Underwater Image Restoration and Enhancement Using Hybrid Algorithms (clahe & Dsihe)

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ABSTRACT- In this paper a hybrid algorithm-driven paradigm for underwater image quality enhancement is proposed. In order to prevent underwater image degradation, we need to address the problems of blurring and uneven colour biassing. Specifically, the red channel correction and input from horizontal cells that are cone-sensitive to colour are used to rectify the nonuniform colour bias. A new background light estimation and an automatic white balancing method is proposed to solve the shortcomings of the conventional dark channel prior approach for underwater image restoration. The revised background light estimate method can increase the accuracy of the background light and decrease the impact of light and white objects in the water. With the colour correction of the restored image in conjunction with CLAHE and DSIHE, the improved automated white balance algorithm can lessen colour distortion and produce a clear image.

Index Terms-Contrast stretching, CLAHE, DSIHE

I.INTRODUCTION

Light is attenuated when it travels through the water, which results in noise, colour distortion, and low contrast in underwater images. The difficulty of numerous tasks, including automatic fish and plankton identification and recognition, is increased by these issues. Thus, a different type of techniques has been suggested to restore or improve the underwater image degradation. Wavelet-based and filter-based techniques could be used to generally categorise the noise reduction techniques for underwater images. With the purpose of eliminating noise and enhancing the overall contrast, certain algorithms consider forward and backward scattering components. Color correction is a process used to lessen the prominent colour cast that frequently appears in underwater images. Several approaches aim for an aesthetic outcome but lack the capacity to achieve colour constancy (CC), which is necessary for effective color-vision based applications. CLAHE &DSIHE algorithms are used to overcome these issues.

II.METHODOLOGY

An underwater image is first subjected to RGB to HSV conversion and then applied to pre-processing techniques like white balance and enhancement contrast to adjust the contrast then this HSV image is converted to RGB image then applied to the enhancement methods. The process is described below.

(1)RGB to HSV conversion

The two separate colour models RGB (Red, Green, Blue) and HSV (Hue, Saturation, Value) are frequently used in digital image processing. Unlike the HSV model, which combines hue, saturation, and value channels, the RGB model shows colour as a combination of red, green, and blue channels. Normalising the RGB data, determining the maximum and lowest values, calculating the hue, saturation, and value values, and finally encoding the resulting colour in the HSV colour space are all steps in the RGB to HSV conversion.

(2)White Balance

White balance is an important step in the digital image processing process that makes an image's colours appear more natural by removing any colour cast brought on by the illumination source. The image may have a colour tint if the source of illumination is not completely white. A more realistic portrayal of the colours in the image is achieved by removing this colour cast with white balance.

(3)Enhance Contrast

The method of contrast enhancement in digital image processing increases the contrast between the brightest and darkest portions of an image to boost visibility and overall quality. When a picture has a low contrast, it is particularly difficult to detect individual details, contrast enhancement is useful.

(4)HSV to RGB conversion

In digital image processing, HSV (Hue, Saturation, Value) and RGB (Red, Green, Blue) are two popular colour spaces. While RGB is a Cartesian colour space that represents colours based on the amounts of red, green, and blue light, HSV is a cylindrical colour space that represents colours based on their hue, saturation, and value/brightness. When converting from HSV to RGB, the hue value is first converted to its equal RGB value, and the RGB values are then computed using the saturation and value/brightness. After that, the generated RGB values are examined to make sure they fall inside the acceptable range of 0 to 255.

(5)Histogram Equalization

Colour image enhancement techniques can be developed to improve distinction with the ultimate goal of improving the visual quality. The familiar enhancement technique is “intensity histogram equalisation (HE)’ method, which extends the complicated histogram to the constant histogram. Likelihood of intensity level I_k occurring in 8bit grey level image of size MN is roughly represented by

$$p_i(I_k) = \frac{n_k}{MN} \quad k = 0,1,2,3.....255$$

Here, n_k represents quantity of pixels with intensity I_k Then, intensity transformation is calculated using

$$c_k = T(I_k) = 255\sum_{j=0}^{k} p_I(I_j)$$

$$= \frac{255}{MN}\sum_{j=0}^{k} n_j \quad k=0,1,2,3,4...255$$

Each pixel in the input image with intensity I_K is therefore translated into a pixel in the output HE images with level C_k to produce a HE image. This kind of normalisation is a crucial step in the processing of digital images. Because it allows the algorithm to adjust the range of pixel intensity values in the image. The intensity distribution is therefore outperformed. The image's overall contrast has been raised to a greater level.

(6)Contrast Stretching

Contrast stretching is also admitted as normalisation, (image enhancement method) which aims to enhance contrast in an image by "extending" the scale of intensity values. it contains a required scale of values, i.e., the entire scale of pixel values that targets the image type. Underwater images have relatively little variation, Dynamic range of histogram is very small. The pixel values are then dispersed

$$I_N(x, y) = (I(x, y) - I_{Min}) \times \left(\frac{Id_{Max} - Id_{Min}}{I_{Max} - I_{Min}}\right) Id_{Min},$$

between 0 and 255 using complexity extending.

Where,

I_N (x, y) = after contrast stretching, normalised pixels intensity value;

I (x, y) = before contrast stretching, pixel intensity value;

I = bottom level intensity of the parent image;

I_{Max} = extreme level intensity of the parent image;

Id_{Min} = the minimal level pixel intensity in the appropriate scale,

Id_{Max} = the maximum level pixel intensity in the appropriate scale.

III. BLOCKDIAGRAM

Here is the block diagram for underwater image restoration and enhancement using CLAHE &DSIHE Algorithms.

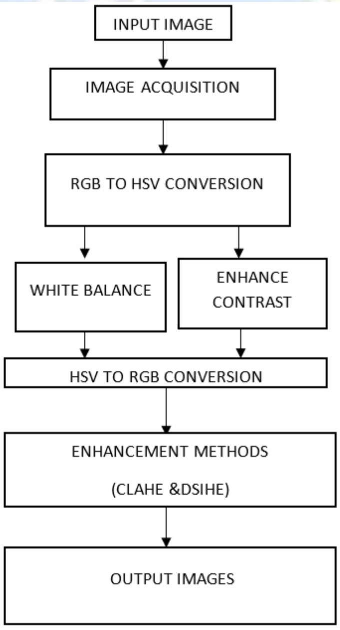

Figure 1: Block Diagram

(1)Contrast Limited Adaptive Histogram Equalization (CLAHE)

A version of adaptive histogram equalisation (AHE) called CLAHE addresses the issue of contrast over-amplification. Creating tiles, adjusting the histogram, and using bilinear interpolation make up the three main.

components of the CLAHE method. Rather than using the complete image, CLAHE acts on individual sections called tiles. After that, the unwanted borders are removed by combining the near bytiles using bilinear interpolation. Images contrast can be increased by using this approach.

(2)Brightness Preserving Bi-histogram Equalization (BBHE)

According to the average of the input image, BBHE initially divides an image into two sub images. After that, the BBHE automatically equalises the sub images based on each one of their independent histograms with the requirement that the samples from the prior set aligned to the range between the input average and the grey scale level, and the trials from the last set be aligned to the scale between the input average and outmost grey extent.

(3)Dualistic Sub-Image Histogram Equalization (DSIHE)

Comparatively to BBHE, dualistic sub-image HE (DSIHE) divides the initial image into two smaller versions before independently adjusting the histograms of the smaller copies of the intial image. As opposed to reducing the image's quality depending on its mean grey level, DSIHE approach collapse the images by amplifying the output image's Shannon's entropy. Input image is degraded into 2 sub images: 1) bright 2) dark. It is described that, brightness of the output image created by the DSIHE approach is equal to the product of the image's centre grey level, or L/2, and its equivalent territory level, L.

III. Performance Evaluation of Enhancement Methods

Below mentioned are the performance evaluation of enhancement methods of the output image.

(1)Peak Signal-to-Noise Ratio (PSNR)

Image quality is quantified mathematically using the signal-to-noise ratio (SNR). According to the distinction in pixels between images, SNR measurement provides an assessment of the revised image's quality in relation to original image. Using the following equation,

$$PSNR = 10\log_{10}\left[\frac{R^2}{MSE}\right]$$

PSNR is defined

Here, the Signal strength is taken in to attention. The values were passed to evaluate the image's quality. While R stands for highest variation or value in the image, its value for an 8-bit unsigned number is 255.

(2)Root Mean Square Error (RMSE)

RMSE equation:

$$\sqrt{\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(R(i,j)-D(i,j))^2}{N\times M}}$$

An image's gradient provides a measurement of its rate of change. The gradient's size indicates how rapidly the image is changing.

(3)Entropy

Entropy is a metric for how many bits are needed to encode a single pixel of a picture. The more entropy there is, the more accurate the image will be.

Entropy is expressed as:

$$\boldsymbol{H} = \sum -(\boldsymbol{p} * \log 2(\boldsymbol{p}))$$

where p represents the imhist-returned normalised histogram counts.

(4)Patch-based contrast quality index (PCQI)

The structural similarity index between two portions of an image object is determined using the Patch-based Contrast Quality Index (PCQI), which considers luminance, contrast, and data structure.

(5)Underwater colour image quality evaluation metric (UCIQE)

UCIQE divides the image into several blocks based on the supposition that local blocks have equal transmittance and uses a quad-tree search technique to estimate background light intensity. The transmittance is attained at the greatest value of the function, which for each block is made up of the UCIQE and the information loss function. Using the guided filter allows for the global optimisation of the transmittance image as a whole. this approach can successfully address the colour asymmetry and blur issues that come from underwater imaging degradation

IV. RESULTS

Out of the entire collection of images, results for a few images are reported in the publication. Average results are produced through histogram equalisation. The BBHE approach produces ambiguous results with a blurred view. Contrast stretching produces a confused image. The proposed methods CLAHE and DSIHE yield superior outcomes. According to performance measurements, the Suggested techniques produce extremely bad results for PSNR, followed by DSIHE, BBHE, Contrast Stretching, and good results for PSNR for the Proposed methods. Poor results are obtained for these two metrics for Contrast Stretching and BBHE. For RMSE, the proposed methods produce the good results, followed by DSIHE, Contrast Stretching, CLAHE, and other methods. Overall findings indicate that the suggested procedures produce pretty excellent outcomes for underwater images.

The original underwater image which is taken as a input image is shown in the figure 1.1

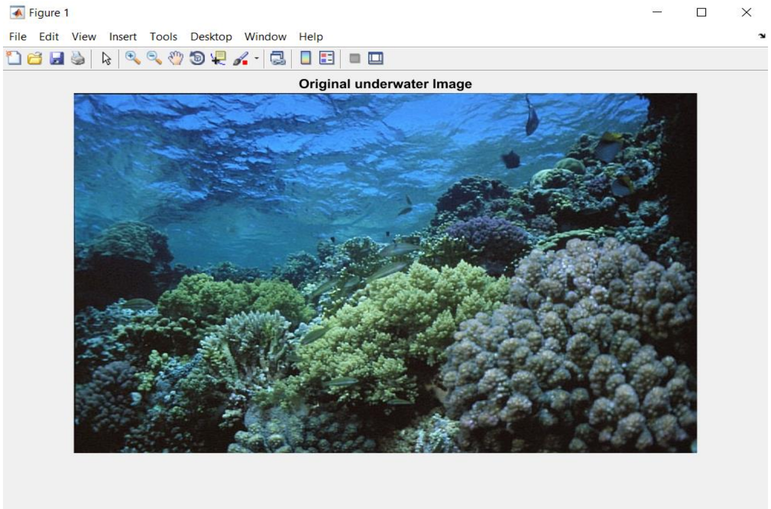

Figure 1.1 Original Image

The enhanced image after applying the methods called Supressed redchannel,Enhanced blue channel,Greenchannel after that whitebalance is shown in figure 1.2.

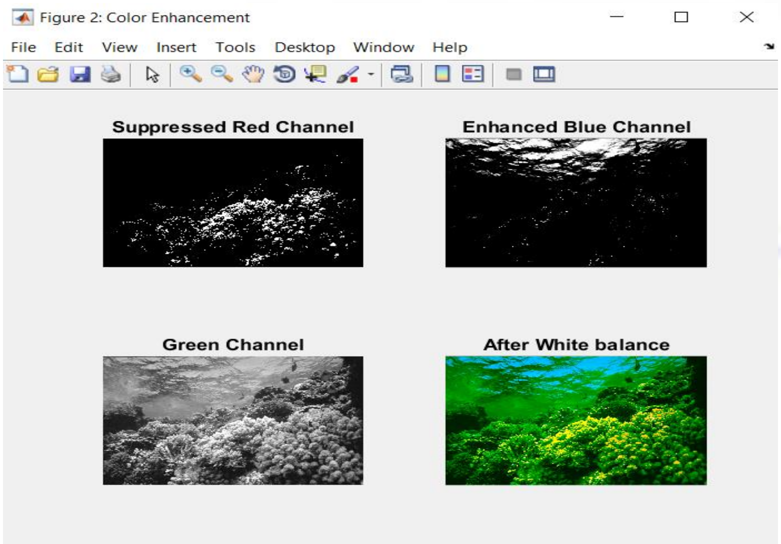

Figure 1.2 Enhanced Image

Whitebalance image after enhancement is shown in figure 1.3.

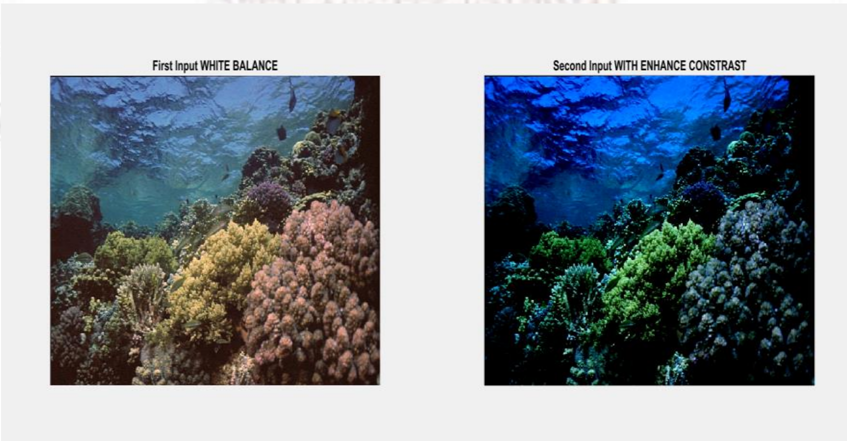

Figure 1.3 WhitebalanceImage

Gamma Corrected image affter applying the whitebalance is shown in figure 1.4.

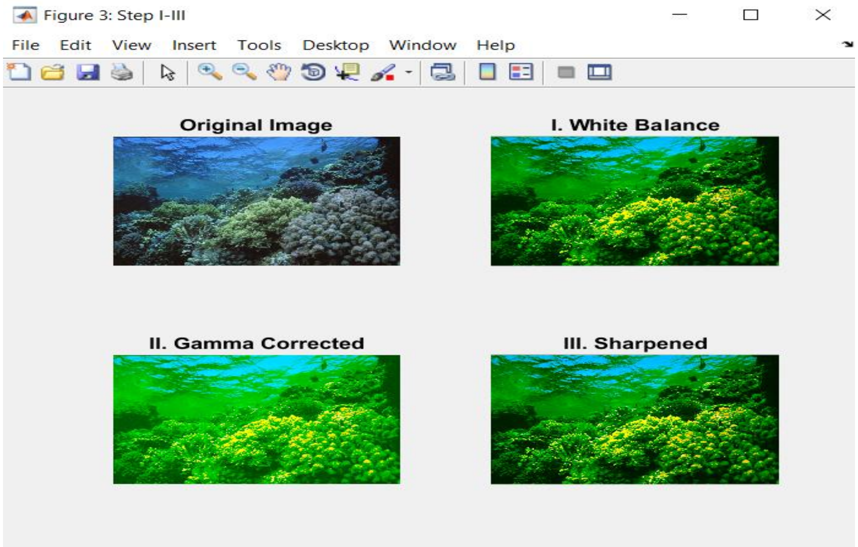

Figure 1.4 Gamma Corrected image

CLAHE output image shown in figure 1.5.

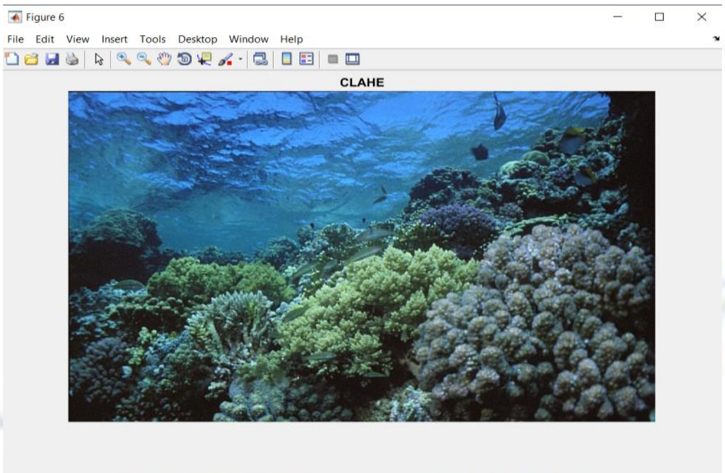

Fig 1.5 CLAHE Output Image

Final output image after applying both the CLAHE & DSIHE algorithms is shown in figure 1.6.

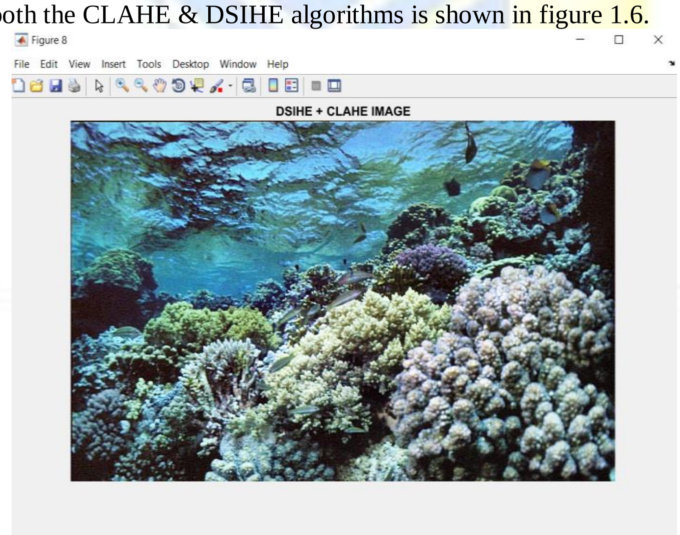

Figure 1.6 CLAHE + DSIHE Output Image

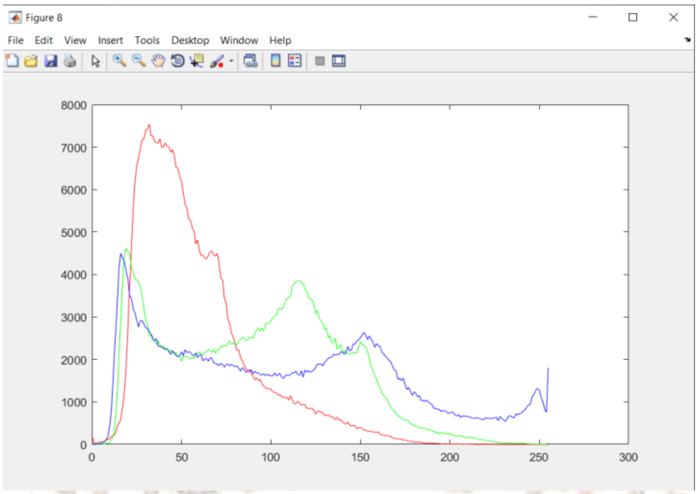

Figure1.7 Histogram of Original Image

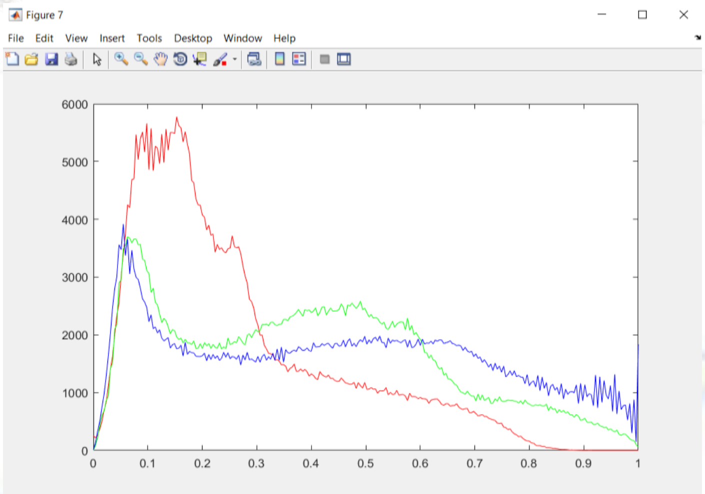

Figure 1.8 Histogram of Output Image

Performance evaluation methods values:
gray_value = 0.3359
Elapsed time is 7.813621 seconds.
PSNR(:,:,1) = 20.9152
PSNR(:,:,2) = 21.7983
PSNR(:,:,3) = 21.1332
image_contrast = 255

V CONCLUSION

Using relevant performance measurements, the strategies described in this are contrasted with other actual enhancement methods. Here, a suggested system for underwater image restoration is based on automatic white balance and enhanced background light estimation. By reducing the impact of light, white objects in the water, improved background light estimate method can increase the background light's accuracy. These techniques improve on the CLAHE and DSIHE-based existing techniques on which they are based. The issue of developing novel improvement techniques that could successfully increase the visibility and enhance the underwater images. The study's suggested procedures should be improved any further to get better outcomes.

VI REFERENCES

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