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Contrast and Color Correction Techniques for Deep Submarine Images

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ABSTRACT: Undersea image enhancement is one of most interesting and attracting field for research purpose. Mostly the deep water captured images are suffers from the problems of greenish and bluish tone, blurring information and haziness due to absorption and scattering in water medium. For elimination of such issues a unique approach is introduced by this paper, uses white balanced bi-directional empirical mode decomposition (BEMD) along with gamma correction, sharpening and stationary wavelet based fusion. Here the gamma parameter is taken as 1.2 for enhancement in global contrast of sub-marine images. Our experimental result depicts that our proposed work of model achieve better results and better quality of images as compared to traditional proposed algorithms.

KEYWORDS: Deep water image enhancement, White Balancing, BEMD, Gamma Correction, Image Fusion, Stationary Wavelet Transform, Deep Water Environment

I. INTRODUCTION

The continuous increasing shortage of resources and global economy development in recent years, the underwater imaging has becoming a novel epicenter of the world. Underwater image enhancement is a most interesting and popular area for a researchers and scientists also now a days. The utilization and exploitation of nature resources in underwater environment is very beneficial for the economic constructions and national defense security system [1]. Generally, the researchers use the underwater images and videos to exact the valuable information during study of marine environment. The underwater captured images are mostly more complex as compared to the atmospheric images because of different medium the light is propagated through [2].The underwater captured images mostly have a problem of degradation in the quality, low contrast, detail blurring and haziness. For better understanding of underwater imaging first, we need have clear knowledge about the basic physics behind the light propagating in different medium. The researchers and scientists have concluded that the water is 800 times denser than air, due to this when light enters in water medium from atmospheric medium, it undergoes reflection phenomena at water surface because of this partial amount of light penetrates the water [3].

The sequential arrangement of paper is as follows:

Section2 gives the brief description of related work, section 3 explains the fully description of proposed work. In section 4 fully description of experimental result are given and then conclusion of this paper is given in section 5.

I. RELATED WORK

In this literature survey, various image enhancement techniques have been proposed. In underwater image, haze can be reduced through dark channel. Wavelength compensation is used to minimize the color variations in underwater image [4]. Underwater image has low contrast, haziness and greenish or bluish shades because of absorption and scattering effect when light propagated in underwater [5, 6]. Zuan et al. [7] introduced a method based on automatic white balance and improved background light estimation to overcome the shortcoming of classical dark channel prior algorithms for underwater image restoration. Ancuti et al. [8] proposed underwater image enhancement using fusion and color balance techniques, firstly obtained white balance version of original degraded image and then this white balanced image is manipulated through gamma correction and sharpening then fusion of both the results and finally get enhanced version of underwater image Iqbal et al.[9] introduced a slide stretching method, firstly the contrast of an image is equalized by contrast stretching method after that true color is increased by using intensity and saturation stretching. Hitam et al. [10] introduced a method based on Mixture CLAHE which is applied on HSV and RGB color space and then Euclidean norms is employed and fusion of HSV and RGB color space version. Ahmad et al. [11] introduced a method based on Rayleigh-stretched CLAHE for dual image, which ameliorate the detail information and contrast of an image. Garg et al. [12] proposed a blending method of percentile and CLAHE which ameliorate the clarity, visual and brightness of underwater image. Amjad et al. [13] proposed fusion method based on wavelet decomposition of underwater image. Ritu et al. [14] recommended a fusion technique for haze removal of underwater images to improve the color and contrast of an image.

II. PROPOSED MODEL

Ourmaingoal in this paper is to achieve better quality of underwater image in terms of contrast, color correction, better visibility, corner and edge preservation and low noise levels. The hierarchical model of our proposed method is as shown on figure 1. Our method basically has four main steps: In first step, we eliminate the unrealistic color cast by using a combination of white balancing and bi-directional empirical mode decomposition (BEMD) after the removal of unrealistic tones, we executed the two worth techniques i.e. Gamma correction and Sharpening method on white balanced BEMD output. Here the optimal value of gamma parameter is taken as 1.2. After that both versions of previous outputs are decomposed into four frequency sub-bands or coefficients using stationary wavelet transform. Then in last and final step stationary wavelet coefficients are fused by using a principle of fusion framework to achieve an enhanced final deep water image. These are the brief description of our proposed method and detailed description is given below which is classified into four categories.

3.1 Color Correction

When the light travelling in deep underwater, there is color absorption takes place which leads to color distortion of RGB color channels and the light having shorter wavelength is absorbed first (red light). This situation becomes worsen when light depth increases up-to 20-25m and it is very difficult to remove such a color distortion. To eliminate such problems in underwater environment, we used White Balanced BEMD method.

3.1 Bi-Directional Empirical Mode Decomposition (BEMD):

Empirical mode decomposition is a process of adaptive time frequency data analysis technique [15]. It is used to decompose non stationary non-linear signals into intrinsic mode functions (IMF). EMD is similar to wavelet decomposition but differ by decomposing the signal into different time scales. In EMD signals are decomposed into different IMF and also residue signal is achieve along with the IMFs signals.

The IMFs achieved by decomposing the signal are perpendicular or same to the original signal. Every IMFs follows the following necessary conditions or requirements:
(a) The no. of rate of zero crossings and extremities are should be differ by one or equal in every IMFs.
(b) The envelop average value computed by using local maxima and local minima must be zero at any time for every IMFs.
The IMFs contains highest frequency components and lowest frequency components, the highest frequency components having the edge details and a lowest frequency component contains spatial details with respect to reference underwater image.

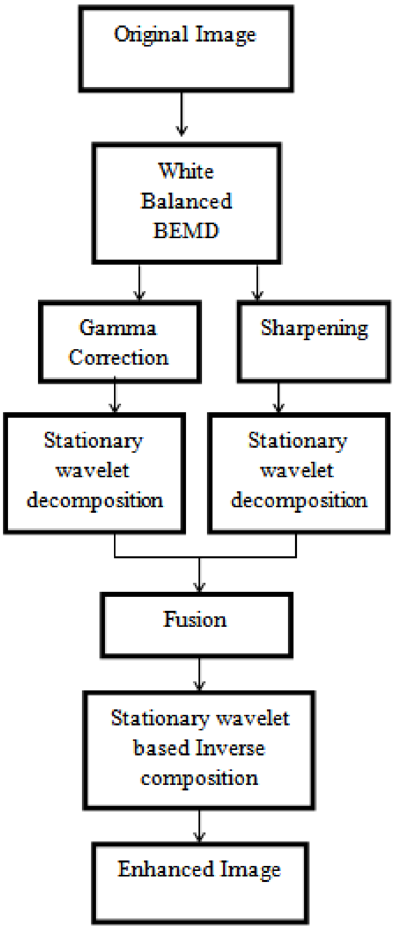

Figure.1 Flowchart of proposed work of model

3.2 Contrast Enhancement
Due to scattering phenomena in deep underwater, the sufficient amount of light is not reach to the objects resultant makes it blur and low contrast image. For reducing such phenomena from underwater images, we used two enhancement techniques such as Gamma Correction and Sharpening.

3.2.1 Gamma Correction: Gamma correction is one of the most commonly used technique for contrast enhancement of digital image processing. GC is belongs to a very popular family that is Histogram Modification method obtained by changing the gamma parameter γ [8]. GC is used for correcting the power law response as shown in equation 1.. The equation for gamma correction is as follows:

$I_{out} = I_{in}^{\gamma}$ (1)

Where, I_{in} denote the input image pixel location intensity and I_{out} denote output image pixel intensity after transformation and γ is a gamma constant, if γ <1 obtained imageislighter one and when **γ**> 1 obtained image is darker one. So the selection of gamma constant is a very crucial task.

3.2.2 Sharpening: Sharpening is an image enhancement technique that needs to highlights the edges and important details of the image [8]. The problems of under/over exposed is eliminated by the sharpening method. Its follows the principle of unsharp masking and it resolves the problems created by scattering phenomena. Sharpening is used to make image more informative and easily understandable.

3.3 Stationary wavelet transform: A shift invariant method of wavelet transform is known as stationary wavelet transforms [16]. According to the rule of stationary wavelet transform a single underwater image is decomposed into four sub-bands. The sizes of sub-bands images are same as the original one. The four sub-bands are as follows: LL (low low frequency), LH (low high frequency), HH (high high frequency) and HL (high low frequency). The LL frequency sub-bands contains the approximation information and HH frequency sub-bands contains the details information of original image.

3.4 Image Fusion: After achieving all SWT versions of images from the previous technique here we need to fuse each SWT coefficients images to their respective weight mapped images. The inter-mixing or interblending of SWT coefficients images with the weight mapped images are known as Image Fusion (IF) [13]. The image fusion grips decisive importance in the procedures of underwater image enhancement.

III. EXPERIMENTAL RESULT

In this section, we will show the effectiveness of our proposed work of model with the already existing algorithms by taking a large number of underwater images which is present in different situations and conditions. Here we are taking two images both of them are present and captured in greenish tones. The quantitative parameters that are used are Power to signal noise ratio (PSNR) and Root mean square error (RMSE). The proposed work of model is compared with the previous method [8]. On the basis of this experimental analysis it is clearly visible that our proposed work of model is better in terms of details and edge enhancement as shown in figure.

Table1. Comparison of PSNR values

Image	Ancuti et al. [8]	Our Work
a	25.2169	34.7005
b	27.4510	32.8123

Table2. Comparison of RMSE values

Image	Ancuti et al. [8]	Our Work
a	13.9860	4.6936
b	10.8140	5.8334

IV. CONCLUSION

Our proposed method explains a novel approach for enhancement of marine captured image by using white balanced BEMD based method. The proposed method mainly eliminates the problems of details and edge burring, low contrast and color uniformity. Through this paper we explained a methodology that is based on white balanced BEMD and stationary wavelet based fusion and we achieve better results in terms of PSNR and RMSE value as shown in table 1 and table 2.

(a) (b) (c)

Figure2. (a) Original distorted image (b) Ancuti et al. [8] image (c) our proposed work image

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