International Journal of Computer Engineering & Technology (IJCET)
Volume 9, Issue 2, March-April 2018, pp. 91–98, Article ID: IJCET_09_02_009
Available online at
http://www.iaeme.com/IJCET/issues.asp?JType=IJCET&VType=9&IType=2
Journal Impact Factor (2016): 9.3590(Calculated by GISI) www.jifactor.com
ISSN Print: 0976-6367 and ISSN Online: 0976–6375

HYBRID BASED IMAGE ENHANCEMENT METHOD USING WHITE BALANCE, VISIBILITY AMPLIFICATION AND HISTOGRAM EQUALIZATION

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ABSTRACT

Images captured outdoor during the winter season have the tendency of producing an image covered with a layer of haze or fog. This makes it difficult to visualize the image comfortably and degrades the quality of the image. Therefore, it becomes a huge requirement for a method that will eradicate this haze and make the processing of the images more effective and efficient. In this research work, white balance is used to work globally on the colours and avoid colour cast. Visibility amplification is used to preserve its visibility in a better way. Finally, histogram equalization is used in order to enhance the contrast by equalizing the pixel intensities

Keywords*:* Dehaze, image enhancement, histogram equalization, visibility amplification, white balance.

Cite this Article: Griselda Nerina Dorothy Mendes and Saravanan KN Hybrid Based Image Enhancement Method using White Balance, Visibility Amplification and Histogram Equalization. *International Journal of Computer Engineering & Technology*, 9(2), 2018, pp. 91–98.
http://www.iaeme.com/IJCET/issues.asp?JType=IJCET&VType=9&IType=2

1. INTRODUCTION

Images are captured throughout the year for various purposes. Every image captured is subjective and has to be visually acceptable. In the early mornings during the winter season, the images that are captured outdoors are most likely to be subjected to natural or artificial aerosols like forest exudates, fog, smoke, haze, etc. These aerosols make it difficult to view every region of the image clearly. As the depth of view in an image increases, so does the dominating appearance of the haze. Therefore, when such images are used for remote surveillance, outdoor photography, satellite imaging, etc. it becomes strenuous for effective processing and tends to be less efficient. Since this is the case with the hazy images, we have

to enhance them in such a way that the contrast is increased and the haze is removed partially or completely.

Image Enhancement is the process used to amplify or modify the image in a way that it the image that is given as output, is more satisfactory for viewing and interpretation by the machine and humans as well. Two types of Image Enhancement methods are available. Firstly, the special domain method that works with each individual pixel values and the neighbouring values. Secondly, the frequency domain method wherein the image is converted into its frequency domain by using the Fourier Transform after which the enhancement is carried out. After the enhancement is completed, the Inverse Fourier Transform is carried out to get the final enhanced image.

The flow of the paper obeyed, is as follows. In section II is the Literature Survey. The Methodology proposed is shown Section III wherein the dehazing steps is showcased. Section IV discusses the results obtained. Finally, Section V is the entire conclusion.

2. RELATED WORK

2.1. Visibility Enhancement for Remote Surveillance System (Hemangi Dhananjay Bhoir, Nilima M. Dongre and Reshma R. Gulwani, 2016) *[1]*

This paper proposes a method that works on remote surveillance images that have undergone bad atmospheric conditions like haze as well as fog that results in degrading the quality of the image. In such challenging environments it becomes a must to enhance these images so as to get rid of the fog, haze or dew that appears on the images. To obtain better visibility the regions have to be preserved by extracting the features that are important, to do so the foreground region preservation map and the saliency feature extraction map is used. After which the average luminance is computed and extracted in the area where there is haze from the original image. To adjust the local contrast of the image and enhance it, the Contrast Enhancing Approach CLAHE (block based contrast enhancement) algorithm is applied at the end. Therefore, we see that five different algorithm for five various purposes are used herewith to enhance the image as a whole and remove the haze present in the image. The drawbacks from previous methods are taken into consideration and worked upon, so as to fill in the missing gaps and make the image enhancement process better and more efficient.

2.2. Contrast Restoration of Weather Degraded Images (Srinivasa G. Narasimhan and Shree K. Nayar, 2003) *[2]*

In this paper, images that are captured outdoor during bad weather conditions are taken into consideration since they suffer from poor contrast. However, these weather conditions degrade or alter the colour and contrast of the image drastically. As the distance from a scene point increases so does the effects caused by the bad weather. With the increasing interest in the vision communities and image processing under issues based on these kind of weather conditions the method proposed her becomes very essential to help in the removal of dense haze, fog and other kinds of aerosols. The wavelength of the incident light strongly determines the scattering of the aerosols. Therefore, photographers use polarization filters in order to help in the reduction of haze in landscape images. However, the entire eradication of haze is not possible using polarization. Therefore, in this paper two or more images are taken in a similar bad weather condition and to restore the contrast from that particular scene, a physics-based method is applied. The monochrome weather model is used to showcase the degradation of a scene as the distance increases. This methodology is also modelled to enhance the contrast of moving objects in videos.

2.3. Haze Removal and Fuzzy Based Enhancement of Image (Vishalkirthi S. Patil and R. H. Havaldar, 2016) *[3]*

In this paper, two methods are applied to remove the haze from images, the dark channel prior method and the fuzzy enhancement based method. It is observed that dispersion and amalgamation by water droplets and atmospheric particles, degrades images that are captured outdoor. When these kinds of images must be used for object recognition, outdoor photography, video surveillance, is impacted in a negative manner and a clear image is not obtained. Therefore, the method of dehazing is performed to remove the haze and make a visually pleasant image so that the performance of the visual applications is improved and is made much easier. To produce an image that appears more natural and without any haze, the dark channel prior method is used that is dependent on the actual outdoor image containing haze. In order to overcome the drawback of the low contrast image obtained in this method due to the background region, we use the fuzzy enhancement method. Wherein, histogram equalisation is performed based on fuzzy logic. Finally, colour correction is performed to get back the rich colours that may have been lost in the process.

2.4. Contrast Enhancement and Brightness Preservation using Global-Local Image Enhancement Techniques (Archana Singh, Sanjana Yadav and Neeraj Singh, 2016) *[4]*

In this paper, the proposed method is one which uses 3x3 sub images and performs contrast enhancement by taking the entire image and applying global mean and local mean on the sub images. The centre pixel value is taken and the mean value of the pixels that surround it are smoothened by using the local mean filter. The digital pixel value of the images is modified by increasing its dynamic range. The neighbourhood of the pixels determines its value every time and the mean replaces it. The method works well because the global mean as well as the local mean are combined to eliminate the artifacts that are dominant in the image.

2.5. Review on Histogram Equalization based Image Enhancement Techniques (Nithyananda C R, Ramachandra A C and Preethi, 2016) *[5]*

In this paper, a review of six different Histogram Equalization (HE) techniques is carried out. First the Classical Histogram Equalization Method (CHE) which is the core method as opposed to the other methods. Second, Brightness Bi-Histogram Equalization Method (BBHE) wherein the original image is divided into two sub images and Histogram Equalization is applied. Third, Dualistic Sub-Image Histogram Equalization Method (DSIHE) which is a method that decomposes the image and applies HE. Fourth, Minimum Mean Brightness Error Bi-Histogram Equalization Method (MMBEBHE) where a threshold is set first and based on which the image is partitioned to reduce the variation between the input and the output mean. Fifth, Recursive Mean-Separate Histogram Equalization Method (RMSHE) a threshold of histograms is taken into consideration and until this threshold is met the algorithm is recursively performed. Finally, Multi-Histogram Equalization (MHE) here each of the histograms class is represented by a sub image.

3. GENERATION OF THE DATA

The proposed method takes a hazy image as the input, applies white balancing algorithm so as to produce a colour balanced image, extract the dominant features in the image by applying the visibility enhancement algorithm, enhances the contrast in the image by using the histogram equalization technique and finally gives the dehazed image as the output.

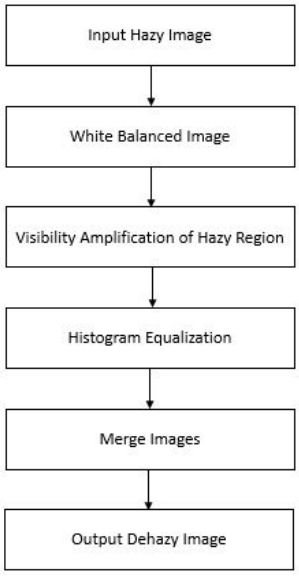

Figure 1 A Flowchart of the Proposed Model

3.1. White Balanced Image

White balance is also called neutral balance, grey balance or colour balance. It is used to globally adjust the intensities of the primarily visible colours which are RGB. Such intensity transformation is used to render specific neutral colours that are present in the image. Atmospheric colours generally create chromatic casts, which we focus on discarding by naturally rendering the hazy images. White balancing the image has its main focus, which is producing the illuminant colour and working towards enhancing it. Once the illuminant colour is detected it must be colour balanced so as to get the colours in the image to be stable.

3.2. Visibility Amplification of the Hazy Region

In a hazy image, the more distinctive seen characteristic is the haze. Whilst taking the average of the image, it is natural to find the hazy part to have more effect on the image because of its dominance over the image. As the distance from the foreground in the image increases, so will the airlight. Which will however be amplified in the far sides of the scenes in the image. To enhance the regions that have low contrast the value of the average luminance is subtracted from the original image. This will gradually help in the amplification of the region that is covered with haze.

3.3. Histogram Equalization

To intensify the global contrast of the image we use the process of Histogram Equalization on the image. The contrast of the image may be low, high, poor, etc. In such cases equalizing these values is of much important so as to make the image appear balanced and visually acceptable. Histogram Equalization does this by spreading evenly and effectively the intensity values of the image, resulting a balanced contrast image.

3.4. Merge Images

In this step, the images are combined by taking the composite of these image data and creating an enhanced image out of these individual sub images. This enhanced image, will now have certain parts of each of the sub images, including the dark, light and medium values. Therefore, intensifying the hazy image and giving it more contrast and visual capability than the original image.

4. IMPLEMENTATION

The implementation of the proposed method is done using MATLAB R2015a on an Intel Core i5 system having processing speed of 2.20GHz and RAM size of 8.00 GB. To implement this method and showcase the results obtained, we have used four images. Figure 2. (a), (b), (c), (d) and (e) of each individual image show the image at the time of input and the images obtained after the algorithms mentioned in the flowchart are applied, as well as the output obtained after applying the proposed method. [6]

Figure 2.1 (a)

Figure 2.1 (b)

Figure 2.1 (c)

Figure 2.1 (d)

Figure 2.1 (e)

Figure 2.2 (a)

Figure 2.2 (b)

Figure 2.2 (c)

Figure 2.2 (d)

Figure 2.2 (e)

Figure 2.2 (a)

Figure 2.2 (b)

Figure 2.2 (c)

Figure 2.2 (d)

Figure 2.2 (e)

Fig. 2 Column (a) - Input Image, Column (b) - White Balance Image, Column (c) - Visibility Amplification Image, Column (d) - Histogram Equalized Image and Column (e) - Output Dehazed Image

By performing the proposed methodology, we notice a huge difference between the original input images and the images obtained as output. The haze that obstructs the eye from seeing a clear picture, mostly in the far distance is reduced and the distant scene is cleared for a better visualisation. The contrast in adjusted so as to give more depth to the colours that appear washed out. Therefore, reducing the haze and highlighting the scene that is of more importance for remote surveillance, outdoor photography, etc.

5. RESULTS

The proposed method is applied over various hazy images and has proven to give better results. This method can be used for all types of hazy images, even those that fail to showcase good contrast.

Quality assessment is carried out in order to compute the different between the images, before and after restoration. Two ways are followed to measure the difference. Firstly, we display the histograms of both the images, before and after.

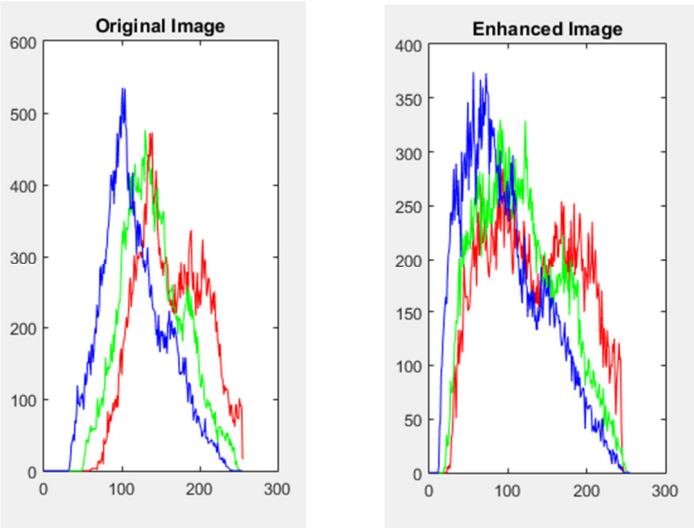

Figure 3 Left Column - Histogram of Hazy Input Image and Right Column - Histogram of Enhanced Output Image

In the above figure, we notice that the histogram of the final output image is more equalised, has a better contrast and visually appealing to the human eye.

6. DISCUSSION AND CONCLUSION

This paper proposed a three-step method towards removal of haze from a hazy image. A white balanced image is obtained first, after which the visibility amplification of the prominent features in the image is done and finally histogram equalization is performed. The output image obtained after the application of these algorithms contains a reduced layer of haze and the image is more visually acceptable. From the analysis of the final output images, it can be concluded that the application of these three algorithms helps is removing the haze from the hazy images. In the future, video dehazing with the proposed method is intended.

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