Comparing the Quality Assessment of Image Dehazing Using Different Techniques

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There is serious image degradation in the images taken in the noisy environment such as haze or fog. Our quality assessment of image dehazing using the traditional and modern approach, actively prescribes a solution for the evergreen problem. Our proposed approach tries to throw some light and find a solution to this problem. We are first using the more traditional approach used in Image Processing. The algorithm we use is the Richardson Lucy algorithm. The Richardson Lucy algorithm, also known as Lucy–Richardson deconvolution, is an iterative procedure for recovering an underlying image that has been blurred by a known point spread function. With an ideal point source not present as a point but on the contrary being spread out into what is known as the point spread function. Our subsequent approach is a modern approach of Deep Learning. We are using Single Image Haze removal using DCP methodology to enhance the dehazing performance and flexibility. This modern approach takes into consideration the estimated transmission, refined transmission, atmospheric light to give us the output dehazed images. We are using a dark channel prior Single Image Dehazing method. Finally, we are doing a quality assessment. Here we are performing a comparative analysis by comparing the quality parameters of output images received from dark channel prior and the LR approach respectively.

Keywords: Dehaze, Histogram equalization methods, convolution neural network, Dark Channel Prior, Richardson Lucy algorithm, De-Convolution.

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1 Introduction

There is serious image degradation in the images taken in the noisy environment such as haze or fog. Our quality assessment of image dehazing using the traditional and modern approach, actively prescribes a solution for the evergreen problem [2]. Haze removal is a rather difficult proposition as the haze is subject to the unknown depth of the scenes. The problem is insufficiently constrained in the case of single Hazy images. Hence many multiple image input models have been proposed such as Polarization-based methods, Depth-based methods, etc. Our proposed approach tries to throw some light and find a solution to this problem. We are first using the more traditional approach used in Image Processing i.e. the different algorithms and different methods helps into improvising the quality of the images. The Richardson–Lucy algorithm, also known as Lucy–Richardson deconvolution, is an iterative procedure for recovering an underlying image that has been blurred by a known point spread function. With an ideal point source not present as a point but on the contrary being spread out into what is known as the point spread function [5]. Our subsequent approach is a modern approach of Deep Learning. We are using Single Image Haze removal using DCP methodology to enhance the dehazing performance and flexibility [26]. This modern approach takes into consideration the estimated transmission, refined transmission, atmospheric light to give us the output dehazed images. We are using a dark channel prior – Single Image Dehazing method [8].

2 Schematic of Proposed Method

To motivate our objective of this research proposal and with the rise of digital camera as both in the consumer market and in various sensing systems, the haze-removal of outdoor images is gaining increasing attention. Image dehazing has taken by storm numerous significant scientific fields of applications such as astronomy, medical sciences, remote sensing, surveillance, web mapping, land-use planning, agronomy, archaeology, and environmental studies. Also our proposed approaches can be applied in vehicular systems, since cameras must be capable enough to generate good images even in bad weathers. External noise such as mist, fog, dirt particles can limit the ability to recognize other vehicles, traffic signs, and pedestrians, dehazing are an indispensable requirement in the consumer devices to acquire high-quality images. It can also be applied in the case of remote sensing, this process results in substantial loss of contrast and color of the images. Such images often lack visual vividness and appeal, and moreover, they hinder further image-processing tasks due to poor visibility. The comparative analyses between the blurry and restored images provide clear pros and cons of each methodology. Henceforth the applicability of each method is clearly stated. Which method to be applied in which system can be known, the method chosen largely depends on the complexity, application and usage of the method. With the proposed methods what we have using this we clear the images with its contrast sides. And hence the methods are here for the better improvement using Wiener filter algorithm and restore quality of images gives values as we find out. The method is helps to improvising the foggy images such as used Richardson – Lucy algorithm for restore quality of images [4].

To use more modern approach of neural network for image dehazing and improving the quality of hazy images implementation of Single Image Dehazing technique dark channel prior algorithm is applied. Establishing qualitative comparison between foggy and blurry image restorations.

3 Methodology for Dehazing Images

Let us first focus on the methodology of hazzy images using: Richardson-Lucy algorithm.

Fig. 1. Block Diagram for LR Methodology

In the first step the algorithm reads the image in RGB and then crops it to be 256-by- 256-by-3. It is capable enough to handle multiple arrays of varied dimensions.

In the next step we simulate a blur and add noise to improve image quality. The lack of focus can cause motion blur in cameras. Disturbances can cause noisy images. The blur is simulated using a Gaussian filter. The Gaussian filter is represented by a Point Spread Function (PSF).

In the next step we restore the noisy and blurred image. The restoration happens in 5 iterations and the default is ten. The output image is falls in the array of the same style as the original input image.

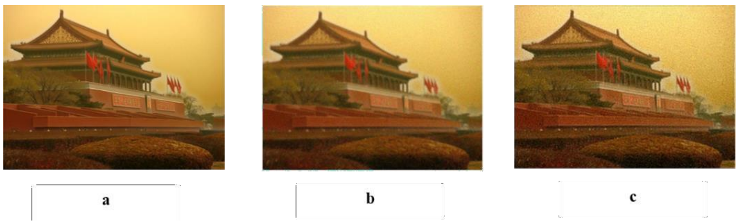

Fig. 2. A: Original Image, B: Blurred and Noisy Image, C: Restored Image

The next methodology is Single Image Dehazing using Dark Channel Prior Method

Fig. 3. Block Diagram for DCP Methodology

The first step is computing the Dark Channel Prior. The rationale behind to implement the DCP method is the underlying awareness that in majority of the patches which are very sticky, and after reviewing the method there has to be at least 1 or less or more colour channel having a very low intensity at some edge of pixels. Hence our proposed method JDark, which takes the (double, normalized) image [13].

Next, Estimating the Atmospheric Light, the atmospheric light is received using, mean pixels in the original input image corresponds to the highest light.

Next, estimating the transmission for better edges, by assuming that the local patch transmission is constant, we can estimate the transmission. To perceive depth as per the human ability, we use the value of omega = 0.96 for the haze removal

Next, Soft Matting, where Image Matting is used to calculate a well refine map of transmission. We recover the map of transmission and the radiance of scene which helps us to get the dehazed image, the same can be seen below.

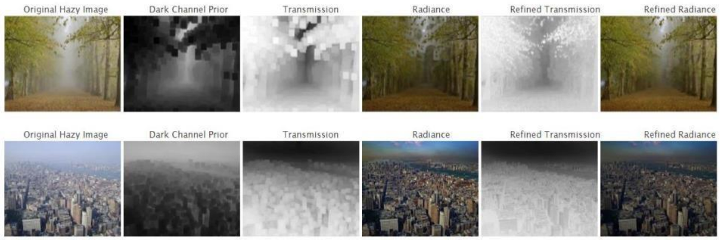

Fig. 4. DCP Methodology

The third methodology is neural network with prior algorithm. Haze is an innate phenomenon, in which the environment particles such as dust, smoke change the vision of the sky and hence it can cause reduction of visibility. Hazy images lead to various kinds of challenges for traffic users and tourists. Outdoor images are hazy as they lose their quality due to the moisture present in the environment, air pollution, smoke or fog, it can also be a combination of all these factors. The blurred images attract noise and lose their quality [11]. Haze removal, reduction is highly pertinent in the field on image processing, computer applications and of course photography. A classical model for dehazing of image is explained by the equation given below.

$$(aa) = PP\ [LL - ii\ (aa)] + [(aa)\ ii\ (aa)] \qquad (1)$$

The highest hypothesized value is denoted by Q, light's deflection is denoted by W, the mean sunlight present in the surrounding is denoted by P and the glow which is plan to the point target and which is not scattered is represented by i

The given equation is used to successfully recover P, W and i from the intensity of light Q.

$$(bb) = zz - \exists\ (bb) \qquad (2)$$

Here, ∃ denotes that light's surface is exponentially dependent on depth scene o.

Geometrically, above equation assumes that everything is in a single color channel, vectors W(a), P and Q (b) are the end and they lie in the same plane. Subsequently they have higher contrast than images that are hazy and secondly the intensity of air light change is dependent on the distance of camera from the object. With reference to the above mentioned observations, the Tan's Model assumes that the removal of scattering of light causes recovery of haze from the image and increases the vision of the image [12].

Based on the above mentioned model of image, the image is segregated into smaller parts of constant albedo. Haze removal fails under certain circumstances such as polarization techniques, which uses filters such as mean guided filter for removal of haze.

The proposed methodology initially extracts the dehazed qualities of the image and this is then fed as an input to the first hidden layer. As this step is not effective on a whole, the second layer is used to extract the feature map. The subsequent layer of output finally checks that the image at the input level is non hazy or hazy image. Please note that this methodology is only applicable to outdoor images. [22]

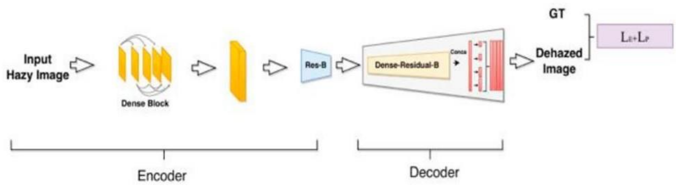

Fig. 5. The Neural Network model to remove haze

The decode, encode phase is shown in Figure above which gathers the feature mapping from the image with haze. This neural network model has seven neurons in the second hidden layer and eight neurons in the third layer. This then leads to a feed- forward manner of information forwarding as shown in Figure 5. This feed forward methodology enables us both backward and forward propagation. The function of the decoder is quite similar to the encoder function, additionally it also enables that each hidden neuron present is efficiently connected to the neurons present in the subsequent layers. [7] With this methodology a nonlinear link is formed between the ground truth and hazy image. This helps us the recover a great quality dehazed Image in a very effective manner.

This is the dataset for an outdoor setup. It can be seen that the images are much for efficient and clear as shown in the figure below.

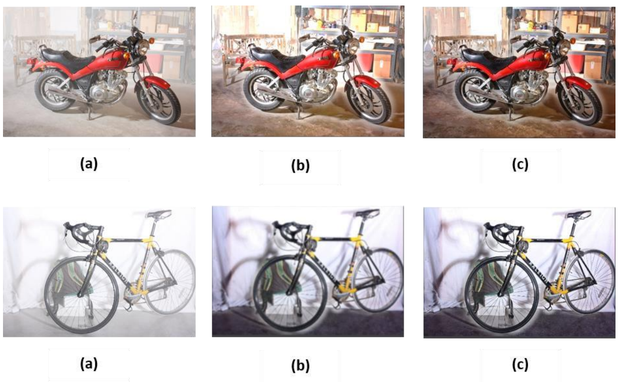

Fig. 6. (a) Input, (b) GT (ground truth), (c) Output

4 Experimental Results

During the experimentation phase, we processed the same dataset through the Richardson-Lucy algorithm and Single Image Dehazing Neural Network algorithm, respectively. The Richardson-Lucy algorithm is implemented using the traditional pro- gramming, while the Neural Network method is implemented using the more advanced Programming Language. All the images used in the data set were of either 620 x 480, or 820 x 533 resolution. We processed a total of 100 images through the respective algorithms. The computer which we used for both the Richardson-Lucy algorithm and Neural Network algorithm had the following specifications – Processor: AMD Ryzen 5 3500U, 2.10 GHz, RAM: 8 GB, WINDOWS 10.

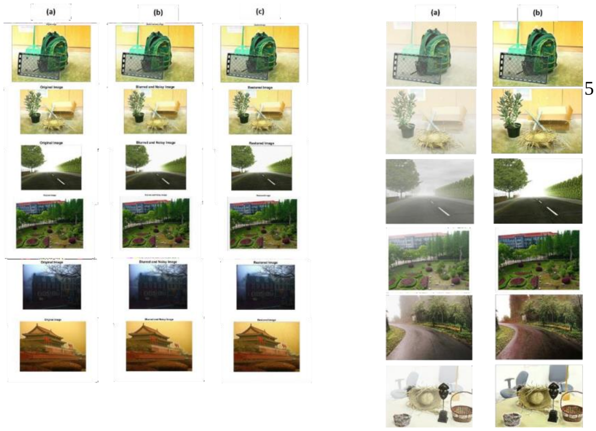

Fig. 7. Left: LR Method results, Right DCP Method Results

5 Qualitative Analysis

Based on the results which we got from the LR algorithm which is the traditional approach and the Single Image Dehazing using Dark Channel Prior, The figure in the table 1 and table 2 clearly shows the recovered images from both the LR algorithm and DCP algorithm. The DCP algorithm is much better than the LR algorithm as it shows the details and manages to recover clear even in densely hazy areas. The esti- mated depth maps are distinctively sharper near the edges and are also strikingly consistent with reference to the input images.

Though both the algorithms works on grey scale images, but the DCP algorithm gives us better results. When we compare both the approaches namely LR algorithm and DCP algorithm, the DCP algorithm is much better as the LR algorithm gives oversaturated colors. The DCP algorithm recovers better quality images as it success- fully recovers the image construction without compensating the fidelity of the colors (e.g. Backpack). The other factor is the halo affects which strikingly smaller in the modern approach.

When we talk about the LR algorithm approach, which is an iterative deconvolution method, the base of which is originates in image reconstruction. A major challenge in the application of Richardson-Lucy method is to decide on the number of iterations. A constraint of the Richardson-Lucy technique balanced to the dark channel prior detain is that it essential the wavelengths step sizes in the measured values and band pass function values, as equal with the values. As a result of its robustness with regard to measurement noise, the Richardson-Lucy method almost always improves the measured spectrum. In contrast, the Richardson-Lucy method appears to be rather insensitive to the value of the wavelength step size as long as the sampling theorem of signal processing is not violated strongly.

To further clarify, the DCP approach is much better than the Richardson Lucy method, as the image quality generated from the method is much better. This is also proved by the PSNR values, as it is higher as compared to the Richardson-Lucy method. Also if we compare the SSIM it shows the Richardson-Lucy method lacks here as well in comparison to the DCP method. This quantitative and qualitative com- parison lays down the marker for which methodology is better. It also clearly show- cases the strengths and limitation of both the modern and traditional approaches.[19] This comparative analysis, backed by the SSIM and PSNR values, proves that DCP approach is better than the

Richardson-Lucy method, as it gives better output images with better, balanced luminance and image saturation along with a lower mean square error.

	LR Algorithm			DSP Algorithm		
Image	PSNR	Mean - Squared Error	SSIM	PSNR	Mean - Squared Error	SSIM
Bicycle	17.0418	1284.9799	0.51902	25.2252	0.003	0.9589
Campus	25.4073	187.2184	0.745313	22.1352	0.0061	0.9033
Bicycle	21.5293	457.2471	0.477563	23.2599	0.0047	0.8949
Backpack	21.3242	479.353	0.446441	21.2019	0.00964	0.8607
Rajpath	20.8148	539.0175	0.463089	19.4014	0.00589	0.86233
City Landscape	23.9206	263.6428	0.607462	22.4776	0.00345	0.93417
Car	22.1182	399.2614	0.553612	24.9876	0.0065	0.84321
Pipes	22.1182	399.2614	0.553612	23.0987	0.00236	0.9123
Bike	23.5234	288.8919	0.893355	21.1098	0.0056	0.83214
Road	23.9009	264.8428	0.858928	19.8907	0.0012	0.85723

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Fig. 8. Qualitative data received from Modern Approach Experimentation

6 Conclusion

We have made it clear about the advantages, limitations and application of both the Traditional and Modern Approach of Image processing. Our attempt will help to im- prove the hazy images in a better manner.

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