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RESEARCH ARTICLE

Comparative Analysis of Various Underwater Image Enhancement Techniques

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Abstract*—Image enhancement is a process of improving the quality of image by improving its feature. In this paper comparative analysis of various enhancement techniques for such underwater images is presented. The underwater image suffers from low contrast and resolution due to poor visibility conditions, hence an object identification become typical task. The processing of underwater image captured is necessary because the quality of underwater images affect and these images leads some serious problems when compared to images from a clearer environment. A lot of noise occurs due to low contrast, poor visibility conditions, absorption of natural light, non uniform lighting and little color variations, and blur effect in the underwater images, because of all these reasons number of methods are there to cure these underwater images, different filtering techniques are also available in the literature for processing and enhancement of underwater images.

***Keywords* — RGB Color Level, color enhancement, Light Correction Method, Median filter**

I. INTRODUCTION

Underwater image enhancement techniques provide a way to improving the object identification in underwater environment. There is lot of research started for the improvement of image quality, but limited work has been done in the area of underwater images, because in underwater environment image get blurred due to poor visibility conditions and effects like "absorption of light", "reflection of light", "bending of light, "denser medium (800 times denser than air)", and "scattering of light" etc. These are the important factor which causes the degradation of underwater images [1].

Another well-known problem concerning the underwater images is related to the density of the water in the sea which is considered 800 times denser medium than air. Therefore, when light rays moves from the air to the water, it is partly reflected reverse and at the same time partly enters the water. The total light amount that enters the water also starts reducing start it goes deeper in the sea. Similarly, the water molecules also absorb certain amount of light. As a result, the underwater images are getting darker and darker as the deepness increases. Not only the quantity of light rays is condensed when it goes deeper but also colors drop off one by one depending on the wavelength of the colors. For example, first of all red color disappears at the depth of 3m. Secondly, orange color starts disappearing while we go further. At the depth of 5m, the orange color is lost. Thirdly most of the yellow goes off at the depth of 10m and finally the green and purple disappear at further depth. From the

fig1 it can be clearly understand that, the blue color travels the longest in the water and in depth due to its shortest visible wave length. Which makes the underwater images having been dominated only by blue color because of this effect of blue color the original color of any object under the water is affected. In addition to excessive amount of blue color, the blur images contain little brightness, little contrast and so on [3].

II. LITERATURE SURVEY

This section presents related literature concerning underwater image processing and enhancement techniques. In 2012 Chiang, J.Y.; Ying-Ching Chen, researched on "Underwater Image Enhancement by Wavelength Compensation and Dehazing," Where Light scattering and color change are two major sources of distortion for underwater photography. Light scattering is caused by light incident on objects reflected and deflected multiple times by particles present in the water before reaching the camera. This in turn lowers the visibility and contrast of the image captured. Color change corresponds to the varying degrees of attenuation encountered by light traveling in the water with different wavelengths, rendering ambient underwater environments dominated by a bluish tone. No existing underwater processing techniques can handle light scattering and color change distortions suffered by underwater images, and the possible presence of artificial lighting simultaneously. This paper proposes a novel systematic approach to enhance underwater images by a dehazing algorithm, to compensate the attenuation discrepancy along the propagation path, and to take the influence of the possible presence of an artificial light source into consideration. Once the depth map, i.e., distances between the objects and the camera, is estimated, the foreground and background within a scene are segmented. The light intensities of foreground and background are compared to determine whether an artificial light Source is employed during the image capturing process. After compensating the effect of artificial light, the haze phenomenon and discrepancy in wavelength attenuation along the underwater propagation path to camera are corrected. Next, the water depth in the image scene is estimated according to the residual energy ratios of different color channels existing in the background light. Based on the amount of attenuation corresponding to each light wavelength, color change compensation is conducted to restore color balance. The performance of the proposed algorithm for wavelength compensation and image dehazing (WCID) is evaluated both objectively and subjectively by utilizing ground-truth color patches Actual implementation results into images with significantly enhanced visibility and superior color fidelity after applying are proposed WCID are obtained.

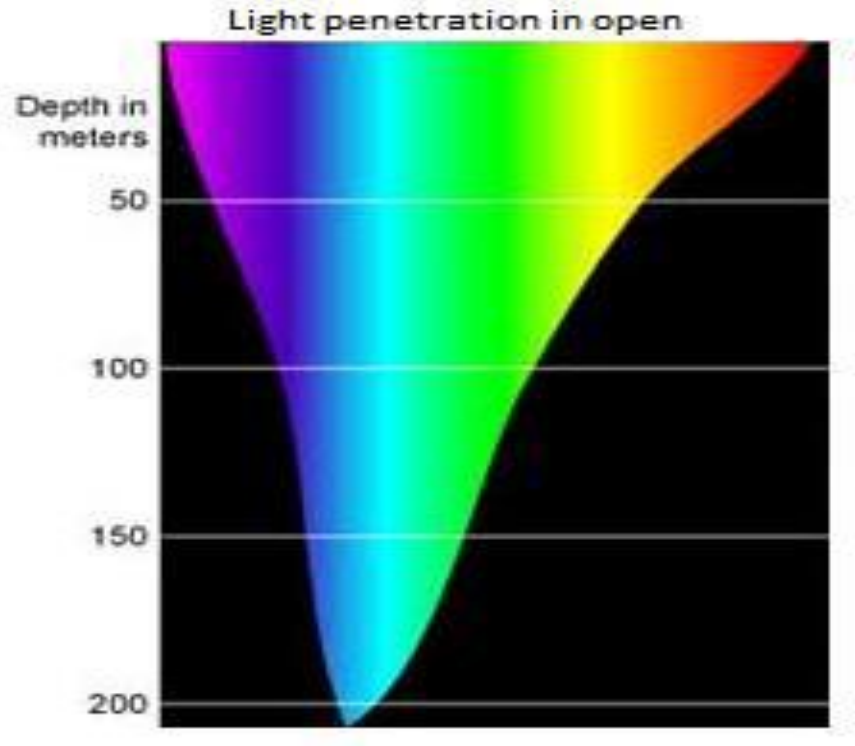

Fig 1- Color penetration pattern

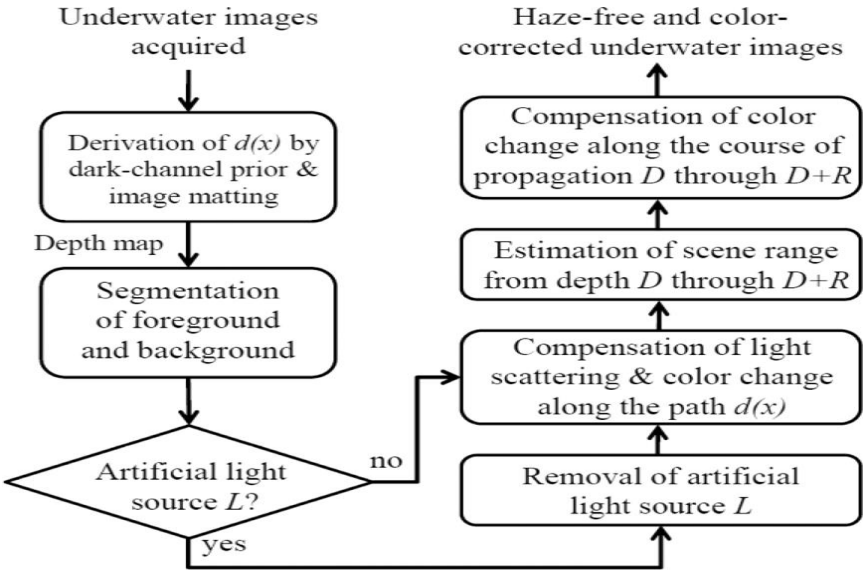

Fig 2- Flowchart of the WCID technique

In 2011 Hung-Yu Yang; Pei-Yin Chen; Chien-Chuan Huang; Ya-Zhu Zhuang; Yeu-Horng Shiau, worked on "Low Complexity Underwater Image Enhancement Based on Dark Channel Prior,". Blurred underwater image is always an irritating problem in the deep-sea engineering. They proposed a competent and low complexity underwater image enhancement technique based on dark channel before. Our technique employs the median filter in its place of the soft matting method to estimate the depth map of image. Furthermore, a color improvement method is adopted to improve the color contrast for underwater image. The tentative results show that the proposed approach can well improve the underwater image and decrease the implementation time. In addition, this technique requires fewer computing reserve and is well appropriate for implementing on the supervision and underwater navigation in real time.

In 2010, Dr.G.Padmavathi, Dr.P.Subashini, Mr.M.Muthu Kumar and Suresh Kumar Thakur did a comparative study and proposed a paper "Comparison of Filters used for Underwater Image Pre-Processing", The filters used normally improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. Therefore an attempt has been made to compare and evaluate the performance of three famous filters namely, homomorphic filter, anisotropic diffusion and wavelet denoising by average filter used for under water image pre-processing. Out of the three filters, wavelet denoising by average filter gives desirable results in terms of Mean Square Error and Peak Signal to Noise Ratio. However the elapsed time of the three filters is also studied to identify the suitable filters that process the image quickly by preserving the image quality.

In 2013 Pulung Nurtantio, Andono, Ketut Eddy Purnama, Mochamad Hariadi proposed a paper "Underwater Image Enhancement Using Adaptive Filtering For Enhanced Sift-Based Image Matching", which says ,Success of scale-invariant feature transform (SIFT) image registration is limited when attempted on camera footage taken under water. This is, largely due to the poor image quality inherent to imaging in aquatic environments. In this research they aimed to overcome this shortcoming using a new method of pre-processing of true-color imagery taken under water based on the Contrast Limited Adaptive Histogram image Equalization (CLAHE) algorithm. CLAHE assumes that the distribution function of the pixel intensity values of an underwater-recorded image is dominated by Rayleigh scattering, and that the noise can be removed as a function hereof. Results showed that after applying the CLAHE image enhancement method registration success of SIFT increased by 41% compared to reference method. This research explained the preprocessing step of underwater image registration using image enhancement framework. This paper proposed a method for image enhancement using adaptive filtering base on CLAHE using Rayleigh Distribution.

In 2014, Pooja Sahu, Neelish Gupta, Neetu Sharma proposed a paper on "A Survey on Underwater Image Enhancement Techniques" This is a review paper which deals with the methods to improve underwater image enhancement techniques, the

processing of underwater image captured is necessary because the quality of underwater images affect and these image leads some serious problems when compared to images from a clearer environment. A lot of noise occurs due to low contrast, poor visibility conditions (absorption of natural light), non uniform lighting and little color variations, pepper noise and blur effect in the underwater images because of all these reasons number of methods are existing to cure these underwater images different filtering techniques are also available in the literature for processing and enhancement of underwater images one of them is image enhancement using median filter which enhances the image and help to estimate the depth map and improve quality by removing noise particles with the help of different techniques, and the other is RGB Color Level Stretching have used. Forward USM technique can also be used for image enhancement.

III. UNDERWATER IMAGE ENHANCEMENT

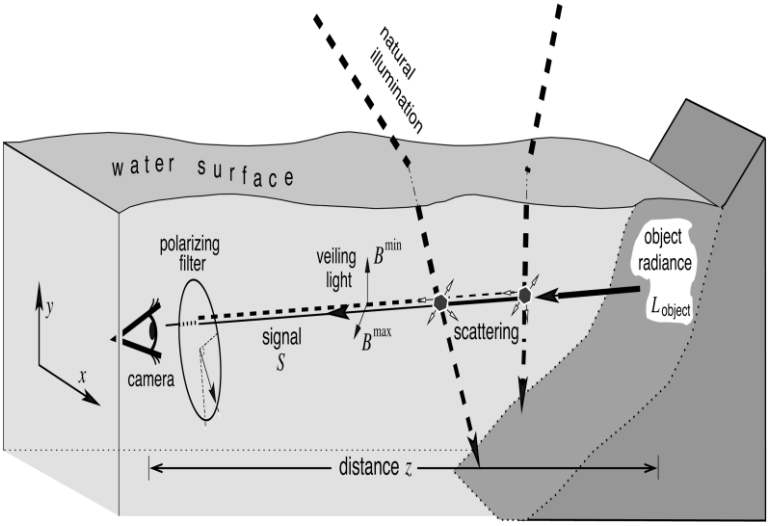

Image enhancement is a technique of improving the quality of image by improving its feature and its RGB values. The underwater image processing area has received considerable attention within the last decades, showing important achievements. This paper has a review on some of the most recent methods that have been specifically developed for the underwater scenarios. These methods are capable of extending the range of underwater image processing, improving image contrast level and resolution quality. After consideration of the basic physics of the light propagation in the water medium, we focus on the different methods available in the Table. A major difficulty to process underwater images comes from light attenuation; it limits the visibility distance, at about twenty meters in clear water and five meters or less in muddy water. The light reduction process is caused by the absorption (which removes light energy) and spreading (which changes the direction of light wave path). Absorption of light and its scattering effects are because of the water itself and to other components such as dissolved organic matter or small observable floating particles. Due to this difficulty, underwater imaging suffers too many problems [1][4]:
first the quick attenuation of light requires attaching a light source to the vehicle providing the essential lighting. Unluckily, synthetic lights tend to illuminate the scene in a non uniform fashion producing a bright spot in the center of the image and poorly illuminated area surrounding. Then the distance between the camera and the scene usually induced prominent blue or green color (the wavelength corresponding to the red color disappears in only few meters). Then, the floating particles highly variable in kind and application, boost absorption and dispersion effects: they blur image features (advance scattering), transform colors and turn out glow artifacts known as “marine snow”. Lastly the non solidity of the sunken vehicle affects once again image contrast. From the pre-processing filter has been assessed on natural underwater images with and without additional synthetic underwater degradations as proposed in [1]. Underwater perturbations we added are typical perturbations observed and it have been tested with varying degrees of severity. We simulate blur and unequal illumination using Jaffe and McGlamery’s model [9][11], gaussian and particles noise as additive contributions to the images and finally reduced color range by histogram operation.

IV. PROBLEM STATEMENT

This review paper covers the image enhancement techniques and the image quality enhancement using filers, the atmospheric light is a major difficulty to process underwater images comes from the poor visibility conditions under the water, scattering of light and light attenuation due to all the reasons the underwater images suffers a lot and affect their visibility and the contrast which they contain actually. Light attenuation limits the visible distance, at about 20 meters in clear water and 5 meters or less in turbid or less muddy water.

Use Dehazing which has proposed Image Enhancement by Wavelength Compensation and Dehazing which is used to estimate the transmission of input image the atmospheric light is obtained by using dark channel prior and used to remove the

noise like pepper noise, with this method the noise can be removed and the image which has less amount of noise and more improved image can be achieved but the actual color contrast and less sharp image is less accurate than the original image therefore in future there is a need of some method in addition to improve the quality of these kind of underwater images.

V. CONCLUSIONS

In this review paper, we focused on a comparative analysis of different techniques of underwater image enhancement to enhance the quality of underwater images and different techniques used Color Stretching, USM filter, Contrast enhancement to enhance underwater images. The approached used i.e. median filter which is used to estimate the transmission of input image. 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.

COMPARATIVE TABLE I

YEAR	AUTHOR	TITLE	APPROACH	RESULT
2014	Pooja Sahu, Neelish Gupta ,Neetu Sharma	**A Survey on Underwater Image Enhancement Techniques**	RGB Color Level Stretching	Enhance the color contrast of the object in underwater and remove different noise particles
2013	Pulung Nurtantio, Andono, Ketut Eddy Purnama, Mochamad Hariadi	Underwater Image Enhancement Using Adaptive Filtering For Enhanced Sift-Based Image Matching	Adaptive Filtering For Enhanced Sift-Based Image Matching	success of SIFT increased by 41% compared to the reference method
2012	Chiang, J.Y.; Ying-Ching Chen	Underwater Image Enhancement by Wavelength Compensation and Dehazing	Wavelength Compensation and Dehazing	Dehazing and improvement in quality in deep water.
2011	Hung-Yu Yang; Pei-Yin Chen Chien-Chuan Huang; Ya-Zhu Zhuang; Yeu-Horng Shiau	Low Complexity Underwater Image Enhancement Based on Dark Channel Prior	Dark Channel Prior	Decrease in implementation time
2010	Dr.G.Padmavathi, Dr.P.Subashini, Mr.M.Muthu Kumar and Suresh Kumar Thakur	Comparison of Filters used for Underwater Image Pre-Processing	Filtering method	Enhance and smoothen the image

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