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Under Water Image Enhancement Using CLAHE and DSIHE Algorithms

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Abstract: Underwater imaging is being used in underwater vehicles, underwater infrastructure assessment, and deep ocean exploration. As a result, high-quality underwater photographs are in high demand for a variety of practical applications. Underwater photos are frequently marred by colour shifts, low contrast, and fuzzy details. The deterioration of underwaterphotographs is caused by two basic reasons. On the one hand, light reflected from the underwater scene is scattered and absorbed by plankton or suspended particles in the underwater medium before reaching the camera, resulting in low contrast and fuzzy images. The specified attenuation of light with different wavelengths, on the other hand, results in colour discrepancies of underwater photographs. As a result, our most demanding objective is to increase the visual quality of underwater photos. Underwater imaging is utilised in underwater vehicles, underwater infrastructure evaluation, and deep sea exploration. As a result, high-quality underwater photography is in high demand for a wide range of practical purposes. Colour changes, low contrast, and fuzzy details are common flaws in underwater photography. Underwater photos deteriorate due to two primary factors. Light reflected from the underwater scene, on the other hand, is dispersed and absorbed by plankton or suspended particles in the underwater medium before reaching the camera, resulting in low contrast and blurry images. However, the required attenuation of light with different wavelengths results in colour differences in underwater images. As a result, our most difficult goal is to improve the visual quality of underwater photographsTo address the shortage of classical dark channel prior algorithms for underwater picture restoration, a new technique for underwater image restoration based on enhanced background light estimate and automatic white balancing is suggested. The enhanced background light estimate approach can lessen the influence of light and white objects in the water while improving background light accuracy. The improved automated white balance algorithm, in conjunction with CLAHE and DSIHE, can eliminate colour distortion and produce a clear image by colour correcting the restored image. We can see from the contrast studies of four different underwater photographs that the algorithm has certainadvantages on subjective and objective evaluation indexes of theenhanced image are better

Keywords: Underwater Image Processing, Color Channel Correction, Contrast Stretching, White Balance, CLAHE, DSIHE.

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I. Introduction:

A significant deal of information in the ocean world must be thoroughly comprehended in order to make better use of marine resources and expand the marine economy. Underwater imaging is a significant method for humans to learn vital information. More usable information can be gleaned through clear processing of underwater photos, allowing for better exploration and development of marine resources. Image restoration is a common way of sharpening underwater images. To complete the image restoration, a known or developed underwater imaging model is applied based on past understanding of light in the process of water degradation. The propagation function of light in water was established experimentally here. The tool's use is cumbersome and has little real application benefit. This method has a large amount of data and high precision, but it is less operational due to the inability to create perfect laboratory settings in the harsh underwater environment. Furthermore, the mathematical modelling approach can be utilised to describe the deterioration process, which helps compensate for the experimental method's lack of generality. Because light is reduced as it travels through water, underwater photographs frequently suffer from noise, colour distortion, and low contrast. These issues make many jobs more complex, such as automatic fish and plankton identification and recognition.. As a result, numerous approaches for recovering or improving degraded underwater photographs have been developed. Noise reduction approaches for underwater photos can be divided into two categories: wavelet-based and filter-based. Some algorithms take forward and backward scattering components into account for eliminating noise and enhancing global contrast. Colour correction is used to minimise the intense colour cast that is common in underwater pictures. Many solutions strive for a visually appealing outcome but lack the capacity to achieve colour constancy (CC),which is necessary for effective color vision based applications.

Furthermore, due to the physical qualities of the aquatic medium, light scattering, and reflection, the quality of underwater photographs degrades and becomes less visible as water depth increases. The haziness is generated by suspended particles in lakes, oceans, and rivers such as sand, minerals, and plankton. As the light reflected by the objects moves towards the camera, a portion of it collides with these suspended particles, which absorb and disperse the light. Capturing clear photographs underwater is difficult due to turbidity generated by colour dispersion, as well as colour emitted by the attenuation of varying light at different wavelengths. Blurred subjects and low-intensity contrast are caused by colour dispersion and emission in underwater photographs. To overcome these concerns, we apply cutting-edge technology that decreases blurriness, low contrast, and colour distortion. We are overseeing crucial criteria such as mean, mean square error, peak signal to noise ratio, and entropy of underwater photographs in this project, and we can say that we are receiving superior output images.

II. LITERATURE REVIEW

[1] Chiruvella Suresh and K. Amith Bansal, "Underwater Image Processing State of the Art of Smoothing and Image Enhancement Methods," a study of some of the most recent approaches developed exclusively for the underwater environment. These techniques have the potential to broaden the spectrum of underwater imaging while also enhancing image contrast and resolution. After reviewing the fundamental physics of light propagation in water, we focus on the many algorithms available in the literature. The conditions under which each of them was originally produced, as well as the quality assessment methodologies used to evaluate their performance, are underlined.

[3] "Mixture contrast limited adaptive histogram equalisation for underwater image enhancement," by Hitam MS, introduces a new method called mixture Contrast Limited Adaptive Histogram Equalisation (CLAHE)color models that was created exclusively for underwater image enhancement. The method employs CLAHE on RGB and HSV colour models, and the results are combined using the Euclidean norm. The underwater photos used in this study were captured on Terengganu's Redang and Bidong islands. The suggested method considerably enhances the visual quality of underwater photographs by increasing contrast and decreasing noise and artefacts, according to experimental data.

[4] In his paper "Robust underwater visibility parameter," H.R. Gordon proposes that the horizontal visibility of a black target be used as the benchmark for underwater visibility. We illustrate how to easily measure the required attenuation coefficient using current inexpensive instruments. The photopic beam attenuation coefficient, which is the attenuation of the natural light spectrum convolved with the spectral responsivity of the human eye (photopic response function), determines diver visibility. In practise, the beam attenuation coefficient is typically measured at one or more wavelength bands.

[11] Iqbal K provides an Unsupervised Colour Correction Method (UCM) for underwater image enhancement in "Enhancing the low quality images using unsupervised colour correction metho." UCM is based on colour balance, RGB colour model contrast correction, and HSI colour model contrast correction. To begin, the colour cast is decreased by balancing the colour values. Second, an enhancement to a contrast correction approach is used to raise the Red colour by stretching the red histogram to the maximum (i.e., right side), while decreasing the Blue colour by stretching the blue histogram to the minimum (i.e., left side). Third, the HSI colour model's Saturation and Intensity components have been used for contrast correction to improve the true colour using Saturation and to address the intensity is used to solve the illumination problem. Using Adobe Photoshop, we compare our outcomes to three well-known methods: Grey World, White Patch, and Histogram Equalisation. The proposed method outperformed the current methods in terms of results.

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[13] The paper "An Efficient Underwater Image Enhancement Algorithm Using Range-gater Laser Method" by D. D. d. O. Finally, the proposed methodology, which combines CLAHE and DSIHE and is applied to underwater photos, produces clear output images with good outcomes.

Rodrigues et al. provides a brief explanation of range-gated laser imaging technology as a method of underwater detection with a long detection distance, which has a wide range of applications in underwater exploration, reconnaissance, rescue, and other fields. A digital image enhancement technique has been shown to significantly improve the image quality of an underwater range-gated laser imaging system. Based on prior research in the lab on underwater range-gated laser imaging technology, we implemented the local non-linear enhancement method on an FPGA hardware platform, resulting in real-time underwater range-gated laser image enhancement. Experiments were conducted in 18m long water-filled pipes to compare and analyse multiple enhancement algorithms at the same time. The results demonstrated that the paper's local non-linear enhancement technique greatly enhanced image quality when compared to standard methods.

[15] The physical impacts of visibility loss were investigated by Y. Schechner and N. Karpel in their paper "Recovery of underwater visibility and structure by polarisation analysis." It is demonstrated that the principal deterioration effects are connected with light partial polarisation. Then, an approach is described that inverts the picture production process in order to recover good visibility in scene photographs. The algorithm is based on two images captured through a polarizer at various angles. A distance map of the scene is producedas a byproduct. Furthermore, the noise sensitivity of the recovery is examined in this research. In experiments conducted at sea, we effectively demonstrated our approach. The underwater visibility range was virtually doubled due to significant improvements in image contrast and colour correction.

[17] Sukhjinder Singh et al.[21] provide three picture enhancement methods in "Comparative Study and Implementation of Image Processing Techniques Using MATLAB": -GHE, LHE, and DS IHE that improve image visual quality. In this research, we implement and test the above-mentioned methodologies to quantify the quality of grayscale enhanced images using objective and subjective image quality criteria (such as PSNR, NAE, S C, AE, and MOS). A comparative analysis is also being conducted. Histogram Equalisation (HE) approaches (such as GHE and LHE) tend to adjustthe mean brightness of an image to the middle level of the gray-level range when dealing with gray-level images, restricting their applicability for contrast enhancement in consumer electronics. The DS IHE approaches appear to address this problem because they tend to preserve both brightness and contrast improvement, albeit at the expense of the input image's naturalness.

III. METHODOLOGY:

Methodology includes Image acquisition, colour channel correction, white balance, Gamma correction and sharpening, ClAHE, and DSIHE are all part of the methodology. The next parts go into the suggested method used in this study for identifying underwater photographs, as well as the data used to validate the proposed model.

i. Image Acquisition

The method of obtaining an image using image sensors such as a camera.

Original Underwater Image

ii. Color Channel Correction

Because underwater photos are composed of three colours: green, red, and blue, the first colour channel adjustment is mostly necessary to obtain a clear underwater image. So we convert RGB images to HSV images, then we perform colour channel correction by locating three channels and simply adjusting the colours. Underwater photos that have been degraded by nature typically feature opaque or muddy colours. A formula for all three channels has been implemented to recover them and complete the processing chain. The promoted transform2ations are performed to each RGB channel model, yielding new Rc, Gc, and Bc values as follows:

$$\boldsymbol{R}' = \mathbf{1}\ \mathbf{2}\ [\ '\boldsymbol{v}\ (\boldsymbol{R}+\boldsymbol{v}) + \boldsymbol{R} - \boldsymbol{v}] \quad \text{….(1)}$$

$$\boldsymbol{G}' = \mathbf{1}\ \mathbf{2}\ [\ '\boldsymbol{v}\ (\boldsymbol{G}+\boldsymbol{v}) + \boldsymbol{G} - \boldsymbol{v}] \text{……(2)}$$

$$\boldsymbol{B}' = \mathbf{1}\ \mathbf{2}\ [\ '\boldsymbol{v}\ (\boldsymbol{B}+\boldsymbol{v}) + \boldsymbol{B} - \boldsymbol{v}] \text{……(3)}$$

where Vc is the lighting intensity value obtained in the preceding sections' non-uniformity of illumination and contrast enhancement with histogram cut correction procedures. The values for V, R, G, and B are derived from the input image.

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Color Channel Correction of RGB Channels

iii. White Balance

This white balance method focuses on restoring the colours that have been damaged due to the absorption of white light as it propagates through the water. The main issues with underwater photographs are the greenish-blue colour caused by wave scattering as depth increases. Higher wavelength waves are absorbed first. As a result, red will be absorbed first, followed by blue, and so on. The loss of colour is proportional to the distance between the observer and the plane. This consists of two steps: correcting the red channel and applying the Gray-World Algorithm to calculate the white balanced image. Compensating the red channel is based on four observations:

1) The red channel degrades first when it enters water, while the green channel is virtually equally safe due to its shorter wavelength than the red channel.

2) Making up for lost time To restore the natural appearance of the underwater photographs, compensate the red channel by adding a percentage of the green channel to it.

3) The mean values of the green and red channels are used to compensate for the red channel. To produce a balanced output, the difference between the mean values of the green and red channels must be proportionate.

4) After the red channel adjustment, eliminate the degradation of the red channel during the Grey World step; First, change the values of the little red channel pixels. That is, where the red channel information is already important, the green channel pixel information will not be delivered to it. As a result, avoid the emergence of reddishhues over regions exposed by the Grey World algorithm. Due to reduced deterioration of the red channel, the severely degraded red channel will be corrected, whereas the less attenuated red channel close to the observer will not be adjusted. The corrected red channel Irc at each pixel location (x) can be expressed mathematically as follows:

$$Irc(x) = Ir(x) + \alpha.(\bar{I}g - \bar{I}r).(1 - Ir(x)).Ig(x) \quad …….(4)$$

Where Ir and Ig signify the red and green colour channels of image I, respectively, and r and g denote the mean value of Ir and Ig at the interval [0, 1]. In the second term of Equation 4, each factor originates from one of the four observations listed above, and signifies a constant parameter, usually the value = 1 for different acquisition settings and lighting circumstances. When the blue channel is severely deteriorated and restoration of the red channel isinsufficient, restore the blue channel deterioration as well, i.e. the compensated blue channel Ibc is computed as:

$$Ibc(x) = Ib(x) + \alpha.(\bar{I}g - \bar{I}b).(1 - Ib(x)).Ig(x), \quad (5)$$

Where Ib and Ig are the blue and green colour channels of image I, respectively, and is assigned to the value one. The remainder of the results are formulated using the red colour compensation (optionallythe blue colour). The Gray-World method assumption is used to calculate and recover the illuminant colour cast. Despite the fact that white balance is necessary for retrieving the colours that are attenuated when light passes through water. This is insufficient for edges and resolving the dehazing issue caused by scattering effects. As a result, an effective fusion based on CLAHE, gamma correction,and sharpening is introduced to reduce the fogginess of a white- balanced image.

White Balance of Under Water Image

iv. Gamma Correction and Sharpening

The relationship between a colour value and its brightness on a certain device is described by gamma. The gamma correction ensures that a constant increase in the RGB component results in a constant proportional increase in the perception of the displayed colour. In other words, "equal steps in encoded luminance correspond roughly to subjectively equal steps in brightness with this nonlinear relationship." Linear RGB: (also known as gamma-expanded values or linear RGB) are the RGB components expressed in the RGB colour space prior to the application of the transfer function (gamma correction). Non-Linear RGB: (or gamma-compressed values) are RGB components expressed in the RGB colour space after the transfer function has been applied. "A typical gamma of 2.2 means that a pixel at 50% intensity emits less than a quarter of the light as a pixel at 100% intensity—not half, as you would expect!" Gamma varies by display device."It is important to note that the RGB pixels that you pass in computer graphics (for example, while designing shaders) must be gamma-corrected.

• The first is luma (or Y'), which is a gamma-compressed weighted number that takes into account differences in how humans see colours, such as perceiving green as brighter than red (0.72) and red as brighter (0.21) than blue (0.07).

luma = ([r,g,b]) => 0.2126*r + 0.7152*g + 0.0722*b …….(6)

• Luma is gamma-compressed, making it difficult to work with, but its gamma-expanded counterpart, luminance (or relative luminance), which is the weighed sum of the gamma-expanded (linear) RGB components (oddly enough, with the same coefficients), is more useful for our purposes.

luminance = ([r,g,b]) => 0.2126*degamma(r) + 0.7152*degamma(g) + 0.0722*degamma(b)…..(7)

Now that we have the luminance function and have taken into

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account the non-linear perception of luminance, we can calculate the perceived lightness, L. Lightness serves as a kind of transmission function from luminance to our sensory system. Because luminance is typically supplied in the range of 0-100, take note that we return a normalised luminance value. Enhanced Gamma Image An essential step in the processing of digital images is sharpening. As seen on the right, a straightforward sharpening algorithm subtracts a portion of nearby pixels from each pixel. The camera's reaction to a point or a sharp line, known as the point or line spread function, is represented by the thin black curve in the lower portion of the image as the input to the sharpening function. The two thin, dashed blue curves are copies of the input that have been sharpened like tiny digital cameras by reducing the amplitude (by multiplying by -ksharp 2) and shifting the image by 2 pixels. The sharpening radius RS is the name given to this distance. The sum of the black curve, the two blue curves, and the thin red curve represents the impulse response after sharpening. The thick, black and red curves that are displayed above the narrow curves are the matching edge responses that have been sharpened and smoothed, respectively. By lowering the rise distance, sharpening improves image contrast at boundary points. It might lead to edge overshoot. Although there are various filters, we employ the Gaussian filter here.

• Filter, Gaussian Black and white photos, which are extensively utilised in digital image processing, have the most prevalent noise. These are primarily employed as a benchmark standard for the AWGN's evaluation of the image performance while applying noise-removal methods. Gaussian noise, often known as statistical noise, is what causes the normal distribution (Gaussian distribution)'s probability distribution function. In a Gaussian distribution, the dram rate is typically added to the spotless pel value; this may be seen clearly in Gaussian phenomena. The mean and variance are the same for every pixel. Here, where the amplifier noise of each noise is the same as the AWGN, the amount of noise is added to each and every value of the pixel. The thermal agitation of the charged carriers, which is frequently observed inside the electrical conductor, is the main cause of this Gaussian noise.

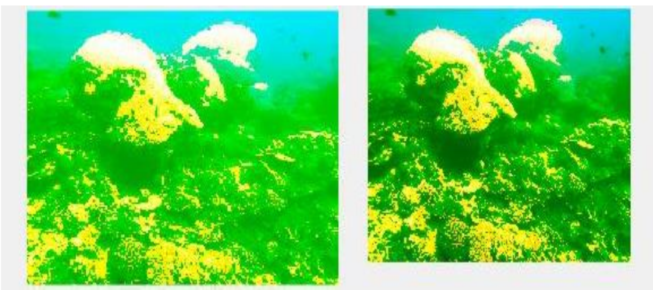
Gamma Correction and Sharpening

v. Wavelet Fusion

The basic idea behind image fusion with wavelets is to combine the wavelet decompositions of the two original images using fusion methods applied to approximations and details coefficients. Wavelet-based fusion systems are extensions of the high-pass filter method, which is based on the assumption that spatial detail is contained in high frequencies. In wavelet-based fusion approaches, detail information is retrieved from the PAN picture and injected into the MS image using wavelet transformations. The distortion of the spectral information is minimised; however, there may be additional detrimental impacts. Some of these effects are caused by the wavelet transform utilised, while others are caused by the method used to inject detail information into the MS image. There are several modelsfor injecting information, the simplest of which is by substitution. Another simple model is through addition, although more complex ways use mathematical models to analyse detail images. The photos to which it is applied must be of the same resolution, regardless of the model. Depending on the ratio of the source image resolutions, the higher resolution image may require numerous levels of decomposition. Because of its simplicity, DWT fusion is the most commonly used transform-domain fusion approach. Furthermore, wavelets' multi-resolution characteristic has been shown to be helpful in preserving image details. As a result, it can be used to fuse numerous photos while preserving as many features as possible.It depicts a schematic diagram for the wavelet transform-based fusion of two pictures. It can be defined by taking the wavelet transform of two registered input images P1(x,y) and P2(x,y) and combining it with the fusion rule. The wavelet coefficients can be chosen using one of various wavelet fusion rules. The maximum frequency rule, which selects the maximum Under water Image Enhancement frequency, is the most commonly used rule. Aditya Engineering College (A) 36 | P a g e coefficients from wavelet processed pictures using CLAHE and DSIHE algorithms. The inverse wavelet transform W-1 is then computed, and the fused P(x,y) is rebuilt:

$$P(x,y)=W^{-1}(\Phi(W(P1(x,y)),W(P2(x,y))))\ldots\ldots(8)$$

The wavelet transform focuses on representing the image in several scales, making it suitable for representing linear edges. The fundamental disadvantage of DWT fusion is the lack of shift invariance.



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as well as low directional selectivity. As a result, an alternate approach with high accuracy of curve localization is required. The wavelet transform focuses on representing the image in several scales, making it suitable for representing linear edges. DWT fusion has two major drawbacks: lack of shift invariance and low directional selectivity. As a result, an alternate approach with high accuracy of curve localization is required.

Wavelt Fusion Image

vi. CLAHE and Contrast Strectching

The target image is divided into tiles through adaptive histogram equalisation (AHE). The intensity remapping function for each tile is created using the histogram of the associated tile. To smooth inter-tile borders, intensity remapping is accomplished via bilinear interpolation. This approach has the disadvantage of increasing noise in backdrop homogeneous regions. Another method for enhancing contrast is contrast limited adaptive histogram equalisation (CLAHE). This method likewise separates an image into numerous sub-images (tiles), and the histogram is computed for each of the image's various portions. However, it clips the histogram at predetermined values before computing the cumulative distribution function (CDF) to restrict the amplification. The excess from the clipped bins is redistributed across the tile's histogram. CLAHE enhanced photos outperform previous HE-based contrast enhancement techniques. Over-enhancement may result in information loss and an increase in local noise gain. The local image contrast preserving dynamic range compression approach is used to overcome this problem by preserving the local picture contrast based on the brightness ratio of the surrounding pixels. Because imaging information has a substantial impact on the enhanced result, the image processing approach used should be carefully examined. While over-enhancement may raise the amplification of local noise and cause various unfavourable side effects, under-enhancement may not adequately enhance the image features. Since an invariant contrast enhancement factor cannot maintain the local picture contrast, the contrast must always be increased in order to detect the message. The strategy that is being advocated combines CLAHE with contrast stretching. The suggested technique keeps the local picture features while also controlling the contrast enhancement factor locally.

The following example shows how the pixel's contrast stretching algorithm uses the linear scaling function:

$$I_N(x, y) = (I(x, y) - I_{Min})\left(\frac{Id_{\max} - Id_{Min}}{I_{Max} - I_{Min}}\right)Id_{Min} \quad ....(9)$$

Underwater photos have relatively little variation, hence the dynamic range of the histogram is very small. After that, complexity extending is used to disperse the pixel values between 0 and 255.

where N I x y is the normalised pixel intensity value after contrast stretching; I x y is the pixel intensity value before contrast stretching; I is the parent image's lowest intensity; MaxI is the maximum intensity of the parent image; MinId is the least pixel intensity in the desired range; and MaxId is the maximum pixel intensity in the desired range. A contrast stretching process presupposes that the picture signal has sufficient dynamic range, which is not the case with underwater images. As a result, the procedure acquires pixel force of the least and most extreme values from the parent image.

Resultant Images of CLAHE and Contrast Stretching

vii. DSIHE

The colour image enhancement techniques should be developed to improve differentiation with the ultimate goal of improving the visual quality [15]. The intensity histogram equalisation (HE) method, which stretches the concentrated histogram to the uniform histogram, is one of the well-known enhancement techniques. The likelihood of intensity level Ik occurring in an eight-bit grey level image of size MN is roughly represented by

$$pi\ (I\ ) = nk\ MN\ k = 0,1,2,3\ \dots .255\ \dots(10)$$

where nk is the number of pixels that have intensity Ik. .The intensity transformation is then computed by

$$Ck = (Ik\ ) = 255 \sum pi(Ij)\ k\ j{=}0\ \dots\dots(11)$$

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As a result, to obtain a HE image, each pixel in the input image with intensity k I is converted into a corresponding pixel in the output HE image with level k c. 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.

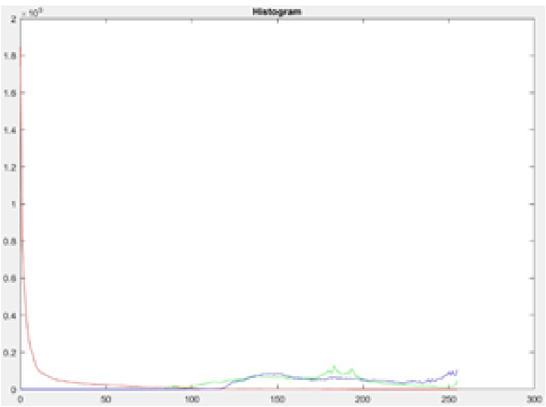
The BBHE approach and the DSIHE algorithm have the same concept. The input image histogram is divided into two sections in this instance as well, although

the distinction is that the image is divided into two parts, one bright and one dark, by taking the median into account. The two sub-histograms are then subjected to separate applications of standard HE. The two components are merged to produce the final output following the equalisation process. Using the median value AD, which is previously defined as above, the input picture A will be divided into two halves, AL and AU.

$$A=A_L U\ A_u \text{ , and median, } \quad \ldots..(12)$$

When the two equalised partitions are combined into a single image, the ultimate outcome of the DSIHE method is taken into account.

Output Image of CLAHE



Histogram Equalization

III. RESULTS

The performance metrics for the following methodology, which improves the clarity and visual quality of photos, are listed below.

S.No	Parameter			
	Mean	MSE	Entropy	PSNR
1	109.8764	1.1916e+04	7.7482	21.6471
2	163.7978	1.9204e+04	7.2521	25.9751
3	110.3738	1.0559e+04	7.7173	22.83395
4	93.7679	5.0129e+03	7.4084	30.2634
5	147.8646	1.3393e+04	7.3916	30.9157

The outcomes demonstrated that all 5 photos performed better in terms of enhancing underwater images. In this case, the mean, MSE, and entropy should all be lower, and the PSNR should be higher.We can therefore conclude that our approach is producing worth while results.

IV. DICUSSION / LIMITATIONS

We'll talk about the outcomes of running the code presented in the previous chapter in this part. Here, the images from the five data sets as well as the augmented images will be displayed. Images taken underwater are improved, and this is done. To glean more information from the merged image, other parameters are determined. More details about the contrast, edge, and brightness levels of the various underwater photographs are provided by this. the PSNR, entropy, and mean square error that were measured from the improved image. the experimental outcomes of several techniques for improving underwater images. Out of the entire collection of photos, results for a select few images are presented in the publication. The results of histogram equalisation are average. The BBHE approach produces distorted results that are confusing. Stretching the contrast results in an indistinct image. The suggested strategies, CLAHE and DSIHE, produce superior outcomes. Based on the values of performance measures, it is discovered that the proposed approaches produce very poor outcomes for PSNR, followed by DSIHE, Contrast Stretching, and BBHE. For these two criteria, Contrast Stretching and BBHE produce subpar outcomes. The best results for RMSE are obtained using the proposed approaches, which are then followed by DSIHE, Contrast Stretching, CLAHE, and other methods. Overall results show that the suggested approaches for capturing underwater photos are fairly good, it is

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found. The settings for five photos are displayed in the table. PSNR, MSE, entropy, and pixel mean are the parameters shown in this table. For the remaining underwater photographs, the exact same parameters are calculated and listed.

V. CONCLUSION

Finally, we assessed the performance of the five photographs. Using relevant performance criteria, the strategies described in this paper are compared to other existing enhancement methods. An underwater image restoration algorithm is described here, which is based on enhanced background light estimate and automatic white balance. The enhanced background light estimate approach can lessen the influence of light and white objects in the water while improving background light accuracy. The proposed solutions attempt to successfully eliminate colour appearance and contrast issues.With colour correction of the restored image, the improved automatic white balance algorithm may eliminate colour distortion and produce a clean image. Numerous types of underwater photographs of various types were used to construct the enhancement method. DSHIE and CLAHE together produce effective results whencompared to all other approaches currently in use. This method divided each image pixel into two or more groups of up to n. It has been determined from the comparison using several performance indicators that the suggested work works well with the DSHIE and ClAHE algorithms. The issue of developing novel improvement techniques that could successfully enhance and improve visibility of underwater photos still exists. The study's suggested procedures should be improved any further to get better outcomes.

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