used to improve the transmission map. CLAHE approach is used to enhance the local image contrast. Then the canny edge detector uses the image images and the NPEA method to detect a wide array of edges to improve image naturalness and edge detection. The simulation results show that the method proposed will automatically detect as well as process foggy images, that foggy images are recognized accurately, and that the images reconstructed have a higher color contrast And the defogging impact is good, enhancing the external vision system's efficiency. Images obtained using the proposed system have better perceptual accuracy, as seen in Fog, SSIM, and PSNR values relative to the current image defogging methods.

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