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Current Issues on Single Image Dehazing Method

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Abstract:- Nowadays the role of computer vision and graphic have seen in wide application fields, so haze and fog fetch trouble to many computer vision and often effect on graphics applications as it diminishes the scene's clarity. Haze forms when climate conditions stay slack for a time-frame. Building on the bearing of view as for the sun it might be brownish or bluish. Haze reduces the contrast and saturation degraded the quality of preview and captured the image. So it attenuates the mild pondered from the scenes and similarly blends it with some additive light inside the atmosphere. Here comes the role of the dehazing method though is very important in computer vision applications, it can take off haze from the pictures, increment the scene vision. From earlier up to now there are many methods have been proposed for improving images, single image dehazing method is one of them, and recently the researchers are more interesting with this method. The goal of this study firstly gives a brief introduction to image enhancement and restoration algorithms and suggested a variety of dehazing algorithm. Secondly, explore the different techniques of single image dehazing to remove the haze professionally from the digital images. Finally, summarized the comparison among these methods based on image quality assessment.

Keywords: Dehazing Method, Single image, Outdoor image, Image restoration, Image Enhancement, Dark Channel.

1. Introduction

1.1 Background Overview

Image processing the global area that involves 1) enhance and improving the visual appearance of images for human scenes 2) preparing images for measurement measuring features and current structures. When atmospheric moisture effect on the scenes it will safely degrade the visibility of outdoor scenes it is called *haze*(1). Haze fetches trouble to many computer vision and frequently affects on graphics applications as it minifies the clarity of the scene(2). So attenuation (decreases the disparity) and the airlight (increases the whiteness) are the two fundamental phenomena those cause a haze, figure 1 illustrates both attenuation and airlight phenomena.

Figure 1 Attenuation and air light phenomena (1,2)

The collaborations between the atmosphere and the light cause fog and haze like absorption, dispersion, and emission, but they are different in the sizes and types of scattering particles(3).

In recent year there are many techniques used in many computer vision applications that recover the color and contrast of the scene to remove this haze, such as outdoor surveillance, object detection, consumer electronics, enhancement etc.[1].

Usually when removing the haze, which is called dehazing, is commonly performed under the physical degradation model, which presuppose a solution of the problem is not reversed(4).

Most picture dehazing algorithms consider utilizing a hard brim presumptions or customer contribution to evaluate atmospheric light(5). According to (C. Chengtao1,) (6), they have characterized the various dehazing picture approaches into two general classifications, i.e. picture improvement and physical recovery model. Image-dehazing methods can be roughly categorized into two kinds: the methods based on computer visions and those based on physical models. The advantage of computer-vision based methods is that they can do the dehazing process by utilizing only single image(7).

Hence, in past periods, numerous dehazing techniques have been suggested to upgrade and enhance the nature of hazy pictures, and some of them are genuinely amazing. And several dehazing methods have established to be successful in evacuating fog out of the hazy picture; however few of them are versatile in dealing with the thick haze.

1.2 Haze Models

In the field computer vision and image processing the using of haze creation model, it assumes a broad position. This model in most cases used for the development of the image in the existence of bad atmospheric situations. The particular size of particles in the atmosphere is between 1-10 µm. So the existence of these particles in the aerosol effect on the quality of image [2].

The condition of the weather effects on changing the number of particles those existing in the atmosphere. The immense effort has been made to compute the measurement of those particles liable for the kind of visual properties. So humble weather situations are classified into two classes: constant and dynamic (8).

The mainstream of vision applications offers humble results in case of degraded weather pictures. And so on haze removal algorithms become important for numerous applications such as aerial imagery, object recognition, image retrieval and object analysis (9)

The deviations that get the atmosphere are also observed from the dreadful weather circumstance consists of haze, fog, mist, a nice decomposition of smoke, or other media from the outdoor landscape, due to this several problems occur, such as automated oversight system, the outdoor identification system, distant sensing systems, and the smart conveyance system, such as traffic observation systems and travelling vehicle data recorders are strongly affected(10).

Haze reduces the contrast and saturation degraded the quality of preview and captured the image. Haze attenuates the mild pondered from the scenes and similarly blends it with some additive light inside the atmosphere.

The goal of haze elimination is to enhance the contemplated light (i.e., the scene colors) from the mix mild

1.3 Hazes in Digital Images

Digital pictures which have caught in outdoor landscape condition are effectively contaminated by haze, which will degrade the transferred information. Haze is a physical phenomenon that darkens scenes, decreases vision, and changes colors.

1.4 Haze Definition

Haze is constituted of aerosol which is a dispersed system of small particles suspended in the gas. Haze has a various set of sources including fiery volcanic debris, foliage exudation, combustion products, and sea salt. The particles formed by these sources react rapidly to changes in relative moisture and turn around the cores (focuses) of tiny water beads when the dampness is high. Haze particles are bigger than air atoms yet littler than haze beads.

1.5 Mechanism of Atmospheric Scattering

The study of the react of illumination with the atmosphere (hence climate) is widely known as aerial optics. Aerial optics lies at the core of the most magnificent visual expertise known to man, including, Sunrise colors and sunset, the blueness of the pure sky, and the rainbow[10-11].

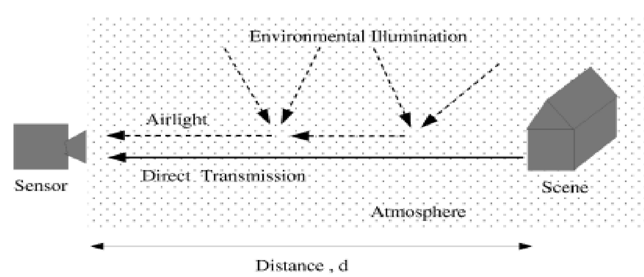

Figure 2 Scattering of light by atmospheric particles (13).

The major source of materials as background in this field is the works of McCartney (1975) and Middleton (1952) which, despite its history, was an excellent review of previous work.

The main features of light, such as density and color, were altered through its connections with the atmosphere. These interactions can be broadly classified into three classes: dispersion, absorption, and emissions(14).

As shown in figure 3 a small particle (about 1/10 λ, where λ is the wavelength of light) scatters almost equally in the forward (incidence) and backward directions, a medium size particle (about 1/4 λ) scatters more in the forward direction, and a large particle (larger than λ) scatters almost entirely in the forward direction.

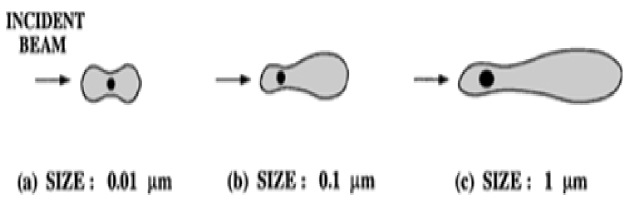

Figure 3 A particle in the path of an incident light wave abstracts and reradiates incident energy. (Adapted from Minnaert (1954)).

In atmospheric scattering, the transmission properties of light can be categorized into two mechanisms which are airlight and direct transmission:

1.5.1 Airlight

The existence of particles in the aerosol those generated by the haze effect on the quality of the image. In this case, when the image is taken, the camera absorbs the light close and scattered by these atmospheric particles. So the technique is called as airlight; which is the first components of transmission properties. Suppose that this haze demonstrate the straight model. From the linearity's definition in this model, the change occurs just on pixel position.

1.5.2 Direct Transmission

In computer vision and image processing, the second components of transmission properties of is the direct transmission of light from the object surface that describes the beam light attenuation as it traverses through the atmosphere from a scene point to the camera(15).

So haze is the mix of the two fundamental phenomena direct attenuation and the air light. So the formation of a hazy image in(14) (15) (16) is broadly written, and it is described as follows:

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

Where I (x) attitude for the spotted density of the xth pixel, J (x) is the radiation sight (the genuine color that we need to retrieval), A Is the light of the universal atmosphere, and t Is the medium transmission that portrays the section of the light that does not spread and reaches the camera.

First expression in the equation, J(x)*t(x) is called the direct attenuation; the second expression, A*(1-t(x)) is called Airlight.

In vision systems, the transmission can be expressed as:

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

Where d(x) is the distance between the viewer and an object and β(x) is the scattering coefficient which is dependent on turbidity T and wavelength λ. In haze condition, the scattering coefficient is assumed to be independent of wavelength(15). Thus, the coefficient varies with turbidity T. Since t(x) $(0 < t(x) \leq 1)$ here does not correspond to the wavelength-depending physical atmospheric transmission, transmissions are the same for all RGB channels(17).

1.6 Particles in space

At most weather cases vary in the kinds and sizes of the particles entangled and their focuses in space. Much effort has been made to measure particle sizes, and concentrations for an assortment of conditions, so bigger particles create an assortment of climate conditions which illustrate more in Table 1. Given the little size of air particles, relative to the wavelength of visible light, dissipating because of air is somewhat negligible(14).

Table 1 Weather conditions and associated particle types, sizes and concentrations (adapted from (13)).

Condition	Particle type	Radius (µm)	Concentration (cm−3)
Air	Molecule	10^{-4}	10^{19}
Haze	Aerosol	10^{-2}-1	10^{3}-10
Fog	Water droplet	1-10	100-10
Cloud	Water droplet	1-10	300-10
Rain	Water drop	10^{2}-10^{4}	10^{-2}-10^{-5}

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2. Dehazing Methods

Haze can transform a colored picture into a white-and-ashy, one, causing lost picture details and the decrease in disparity. Likewise haze trouble numerous applications, including targeted direct monitoring and indirect confession, tracking, and measurements. Image dehazing can take off haze from the pictures, increment the scene vision, and enhance the general impact visual (18).

The great challenge that rests with mathematical ambiguity is the removal of haze. Though, dehazing images are very important in computer vision applications. Consequently, most of the researcher strived to attitude these challenging tasks and suggested a variety of dehazing algorithm.

Dehazing methods can be collected into three categories that are image enhancement, image fusion, and image restoration. Each one of them has specific classes, so in turn image restoration single has two categories single image haze removal which required only single image as input and multiple image haze removal which are take multi images two, three, or more of the same sight. Both methods come under many categories are described in the following diagram.

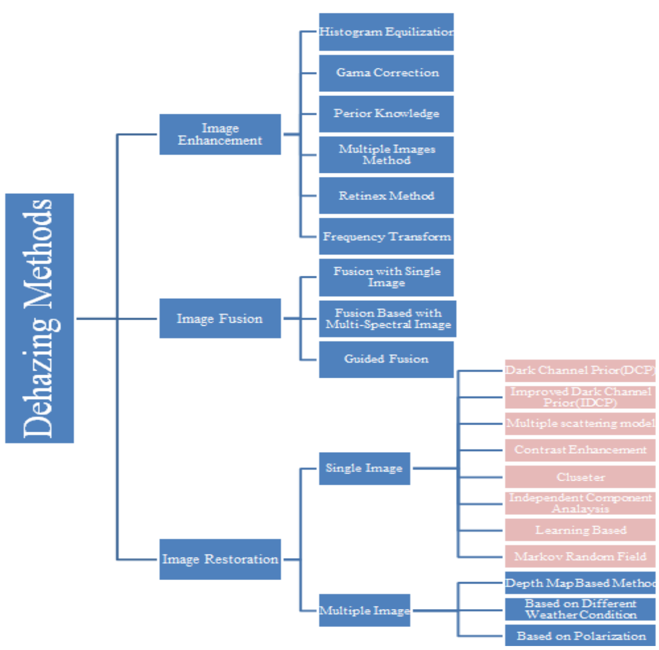

Figure 4 Dehazing Methods Diagram.

2.1 Single Image Dehazing

Haze removal algorithm which required only single image as input can classify the single image into three major types: 1) Algorithms based on priors or hypotheses. This type of methods takes off fog from image during valuing parameters of the model fog imaging, which can fulfill satisfying outcomes, examples Fattal, and He et al. 2) Enhancement image on the basis of image processing, since these methods at most focus on picture enhancement and consider little of imaging model of debased pictures, so when the scene is unpredictable unsatisfying outcomes will obtain, examples histogram equalization, and retinex. 3) Dehazing based fusion strategy example Ancuti et al. In their technique, two information sources obtain from the first picture authentic are weighted by three standardized weight maps (luminance, chromatic and salience) and mingled in a multi-scale combination finally to take out haze impacts(19).

Recently the researchers are more interesting with this method. This method classifies techniques into the following categories.

2.1.1 Dark Channel Prior (DCP)

Different dehazing algorithms of single image dark channel have planned to handle the issue of haze picture passage in a quick and effective way. The DCP is founded on the property of "dark pixels," which have a much-decreased density in the single color channel at least, Except the sky area (20).

Such algorithms depend upon the dark channel prior hypothesis towards the air light the estimation of which offers itself as an urgent parameter towards dehazing. The approach of the dark channel towards the image haze removal based on the surveillance that in parts other than in the sky, there is at least one color channel with associated pixels of very low density, sometimes terminate to zero. Intuitively, the intensity calculated within these zero approach parts. This connotation is exemplified mathematically in equation (3) below(21)

$$J^{dark}(x) = \min_k(\min_{y\in\Omega(k)}(J^c(y))) \qquad (3)$$

In above equation, J^c denotes channel color of J while Ω (k) signifies the native patch which is center around k. The hypothesis of the dark channel prior recommends that rejecting sky patches, the intensity of J^{dark} expressively low and in most cases preserve value of zero. This condition holds if J is an open-air picture not affect upon by fog. With all the fulfilment of conditions, J^{dark} is alluded to as the dark channel which relates to the fog-free outside picture, J. According to (20) flows the following flowchart for the proposed image dehazing algorithm.

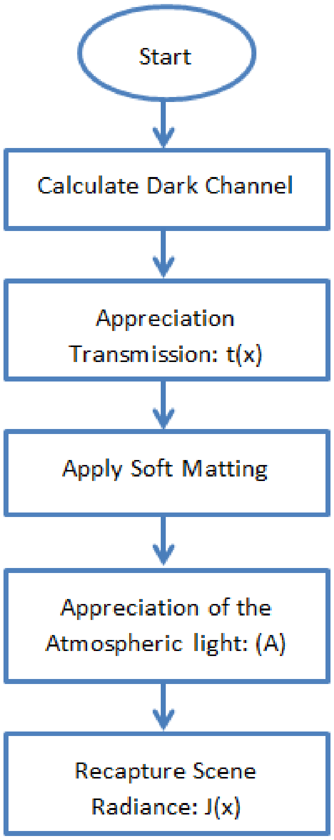

Figure 5 Representation of Image Dehazing Algorithm.

According to (22) utilized the dark channel prior model productively as a part of work to apply in real time with reduced complexity of timing. There are a few ancient rarities still exist after dehazing in the result when using the proposed method. For the most part, it is happening in the sky pixels. Hiding the sky part of the image ensures guaranteed enhanced yield. So the block diagram is shown in figure 6.

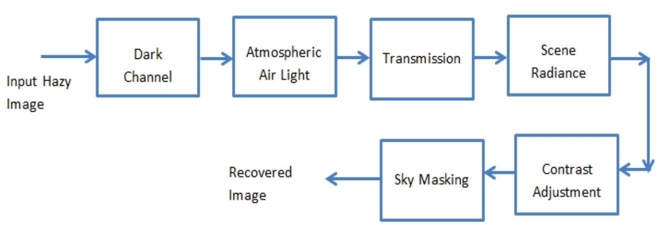

Figure 6 Dark Channel Block Diagram.

By Tae Ho Kil et al. (23)perfects the inequality with reducing color variation and announced to preserve a balance among the contrast and colors deformation by the optimization function.

2.1.2 Improved Dark Channel Prior

Environmental conditions such as fog, haze or rain significantly affect vision. The water drops existing in the environment creates fog, haze and mist dimness comes about because of scattering of light as it flows through these particles. These chromatic impacts of picture scattering can be switched for the recuperation of picture information. A solitary picture dehazing strategy utilizing dark channel prior has been expanding. The proposed paradigm takes into account both, chromatic and colorless features of the picture to characterize the dark channel(24).

When improving sky area from haze by classical dark channel prior the returned image not dispose from noise so improved dark channel algorithm address this issue, which recognizes the atmosphere areas in the hazy image by incline threshold combined with the absolute value of the diversity of aerial light and dark channel(25). Some researchers have addressed the segmentation threshold algorithm and some others to use OTSU segmentation, where the hazy image is divided into the sky zone and non-sky zone respectively, the critical parameters are obtained, i.e. light intensity and transmission ratio based on several factors, some comparative trials have additionally been conducted to validate the performance of the proposed approach, for more details figure 7 illustrate the pipeline of hazy image dehazing (26,27).

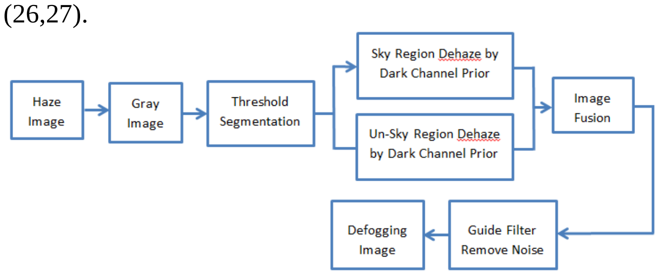

Figure 7.a The pipeline of hazy image dehazing (using threshold segmentation)

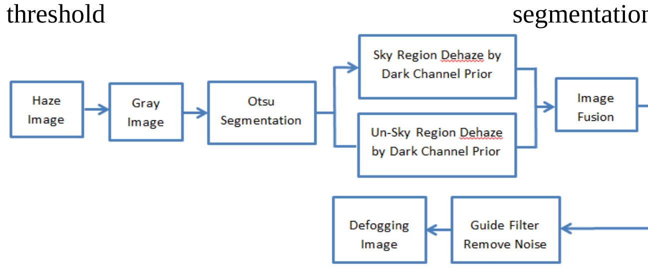

Figure 7.b The pipeline of hazy image dehazing (using Otsu segmentation)

2.1.3 Multiple Scattering Model with Superpixel Algorithm

Most of the existing hazing algorithms are recognized on the disregarded of single scattering, but the multiple scattering is observable and cannot be ignored. The aerial scattering model is set up on the presumption of single scattering of light by aerial particles. So should consider multiple scattering into account. Multiple scattering models (MSM) is a well-organized method to eliminate haze from the single image based on dark channel prior and described by atmosphere point spread function (APSF), unlike, existing DCP approaches that utilize single scattering model (SSM) and steady size picture spots. So in this matter Rui Wang et al. apply global Gaussian appropriation to estimate APSF kernel in the picture area with parameter mapping from both figure closeness and numeric reasonability. These strategies make the proposed method to accomplish expressive outcomes from both, qualitative and quantitative estimate contrasted to the state of the art algorithms. Besides, a superpixel strategy is utilized for evaluating the transmission on the sky and non-sky locale with a specific end goal to relieve the halo object around the sharp boundaries and lessen shading contortion in the sky region. In this manner, the fog-free pictures with much recognized subtle elements and little halo can be at last reestablished by first applying deconvolution to the ethnic haze picture. Since the more common recuperation impact can be developed with the type of spot-wise sort of fix astute, self-adaption learning (28) (29).

2.1.4 Transmission Function Based on a Linear Model

Various techniques have been developed in current years in an endeavour to perfect the quality of the picture from the hazy conquest, and hereafter enhance the performance of the machine sight systems.

The best characterizes of the scatter of airlight that employs quadtree to search for a region and allows efficient computation to improve picture eminence. The role of quadtree discern when happening the assessment of sunlight radiation, it that incorporates topical brightness and inclination as well as spatial necessity afford a robust means to identify the area of sky (30).

So based on Eq. (1), the light attenuation function t(x) can be represented as follows:

$$t(x) = \frac{A - I(x)}{\mathrm{A} - \mathrm{J(x)}} \qquad (4)$$

Since sunlight is widespread by particles in the atmosphere, the atmospheric color of light in hazy conditions is mostly identical. That's why; we can reword Eq. (4) by taking the minimum value of the three color bands:

$$t(x) = \frac{A0 - I^*(x)}{\mathrm{A0} - J^*(\mathrm{x})}, \qquad (5)$$

Where $I^*(x) = \min[I^r(x), I^g(x), I^b(x)]$ and $J^c{}_m(x) = \min[J^r(x), J^g(x), J^b(x)]$. Under haze situation, the minimum color component of the three channels is commensurate with the conveyance rate. The minimum of I(x) can be approached with a linear function of J(x) as follows:

$$I^*(x) = aJ^*(x) + b\,, \qquad (6)$$

Where a and b are fixed. Collecting the above equations, we have

$$J^*(x) = \delta \frac{I^*(x) - p}{q - p} I^*(x)\,, \qquad (7)$$

Where q and p give the range of I^*, and δ (δ ≤ 1) is a factor scale. Hence t(x) can be calculated by combining Eqs. (5) and (7) as follows:

$$t(x) = \frac{A0 - I^*(x)}{\mathrm{A0} - \delta \frac{I^*(x) - p}{q - p} I^*(x)}\,. \qquad (8)$$

2.1.5 Contrast Maximization Method

Haze reduces comparison. Remove fog decorates the image comparison. Maximizing contrast is the method that supplements evaluation under restriction. Nevertheless, the resultant photographs have extensive immersion values since this method does not physically enhance the shine or profundity but rather to some degree just prettifies the vision. So under the circumstances, it enhances the contrast. The method does not indeed get better brightness but enhances visibility, this cause larger immersion for the remaining pictures. Moreover, the final contains corona results the depth interruption.

2.1.6 Contrast Enhancement using Histogram Stretching

Airlight makes the genuine picture be crumbled, and original differentiate moves radically. Histogram extending before dehazing will convey picture pixels over the whole brilliance go qualities to fill the whole shine run guaranteeing high complexity picture. The RGB standardized picture was changed over to HSV, histogram extending was additionally connected to the S and V channel before changing it back to RGB.

Tan et al. in 2008 (31), proposed to maximize the regional contrast of the hazy picture during variance enhancement technique. The major thought that this method depends on to appreciation airlight from the brightest pixels in the hazy picture by expanding the regional contrast and the color with chromaticity division of airlight. Utilizing algorithm represented as:

$$\text{Contrast}(\hat{R}(x)) = \sum_{x,c}^{S} \left|\nabla \hat{R}_{c(x)}\right|, \quad (9)$$

Where S is the size of the window set to 5x5.

The specific problem that selected this method is the connection, and the contrast is rounded which can be cast into Markov Random Field. The method was proficient to handle haze depth and mechanism well for both color and gray images.

2.1.7 Independent Component Analysis

In 2008 Fattal (32) used independent component analysis (ICA) and Markov random field (MRF) model to estimate the surface albedo and under the assumption that the transmission and the surface shading are locally uncorrelated. This process is physically useful and can deliver high outcomes, yet force is uncertain in light of the facts that it does not act completely for heavy haze. With independent component assumption, the statistical decomposition of shading and transmission can be optimized and works well. In 2014, Fatal introduced a new method with color lines. This method assumes that small patches have a uniformly colored surface and the same depth, yet different shading. The haze image can be described as:

$$I(x)=I(x)J(x) + (1\text{-}t)A \quad (10)$$

where $l(x)$ is the shading.

In this method, airlight A is known, then by having the intersection, (1-t) can be obtained. To get the transmission for the entire image, the method has to scan the pixels, extract patches and find the intersections. Some patches might not give correct intersections; however, if the most of patches do, then the estimation can be correct. Patches containing object color identical to the atmospheric light color will not give any intersection, as the lines will be parallel. A Gaussian Markov Random Field is used to do the interpolation.

2.1.8 Based on Markov Random Field (MRF)

Robert T Tan proposed a novel based haze removal method by maximizing the brightness of the image based on Markov Random Field (MRF).It is a graphical model of the joint probability distribution. It consists of an undirected graph in which the nodes represent the random variables. Two observations are made based on this method. First, the higher contrast in images taken on a clear day compared to images clicked in bad weather. And the second, based on airlight. This varies with the distance between the objects and the observer.

3. Comparison

3.1 Comparison of Current Methods

Table 2 A comparison based on single image dehazing of different methods (declaring cons & pros).

Reference	Author	Year	Method	Cons	Pros
(31)	Tan	2008	Maximize Contrast	1. Halos effects due to the patch based operation 2. Oversaturation	Good contrast for foggy image
(32)	Fattal	2008	Independent Component Analaysis	1. Not recover gray image 2. Low brightness 3. Fail to enhance the image with dense haze and insufficient signal-to-ratio 4. Not suitable for real time	High image visibility in homogenous or thin fog
(33)	Tarel	2009	Contrast Enhancement	1. Unsuitable for images with a discontinuous depth 2. Over enhancement 3. Halo, artefacts at the sky region	Fast Good visibility for thin image
(20)	He	2009	Darck channel Prior	1. Overestimate transmission 2. High computation cost	Output image is just similar to input image

				3. Fail to restore the image to inhomogeneity fog and haze 4. Fail to restore the image with large sky are large white area	and has good color restoration
(34)	Fattal	2014	Color Lines	1. Low brightness 2. Nor recover for grey images	High image visibility.
(35)	Tang	2014	Learning-Based	Ineffective when there are significantly thicker haze particles in an images	Good contrast for hazy image
(36)	Zhu	2015	Color Attenuation Priors	Ineffective when there are significantly thicker haze particles in an images	1. The depth information can be well recovered 2. Easily estimate the transmission and restore the scene radiance.
(37)	Cai	2016	DehazeNet	1. Small error in airlight will drop the performance 2. Enhance single images dark colors	Better restores the sky and white area
(38)	Berman	2016	Non Local Dehazing	1. May fail in scenes where the airlight is significantly brighter than the scene 2. Work well only at certain haze levels.	

Table 3 A comparisons of different single image dehazing methods (declaring Input & Output).

Reference	Author	Year	Known Parameter (Input)	Estimating (Output)	Key Idea	Applications
(31)	Tan	2008	Single image I(x)	L∞, t(x), R(x)	Brightest value assumption for Atmospheric light *L∞* estimation Maximal contrast assumption for Scene reflection R(x) estimation	Single color or grey, foggy image
(32)	Fattal	2008	Single image I(x)	L∞, t(x), R(x)	Shading and transmission are locally and statistically uncorrelated	Single color hazy image
(33)	Tarel	2009	Single image I(x)	L∞, t(x), R(x)	Maximal contrast assumption Normalized air light is upper bounded	Single color or gray, foggy image
(20)	He	2009	Single image I(x)	L∞, t(x), R(x)	Dark channel: outdoor objects in clear weather have at least one colour channel that is significantly dark	Single color image specially image with haze

(34)	Fattal	2014	Single image I(x)	L∞, t(x), R(x)	Colour line: small image patch has uniform colour and depth but different shading	
(35)	Tang	2014	Single image I(x)	t(x), R(x)	Machine learning of transmission t(x)	
(37)	Cai	2016		t(x), R(x)	Learning of t(x) in CNN framework	Single images
(38)	Berman	2016		t(x), R(x)	Non-local haze line; finite colour approximation	

3.2 Analysis of Current Methods

To verify the image quality, this paper evaluates qualitatively and quantitatively the current method (as below) based on image quality assessment. The evaluation consisted of both natural and synthetic images.

CE :Contrast Enhancement

ICA : Independent Component Analysis

FVR : Fast Visibility Restoration

DCP : Dark Channel Prior

BF : Bayesian Fogging

BC :Boundary Constraint

MSF :Multi-Scale Fusion

RF :Random Forest

CL :Color Lines

CAP :Color Attenuation Prior

HL :Haze Lines

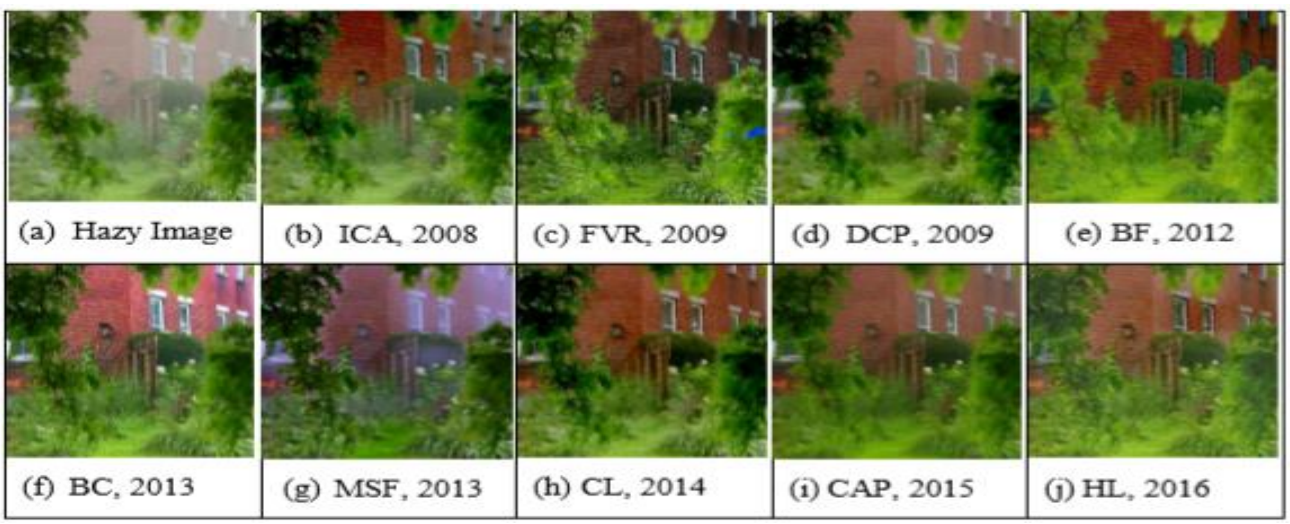

Figure 8 Brick House

Table 4 Image Quality Assessment for Brick House Image

	ICA'08	FVR'09	DCP'09	BF'12	BC'13	MSF'13	CL'14	CAP'15	HL'16
MSE	0.0424	0.0560	0.0280	0.0654	0.0158	0.0366	0.0474	0.0338	0.0321
PSNR	13.77262	12.5200	15.5253	11.8432	18.0200	14.3671	13.2404	14.7086	14.9324
SSIM	0.6822	0.7323	0.7021	0.5623	0.8257	0.4713	0.5725	0.7949	0.6713

Figure 9 New York Image

Table 5 Quantitative Value for New York Image

	ICA'08	FVR'09	DCP'09	BF'12	BC'13	MSF'13	CL'14	CAP'15	HL'16
MSE	0.0073	0.0445	0.0188	0.0526	0.0492	0.0128	0.0294	0.0305	0.0446
PSNR	21.3637	13.5116	17.2611	12.7885	13.0782	18.9201	15.3105	15.1635	13.5025
SSIM	0.8889	0.8374	0.8351	0.7832	0.6710	0.6334	0.7665	0.7916	0.6956

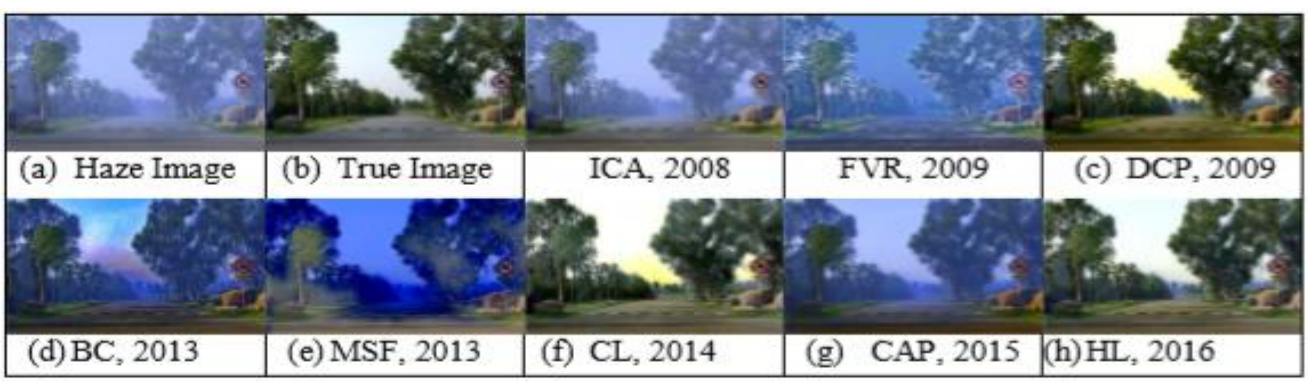

Figure 10 Synthetic Road Image

Table 6 Quantitative Synthetic Road Image

	Original	ICA'08	FVR'09	DCP'09	BC'13	MSF'13	CL'14	CAP'15	HL'16
MSE	0.0547	0.0025	0.0107	0.0727	0.0433	0.0775	0.0579	0.0269	0.0511
PSNR	12.6198	26.0145	19.7035	11.3867	13.6397	11.1080	12.3765	15.7025	12.9159
SSIM	0.3051	0.8685	0.8936	0.0025	0.7049	0.4589	0.1202	0.7845	0.2044

The comparison between existing methods in this study during figures and tables those explained above. The qualitative and quantitative are measurement. In Figure 8 and Figure 9, these two images are natural images; in Figure 10 is the synthetic image from Middlebury stereo set. According to this evaluation, the methods that obtain a good quality is own by dark channel prior (He, 2009), color lines (Fattal, 2014) and haze lines (Berman, 2016). It can be shown from synthetic images which refer original value as the benchmark. The results have similarity the original image. While for natural images, the quality of the image can be seen by qualitative comparison. These three methods produced more natural. Thus, for enhancement method will inspire by this method to improve any remaining problems and produce better results.

4. Discussion

In the field of computer vision and image processing the using of haze creation model, it assumes a broad position. This model in most cases used for the development of the image in the existence of bad atmospheric situations. Though Haze removal method or alleged dehazing images is very important in computer vision applications, provided many benefits to computer vision application. However, to remove haze from the digital image is quite difficult due to lack of scene information. According to that, this literature review has discussed prior method about the method to remove haze from the single image or multiple images. There are three categories for dehazing method which are image enhancement, image fusion, and image restoration. However, this research was only focusing hazes removal method for the single image which applied image restoration. Many previous researchers struggled to resolve the problem of haze removal in term of haze isolation or haze thickness. Even though the problem can be reduced, but it still has the remaining limitation which is to handle haze level and abrupt changes in depth discontinuity. Hence, an enhancement to improve the remaining problem will be proposed to produce a better result.

5. Conclusion and Future Scope

The role of dehazing methods is very bright in recent years because one of the most important fields appears to be more valuable for many vision applications, so there are many applications available concerning the field of computer vision and graphic depend on these methods. It can dislocation haze from the pictures, increment the scene vision. There are several dehazing methods has been used from beginning up to now to remove the haze and improve images, and recently become most filed the researchers concerned. This survey contributes the summary introduction to image enhancement and restoration algorithms and their associated methods, to learning about hazy image's characteristics and some problems whereas catching an image. And the development of methods for haze removal from hazy images has been studied.

Finally, the paper summarized the comparison among these methods based on image quality assessment.Single image dehazing technique can be useful in surveillance, military, night vision, security, underwater vision, remote sensing, driving aid, navigation, air traffic control, astronomy, old image restoration.Framework and challenges for the haze removal techniques have been discussed. It is essential that during recovery of the hazy image, both the illuminate and color characteristics should be restored efficiently to preserve the color fidelity and appearance. Hence, future work of the research is to explain the most remaining algorithms for dehazing methods like image enhancement, image fusion, and their connected techniques.

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