An Extensive Survey on Image Dehazing Approaches

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Abstract-In For each situation what people see are images. In any case, while changing this to our digital gadgets what we record are numerical qualities for every one of the purposes of the image. The across the board accessibility of moderately ease PCs has proclaimed an unrest in digital image preparing exercises among researchers and the buyer populace by and large. When all is said in done, the without haze image is all the more outwardly pleasuring. Second, most computer vision algorithms, from low-level image examination to abnormal state object acknowledgment, normally accept that the info image is the scene brilliance. Significant advance in single image haze evacuation has been made as of late. mentioned the objective fact that a without haze image has higher difference than a foggy image while accepting a smooth layer of airlight, and had the capacity to get great outcomes by expanding contrast in neighborhood areas of the info image.

Keywords- Image Restoration, Dehazing, Defogging, Visibility Enhancement.

I. INTRODUCTION

A number of developments in computer vision are there to enhance the visibility of outdoor images by reducing the undesirable effects due to scattering and absorption caused by the atmospheric particles. This could be a pre-step of other applications, which assume that input is exactly the scene radiance. Otherwise, these algorithms would generate inaccurate . Images of outdoor scenes often contain haze, fog, or other types of atmospheric degradation caused by particles in the atmospheric medium absorbing and scattering light as it travels from the source to the observer.

While this effect may be desirable in an artistic setting, it is sometimes necessary to undo this degradation. For example, many computer vision algorithms rely on the assumption that the input im- age is exactly the scene radiance, i.e. there is no disturbance from haze. When this assumption is violated, algorithmic errors can be catastrophic. One could easily see how a car navigation system that did not take this effect into account could have dangerous consequences. Accordingly, finding effective methods for haze removal is an ongoing area of interest in the image processing and computer vision fields.

Dehazing is needed for human activities and in many algorithms like recognition, tracking and remote sensing and sometimes in computational photography. Applications that are of interest in this scope fully autonomous vehicles typically use computer vision for land or air navigation, monitored driving, outdoor security systems, or remote surveillance systems. In bad visibility environments, such applications no longer function efficiently. An extra layer of processing should be added.

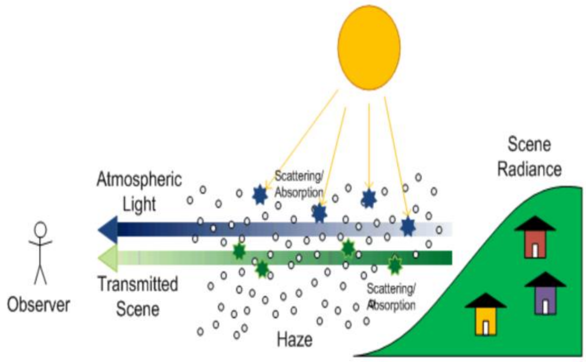

Fig.1.1 Haze Model.

A widely used model for haze formation is:

$$I(x) = R(x)t(x) + a\infty(1 - t(x)) \dots\dots\dots\dots (1.1)$$

Where x is a pixel location, I is the observed image, R is the underlying scene radiance, a∞ is the atmospheric light, and t is the transmission coefficient. Intuitively, the image received by the observer is the convex combination of an attenuated version of the underlying scene with an additive haze layer, where the atmospheric light represents the color of the haze.

Image dehazing is a trans disciplinary challenge, as it requires knowledge from different fields: meteorology to model the haze, optical physics to understand how light is affected by this haze and computer vision as well as image and signal processing to recover the parameters of the scene. Researchers have been always searching for an optimal method to get rid of degradation by light scattering along aerosols. Many methods have been proposed and compared to each other. Although today we have a varied collection of approaches, they are limited and they do not meet efficient recovery requirements.

Throughout dehazing process, many modifications are introduced, affecting the image features. These modifications might lead to have a better or a worse rendering to the whole image, while knowing that image features are affected differently. The rendering level depends directly on the method hypothesis and the distortions introduced by the viewing and capture conditions.

Image goals are one of the basically received metric to express the nature of the image procurement and show frameworks. It is formally characterized as the littlest detectable detail in a visual introduction. In digital image processing the term goals is ordered into four kinds.

(a) Spatial Resolution

An image is made out of a few picture components called pixels. Spatial resolutions or pixel resolutions alludes to the dividing of pixels in an image and is estimated with an arrangement of two positive whole number numbers (i,j), where the primary number „i' demonstrate the quantity of pixel sections (width) and the second number 'j' alludes to pixel lines (tallness). For instance spatial resolutions of (640x480) relates to an image comprising of 640 pixels along the lines and 480 pixels along the segments of the image.

(b) Spectral Resolution

This alludes to the frequency or spectral resolving power of a sensor and is characterized as the littlest resolvable wavelength distinction by the sensor. The settling power R of a sensor is given by R =_, where X relates to the wavelength of the light which can be detected by the sensor and Hatchet is littlest perceivable wavelength distinction that can be detected by the sensor.

II. DEHAZING METHODS

The main objective of haze/fog removal, defogging or dehazing is to recover the attenuated light of the scene (i.e. scene radiance). This problem is mathematically ill-posed since the number of unknown parameters is bigger than the number of equations. This explains the great attention given to this research domain and the variety of approaches, which are reflected by a dramatically increasing in the number of publications over the past few years.

Dehazing methods can be classified into two main categories.

Single image methods: these methods can be whether physics-based and image enhancement methods. This category has had a lot of success and popularity. It represents a very active domain of research, since approaches do not require user interaction nor additional information (the vast majority of recently proposed dehazing methods belong to this category). Considering a single degraded image, these color-based methods provide improvement as good as other categories'. They are used for a variety of applications ranging from simple visualization to e.g. monitored driving, outdoor security system, or remote surveillance systems.

Multiple image methods: unlike single image methods, these methods suffer from additional cost. Some of them cannot be performed without user interaction. More- over, special equipment are usually required, such as polarizers. Different images may be used, such as images taken for the same scene under different weather conditions or images of different types (RGB and NIR). Thus, they are less prone to be used into real time applications. Sometimes, besides the degraded image, additional information are required, such as the scene depth map. These methods, like multiple image methods, have not raised yet a lot of interest.

Single Image Dehazing

Single image dehazing approaches can be divided into two groups: physics-based and image enhancement methods. Methods in the first group are based on the inversion of the visibility degradation model. The challenge is to evaluate the model parameters, and for that, prior assumptions and constraints have to be taken. The key point is then to find the most suitable hypothesis which leads to the best parameter estimates. Such methods are known by image restoration methods.

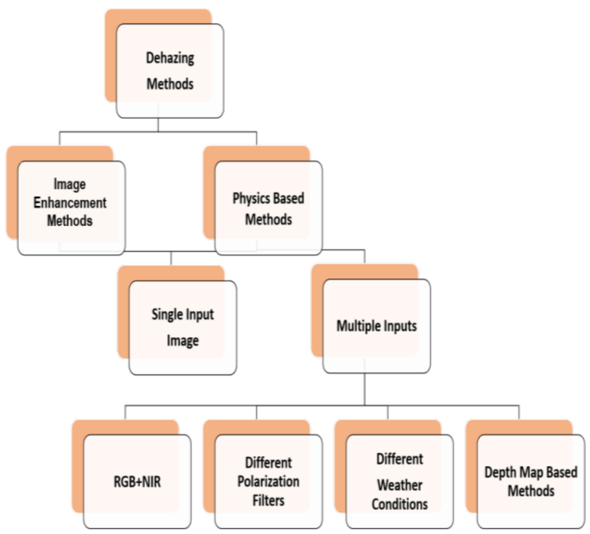

Fig. 2.1 The family of Dehazing Methods.

Methods in the latter category do not consider the physical causes of image degradation caused by weather conditions, but rely on observers preferences that are known to improve the image quality. In particular, contrast enhancement is the major general concept. They include image enhancing techniques such as the applying of bilateral and guided filter for image smoothing or the histogram equalization for contrast adjustment, etc. They suffer from less effectiveness on maintaining color fidelity. Since they aim to improve the quality of images, no matter if the features of images are accurately recovered or not, they are called image enhancement methods.

Multiple Images Dehazing

More than a single image imply the use of a special equipment, such as polarizers are required, or some scenes taken under different weather conditions, or maybe various image types. In this section, methods dealing with two input images are presented: first, a method that considers images taken under different weather conditions. Second, a method that uses the dissimilarity between RGB and infrared images, which may be acquired by a single sensor. Third, a method that manipulates images with different polarizing angles. Perhaps these methods are not suitable for many applications since they require a considerable effort and cost in terms of user interaction, time and complexity. In light of this, methods of this category cannot be used in applications requiring autonomous control. Thus, little work exists in this domain, since in addition to what is mentioned before, they do not provide more enhanced improves comparing to single image dehazing methods.

III. LITERATURE SURVEY

Sr. no.	Title	Author	Year	Approach
1	Learning a Patch Quality Comparator for Single Image Dehazing	S. Santra, R. Mondal and B. Chanda	2018	In this paper, we propose a method that dehazes a given image by comparing various output patches with the original hazy version and then choosing the best one.
2	Improve Transmission by Designing Filters for Image Dehazing	Y. Chen, Z. Li, B. Bhanu, D. Tang, Q. Peng and Q. Zhang,	2018	In this paper. First, filters (Sobel operator and mean filter) are used to refine the initial transmission map estimated from the dark channel prior. Second, a piecewise constrained function is proposed to keep color fidelity.
3	Learning-based local-patch resolution reconstruction of iris smart-phone images	F. Alonso-Fernandez, R. A. Farrugia and J. Bigun	2017	In this paper, we evaluate two trained image reconstruction algorithms in the context of smart-phone biometrics. They are based on the use of coupled dictionaries to learn the mapping relations between low and high resolution images.
4	Efficient real-time single image dehazing based on color cube constraint	E. A. Kponou, Z. Wang and P. Wei,	2017	In this paper, we use a simple but effective prior, a variation of distance (VoD) prior, to estimate the transmission map and remove haze from a single input image.
5	Learning deep transmission network for single image dehazing	Z. Ling, G. Fan, Y. Wang and X. Lu	2016	n this paper, we develop a deep transmission network for robust single image dehazing. This deep transmission network simultaneously copes with three color channels and local patch information to automatically explore and exploit haze-relevant features in a learning framework.
6	Single image dehazing with varying atmospheric light intensity	S. Santra and B. Chanda	2015	Here we propose a method that works under the relaxed assumption that the color of atmospheric light is constant but its intensity may vary in the image.
7	An single image dehazing algorithm using sky detection and segmentation	Y. Zhu, J. Liu and Y. Hao	2014	In this paper, an improved dark channel prior algorithm is proposed, which detects the sky firstly and divides the image into sky region and nonsky region, and then estimates the transmissions of the two parts separately, followed by the combination with a refining step.

S. Santra, R. Mondal and B. Chanda [1] In bad weather conditions such as fog and haze, the particles present in the atmosphere scatter incident light in different directions. As a result, the image taken under these conditions suffers from reduced visibility and lack of contrast, and as a result, it appears colorless. An image dehazing method tries to recover a haze-free portrayal of the given hazy image. In this paper, we propose a method that dehazes a given image by comparing various output patches with the original hazy version and then choosing the best one. The comparison is performed by our proposed dehazed patch quality comparator based on the convolutional neural network. To select the best dehazed patch, we employ binary search. Quantitative and qualitative evaluations show that our method achieves good results in most of the cases, and are, on an average, comparable with the state-of-the-art methods.

Y. Chen, Z. Li, B. Bhanu, D. Tang, Q. Peng and Q. Zhang [2] Image haze removal techniques have a promising application prospects. However, color distortion by excessive dehazing is a common problem especially for images containing light color surface objects. To solve this problem, an improved image dehazing method based on dark channel prior with color fidelity is proposed in this paper. First, filters (Sobel operator and mean filter) are used to refine the initial transmission map estimated from the dark channel prior. Second, a piecewise constrained function is proposed to keep color fidelity. Experimental results on real world images show that the approach is effective in haze removal and preventing the color distortion from excessive dehazing. Preferable results of recovered images with bright and realistic colors and enhanced details are achieved.

F. Alonso-Fernandez, R. A. Farrugia and J. Bigun [3] Application of ocular biometrics in mobile and at a distance environments still has several open challenges, with the lack quality and resolution being an evident issue that can severely affects performance. In this paper, we evaluate two trained image reconstruction algorithms in the context of smart-phone biometrics. They are based on the use of coupled dictionaries to learn the mapping relations between low and high resolution images. In addition, reconstruction is made in local overlapped image patches, where up-scaling functions are modelled separately for each patch, allowing to better preserve local details. The experimental setup is complemented with a database of 560 images captured with two different smart-phones, and two iris comparators employed for verification experiments. We show that the trained approaches are substantially superior to bilinear or bicubic interpolations at very low resolutions (images of 13×13 pixels). Under such challenging conditions, an EER of ~7% can be achieved using individual comparators, which is further pushed down to 4-6% after the fusion of the two systems.

E. A. Kponou, Z. Wang and P. Wei [4] Image degraded by haze is a critical aspect in today's environment while getting a high-quality haze-free image remains an important task in computer vision. In recent year, many works have been done to improve the visibility of image taken under bad weather. Conventional designs use multiple image and/ or single image to deal with haze removal. In this paper, we use a simple but effective prior, a variation of distance (VoD) prior, to estimate the transmission map and remove haze from a single input image. The VoD prior is developed based on the idea that the outdoor visibility of images taken under hazy weather conditions seriously reduced when the distance increases. The thickness of the haze can be estimated effectively and a haze-free image can be recovered by adopting the VoD prior and the new haze imaging model. Our method is stable to image local regions containing objects in different depths. Our experiments showed that the proposed method achieved better results than several state-of-the-art methods, and it can be implemented very quickly. Our method due to its fast speed and the good visual effect is suitable for real-time applications. This work confirms that estimating the transmission map using the distance information instead the color information is a crucial point in image enhancement and especially single image haze removal.

Z. Ling, G. Fan, Y. Wang and X. Lu [5] State-of-the-art single image dehazing algorithms have some challenges to deal with images captured under complex weather conditions because their assumptions usually do not hold in those situations. In this paper, we develop a deep transmission network for robust single image dehazing. This deep transmission network simultaneously copes with three color channels and local patch information to automatically explore and exploit haze-relevant features in a learning framework. We further explore different network structures and parameter settings to achieve tradeoffs between performance and speed, which shows that color channels information is the most useful haze-relevant feature rather than local information. Experiment results demonstrate that the proposed algorithm outperforms state-of-the-art methods on both synthetic and real-world datasets.

S. Santra and B. Chanda [6] Images taken in bad weather conditions like haze and fog suffer from loss of contrast and color shift. The object radiance is attenuated in the atmosphere and the atmospheric light is added to the scene radiance creating a veil like semi-transparent layer called airlight. The methods proposed till now assumes that the atmospheric light is constant throughout the image domain, which may not be true always. Here we propose a method that works under the relaxed assumption that the color of atmospheric light is constant but its intensity may vary in the image. We use the color line model to estimate the contribution of airlight in each patch and interpolate at places where the estimate is not reliable. We apply reverse operation to recover the haze free image.

Y. Zhu, J. Liu and Y. Hao [7] mage dehazing has always been a focus of wide attention in recent years with great breakthrough. However, the existed algorithms may produce noise and color distortion in the process of image restoration, especially in the sky region. In this paper, an improved dark channel prior algorithm is proposed, which detects the sky firstly and divides the image into sky region and nonsky region, and then estimates the transmissions of the two parts separately, followed by the combination with a refining step. The results show that more natural images can be restored in the process of image dehazing, whether there is a sky area or not.

IV. PROBLEM IDENTIFICATION

One of the most serious environmental problems in the world is air pollution. Air pollution can be defined broadly as the introduction of chemicals, particulate matter, or biological materials into the atmosphere that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment. Recorded color images taken in bad environments exhibit problems such as low visibility, reduced contrast and generally bad ”quality”. For this reason, many methods known as dehazing methods have been designed to improve the perceived image quality in order to be used later in Computer Vision applications, which require images of high quality. Unlike computational photography, image usability and fidelity may be promoted over preference in computer vision. Amongst these two aspects, we consider particularly the fidelity.

V. CONCLUSION

In this paper, a brief survey of distinctive specialists on image dehazing strategy that gauges air light proficiently and evacuates haze through the estimation of a semi-all inclusive versatile channel. The upgraded images are described with little commotion and great introduction in dark districts. The surfaces and edges of the prepared images are likewise upgraded altogether. For haze estimation, this incorporates dark channel patch size and refinement parameters. Albeit some "great" parameters have been found observationally, these may just function admirably for a few images. By and large, it is to our greatest advantage to have an unmistakable visibility, regardless of where we are. For security reasons: within the sight of mist, the danger of street mishaps increments; in a not clear zone, surveillance cameras are not effective.

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