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FAST AND EFFICIENT VISIBILITY RESTORATION TECHNIQUE FOR SINGLE IMAGE DEHAZING AND DEFOGGING

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ABSTRACT
Haze is a natural phenomenon in which the dust, smoke and other particles alter the vision of the sky to reduce the visibility. Hazy images cause various visibility problems for traffic user, tourists everywhere, especially in hilly areas where haze and fog are very common. In this paper, a method for single image dehazing using convolutional neural network is proposed. Outdoor images have been used on which particular filters are applied to find the haze in image. Hazy images contain small value in only one-color alpha channel from Red, Blue, green RGB channel. The intensity of these pixels is mainly bestowed by air light depth map. Estimating these low value points of haze transmission map are useful to obtain a high quality dehazed image. An end-to-end encoder-decoder training model is utilized to achieve a high quality dehazed image. The approach is validated on datasets which consists of around 1500 outdoor images. The method also gives transmission map of the hazy image which can further be used to enhance visibility of the scene.

INTRODUCTION

THE execution of visual activities such as object detection and recognition depends heavily on the perception of outdoor natural scenes. Unfortunately, images of outdoor scenes are often degraded in bad weather conditions such as haze, fog, smoke, rain and so on. The light is blended with ambient light reflected from other directions into the line of sight by atmospheric particles. The irradiance received by the camera from the scene point is attenuated along the line of sight. As such, the objects captured under the bad weather conditions suffer from low contrast, faint color, and shifted luminance [1]. Haze removal can significantly increase the contrasts of the objects, and correct the color distortion caused by the airlight. Therefore, haze removal is highly demanded in image processing and computer vision applications [2]. Many single image haze removal algorithms were proposed due to their broad applications. Based on an observation that a haze-free image has higher contrast than its haze image, an interesting single image haze removal algorithm was proposed in [3] by maximizing the local contrast of the restored image using markov random field. Although the algorithm in [3] is able to achieve visually compelling results, it tends to produce over-saturated images which might not be physically valid. A haze image is interpreted by Fattal in [4] through an image formation model that accounts for both surface shading and scene transmission. Under an assumption that the transmission and surface shading are locally uncorrelated, the air lightal bedoambiguity is resolved. The algorithm in [4] produced impressive results except in presence of heavy haze. Inspired by the widely used dark-object subtraction technique [5], a novel dark channel prior

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based haze removal algorithm was proposed in [6] and [7]. The dark channel prior is based on an observation that it is very often that some pixels of haze-free outdoor images have very low intensity in at least one color (RGB) channel. The algorithm is physically valid and can handle distant objects even in images with heavy haze. However, noise in bright regions including the sky could be amplified by using the algorithm in [6] and [7] even though a lower bound was introduced for the transmission map in [6] and [7]. Based on observations that the color of the scene fades under the influence of the haze and the brightness increases at the same time producing the high value of the difference, a simple color attenuation prior was proposed in [8], and a linear model was then built up to represent the relationship between the depth and the brightness as well as the saturation using the prior. The linear model was finally adopted to design a single image haze removal algorithm with the help of the guided image filtering (GIF) in [7]. The algorithm in [8] is simple and it also avoids amplification of noise in the sky region. In addition, the haze is removed well if it is light. However, the quality of the dehazed images needs to be improved if the haze is heavy. This is because the coefficients of the linear model and the scattering coefficient of the atmosphere are fixed for the algorithm in [8] while their values should be adaptive to the haze degree of the input image. It is interesting but challenging to properly determine the coefficients of the linear model and the scattering coefficient of the atmosphere for the algorithm in [8]. Inspired by an observation in [9] that single image haze removal can be regarded as a type of spatially varying detail enhancement, a neat framework was proposed in [11] by introducing a local edge-preserving smoothing based method to estimate the transmission map of a haze image. However, local edge-preserving smoothing techniques such as the GIF in [7] and the weighted GIF (WGIF) in [9] could over smooth images [12], especially in areas of fine structure. An example is given in Fig. 1. The GIF in [7] and the WGIF in [9] are adopted to study single image haze removal. As shown in the zoom-in regions, the hair of the human subject is over smoothed by both the GIF and the WGIF. Therefore, both the GIF and the WGIF could not preserve the fine structure even though they are very simple.

EXISTING SYSTEM:

The linear model was finally adopted to design a single image haze removal algorithm with the help of the guided image filtering (GIF) The algorithm in [8] is simple and it also avoids amplification of noise in the sky region. In addition, the haze is removed well if it is light. However, the quality of the dehazed images needs to be improved if the haze is heavy.

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LITERATURE REVIEW Various literatures reviewed on dehazing are presented in this section. A review of literatures is presented in brief summarizing the work done by different scholars and researchers.

- **Y.Y.Schechner et.al (2001),** Haze removal techniques are gaining popularity due to its availability in many classifications. These methods can be used to construct a high quality, noise free, and dehaze images. The classifications are done in two major types' image segmentation and image restoration. This air light is scattered by the atmospheric particles. In the proposed work, the image formation process is shown where the image is a clean image. The polarization impact is taken into account and also inverting method is employed, wherever it outputs into a haze free image. Two components are used to compose the image, one is known as scene radiance and the other is air light. Scene radiance is in the absence of haze and air light is the ambient light that is scattered towards the viewer. For recovering the two components, there is a need for two non-dependent images. And these images can easily be acquired because air light is partially polarized. This approach can be immediately applied. It does not require the change in weather conditions. The images that are taken by a polarizer use the concept of polarization filtering. This polarization filtering is used in photography across haze.
- **Xie, Bin, Fan Guo (2010),** Paper deals with the bad weather conditions may demean the quality of the images of outdoor scenes. This is an ultimatum to reliability of many applications. The unwanted condition is caused by the atmospheric conditions like haze and fog, which blurs the captured scene. Always the air is misted by some added particles which are scattered around, and hence, the reflected light is also scattered which results in less visibility of distant objects. The scattering is caused by two basic events namely attenuation and air light. In the last few years, a technique has gained popularity and this is known as restoration of images that are taken into bad atmospheric conditions. This paper additionally focuses on the approach that provides the automated and quick acquisition of transmission map of the scene. This approach is based on the implementing the multi scale retinex algorithm on the luminance component in YCbCr space of the input image to get the pseudo transmission map.
- **G. Meng, et.al (2013),** Haze removal techniques will retain the color and brightness of the scene. These techniques are widely used in many applications such as underwater photography, satellite images etc. Haze removal is very difficult task because fog depends on the scenes depth information which is unknown. There for the removal of fog requires the estimation of air light lamp the overall objective of this paper is to describe the various methods for efficiently removing the haze from remote sensing images .It also gives description of some filters used for dehazing. It also decreases the clarity of satellite images and underwater photography. So removing haze from images is an accepted and broadly demanded area in computer vision and computer graphics related systems. The quality of images of outdoor scenes depends on the haze such as

fog, mist and other bad weather condition. It's usually degraded by scattering of a light. Before reaching the camera due to these large quantities of particles (fog, haze, smoke impurities)in the atmosphere, it got degraded. This phenomenon affects the normal work of automatic monitoring system and outdoor recognition system racking and segmentation process and intelligent transportation system very often. Haze removal algorithms become more useful in many computer vision applications.. This survey has shown that the presented methods have neglected the techniques to reduce the noise which may presenting the output images of the existing fog removal algorithms. So it is required to work under more filtering methods.

- **Archana Kaushik, Alka Choudhary (2014),** Image dehazing plays a vital role in the field of image processing. One of the key problems observed by us in image dehazing is that it is very challenging to recognize the white scenery objects whose pixel value is inherently similar to atmospheric light's value. In image dehazing is to acknowledge the white scenery objects whose component price is inherently like region light's price. So there is requirement of a more robust method for image dehazing in homogeneous atmosphere. This paper proposed a simple, efficient and powerful method haze removal in image. It is a robust method that is capable enough to improve the detection quality of hazed image by minimizing atmospheric haze effect.
- **Manpreet kaur saggu and satbir singh (2015),** The general objective of this paper is to explore the short comings of the earlier presented techniques used in the revolutionary era of image processing applications. The deterioration may be due to various factors like relative object-camera motion, blur due to camera misfocused, relative atmospheric violent features and others. In this paper discussing about the degradations due to bad weather such as fog, haze in an image. This incidence influences the traditional work of automatic (mechanized) observance system, outdoor recognition system and sensible installation. Scattering is caused by two basic phenomena such as attenuation and air light. By the usage of effective haze or fog removal of image, improve the stability and robustness of the visual system. Under water image enhancement based algorithms become more useful for many vision applications. It is found that largely the prevailing researchers have neglected several issues; i.e. no technique is precise for various kinds of circumstances. The existing techniques have neglected the employment of dark channel before scale back the noise and uneven illuminate downside. To overcome the issues of existing analysis a brand new integrated rule are going to be projected.
- **Sajana M Iqbal, MuhammadNizar (2015),** In the study on the different haze removal techniques, haze brings trouble to many computer vision/graphics applications as it diminishes the visibility of the scene. Haze is made attributable to the elementary phenomena that are attenuation and also the air light weight. Haze removal techniques recover the color and contrast of the scene. The overall objective of this paper is to explore the various methods for efficiently removing the haze from digital images. Haze is historically associate degree physical phenomenon during which smoke and

alternative dry particles obscure the clarity of the scenery objects. Environmental illumination tends to be scattered by this kind of turbid medium and the white air light is formed. It turns out that images taken in such bad weather are often much brighter and the color of the scenery object fades in different degree. Experimental results show that the projected approach achieves dramatically high and outstanding dehazing result as well

METHODOLOGY Haze removal methods fails under certain conditions. Which includes polarization techniques where the haze is removed by applying haze removal filter such as mean guided filter. In some other studies, they also computed the transmission map to further clear the visibility of the hazy image [13-16]. The proposed training model first extracts the dehazed feature from the image using the convolution operation and fed-up the feature map to 1st hidden layer. These features will not be enough in order to remove haze from the given datasets. So, there is need to extract some high-level features. For this purpose, the size of feature map is reduced which extract the significant part in the 2nd hidden layer. The output layer can check whether the input image is hazy or not. Figure 2 shows the architecture of methodology. This dehazing method is applicable only to outdoor images. The main technique is to find the low intensity pixel from the hazy image by applying a filter [17-18]. These intensity pixels further compute the transmission map which further improve visibility. By this, these particular pixels can give us the accurate computed haze model. After that, apply some methods on it and recover high quality dehazed image. The proposed method is applicable to handle the distant objects even in the very high turbid medium.

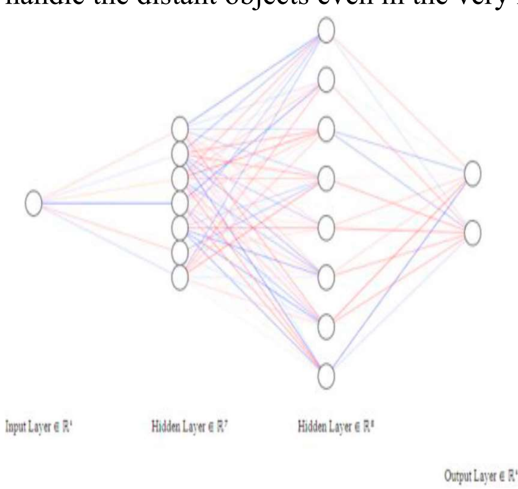


Figure 2: Architecture of proposed methodology

The encoding and decoding phase is shown in Figure 3, filters of all the previous approaches forming an opaque convolutional neural network is applied to extract feature map from the hazy image. This CNN model contains 7 neurons in the 2nd hidden layer and 8 neurons in the 3rd hidden layer forwarding the information in a feed-forward manner as shown in Figure 3. The type of model presented in the paper ensures the efficient method to pass the parameters in both forward and backward propagation pass.

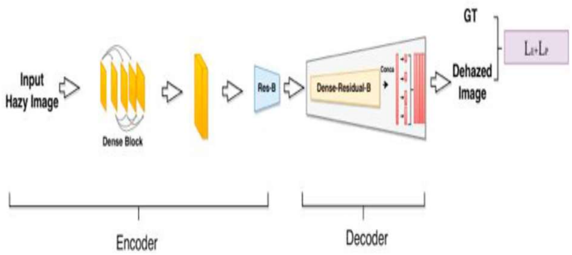
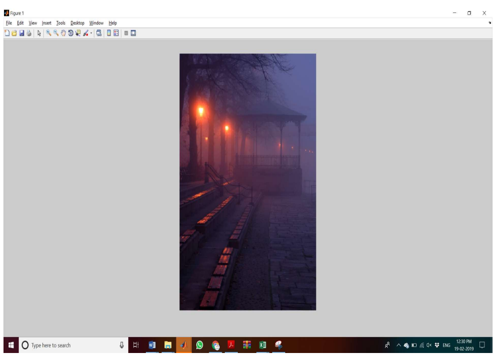
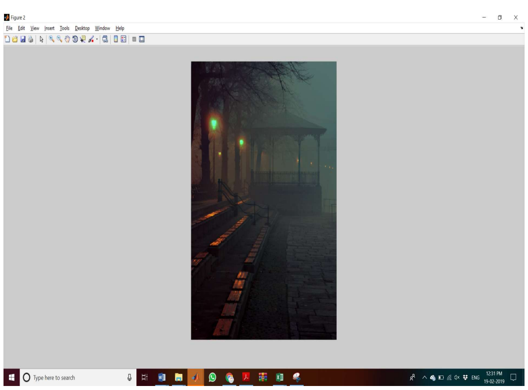


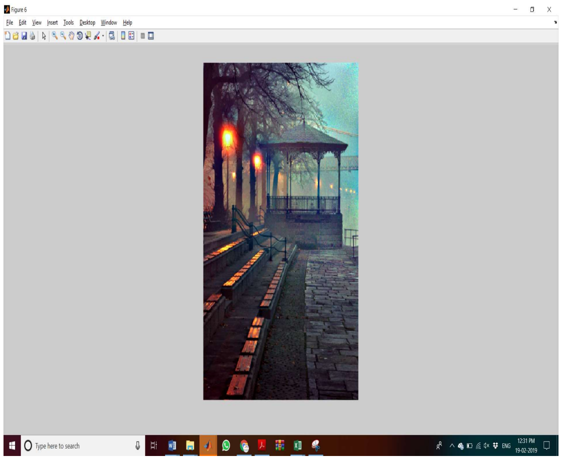
Figure 3: CNN model for haze from removal

The decoder function is similar to the encode phase except that it uses residual function which ensures that each hidden neuron is fully connected to all other neuron connected in the second layer as shown in Figure 3. The advantage of this function is that it improves the learning rate and converge our training data set model. A non-linear relation is established between a hazy image and estimated ground truth. This relationship recovers a high quality dehazed image from a hazy image in an efficient manner. The proposed model involves an encoder-decoder structure using a deep neural network. The involvement of gradient descent increases the reliability of convergence of training dataset model. The mean squared error and residual loss function play a vital role in training of the dataset model. This approach is based on the mentioned hypothesized of the hazy images: in most of the non-environmental.

RESULTS:







CONCLUSION In this paper, we have proposed a very simple and efficient end-to-end encoder and decoder architecture for image dehazing using convolutional neural network. The end-to-end encoder model removes limitations found in the dehazing process. The experiments were carried out on the standard datasets. Proposed approach gives better and efficient results than previous results using high-intensity pixel value. In future, this work may be extended to dehaze those images having no shadow cast and to run on all cases. The real time streaming for dehazing by showing a video that remove haze in real time that will be a great achievement for solving traffic problem in northern areas.

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