A Novel Approach for Enhancing Foggy Images

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Abstract - A Contrast image enhancement is proposed for the images degraded by fog. This paper introduces a novel method to enhance foggy images. The proposed algorithm changes the intensity component among the converted HIS components from the RGB components of the original foggy image. Again by converting back to RGB components, the foggy image tends to appear more clearly than the original image in terms of Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). Finally the enhanced foggy image is obtained and the results are presented. The output image has high efficiency and reduces computational complications for many applications.

Keywords - Contrast image enhancement, HIS components, Intensity, MSE, PSNR, RGB components.

I. INTRODUCTION

Image processing refers to the field of science that deals with processing of an image by means of a digital computer. Image enhancement is the field of image processing that deals with enhancing the noise and blur affected images. Image enhancement techniques help in improving the visibility of any portion or feature of the image suppressing the information in other portions or features. Image enhancement alters the visual impact that the image has on the interpreter in a fashion that improves the information content. Image enhancement techniques can be used in wide variety of applications such as video surveillance, under water image enhancement and in many more areas in which we need a better image both in terms of quality and quantity. Many such performance metrics are available to estimate the quality of the enhanced image and here we have taken two such metrics termed PSNR (Peak signal to Noise Ratio) and MSE (Mean Square Error).

Fig 1 Basic steps in image enhancement

Fig 1 shows the basic steps in image enhancement process which includes normalization, image estimation (both orientation and frequency), region mask generation and filtering.

Images taken in foggy weather conditions are not clear and cannot be used for wide variety of applications. Foggy image tends to reduce the ability of vision and needed to be enhanced for wide variety of applications [1], [2], [3]. Fog occurrence impacts wide variety of applications worldwide. Fog tends to scatter the pixels of the digital image and also it changes the corresponding RGB components of the image. Fog also changes the illumination parameters, intensity parameters, and chrominance and color characteristics of the image that makes the image to appear more clearly. Hence the basic challenge is to nullify the whitening effect produced by fog. This paper deals with one such algorithm to remove fog from the foggy images.
This paper is organized as follows. Chapter two deals with various existing works done on the fog removal from the fog affected images. Chapter three deals with the proposed methodology for fog removal. In chapter four, experimental results are discussed. Conclusions and future works are discussed in chapter five.

II. BACKGROUND WORK

In [5], a defogging algorithm based on wavelet transform and histogram equalization is proposed. Here first the original image is histogram equalized and it is subjected to wavelet transformation. Then the coefficient adjustment is done followed by the inverse wavelet transform. This method reduces the computation time and hence provides a reduced execution time. But the process of histogram equalization fails to enhance the local features of the foggy image.

In [6], the gray scale image or the luminance image is calculated from the original foggy image. The luminance image is enhanced by applying filters. After applying filters, brightness parameters are calculated and the binary image is formed. In the next step, both the binary image and the enhanced image is merged followed by the color restoration.

In [7], the RGB image is converted into HIS space to get the brightness component. Then the image is processed block by block. These blocks are enhanced one by one according to the pixel intensities. In this method, there is no need to control salt and pepper noise.

In [8], dynamic histogram equalization is done. Here the original image is divided into same size sub-images. For each sub-image, histograms are formed which are further sub-divided into sub-histograms. Finally, histogram equalization and bilinear interpolation are implemented to the image.

In [9], a dual domain method which combines both spatial and frequency components is used for obtaining a fog free image. In spatial domain dehazing of fog is done followed by the enhancement in the transform domain. The DCT coefficients are used to perform image enhancement.

III. PROPOSED METHOD

A. Contrast Enhancement algorithm

The proposed method follows a contrast enhancement algorithm which consists of three steps. At first, the RGB components are converted into HIS components.

Then correction is made in the intensity values. Again we get back the RGB components by converting HIS components into RGB components. The foggy image model is given by

\[ I(x) = J(x)t(x) + A(1-t(x)) \]

Where \( I(x) \) is the original foggy image, \( J(x) \) is the fog free image, \( t(x) \) is the transmission ratio, \( A \) is the light in the atmosphere. The term \( J(x)t(x) \) is called direct attenuation. The term \( A(1-t(x)) \) is called air light component. Due to direct attenuation and air light component, there will be a color shift in the original image. The ultimate aim here is to extract the fog free image \( J(x) \) from the foggy image \( I(x) \).

B. Algorithm

Step 1: Let the foggy image be \( I(x,y) \) of size MxN and let the output image be \( O(x,y) \).

Step 2: Convert this image into HIS component. Initialize the SUM and COUNT values.

Step 3: Calculate the Intensity I value with \( P=\text{Max} (I(x,y)) \).

Step 4: Corrections are made in the intensity values and the new intensity value is taken as \( I' \).

Step 5: Convert this new HIS component back into RGB component and increment sum and count values for each iteration.

Step 6: Finally calculate the output as the ratio of sum and count values.

IV. EXPERIMENTAL RESULTS

MATLAB (Matrix Laboratory) is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, we can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable us to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java. Although MATLAB is used in wide variety of applications, it plays a vital role in image processing. The foggy image is given as input to the MATLAB and the input and output images are shown below.
V. CONCLUSION & FUTURE WORKS

The image enhancement has become one of the recent research areas in image processing. This paper has proposed a contrast enhancement technique based on intensity adjustment. By applying the proposed technique to the foggy image, PSNR and MSE has increased to a significant value. The details of the image are clearer than the original foggy image. The visibility of the image has increased. The future scope of this paper includes enhancing this image further by using discrete wavelet transform and it is also one of the emerging trends in the field of image processing.

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