An Analysis of Various Techniques in Underwater Image Enhancement

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ABSTRACT:

In underwater situations, the precision of images is degraded by light absorption and scattering. The refuse of light that movements through the water standard result in the underwater image to undergo from some problems. Low contrast and color presentation, the appearance of haze are the problems that result in the image to loss essential information. In this paper enlarge an analysis of various enhancing methods using the underwater image. For that motive mainly focus on the underwater image enhancement all the way through haze removal algorithm by various enhancement techniques. It has a partiality to darken the image in a few states of interaction but shows a high-quality outcome by reducing haze and noise effects. The enhancement techniques are improved quality of underwater images visually as well as quantifiable by enhancing the contrast of the image and degrade the noise as well as artifacts in the image.

KEY TERMS: Haze removal, Contrast stretching, Homomorphic filtering, Anisotropic filtering, Mix-CLAHE On RGB and HSV, Trilateral Filtering, Gamma Correction etc.

I. INTRODUCTION

Underwater vision is one of the scientific fields of study for researchers. Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV) are naturally engaged to confine the figures such as underwater mines, shipwrecks, coral reefs, pipelines and telecommunication cables from the underwater atmosphere. Underwater images are mostly characterized by their pathetic visibility because the light is exponentially attenuated as it is travel in the water, and the outcome is defectively contrasted and haziness. Forward scattering typically leads to a blur of the image facial appearance.

On the other hand, backscattering generally restricts the contrast of the images. Absorption and scattering effects are not only outstanding to the water itself but also outstanding to the components such as a dissolved natural substance. The underwater image endure from a number of troubles such as limited choice of visibility, blur, low contrast and color, bright artifacts, noise, the exterior of haze and non-uniform lighting. As light movements in the water, an exponential loss of light power occurs depending on the color spectrum wavelength. Visible light is absorbed in the highest wavelength first. Red, the mainly exaggerated color, is reduced to one-third of its capacity after 1 m and basically lost later than a distance of 4 m to 5 m underwater. Underwater images normally show green-blue on the basis that these colors are the last to be absorbed. According to that, light decrease restrictions of the visibility distance at about 20 m clear water and 5 m or below polluted water. In adding up, the color losing problem causes the captured images to have low contrast, color performance and occurring of haze result in the images to lose important information. The objective is to achieve to remove haze and noise from underwater images. The absorption of light by water was shown below in Fig.1.

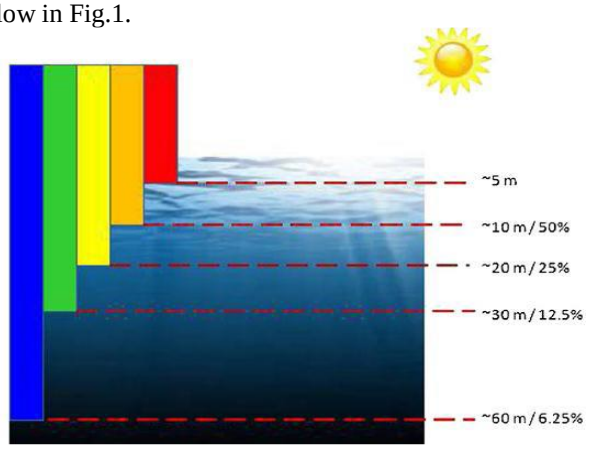

Fig. 1 Absorption of light by water

II. IMAGE ENHANCEMENT

Image enhancement is a process of improving the interpretability or perception of information in images for human spectators or to give `better' input for other computerized image processing techniques. Image enhancement techniques can be divided into two extensive categories:

- ***Spatial domain methods***, which work straightforwardly on pixels.
- ***Frequency domain methods***, which work on the Fourier transform of an image.

III.DIFFERENT TECHNIQUES FOR UNDERWATER IMAGE ENHANCEMENT

1. Contrast stretching

Contrast stretching is a basic image enhancement method that is used to improve, enhance the image contrast by `stretching' the series of intensity values. A measure of image's dynamic range or the "broaden" of image's histogram is the contrast of an image. The entire range of intensity values in attendance within the image, or in an easier way, the minimum pixel value subtracted from the maximum pixel value is called dynamic range of the image. It differs from the more difficult histogram equalization in a way that it can only apprehension a linear scaling function to the image pixel values.

2. Empirical Mode Decomposition

EMD is a flexible and based on the local moment period function. So, it is suitable to help nonlinear beside with non-stationary data so that it is an extremely adept chance for real-life software. The EMD method is extremely direct, and the fundamental procedure is to carry out sifter operations on the new data arrangements until the final data series are fixed and subsequently collapse the whole signal into many Intrinsic Mode Functions (IMFs) and a residue. EMD is connected to the Red, Green, Blue channels independently. The original image is wrecked up into a number of fundamental mode functions by EMD process.

3. Homomorphic filtering

The homomorphic filtering is utilized to fix non-uniform lighting to highlight contrast from the impression. This is a frequency filtering technique. It is mainly utilized system on the foundation that it redresses non-uniform lighting and sharpens in the depiction. Where F(x, y) is the function of the image detected by the device, I(x, y) the illumination function and r(x, y) the reflectance function. By multiplying these components filter can reduce the non-uniform illumination present in the image.

4. Anisotropic filtering

Anisotropic filtering disentangles picture components to enhance picture allotment. This channel smoothes the picture inhomogeneous range still preserve edges and upgrades them. It is utilized to smooth compositions and diminishes remainder by erasing little edges enhanced by homomorphic filtering.

5. Wavelet denoising by the average filter

Wavelet denoising is used to suppress the noise (i.e. the Gaussian noise are normally present in the camera pictures and another kind of instrument pictures). While moving the pictures, Gaussian noise can be included. This gives huge outcome contrasted with other denoising routines because, distinct other methods, it does not imagine that the coefficients are independent. Wavelet coefficients in normal pictures have huge conditions. Besides the calculation time is short.

6. Red channel method

In this method, colors associated with short wavelengths are improved, leading to a recovery of the lost contrast. The first thing to estimate is the color of the water. Pick a pixel that deception at the maximum depth with admiration to the camera. It is assumed that degradation of the image depends upon the location of the pixel. After estimating the water light transmission of the scene is predictable.

7. Histogram equalization

Histogram equalization is helpful in pictures with background and foreground areas that are both bright or dim. This is a simple and basic technique. But it has a drawback also that amplifies the background noise appears in the image and lead to decrease in the valuable signal. So it produces impractical effects in the output images. The basic idea false behind this method is mapping the gray levels depending ahead the probability sharing of the input gray levels.

8.Contrast Limited Adaptive Histogram Equalization (CLAHE)

It is a generalization of adaptive histogram equalization. With this technique, the image is out of order up into tiles. The gray scale is calculated for each of these tiles, based upon its histogram and transform function, which is consequent from the interpolation among the manipulated histograms of the nearest sub-regions. The transformation function is relative to the cumulative distribution function (CDF) of pixel values in the area.

A. CLAHE on RGB color model

RGB color is an additive color model which depicts hues concerning the assessment of red (R), green (G) and blue (B) present. CLAHE can be applicable to all the three parts separately. The effect of full-color RGB can be acquired by combining the individual components of the model.

B. CLAHE on HSV color model

HSV color model defines colors in terms of the Hue (H), Saturation (S), and Value (V). HSV color model is a cylindrical-coordinate illustration of points in an RGB color model. Hue is the characteristic of a visual sensation.The hue and saturation level don't have any kind of effect when a value is at max or min intensity level. CLAHE is applied to V and S components.

9.MIX – CLAHE

The visibility of the underground image is improved by this method. It produces the maximum PSNR and the minimum MSE value. The aim is to enhance the image contrast and at the same time keep the natural appearance of an underwater image. CLACHE techniques result applied on HSV and RGB color model.The CLAHE-HSV result shows that the overall color is extra balanced in assessment to CLAHE-RGB. But, the overall image looks nonstandard and is much brighter. Also, there is an enhancement of noise in

smooth regions is identified which is unavoidable. This method of mixing both images is known as CLACHE-MIX. The method expected to enhance the contrast of the image while preserving the natural appearance of the underwater image. Table (1) shows Comparison between CLAHE and Mix-CLAHE.

Table 1: Comparison between CLAHE and Mix-CLAHE

S.No	CLAHE	Mix-CLAHE
1.	CLAHE stands for Contrast limited adaptive histogram equalization	Mix-CLAHE stands for Mixture contrast limited adaptive histogram equalization
2.	CLAHE operates separately on RGB and HSV color models	Mix-CLAHE mixes the results of CLAHE- RGB and CLAHE-HSV color models.
3.	The overall image is much brighter and looks abnormal to the underwater image. Moreover, the necessary enhancement of noise in smooth regions is identified. This is the outcome of CLAHE technique working on RGB and HSV color models.	The result of mix-CLAHE is an enhancement of image contrast and at the same time preserves the natural look of the underwater image. There is no enhancement of noise in smooth regions is identified.
4.	CLAHE has low Peak signal to noise ratio.	Mix-CLAHE has high Peak signal to noise ratio
5.	CLAHE has a high Mean square error.	Mix-CLAHE has a low Mean square error.

10.Gamma Correction

Enhanced color images are acceptable to human vision by using the HSV color model, which can decouple the achromatic and chromatic information of the original image to maintain color allocation. In the HSV color model representing the luminance intensity. The color image can be enhanced by preserving H and S while enhancing only V.

11.Integrated Color Model

The integrated color model is chiefly established on color balancing by contrast improvement is RGB color space and color adjustment in HSI model. In integrated color model first step is to diminish the color emit by the equalization of all the color values in attendance .In the second step, the upgrading is applied to the contrast adjustment to widen the histogram values of the red color. The second step is again done in green and blue colors. In the last step, the saturation and intensity apparatus of the HSI color model is relevant for contrast adjustment to enhance the proper color.

12.Trilateral Filtering

This filter smooth image, by using a non-linear grouping of neighbor pixel values with no effect on edges. In this method, average weighted value replaces each pixel value of its neighborhood pixels. The allotted weighted value of each neighbor pixel will reduce as the distance in the image plane and distance on the intensity axis increases. The filter is faster in assessment with other methods. For pre-processing, it uses the histogram stretching and equalization of the histogram for post-processing. Histogram stretching and equalization are required to successfully increase the contrast of an image.

IV CONCLUSIONS

In this paper, various underwater image enhancement techniques are analyzed and studied. All the analyzed methods are enhancing the underwater images to great scope. Underwater image, enhancement based algorithms become more useful for many vision applications. The enhancement methods efficiently improve the visibility of underwater images.

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