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A Review on Dark Channel Prior to Haze Removal Using Visibility Restoration Techniques

Vaibhav Yadav, Khushboo Agarwal
Information Technology, MITS, Gwalior, India

Abstract—This paper provides an analysis of different image dehazing approaches to eliminate haziness from hazy images captured in real-world weather circumstances to achieve quick & enhanced haze-free image quality. Haze creates problems in different applications based on computer vision and image processing, as it diminishes the brightness of the scene. The dehazing of photographs is amongst the most relevant areas of research in image processing and design study. Haze is an ambient reaction, obviously. Its research looked at different haze reduction techniques used during image analysis systems to dehaze activity. The restore of clarity plays a leading role in several applications for image processing. Outdoor photo vision is often impaired by the appearance of clouds, rain, sand storms, etc. Reduced visibility induced from atmospheric phenomena is forcing image analysis systems to crash. The Dark Channel Prior is the type of haze-free outdoor photo figure. And thus, using an Image processing technique, it obtains a haze-free image of high quality.

Keywords—Image Dehazing, Haze Removal, Visibility Restoration Technique, Dark Channel Prior, Dehazing Method.

I. INTRODUCTION

Outdoor landscape pictures are typically distorted by ambient turbid medium (for example, water particles & droplets). Owing to air accumulation and dispersal, clouds, fog, and smoke are such phenomena. This phenomenon influences the normal functioning of automated (mechanized) tracking systems, smart transportation systems, & outdoor recognition software. The water droplets scatter light from atmosphere & light absorbed by an object, resulting in a loss of the scene's brightness. Haze elimination is a challenging task since fog relies on both the details from the depth chart of the unidentified location. Fog impact was the product of that same camera as well as the target being remote. Thus elimination of fog includes an air-light chart or depth map calculation. The recent process of eliminating haze could be classified across two subgroups: (a) image enhancement or (b) image restorement. For applications including driving assistance, aerial photography & visual monitoring, improving photographs obtained in poor weather circumstances is known as de-weathering also has been a most important concern. In several outside technologies including remote sensing, intelligent vehicles, etc., image restoration is significant [1].

For machine vision technologies & digital photography haze reduction or dehazing is strongly needed. Removing the hazed surface by either hazy image feedback will substantially enhance scene visibility. Haze-free image is inherently attractive for design. Most visual analytics benefit from the radiance of low-contrast image. Haze or fog that particles in the atmosphere give the data about the nature of the scene. The elimination of haze in IP (image processing) area is challenging problems or activities, as haze relies on uncertain depth. The haze elimination problem is under constrained problem for a single input hazy image. Most scholars then followed the approach through which their looked at multiple pictures or supplementary images [2].

In poor visibility, the accuracy of the image is impaired by the appearance of cloud, smoke, smog, water. Because the environment has been changed, the image contrast is reduced considerably. Dehazing is the mechanism by which the haze is eliminated from a captured photograph. Haze removal from a single image of a weather-degraded sight remains a difficult task as the haze relies on the unclear knowledge regarding distance. Over the past couple of years, several researchers have suggested various methods to solve the problem of how to achieve a haze-free image of high quality. Outdoor scene images can be greatly damaged because of adverse weather conditions including fog & haze. Therefore, it contributed to an atmospheric dispersal on the scene point of tiny water droplets and atmospheric aerosol, creating a blurred image, low visibility and starting to affect the efficiency of an outside device. This occurs due to the existence of various particles in the atmosphere which absorb and disperse light. These degraded images lose all of their contrast and become blurred, particularly in remote regions, blurring of their surroundings. To order to make the network stable and secure to bad weather, this deteriorated image must be defeated [3].

II. HAZE REMOVAL

Haze reduction in various fields such as machine vision systems, image processing, and photography is highly desirable. Secondly, eliminating haze from either the background raises the clarity of the hazy image induced by particles in the atmosphere. From larger-scale IP to sophisticated scale shape detection, most digital image processing technologies assume the accompanying image to be the Luminant scene. The determination of those methods depends on both the scenes. If a picture or scenario is slow, then the visual algorithm faces several problems and therefore does not show successful results. So, it is necessary to remove haze for better outcomes and performance. We should put the bad pictures in greater usage. An amount of distribution from the camera depends on the length of the scene and that deterioration is temporal-variant. The reduction of haze from those in the background raises the clarity of hazy images produced by the particles in the atmosphere [3].

A. Haze Removal methods

Haze reduction techniques can be used to create images that are of high quality, noise-free, and dehaze. The classifications are done in two main image segmentation and image restore forms.

1) Image Segmentation:

As when the name suggests, differentiation of images is the method of sorting into multiple segments of a digital image. The aim of differentiation is to explain and/or make an image's representation more relevant and easier to interpret. This approach is used mainly to identify pictures of objects and borders.

2) Image Restoration:

Image restoration is an act of having a damaged / broken image or reviewing the original clean image. Some causes including motion blur, noise, and camera miss-focus shot etc cause image corruption. The image restorement process is very different from either the image restoration principle. The layout of the image is done in the image enhancement process to highlight the captured image attribute which makes the image very attractive to the viewer.

B. Haze Removal using dark channel prior

In recent days a significant improvement in eliminating a single image haze technique has been noted. Use better hypotheses or previous approaches may lead to the haze removal technique being effective. Various researchers can use various methods to eliminate haze from the images. In [5] a simple matting algorithm was used by the author to eliminate the haze. However this design is theoretically inaccurate, and when the sunshine is very powerful, assuming constant air exposure may be unsuitable. Tarel uses the technique of image restores to remove the haze. In [6], the analyst calculates the scene albedo and medium transmission, on basis that transmission & surface shading is local uncorrelated. This method is achievable mechanically and can produce impressive results. But now this method has some disadvantages, as it can't dark hazy images and it can also crash when the presumption is violated.

III. DEHAZING METHODS

Dehazing attenuates the light emitted from the images, and thus combines with some ambient artificial light. The purpose of haze reduction is to enhance the light reflected (i.e., the colors of the scene) from either the mixed light. The visual system's constancy and intensity may be enhanced by successful haze removal of background. There are several ways to defeat haze from the image, such as polarization, independent review of elements, prior dark channel etc.

The dehazing methods can be divided into the following two subgroups:

1) Various Image Dehazing Method

2) Single Image Dehazing Methods

1. Multiple Image Dehazing Methods

Two or more images or various images of similar scenes are favored by this process. This totally prevents undefined techniques and only achieves known methods. Explanation of the methods under this category is given below:

a) Weather condition-based method

This technique utilizes multiple images adapted from various weather circumstances. In the basic method of two or more combinations of photographs of the same scene are considered. Such pictures have distinct contributory characteristics medium, on the one hand, it enhances visibility but on the other hand, it also makes the user wait till the characteristics of the medium change.

b) **Polarization based method**

This method having different polarization filters but of the same scene are considered. First of all, in this method distinct images are captured by ratting a polarizing filter But that the outcome of complex scene treatment isn't really great.

c) **Depth map-based method**

This system depth knowledge is known for haze removal. Here we assume 3D geometric scene model is provided by certain datasets such as google maps as well as consider the structure of both the scene provided (from aerial photographs or satellite images). This approach needs to communicate with the scene to match the 3D model [12] and also provide accurate results. Special equipment is not needed in this process.

2. **Single image dehazing method**

Like the previous approach, this technique only needs a single image entry. This approach varies on the mathematical assumption [14] and the nature of the scene & also reclaims scene data from a single image based on the last data. This technique is now attracting many researchers. The following are the methods which come under this category.

a) **Contrast maximization method**

Haze reduces contrast elimination of haze increases the contrast of an image. Under the restriction, this approach improves comparison. As this approach does not increase the depth of visibility mechanically, the resultant image has greater saturation values.

b) **Independent Component Analysis (ICA)**

ICA is a mathematical formalism of distinguishing two passive components of one single part. This approach is catastrophic and is dependent upon the assumption that surface coloring in local patches is statistically uncorrelated. Which method yields good results and is scientifically true, but one of the most important disadvantages of this method is that it does not give paper results in case of dense haze.

c) **Dark Channel prior (DCP)**

DCP is focused on outdoor haze-free image figures. At most one-color filter (RGB) has very low intensity at several pixels in most of the non-sky areas (called dark pixels). Those dark pixels give a haze transmitting approximation. This technique is true scientifically and fits well in a thick haze.

d) **Anisotropic diffusion (AD)**

AD is a method that eliminates haze by removing parts of images like borders, lines or further information that is important for the viewer to interpret. Versatility allows for the integration of smoothing and image enhancing qualities [4].

IV. VISIBILITY RESTORATION

Visibility repair refers to various methods aimed at reducing or eliminating the deterioration that happened while the digital image was being collected. The loss might be due to different causes such as relative image-camera rotation, relative atmospheric turbulence, camera misfocus distortion, & others. In this, we'll address degradations in an image due to bad weather like smoke, cloud, snow & rain. Thanks to these big amounts of floating particles (for example cloud, dust, impurities, smoke) in the environment, the image quality of an exterior viewer in fog & haze weather conditions is typically impaired by the reflection of light before entering the sensor. This condition affects the normal functioning of an automated monitoring system, outdoor recognition system & smart transportation system.

A. Visibility Restoration Technique

Various techniques are used for removing haze, fog, and mist from the background. Typical approaches for returning pictures to the fog are:

a. **CLAHE**

The short form of adaptive histogram equalization with minimal contrast is CLAHE [3]. For hazed IP this system does not require any predict weather data. Next, the camera captured image in the foggy condition is transformed by color space red, green and blue (RGB) to color space hue, saturation, and intensity (HSI). Images are transformed because the colors of human senses are identical to those of HSI. Secondly, CLAHE processes the strength portion before affecting the hue & saturated. This method uses the equalization of histograms into a spatial field. The initial histogram is trimmed, and each gray amount is redistributed to the clipped pixels. In this, every pixel size is decreased to selectable consumer maxima.

b. **Wiener filtering**

It [4] is utilized to combat issues like color-shifting whilst DCP to processing images of big white field. Whilst using DCP to media feature value is uneven that in the final image produces a halo effect. Median processing is used to approximate the media role, in order to preserve the edges. It is paired with wiener filtering after rendering the median function more precise so that the problem of image restoration is turned into an optimization problem.

c. **Bilateral filtering**

Through a non-linear mixture of neighboring image values, this filtering [5] smooth images with no impacting edges. Every pixel is replaced through weighted averages of pixel of its neighbor in this filter. With both distance in an image plane as well as range on strength axis, weight allocated to each Neighbour pixel is decreasing. This filter lets us get a quicker outcome as opposed to others. For better results, we utilize post-processing & pre-processing steps while using a bilateral filter. Equalization of the histogram is used as preprocessing and extension of the histogram was used as post-processing. Such 2 stages help to improve image contrast before & after bilateral filters use [5].

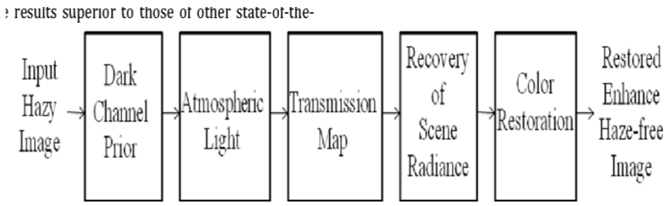

Fig.2. Block diagram of visibility restoration technique

V. DARK CHANNEL PRIOR (DCP)

DCP is being utilized in dehazed image to measure ambient light to get a very accurate outcome. This approach is generally utilized to non-sky regions because at most one light channel at some pixels has very low intensity. The low intensity of the dark channel (DC) is mostly due to 3 components: -

- Colorful things or exteriors
- Obscurities (shadows of auto, structures and so forth)
- Dark things or exteriors (dark tree trunk, stone)

The hidden channels of these videos will be really dim, as outdoor images are usually full of colors & colorful. A haze image is darker than its haze-free version because of fog (airlight), so we can assume a dark haze image channel will have high intensity in the area by higher haze. So DC width visually is a rough approximation of haze thickness.

Due to the three factors: colored material, darkness, and dark matter, the procedure is less powerful before deciding the creation of dark channels. We use 2 steps of pre-processing tools and subsequent processing in DCP to achieve decent results. Bilateral filter (BF) is a non-linear filter in system dispensation [6]. It is used to smooth out the picture. Mass centering on the Gaussian distribution can occur. I.e., even write-up data before processing. The histogram can be used as a pre-processing tool, as well as a histogram as a process of writing up. The dark channel prayer was proposed for the first time in 2009 by He, K., Sun, J., Tang, X. This uses a single picture to erase fog through the air-light and transmitting diagram. [7]

Fig.5. Dark channel prior method

1. **An improved single image with previous dark channel dehazing**

This approach is identical to the previous system of the dark screen; the discrepancy is increased to 31 for determining ambient light window size.

2. **Improved algorithm for haze elimination using DCP (Based on Guided Filter)**

When the image's broad gray area reflects the ambient sun, DCP is unable to function. A guided filter is used to get a better result in this case. It delivered better, more accurate results.

3. **Improved single image haze removal algorithm based on DCP and Histogram specification.**

First DCP is proposed in this process, the reconstruction of the image histogram by adjusting contrast & intensity of the resulting image. Major advantages are reduction of contrast background, thick haze elimination. The downside is that haze thickness decreases if haze in the image is not explicitly eliminated [8].

VI. LITERATURE SURVEY

M. Ju et al. [2019] For RGB channel RS (RRS) images and multi-spectral RS (MSRS) images this article proposes two simple yet effective visibility restore formulas. In particular, an RGDM (robust dehazing system) dependent on gamma-correction is first described which may better address issues of non-uniform explanation in hazy images. Applying pre-established know how to use this RGDM to eliminate the interference of brushed and uniform lighting, then can scene albedo restoration equation (SARF) utilized in RRS artifacts. The extended restore formula (E-SARF) method for MSRS data is then further developed in compliance with Rayleigh's law. Used current E-SARF, spatially differing haze within every band can be eliminated completely with no using additional data [9].

W. Mei and X. Li [2019] Aiming at the flaw that some conventional single image dehazing algorithms malfunction in sky areas and suffer from darkness and remaining artifacts, this work proposes a technique of dehazing single image focused on haze density weight & DC fusion. Approach to DC fusion, which may efficiently ensure pixel intensity of sky areas on the DC map is as low as that in non-sky regions, is then suggested to estimate the DCl process. Assuming that haziness density is distinct in various areas of a hazy image, hazy weight is calculated to an exact transition. [10].

B. Chen et al.[2018] In this work we suggest a haze removal method dependent upon RBF (radial base function) using Artificial Neural Networks (ANNs) committed to actually remove haze formation whilst preserving not only apparent edges however also the clarity of revived images. In restored images, more prominent edges are preserved through this process. Afterward, during the testing procedure, the activation function is used to reflect the brightness of the restored image. We equate the proposed method by other state-of-the-art haze-removal approaches & record experimental outcomes to qualitative and quantitative assessment of standard color images taken in normal hazy conditions. Experimental results show that the proposed approach can create clearer & more vibrant haze-free images with more prominent edges than another state of the art approaches. [11].

Y. K. Sonar and K. K. Warhade [2018] Provides color attenuation prior to haze removal of the image. The main objective is to solve the problem of decreased visibility by means of an excellent technique for IP & aim is to enhance image quality that lacks shading, complexity & depth whenever the human eye is viewed. The transmission can also be easily determined using the atmosphere scattering model by establishing an even pattern for scene size of a hazy image to restore scene radiance [12]

Z. Khan and A. A. Potnis et al. [2017]In this article, haze reduction is achieved by previous practice using the dark channel and Atmospheric light methodology approximation. The dark channel area is determined using DC equation then atmospheric variance on that DC region is measured. Estimation of the pixel value in dark region & estimate of atmospheric variance is estimate of transition got as a transient signal. Alternatively, graphics processing is achieved by smoothing to achieve a gradient image or dehydrated image [13].

L. Zhang et al. [2017]In this article, we suggest a prior saliency, which incorporates the process of human visual focus into the elimination of haze. The prior shows the connection between the study of salience and the complexity of hazy scenes. Secondly, saliency maps and salient regions are obtained in our dehazing process. Then, a detailed airlight and a standardized transmitting chart can be obtained based on prior and recent dark channel saliency. Eventually, using the airlight and the transmission diagram, we may restore haze-free image with success. Experimental outcome proposes that our method works much better than others in the recovery of large white areas which are essentially close to the airlightst [14].

A. Sabu and N. Vishwanath et al. [2016]This work underlines the image loss that may occur as a result of the haze. Haze is conventionally a natural effect where the illumination of the atmosphere is blurred by smoke, dust and other dried objects. Dehazing the picture is found very difficult as haze concentration is different for some sites & therefore identifying & testing them is expected to be the biggest challenge. Light Attenuation rollout trend in photographs helps us to adjust light color & volume. This effect can, therefore, be utilized to describe attenuation, and may, therefore, be utilized well to determine the intensity of haze in images. It works suggests using the color attenuation subsequent to dehazing a single image. This simple & elegant foreplay may help to make a linear pattern for hazy image's scene scale. By using a supervised learning approach to learn the parameters of the linear model, the relation between the hazy picture and its subsequent depths map [15].

B. Chen and S. Huang [2016] Haze reduction is a significant development for image restoration which plans to removal annoying haze particles of images. Nonetheless, conventional dehazing methods ' efficiencies are quickly hampered by inadequate haze thickness measurement, & therefore cannot offer adequate haze removal performance. In this work, we suggest an edge-based dehazingalgo by which the transmission map can be dynamically repaired and satisfactorily restored to visibility. Experimental data using theoretical and practical analyses indicate that now haze removal capability of planned edge collapse-based dehazing technique is considerably superior with that of additional state-of-the-art approaches [16].

N. Sadhvi et al. [2016]Some of the strategies available for eliminating haze are other data methods, various image approaches & single-image approaches. Very first two approaches are inefficient and have high numerical methods. Thanks to their simplicity and low cost, a recent single image solution is utilized for this de-hazing procedure. Bi-orthogonal wavelet transformation is utilized to get clear data from the hazy image and edge detail. The propagation chart is calculated using the calculation of ambient radiation. Adaptive gamma correction and Median filters are utilized to boost propagation to prevent issues with the halo effect. The vision restoration component then utilizes average color difference values & improved transmission to create a better quality image [17].

VII. CONCLUSION

Haze reduction methods are used to eliminate the haze which is caused by the ambient impurities. This paper explores various haze reduction approaches that are used in digital image processing. From the survey, we found that almost all existing haze removal methods have their own advantage and some limitations. In this survey, we studied that most of the methods above used Dark prior channel as a base to their estimation. As we have seen the dark channel prior has some drawbacks, hence these methods results are not efficient in some cases. There are some methods that give high-quality images but these are not applicable to varying weather conditions. So first there is needed to overcome the drawback of dark channel prior and estimate good result.

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