A Review on Various Underwater Enhancement Techniques

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Abstract- *Underwater picture improvement (IE) is basic and testing preprocessing strategy and the significant hotspots for twisting of underwater pictures are light dissipating and shading change. This paper introduces a near investigation of different IE procedures utilized for improving underwater pictures. The nature of underwater pictures is poor due to particular spread properties of light in water. At the point when catch such pictures corrupt because of many components like swells in water, absence of accessibility of light natural matter broken up in water and so forth and furthermore such pictures are caught from little separation so the pictures must be preprocessed before applying any sort of operation on these pictures distinctive sifting procedures are accessible in the writing for preprocessing of under pictures. The channels utilized ordinarily enhance the picture quality, smother the noise protect the edge in a picture, enhance and smooth the picture.*

Keywords- Underwater images; Dark channel prior; Histogram Equalization; CLAHE

I. INTRODUCTION

Digital Image Processing (DIP) is the under Digital Signal Processing (DSP) which is managing the control of the advanced pictures by the utilization of advanced PCs. Computerized picture preparing is superior to anything simple picture handling. It is done as such that the pictures are translated effectively by human eyes. But human eyes cannot interpret images inside underwater easily. Along these lines, underwater IE procedures give an approach to enhance the protest recognizable proof in underwater condition. Underwater ocean pictures should be preprocessed because of lower nature of ocean water pictures [1]. When images are captured, the quality of the underwater images degrades and depends on the density of the water, depth of the water, distance between camera and object, artificial light, water particles, etc. Underwater images are affected by the light scattering effect and color change effect [2]. The good quality image is obtained when the water is clear and limpid. As we go deep into the water, the water becomes denser due to sand, planktons and minerals. Due to the increased density of water, camera light gets reflected back and sometimes it gets deflected by the particles before reaching towards the camera. Many times camera light get absorbed by the particles. Due to scattering effect, the visibility and contrast of the image get reduced. Wavelength of the light travel in the water determines the color change effect. The color with the highest wavelength goes the very short distance in water. Figure 1 shows the light penetration pattern in the clear water. Blue color has the shortest wavelength, so it travels very long in the deep water. That's why the blue color is more in underwater images [3]. As the degree of attenuation varies for different wavelengths, the color change effect occurs.

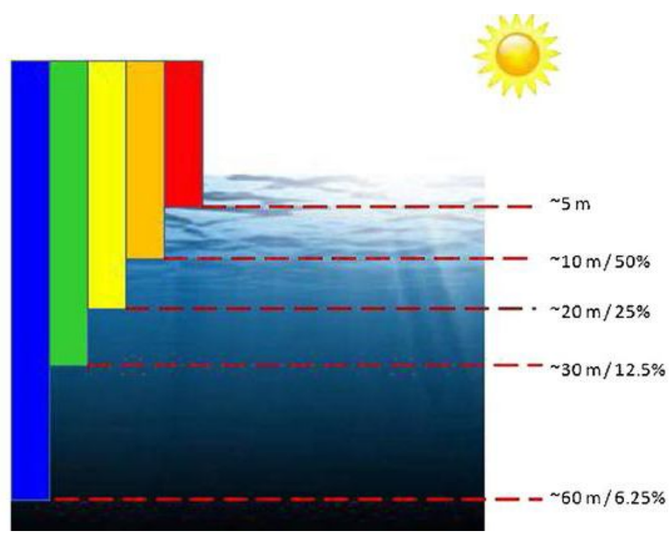


Fig. 1 Light Penetration in Clear water

The scattering effect and color change effect combined results in reduced visibility in underwater images. It affects the resolution and contrast attribute to degrade the quality of the image. Image enhancement is one of the pre-processing methods which improves the quality of an image by increasing the perception of information in it. This task is achieved by suppressing the undesired distortions like light scattering and color change effect to enhance image features relevant for further processing and analysis work. A lot of research work has been done in underwater enhancement techniques to pre-process image quality. In this paper, we describe several underwater image enhancement techniques.

II. LITERATURE REVIEW

In this section describe the various researches study on underwater image enhancement:

M. A.-A.-Wadud et al.[4] in this paper, a sharp complexity improvement prepare established on conventional HE calculation is proposed. This DHE strategy takes control over the result of characteristic HE so it plays out the upgrade of a photo without making any absence of subtle elements in it. DHE partitions the image histogram founded on regional minima and assigns targeted grey stage levels for each partition earlier than equalizing them individually. These partitions additional go via a repartitioning experiment to make sure the absence of any dominating parts.

Sharumathi.K et al.[5] presents a study on different IE systems connected on acoustic pictures. It is as of late demonstrated that change procedures, for example, wavelet, curvelet and contourlet are more appropriate for expelling speckle noise in acoustic pictures. This paper additionally gives a system to understanding the path by which distinctive sorts of noise in an acoustic picture can be eliminated by separating procedures.

Dr. D. Deepa [6**]** the nature of underwater pictures is poor on account of particular engendering properties of light in water. In this way, underwater IE is important to increment visual quality. IE should be possible in two spaces: Spatial area and frequency area. Different methodologies like difference extending, versatile histogram evening out, EMD (Empirical Mode Decomposition), UCM procedures are utilized to upgrades the submerged pictures. Some separating strategies are additionally used to keep away from the noise in the ocean picture.

Jinbo Chen et al [7]: presented "A disclosure system in light of sonar picture for underwater pipeline tracker. The perception and appraisal of underwater pipelines are finished by heads who drive a remotely worked submerged vehicle (ROV) with a camera mounted on it.

Cheolkon Jung (8)**-** In this work, it proposed a powerful difference upgrade technique in light of dual tree complex wavelet transform (DT-CWT) to work on an extensive variety of symbolism without IE. In the terms of improvement, it utilized the nonlinear reaction of the human eye to the luminance to outline a logarithmic capacity for worldwide shine advancement. Additionally, the nearby difference is upgraded by CLAHE in low-pass sub groups, which makes the structure of picture clearer.

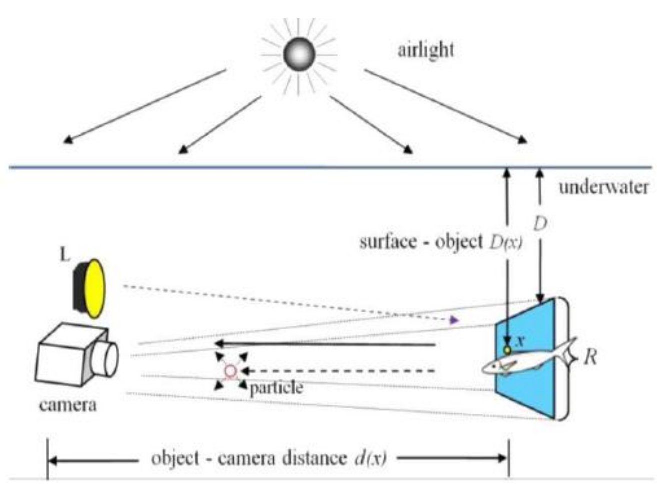
Chiang et al. 2012[9] have presented a new effective approach in light of dehazing calculation, used to enhancement underwater pictures. This calculation is utilized to remunerate the lessening irregularity along the transmission course and to secure the conceivable impact of nearness of a counterfeit wellspring of light into thought. The haze occurrence and deviation in wavelength attenuation along the engendering way submerged to camera are redressed in the wake of repaying the impact of simulated light. The execution was assessed both equitably and subjectively, of the proposed calculation for wavelength compensation and image dehazing (WCID) by utilizing ground-truth shading patches.

III. TECHNIQUES OF UNDERWATER IMAGE ENHANCEMENT

In this section, we discuss several underwater image enhancement techniques that are used to recover corrupted image.

WCID:

A WCID implies wavelength remuneration and picture dehazing. WCID is an underwater IE strategy or system which repay wavelength. The two fundamental drivers of underwater picture contortions are light dissipating and shading change. Once in a while fake light source is utilized to beat inadequate helping issue. Be that as it may, it presents extra luminance in the picture. WCID is an exclusive system which handles issues of light scrambling, shading change and fake light source nearness at the same time. This strategy has a novel deliberate way to deal with improves submerged pictures by dehazing calculation [8]. Various underwater IP strategies used to expel light diffusing and shading change impact. By and large the greater part of the processing methods concentrate on evacuating either light dissipating impact or shading change impact. The main strategy called WCID will deal with these issues at the same time [8].



Dark-channel prior method

A dark channel prior (DCP) is a productive and successful technique to reestablish unique lucidity of the underwater picture. Pictures taken in the underwater condition are twisted on account of light constriction [10]. Utilizing DCP, the profundity of the turbid water can be assessed by the supposition that most neighborhood fixes in water free pictures contains a few pixels which have low powers in no less than one shading channel. DCP depends on the insights of clear pictures in air. In immaculate water, it is frequently that a few pixels have less power. Such pixels are known as dull pixels. In underwater pictures, the force of these dark pixels is contributed by foundation light. Consequently these dark pixels can straightforwardly give exact estimation of water transmission. Joining a underwater imaging model and a delicate tangling addition technique, we can recuperate a high quality water free image and produce a good depth map [11]. This approach is physically plausible and can get far off items even in the substantial obscure pictures. DCP may not be helpful when scene protest is intrinsically like the foundation light finished a substantial neighborhood area and no shadow is thrown on the object.

Histogram Equalization:

HE is the highest operated contrast enhancement technique due to the easiness comfort. HE makes density scattering flatter and it expanses the gray level range to enhance the total contrast of the given image. Transformation of gray levels of the given image to its improved image level cumulative distribution function (CDF) has been utilized by this technique. HE changes the mean brightness of image to middle of overall dynamic range, which is a drawback of HE because of intensity saturation and annoying artifacts occurs [12].

Contrast-limited adaptive Histogram Equalization (CLAHE)

It improves the complexity of the grayscale image by changing the qualities. CLAHE works on small areas in image, called tiles, as opposed to the whole image [13]. This feature is also applicable to global HE, which gives rise to CLAHE. It is mostly used in enhancement of low contrast retinal image. In case of CLAHE, a transformation function derived from contrast limited procedure to each neighborhood pixel. [12].

Fig. 1. Example of Contrast-Limited Adaptive Histogram Equalization Enhancement

- **CLAHE on RGB Color Model**

The RGB color model is an additive color model. Here red, green and blue light are added together in various ways to reproduce a broad array of colors. The value of R, G, and B components is the sum of the respective sensitivity functions and the incoming light. In RGB color space, CLAHE is applied on all the three components individually and the result of full-color RGB can be obtained by combining them.

- **CLAHE on HSV color model**

HSV is a cylindrical-coordinate representation of points in an RGB color model. In color space it describes colors in terms of the Hue (H), Saturation (S), and Value (V). Irrespective of the value being at either min or max intensity level, hue and saturation levels will not differ. CLAHE can only be applied on V and S components [14].

IV. DISCRETE WAVELET TRANSFORM (DWT)

DWT decomposes the input signal into four parts with the use of the translation and dilation property. An appropriate wavelet function is chosen for decomposing the image. The 2-D DWT decomposition can be achieved by employing 1-D wavelet transform first along the rows and then along the columns on the resultant. The image is decomposed into four frequency bands and they are LL, LH, HL and HH [15].

V. FILTERING TECHNIQUES OF UNDERWATER IMAGE ENHANCEMENT

Filtering is a process of removing the noisy elements which are present in digital images which are horizontal to a variety of noise.

a. Homomorphic Filtering:

Homomorphic filtering is used to correct the non-uniform illumination and to enhance the contrast in the image. It is a frequency filtering method which is preferred to other techniques because it corrects non-uniform lighting and sharpens the image features at the same time [16].

$$f(x, y) = i(x, y) \,.\, r(x, y)$$

Where $f(x, y)$ is the image sensed by the camera,
$i(x, y)$ the illumination multiplicative factor and
$r(x, y)$ the reflectance function. affiliations.

b. Anisotropic filtering

Anisotropic filtering simplifies image features to improve image segmentation. This filter smoothes the image in homogeneous area but preserves edges and enhances them. It is used to smooth textures and reduce artifacts by deleting small edges amplified by homomorphic filtering. The previous step of denoising is very important to obtain good results with anisotropic filtering. It is the association of wavelet denoising and anisotropic filtering which gives such results. Anisotropic algorithm is usually used as long as result is not satisfactory. Perona and Malik anisotropic diffusion is the edge sensitive extension of the average filter. Anisotropic diffusion can be applied to radar and medical ultrasound images, underwater images.

c. Wavelet Filtering:

Wavelet filter is also used to suppress the noise i.e. the Gaussian noise are naturally present in the camera images and other type of instrument images. While transferring the images Gaussian noise can be added. This wavelet denoising gives very good results compared to other denoising methods because, unlike other methods, it does not assume that the co efficient is independent. Thresholding is a simple non-linear technique; which operates on one wavelet co efficient at a time. In its most basic form, each coefficient is thresholded by comparing against is thresholded, if the coefficient is smaller than threshold, set to zero; otherwise it is kept or modified . Replacing the small noisy coefficients by zero and inverse wavelet transform on the result may lead to reconstruction with the essential signal characteristics and it's the less [16].

d. Bilateral Filtering

A bilateral filter is a non-linear, edge-preserving and noise-reducing smoothing filter for images. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. This weight can be based on a Gaussian distribution. Crucially, the weights depend not only on Euclidean distance of pixels, but also on the radiometric differences (e.g. range differences, such as color intensity, depth distance, etc.). This preserves sharp edges by systematically looping through each pixel and adjusting weights to the adjacent pixels accordingly [17].

VI. PERFORMANCE MEASURES

The performance parameters are histogram, entropy, SNR and PSNR.

A.Entropy

The average information content known as entropy is used for measure of image quality. Larger the value of entropy, more the information content in the image.

$$ENT = -\sum_{i=0}^{L-1} I(l) \log I(l) \quad (1)$$

Where ENT (i) denotes entropy, I(l) is pdf of image having l intensity level and L denotes the number of gray levels.

B.Peak signal-to-noise ratio (PSNR)

For PSNR calculation first mean square error (MSE) is calculated as-

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}[X(i,j) - Y(i,j)]^2}{M \bullet N} \quad (2)$$

The root mean square error (RMSE) is calculated from root of MSE then PSNR as-

$$PSNR = 20.\log_{10}\left(\frac{\max\,(Y(i,j))}{RMSE}\right) \quad (3)$$

Here, X (i, j) is input image having M by N pixels, Y(i, j) is enhanced image. Greater the PSNR better will be contrast of enhanced image.

C.Signal to Noise Ratio (SNR):

Consider r(x,y) be the original image and t(x,y) is enhanced image. The noise estimation in enhanced fundus image is analyzed by-

$$SNR = 10.\log_{10}\left[\frac{\sum_{0}^{n_x-1}\sum_{0}^{n_y-1} r[(x,y)]^2}{\frac{1}{n_x n_y}\sum_{0}^{n_x-1}\sum_{0}^{n_y-1} r[(x,y) - t(x,y)]^2}\right] \quad (4)$$

VII. CONCLUSION

In this review paper, we focused on a survey of different techniques of underwater image enhancement to enhance the quality of underwater images and different techniques. The atmospheric light is obtained by using dark channel prior. Further improvement a color correction quality is employed to enhance the color contrast of the object in underwater and remove different noise particles.

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