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REVIEW ARTICLE

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Review and Comparative Analysis on Image Enhancement for Underwater Images

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Abstract: In the oceanic engineering the underwater images plays a crucial role. The underwater images are degraded due to scattering of light, reflection and absorption *etc* because as light travels in water, there is exponential loss of light intensity occur depending on the color spectrum wavelength. To resolve these issues image restoration and image enhancement are two areas in which work is going on. In this paper, a survey and comparative analysis is done for the underwater images enhancement. The comparative analysis is done on the basis of Quantitative analysis parameters such as Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Entropy is measured for original and enhanced image. Basis on the literature survey, identify some research gaps on which further work can be done.

Keywords: image, enhancement, underwater, image

I. INTRODUCTION

In the modern era, the oceanic engineering plays an important role. The ocean engineering provides a link between the other oceanographic disciplines, and used for marines monitoring and underwater conditions such as underwater mountains and plants. So, underwater image enhancement plays an important role for monitoring purposes in oceanic engineering. But, due to reflection, scattering and absorption the images quality degraded as shown in fig. 1. These issues are resolved by image enhancement and image restoration techniques. In general, the image enhancement techniques aim to improve the perception of information in images. The image enhancement techniques are classified in two terms spatial domain method (worked directly on pixels) and frequency domain methods (worked on Fourier transform of the image).

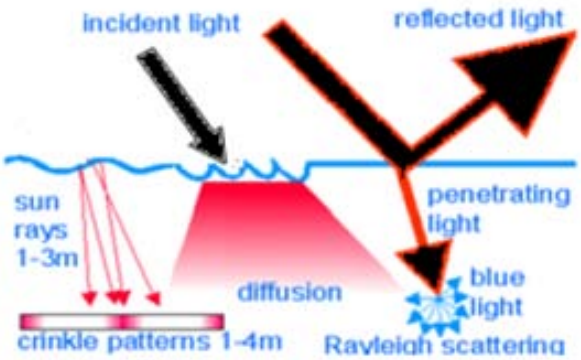

Fig.1 Reasons for degradation of underwater images [2]

On the other hand in image restoration techniques the 2-3 corrupted or noise images are taken and fusion process is done to estimating an enhanced image. The corruption comes due to motion, blurring and noises due to camera miss-focus.The remaining part of the paper organized as follows: Section 2 describes the literature survey and comparative analysis of different techniques is done on the basis of their performance parameters. In Section 3, outlines the research gap which determine from literature survey. In the last section, the work has been concluded.

II. LITERATURE SURVEY

Bhandari, *et al.* [1], discuss that how they resolve the color image segmentation by using the nature inspired algorithm. Also, they have done comparative analysis of their work with other three nature inspired algorithms namely differential evolution, wind driven optimization, and Particle Swarm Intelligence on the basis of objective function values. Moreover, they also done qualitative and quantitative analysis and taken most popular performance parameters like Mean Square Error, Peak Signal to Noise Ratio, SSIM and FSIM. From their statistical analysis, they conclude that kapur's entropy was found to be more accurate and robust for multilevel colored image segmentation. On the other hand, for colored satellite image segmentation, cuckoo search was most promising technique.

Dwivedi, *et al.* [2], discussed that underwater images quality degraded due to scattering of light, reflection, banding losses *etc*. In this paper, they have taken two enhancement techniques such as contrast limit adaptive histogram equalization (CLAHE) and, global contrast adjustment method. Also, comparative analysis has been done for both technique and concludes that the CLAHE technique give better improved results and give better information. These enhancement techniques also further used for segmentation purposes.

Ghani, *et al.* [3], proposed a two stage method for improving the contrast and color correction. In the first stage, image is multiplier with a gain factor and further histogram divided into two parts at the mid-point and contrast stretching is done. In the second stage, to improve the color correction the image is converted into HSV color space. The S and V components are stretched.

Gao, *et al.* [4], discussed that they improving the underwater images by using the restoration and enhancement methods. In the initial stage, image restoration is done by estimating the atmospheric light, refining the transmittance image. After restoration process, the image enhancement is done using deduced histogram equalization method. Their experiment result shows that image quality improves effectively.

Xiu Li, *et al.* [5], discussed two parameters due to underwater images quality degraded. These are light scattering and color distortion. Also, they defined that the light scattering occurs due to light be reflected and deflected number of times by the suspended particles in the water and color distortion due to absorption degrees and its vary according to the wavelength. They proposed a novel technique based on dark channel prior and luminance adjustment. Their technique resolves these two parameters issues and gives better visualization result.

Chong- Yi Li, *et al.* [6], discussed that how images captured under water are usually degraded due to the effects of absorption and scattering parameters. To overcome these limitations, proposed hybrid technique. They hybrid the dehazing and contrast enhancement algorithms. The dehazing algorithm restored the visibility, color and nature appearance of underwater images and further contrast enhancement technique is used for increases the brightness of the image. To evaluate the performance of their technique they have done qualitative and qualitative analysis and their comparison with existing techniques, as well as measured color accuracy.

Alex, *et al.* [7], worked on adaptive histogram equalization technique to improve the enhancement of images. In the adaptive histogram equalization technique the pixels are mapped based on it local gray scale distribution. In this method, the enhancement mapping applied to a particular pixel is a function of the intensity values of pixels immediately surrounding the pixel. Hence the number of times that this calculation should be repeated is the same as the number of pixels in the image. They have implemented their algorithm on FPGA for hardware implementation. They are improving the performance by doing the parallel processing. The algorithm is implemented in Xilinx Spartan 3AM on Altium Nanoboard NB3000 board using Altium Designer.

Amjad Khan, *et al.* [8], explained that most of the underwater images contain a layer of haze, formed by suspended particles in the turbid water that create scattering and absorption of light. In this paper, they are used wavelet-based fusion method for improving the quality of underwater images. They are targeting their research to enhance the underwater pipeline for the corrosion estimation. Their technique has three stages. In the first stage, the corroded pipeline is enhanced by adjusting its contrast and the color profiles. In the second stage, the wavelet-based decomposition and inverse composition are performed to fuse the enhanced versions into a dehazed image. At the final stage, the corrosion on the surface of the pipeline is estimated. In order to validate the performance, the corrosion is estimated in both hazy and dehazed image.

Peng, *et al.* [9], worked on a depth estimation method for underwater scenes based on image blurriness and light absorption, which can be used in the image formation model (IFM) to restore and enhance underwater images. Previous IFM-based image restoration methods estimate scene depth based on the dark channel prior or the maximum intensity prior. These are frequently invalidated by the lighting conditions in underwater images, leading to poor restoration results. The proposed method estimates underwater scene depth more accurately. Experimental results on restoring real and synthesized underwater images demonstrate that the proposed method outperforms other IFM-based underwater image restoration methods.

Banerjee, *et al.* [10], explained that *R*GB *Y*CbCr *Pro*cessing method (*RYPro*) is proposed for underwater images commonly suffering from low contrast and poor color quality. The degradation in image quality may be attributed to absorption and backscattering of light by suspended underwater particles. Moreover, as the depth increases, different colors are absorbed by the surrounding medium depending on the wavelengths. In particular, blue/green color is dominant in the underwater ambience which is known as *color cast*. For further processing of the image, enhancement remains an essential preprocessing operation. Color equalization is a widely adopted approach for underwater image enhancement. Traditional methods normally involve blind color equalization for enhancing the image under test. In the present work, processing sequence of the proposed method includes noise removal using linear and non-linear filters followed by adaptive contrast correction in the RGB and YCbCr color planes. Performance of the proposed method is evaluated and compared with three *golden* methods, namely, Gray World (GW), White Patch (WP), Adobe Photoshop Equalization (APE) and a recently developed method entitled "Unsupervised Color Correction Method (UCM)". In view of its simplicity and computational ease, the proposed method is recommended for real-time applications. Suitability of the proposed method is validated by real-time implementation during the testing of the Autonomous Underwater Vehicle (AUV-150) developed indigenously by CSIR-CMERI.

Kuldeep, *et al.* [11], proposed two recursive histogram equalization methods for underwater image enhancement. In their first method, the histogram is divided into under expose and over expose area and successive recursive operation less than predefined threshold is applied for histogram equalization. In the second method, three exposure values were calculated and successive recursive operations on each sub histogram was applied for histogram equalization.

Ghani, *et al.* [12], discussed that they are doing contrast stretching by determining the minimum and maximum point on histogram and also calculate mid-point. Basis on the mid-point they are increasing 5% left half of mid-point and reducing 5% right hand side of mid-point. The main goal of their method was to increase image's details and to improve the visibility by contrast correction.

Samarth Borkar, and S.V. Bond [13], discussed that due to longest wavelength of red color component maximum attenuation occurs in underwater scenario. They have worked on red color channel and determine depth map using morphological operations. Their proposed technique significantly restores the color and minimizes the effect of hazes. Also, they have qualitative and quantitative analysis of their proposed techniques and comparative analysis of their results done with the existing techniques.

Table 1: Comparative Analysis of Different Enhancement Techniques

Paper	Technique Overview	Performance Parameters
Bhandari, *et al.* [1]	Resolve the color image segmentation by using the nature inspired algorithm.	Entropy:0.96 Mean Square Error:1.81 Peak Signal to Noise Ratio:25.50dB SSIM:0.97 FSIM:0.93
Dwivedi, *et al.* [2]	Worked on two enhancement techniques such as contrast limit adaptive histogram equalization (CLAHE) and, global contrast adjustment method.	Original Entropy: 6.118 Global Contrast Adjustment Method: 7.83 CLAHE Method:7.4 With Dual Method: 7.69
Ghani, *et al.* [3]	Improving the contrast and color correction.	Average Gradient: 3.922 PSNR:21.16dB Entropy:6.84
Gao, *et al.* [4]	Improving the underwater images by using the restoration and enhancement methods	Original Image:32343 Canny Edge Point Amount:40889 Original Image:2011 Sift Feature Point:4090
Xiu Li, *et al.* [5]	A novel technique based on dark channel prior and luminance adjustment for resolving scattering and distortion issues.	Original Image:4.29 Naturalness Image Quality Evaluator: 3.20
Chong- Yi Li, *et al.* [6]	They hybrid the dehazing and contrast enhancement algorithms. The dehazing algorithm restored the visibility, color and nature appearance of underwater images and further contrast enhancement technique is used for increases the brightness of the image.	Approximate MSE: 425.68 PSNR:21.84dB
Alex, *et al.* [7]	Worked on adaptive histogram equalization technique to improve the enhancement of images.	Total Number of LUT: 10244
Amjad Khan, *et al.* [8]	They are used wavelet-based fusion method for improving the quality of underwater images.	
Peng, *et al.* [9]	Worked on a depth estimation method for underwater scenes based on image blurriness and light absorption, which can be used in the image formation model (IFM) to restore and enhance underwater images.	Approximate PSNR for different Images varies:17dB to 30dB
Kuldeep, *et al.* [11]	Proposed two recursive histogram equalization methods for underwater image enhancement.	Original Entropy: 5.55 Proposed Entropy: 5.48
Ghani, *et al.* [12]	The main goal of their method was to increase image's details and to improve the visibility by contrast correction by determining the mid-point from maxima and minima point on histogram.	Original Entropy: 7.338 MSE:153.01 PSNR: 26.28 Sobel Count:47,608 MSSIM: 0.986 EMEE: 2.335 NIQE: 3.126

III. RESEARCH GAPS

From the survey, found out some research gaps on which further work can be done.

1. In the past few years, numbers of techniques were proposed for image enhancement using histogram equalization and contrast stretching. These techniques improve visualization but degrade the quantitative parameters such as Entropy and PSNR. In the current era, natured inspired algorithm gives better visualization and enriches image quality in terms of entropy, good PSNR.
2. In the underwater images, due to reflection and absorption of light image quality degraded. So, image fusion techniques give an improved version of the original image. The fusion is done in transform domain gives better result. But, transform domain operations complex in nature. So, further research direction going on how to optimize these operations for hardware implementation.
3. In the existing technique image restoration or enhancement is done on all color channel component. So, further research direction is determine to which channel component distorted or need enhancement.

IV. CONCLUSION

The underwater images quality degraded due to scattering of light, refraction and absorption parameters. To resolve these issues and to improve the quality of underwater image, number of techniques is proposed in recent years. We have done literature survey on underwater image and conclude that the hybridization of algorithms is done for better visualization like wavelet fusion and contrast enhancement, improving contrast and color correction *etc*. Also, we have done comparative analysis of different techniques on the basis of different performance parameters like Entropy, MSE, and PSNR, Sobel Count, SSIM, FSIM, Naturalness Image Quality Evaluator *etc*. From the literature survey, also found some research component in which further work can be done.

V. REFERENCES

[1] A.K. Bhandari, A. Kumar, S. Chaudhary, and G.K. Singh, "A novel color image multilevel thresholding based segmentation using nature inspired optimization algorithm," Expert System with Applications, Vol. 63, pp. 112-133, June 2016.

[2] Vikram Dwivedi, Paresh Rawat, and Nashrah Fatima, "Image set creation using different image enhancement technique for underwater image segmentation," International Journal of Computer Applications, Vol. 150, Issue No.10, September 2016.

[3] Ahmad Shahrizan Abdul Ghani, Raja Siti Nur Adiimah Raja Aris, and Muhamad Luqman Muhd Zain, "Unsupervised Contrast Correction for underwater Image Quality Enhancement through Integrated Intensity Stretched-Rayleigh Histogram," Journal of Telecommunication, Electronic and Computer Engineering, Vol. 8, No. 3,pp. 1-7, 2016.

[4] Yakun Gao, Haibin Li, and Shuhuan Wen, "Restoration and enhancement of underwater images based on bright channel prior," Mathematical Problems in Engineering, pp. 1-15, September 2016.

[5] Xiu Li, Zhixiong Yang, and Min Shang, "Underwater image enhancement via dark channel prior and luminance adjustment," Shanghai Ocean, April 2016.

[6] Chong-Yi Li, Ji-Chang Guo, Run-Min Cong, Yan-Wei Pang, and Bo Wang, "Underwater image enhancement by dehazing with minimum information loss and histogram distribution prior," IEEE transaction on image processing, Vol. 25, No. 12, pp.5664-5677, December 2016.

[7] Alex Raj S., Deepa, and Supriya M.H., "Underwater image enhancement using CLAHE in a reconfigurable platform," MTS/IEEE Monterey Oceans, December 2016.

[8] Amjad Khan, Fabrice Meriaudeau, Syed Saad Azhar Ali, and Aamir Saeed Malik, "Underwater Image enhancement and dehazing using wavelet based fusion for pipeline corrosion inspection," 6th International conference on intelligent and advance systems, January 2017.

[9] Yan- Tsung Peng and Pamela C. Cosman, "Underwater image restoration based on image blurriness and light absorption," IEEE transaction on image processing, Vol. 26, No. 4, April 2017.

[10] Jeet Banerjee, Ranjit Ray, and Shambhunath Nandy, "Real-time underwater image enhancement: An improved approach for imaging with AUV-150", Indian Academy of Sciences, pp. 225-238,September 2015

[11] Kuldeep Singh, Rajiv Kapoor, and Sanjeev Kr. Sinha, "Enhancement of low exposure images via recursive histogram equalization algorithms," Optik Journals, pp. 2619-2625, June 2015.

[12] Ahmed Shahrizan Abdul Ghani and Nor Ashidi Mat Isa, "Enhancement of low Quality Underwater Images through Integrated global and local contrast," Applied Soft Computing, pp.332-344, August 2015.

[13] Samarth Borkar, and S.V. Bond, "Underwater image restoration using single color channel prior," International Conference on Signal and Information Processing, February 2017.