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Quality Enhancement for Underwater Images using Various Image Processing Techniques: A Survey

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Abstract: Underwater images are essential to identify the activity of underwater objects. It played a vital role to explore and utilizing aquatic resources. The underwater images have features such as low contrast, different noises, and object imbalance due to lack of light intensity. CNN-based in-deep learning approaches have improved underwater low-resolution photos during the last decade. Nevertheless, still, those techniques have some problems, such as high MSE, PSNT and high SSIM error rate. They solve the problem using different experimental analyses; various methods are studied that effectively treat different underwater image distorted scenes and improve contrast and color deviation compared to other algorithms. In terms of the color richness of the resulting images and the execution time, there are still deficiencies with the latest algorithm. In future work, the structure of our algorithm will be further adjusted to shorten the execution time, and optimization of the color compensation method under different color deviations will also be the focus of future research. With the wide application of underwater vision in different scientific research fields, underwater image enhancement can play an increasingly significant role in the process of image processing in underwater research and underwater archaeology. Most of the target images of the current algorithms are shallow water images. When the artificial light source is added to deep water images, the raw images will face more diverse noises, and image enhancement will face more challenges. As a result, this study investigates the numerous existing systems used for quality enhancement of underwater mages using various image processing techniques. We find various gaps and challenges of current systems and build the enhancement of this research for future improvement. Aa a result of this overview is to define the future problem statement to enhance this research and overcome the challenges faced by previous researchers. On other hand also improve the accuracy in terms of reducing MSE and enhancing PSNR etc.

Keywords: Underwater images, segmentation, noise removal, quality enhancement, PSNR, MSE, SSIM, image filtration.

I. INTRODUCTION

Underwater data or images acquisition technology has progressed rapidly in last decade, and the use of underwater item identification technology has grown more common. Submarine optical cables are laid, underwater oil platforms are built and maintained, sunken submarine ships are salvaged, marine organism fishing is done, and marine environment research is done, among other things. Underwater optical images have a great resolution and a lot of information, which gives them an evident advantage in detecting underwater targets at a short distance. Underwater photographs, on the other hand, often suffer from noise interference, fuzzy texture characteristics, poor contrast, and color distortion as a result of light scattering and absorption. Due to a lack of useable information in an underwater picture target recognition. Submerged image enhancement knowledge can help with challenging tasks like finding and monitoring marine species while also improving the quality of underwater photographs. Consequently, if high-resolution and high-color saturation underwater images are to be produced, enhancing the attributes of underwater image objects is crucial.

Underwater optical imagery is substantially influenced by light capture and scattering by aquatic organisms compared to air optical imaging. Furthermore, water absorbs light of differing wavelengths in opposite directions, and absorption is the signal loss produced by the sun reflecting off a material entering the camera. Color attenuation may occur as a result of absorption. Because red light absorbs most of the energy and blue-green light absorbs the least, the underwater picture is blue and green. On the other hand, scattering is the loss of energy caused by a change in the direction of light in the diffusion process, which can be produced by colloidal particles or ambient light. Backscattering causes picture

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background noise and reduces image contrast when used in underwater photography. Forward scattering causes the point light source to scatter in a scattered circle, resulting in blurring in texture, edges, colors, and other features. To address the aforementioned issues, a variety of underwater image processing technologies have emerged, which are broadly divided into contrast enhancement methods derived from non-model, multi resolution methods regarding the physical model, and contrast enhancement techniques based on deep neural networks. This paper section II demonstrates a literature review of various existing research work done by previous authors and section III depicts the discussion of research and section IV demonstrates a conclusion of future work of proposed research.

II. LITERATURE SURVEY

Contrast Enhancement of underwater images [1]

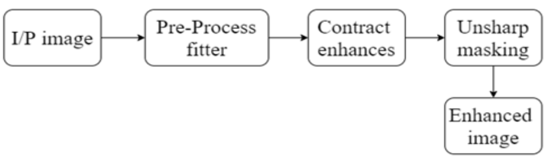

Figure 1: Contrast enhancement of underwater images

In this paper, novel pre-processing filters are used to restore the image. The focus on contrast enhancement to recover image of specific area it also improves blurred and darkness of image for visual quality. The major benefit of this work it improves Quality of image which are dark & blurred and enhance the performance of still image regardless of its construction.

Image Enhancement in the Water Based on histogram equalization both globally and locally, as well as dual-image multi-scale fusion [2]

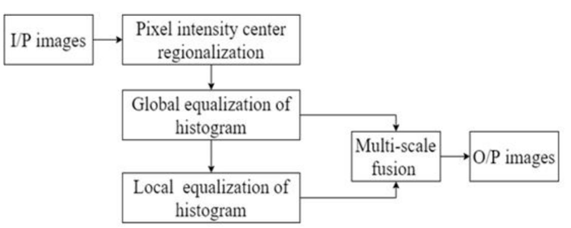

Figure 2: Water Based on histogram equalization

After this global and local equalization histogram approach, this technique concentrates the pixel intensity center regionalization plan, which increases color and contrast. Finally, a double image is employed to improve the quality of multi-scale fusion pictures. The luminance and chrominance features have been used for generating the multi scale fusion. This approach can improve the quality of the real world and low light images, and natural colors can enhance images with high contrast and sharp textures. The limitation of this work is that image enhancement cannot achieve the background colour's consistency for underwater photos and does not apply to water images taken at different turbidity levels.

A deep residual framework is used to improve underwater images [3]

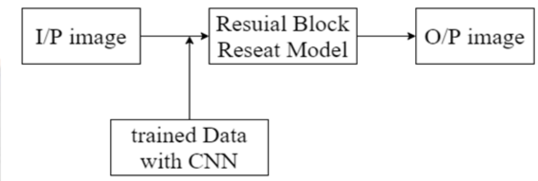

Figure 3: Deep residual framework

In this approach deep residual frame framework used. Firstly, the cycle consistent adversarial network is used to developed training data for CNN. An intense super-resolution reconstruction model is used with the recent model. The technique mentioned above enhances image contrast and improves the visual effect of underwater images, which is helpful for the execution of vision-based tasks like segmentation and trucking. The limitation of this technique not used for dehazing & super resolution reconstruction to test the generality of proposed method.

Improvement of underwater images using a combination of CLAHE and percentile methods [4]

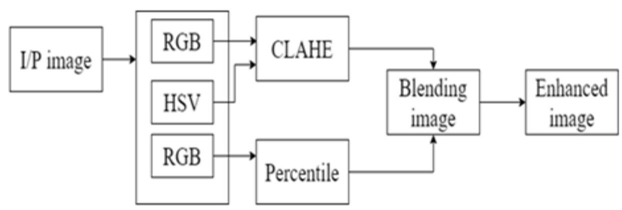

Figure 4: CLAHE and percentile methods

In this technique construct limited adaptive histogram equalization and percentile methodologies used & both techs are blended foe improve quailing of images. Root mean squared error & entropy have been considered for finagling results. It can effectively enhance image visibility and better in term of color & clarity.

Enhancement of underwater images via color balance and fusion [5]

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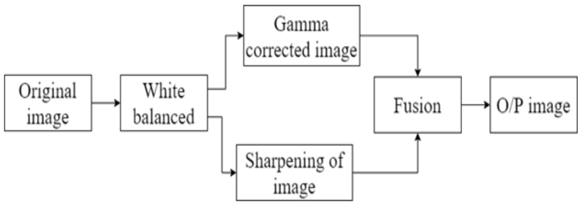

Figure 5: Color balance and fusion

In this technique fusion is used only one image consider as input & white balancing is applied on image after this gamma correction & sharpening operation perform on I/P images. Both results are combined by using fusion technique & quality. It can improve a wide variety of underwater photos. e.g., various cameras, depths, and light conditions with great precision beginning to be able to restore essential fading features and edges. It is used in segmentation & local feature point matching application.

Wavelet-based fusion for underwater image enhancement [6]

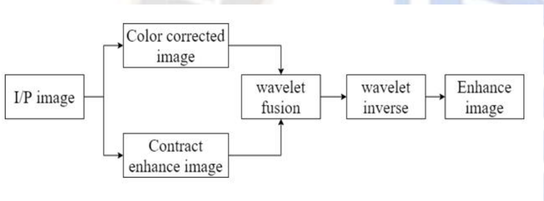

Figure 6: Wavelet-based fusion for underwater image enhancement

This paper proposed a approach of hazy image is taken as input image & color corrected & contrast enhanced image used for fusion. On both images wavelet coeffect are applied finally fusion of image process & wavelet based inverse composition is applied after this Enhance image get as an output. In extensive experimental analysis of system, it demonstrates it enhances the quality hazy images.

Improvement of a single underwater image utilizing depth estimate based on blurriness [7]

In this technique firstly pine blurriness estimation is done. Rough depth map is generated & map is refined for enhancement. The pixel values estimation technique has used for estimation of pixels on blurriness. This approach can give improvement with MSE, PSNR and SSIM for performance evaluation parameters. The major benefit of this system it produces very good results in different lighting condition.

Unique underwater image, a retinex-based enhancement method [8]

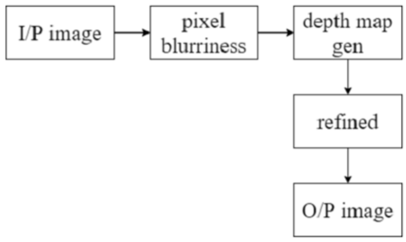

Figure 7: Retinex-based enhancement method

Description: In this technique firstly color correction strategy is applied then retinex algorithm used to adjust brightness seconding optimization stalely used with under exposure and fuzzy problem. It is using this multi-technique approach, the outcome improves. It uses a simple and effective post-processing method to enhance photos that have been deteriorated. It also improved the picture by adding color correction, brightness, naturalness, and sharpness.

Underwater image improvement using mixture contrast limiting adaptive histogram equalization [9]

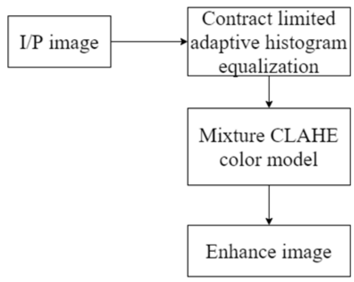

Figure 8: mixture contrast limiting adaptive histogram equalization

In this contrast limited adaptive histogram equalization color models used for enhancement. It applied or RGB & HSV color models & finally result are combined using Euclidean norms. To improve the picture quality, they utilised a combination CLAHE colour model. This approach may increase underwater picture visibility while producing the lowest MSE and most excellent PSNK value.

Wavelength adjustment and dehazing are used to improve underwater images [10]

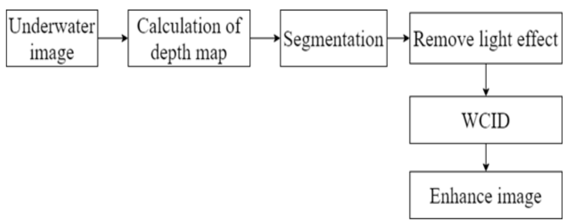

Figure 9: Wavelength adjustment and dehazing

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In this technique focused on light scattering and color change distortion issue. Dehazing algorithm used depth map is calculated color compensation is used to color balancing & finally wavelength, color change compensation is conducted to restore color bilevel (WCID) wavelength compensation & images dehazing. This approach can effectively work for restore image & color balance & it removes haze and it can handle light scattering & color change distortion.

Improvement of low-complexity underwater images using dark channel priors [11]

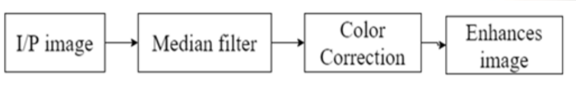

Figure 10: dark channel priors

In this technique median filter used to estimate the dept map & color correction techniques are used to enhance the contrast. Filtration techniques remove the noise from image and after RGB and CMYK correlation model has used for enhancement of resultant image. This system required less execution and communication cost with low resource dependency.

Using an unsupervised colour restoration approach to improve a low-quality representation [12].

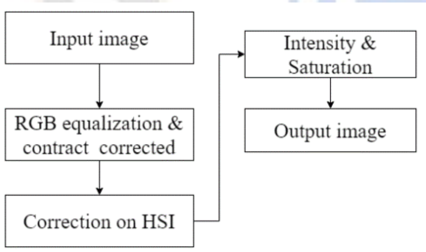

Figure 11: unsupervised color restoration approach

This technique offered an unsupervised color correcting algorithm for picture improvement underwater. It works on color cast first, and then it improves contrast correction in all color Changes. Finally, for contrast correction, the saturation and intensity of HSI have been changed. It can remove the bluish color cast & improve low red color and it improve the true colors & illumination. This method not produce good result when applied to images which do not have blue colors cast such as land images. Enhancement of underwater images using Quaternions and attenuation inversion [13]

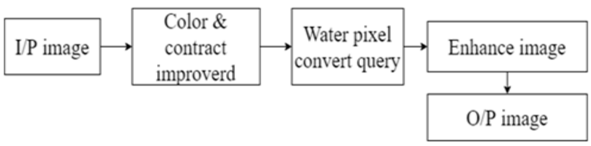

Figure 12: Quaternions and attenuation inversion

Description: In this paper the color & contrast is improved. Pixel of water moved top gray and it differentiate turn object by using such technique result are get improved. The major benefit of this work is, color balance handier very property. It gives better separation for balance priority & fragment.

Underwater imaging contrast improvement using coherent optic image processors [14]

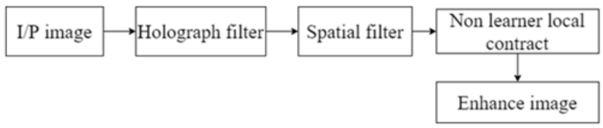

Figure 13: coherent optic image processors

In this technique holographic filter is used to enhance contrast in underwater images. filter is modified with spatial filter for enhancing local part. Hologram filter and spatial filter has used for remove the noise. The non-learner local contract model has used for enhancing the image quality. This approach provides high quality of services of images.

Self-tuning method for underwater image restoration [15]

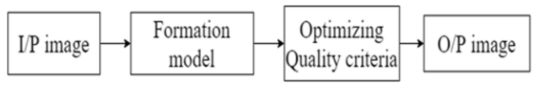

Figure 14: Self-tuning met

By maximizing a quality criterion based on a global contrast measure, optimal values of a filter para are automatically computed for each unique picture. For preprocessing, they utilized the formation model. It's self-tuning inside the sense that it calculates the best para values.

To use an integrated color model to improve underwater images [16]

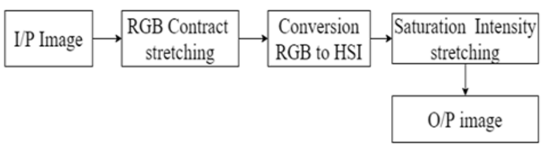

Figure 15: integrated color model

In this technique side stretching used for improve the saturation intensity stretching. First, the RGB algorithm is used to lengthen the color contrast in the picture, then the HSE is used to raise the actual color, and finally, the image is enhanced. It aids in balancing color contrast in photographs and focusing on lighting issues.

An Underwater Color Image Quality Analysis Metric [17]

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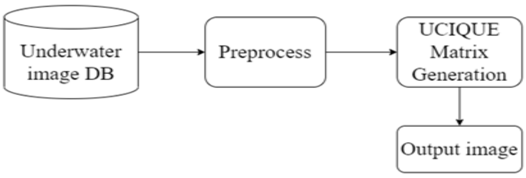

Figure 16: Image Quality analysis

Subjective underwater picture quality assessment has been organized. According to the statistical distribution of underwater image pixels in the CIE-Lab color space attached to the individual review, sharpness and color aspects firmly match the perception of subjective picture quality.

Underwater Image Enhancement by Dehazing with Minimum Information Loss and Histogram Distribution Prior [18]

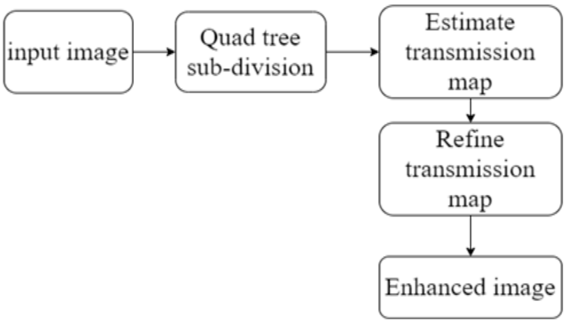

Figure 17: deep residual framework

An underwater picture enhancement approach may provide two separate output versions. An underwater picture dehazing technique and a contrast enhancement algorithm are included in the suggested process. Based on the most negligible information loss principle and underwater photography optical features, the dehazing method may reduce the information loss of improved underwater photos.

A Review of Contrast Enhancement and Restoration Methods for Underwater Imaging Based on Experiments [19]

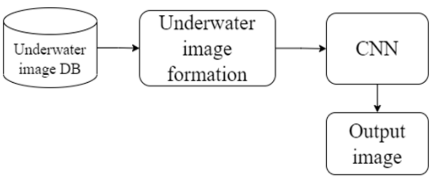

Figure 18: Contrast Enhancement and Restoration Methods

Picture improvement and restoration techniques that address frequent underwater image problems, such as severe degradations and distortions. In terms of the underwater picture generation paradigm, we first discuss the primary reasons of quality loss in underwater photos (IFM). Then we go through underwater restoration strategies, looking at both IFM-free and IFM-based options.

A Novel Two-Step Underwater Contrast Enhancement Strategy Is based on White-Balancing and Fusion [20]

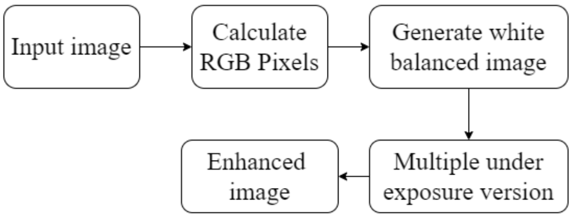

Figure 19: Two-Step Underwater Contrast Enhancement Strategy

An enhancement method for improving the visual quality of underwater photos does not need special equipment or information beyond the original single image. For underwater photography, the suggested solution consists of two steps: better white-balancing or artificial multiple underexposure picture fusion mechanisms.

Sonar Image Quality Assessment Using Task and Visual Perception as a Semi-Reference [21]

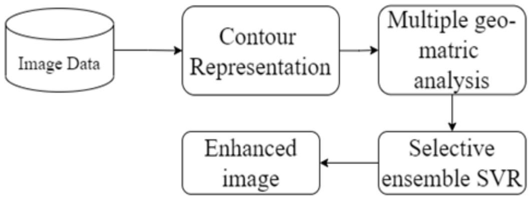

Figure 20: Task and Visual Perception framework

TPSIQA is a task- & perception-oriented sonar image quality assessment system that adjusts to the limited bandwidth of underwater communication channels using a semi-reference (SR) technique. Extensive testing on the SIQD database has shown that the TPSIQA methodology is superior to the existing state-of-the-art FR IQA approaches and often discussed SR IQA methods for NSIs and SCIs.

Improving Underwater Acoustic Interference Pattern with a Confidence-Based Approach [22]

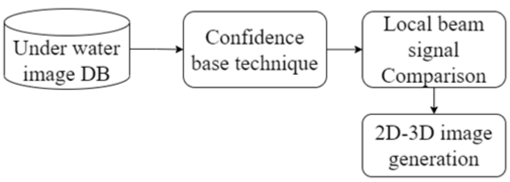

Figure 21: Confidence-Based Approach

The method serves as an excellent interface between the signals generated by a focused beamforming technique (i.e., beam signals) and the accompanying image, which may be two-dimensional (2-D) and three-dimensional (3-D) (3-D). Following white Gaussian noise, they evaluated the

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recommended confidence measures on objective data (1-D array) and simulated data (2-D array).

Landscape Depth-Based Adaptive Frequent Source Estimation with Dark Channel Prior Algorithms for Underwater Image Enhancement [23]

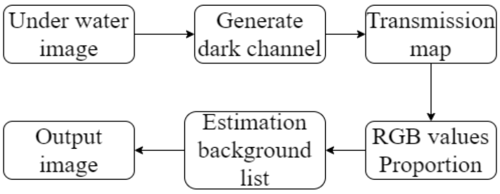

Figure 22: Landscape Depth-Based Adaptive Frequent Source Estimation with Dark Channel Prior

It is a new approach for estimating background light that may improve underwater images. They may also use it with artificial illumination in depths of 30-60 meters. The system uses deep learning to obtain red channel information of the background light in the dark channel of the underwater image. The precision of scene depth assessment, on the other hand, influences our technique.

Spiral Generative Adversarial Framework for Underwater Image Enhancement [24]

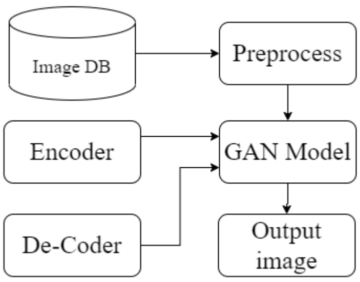

Figure 23: Spiral Generative Adversarial Framework

Spiral-GAN is a novel underwater image enhancement technique that use a spiral generative adversarial architecture to successfully recover real-world underwater photos with increased features, colors, and contrast. We combine the pixels losses, composed of a mean squared error or an angle error, into our objective function for regular training and color correction—a GAN-based model for underwater photo improvement that is simple but effective.

To use the Multilayer Perceptron with Color Feature-Based SRCNN to Display High-Definition Underwater Images [25]

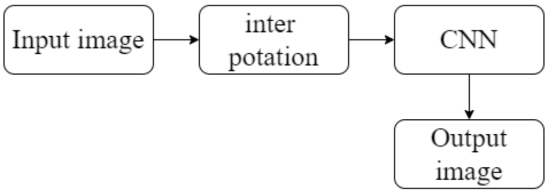

Figure 24: Feature-Based SRCNN

An approach for underwater picture enhancement and a super resolution algorithm for images The Retinex method is modified and used with a neural network to increase the quality of underwater photographs. The underwater picture is defogged using the Retinex method, and then the brightness of the image is increased using gamma correction. To increase the dynamic range of the picture, the wavelet transform is combined with the contrast enhancement and a multi-layer recurrent neural network.

III. FINDINGS AND DISCUSSIONS

According to above literature we analyze numerous underwater image quality analysis and quality enhancement methods using various segmentation techniques. Below are the findings we identified after this investigation.

- For restoration, the majority of systems employed different filtering approaches as well as color models, resulting in significant MSE and computation.
- Because many paired underwater datasets are difficult to come by, most systems have relied on real-time datasets to simulate underwater pictures from in-air images and depths. To produce underwater degraded output pictures, the generative adversarial network combines the process of underwater image generation. The image improvement network will employ the synthetic underwater photos.
- We describe most of image processing techniques and utilization of supervised machine learning classification algorithms, for enhancement of quality to underwater images.
- The accompanying mathematical formulation for the platform's hidden layer output is constructed using a deep supervision mechanism, which directs the network training process and improves the phenomena of the gradient disappearing during stochastic gradient descent of the deep learning model. This increases the network's resiliency and allows the model to provide a decent enhancement impact on photos with varying degrees of deterioration

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IV. CONCLUSION

It is difficult to obtain huge amounts of underwater data in depths settings for underwater picture improvement using several state-of-the-art approaches. Getting the actual hues of natural seafloor landscapes from the ground truth is also a challenge. Additionally, most supervised learning algorithms fail to retain and transmit underwater picture information correctly and extract depth data from underwater photos entirely. It results in colour imbalance and detail blurriness in recovered images, restricting their applicability in real-world scenarios. This research offers a deep supervised residual dense network for underwater picture improvement that learns the mapping connection between clean in-air images and synthetically damaged underwater photos more effectively. The whole study looks at the problems of current underwater picture quality improvement research, as well as the necessity for enhanced supervised deep learning in subsequent researcher.

REFERENCES

[1] Sinha, G. R., Kavita Thakur, and M. K. Kowar. "Contrast Enhancement of Underwater Images." Journal of Acoustical. Society of India 35.1 (2008): 33-35.

[2] Bai, Linfeng, et al. "Underwater image enhancement based on global and local equalization of histogram and dual-image multi-scale fusion." IEEE Access 8 (2020): 128973-128990.

[3] Liu, Peng, et al. "Underwater image enhancement with a deep residual framework." IEEE Access 7 (2019): 94614-94629.

[4] Garg, Diksha, Naresh Kumar Garg, and Munish Kumar. "Underwater image enhancement using blending of CLAHE and percentile methodologies." Multimedia Tools and Applications 77.20 (2018): 26545-26561.

[5] Dhivya, R., R. Praka1sh, and M. R. Mohanraj. "Color Balance and Fusion for Underwater Image Enhancement." Digital Image Processing 11.2 (2019): 25-29.

[6] Khan, Amjad, et al. "Underwater image enhancement by wavelet-based fusion." 2016 IEEE International Conference on Underwater System Technology: Theory and Applications (USYS). IEEE, 2016.

[7] Peng, Yan-Tsung, Xiangyun Zhao, and Pamela C. Cosman. "Single underwater image enhancement using depth estimation

[8] based on blurriness." 2015 IEEE International Conference on Image Processing (ICIP). IEEE, 2015.

[9] Fu, Xueyang, et al. "A retinex-based enhancing approach for single underwater image." 2014 IEEE international conference on image processing (ICIP). IEEE, 2014.

[10] Hitam, Muhammad Suzuri, et al. "Mixture contrast limited adaptive histogram equalization for underwater image enhancement." 2013 International conference on computer applications technology (ICCAT). IEEE, 2013.

[11] Chiang, John Y., and Ying-Ching Chen. "Underwater image enhancement by wavelength compensation and dehazing." IEEE transactions on image processing 21.4 (2011): 1756-1769.

[12] Yang, Hung-Yu, et al. "Low complexity underwater image enhancement based on dark channel prior." 2011 Second International Conference on Innovations in Bio-inspired Computing and Applications. IEEE, 2011.

[13] Iqbal, Kashif, et al. "Enhancing the low-quality images using unsupervised colour correction method." 2010 IEEE International Conference on Systems, Man and Cybernetics. IEEE, 2010.

[14] Petit, Frédéric, Anne-Sophie Capelle-Laizé, and Philippe Carré. "Underwater image enhancement by attenuation inversionwith quaternions." 2009 IEEE International Conference on Acoustics, Speech and Signal Processing. IEEE, 2009.

[15] Christie, S. M., and F. Kvasnik. "Contrast enhancement of underwater images with coherent optical image processors." Applied optics 35.5 (1996): 817-825.

[16] Trucco, Emanuele, and Adriana T. Olmos-Antillon. "Self-tuning underwater image restoration." IEEE Journal of Oceanic Engineering 31.2 (2006): 511-519.

[17] Gunjal, M. B. ., & Sonawane, V. R. . (2023). Multi Authority Access Control Mechanism for Role Based Access Control for Data Security in the Cloud Environment. International Journal of Intelligent Systems and Applications in Engineering, 11(2s), 250 –. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/2623

[18] Iqbal, Kashif, et al. "Underwater Image Enhancement Using an Integrated Color Model." IAENG International Journal of computer science 34.2 (2007).

[19] Yang, Miao, and Arcot Sowmya. "An underwater color image quality evaluation metric." IEEE Transactions on Image Processing 24.12 (2015): 6062-6071.

[20] Mr. Ather Parvez Abdul Khalil. (2012). Healthcare System through Wireless Body Area Networks (WBAN) using Telosb Motes. International Journal of New Practices in Management and Engineering, 1(02), 01 - 07. Retrieved from http://ijnpme.org/index.php/IJNPME/article/view/4

[21] Li, Chong-Yi, et al. "Underwater image enhancement by dehazing with minimum information loss and histogram distribution prior." IEEE Transactions on Image Processing 25.12 (2016): 5664-5677.

[22] Wang, Yan, et al. "An experimental-based review of image enhancement and image restoration methods for underwater imaging." IEEE Access 7 (2019): 140233-140251.

[23] Tao, Ye, Lili Dong, and Wenhai Xu. "A Novel Two-Step Strategy Based on White-Balancing and Fusion for Underwater Image Enhancement." IEEE Access 8 (2020): 217651-217670.

[24] Chen, Weiling, et al. "Semi-reference sonar image quality assessment based on task and visual perception." IEEE Transactions on Multimedia 23 (2020): 1008-1020.

[25] Murino, Vittorio, and Andrea Trucco. "A confidence-based approach to enhancing underwater acoustic image formation." IEEE transactions on image processing 8.2 (1999): 270-285.

[26] Yang, Shudi, et al. "Underwater image enhancement using scene depth-based adaptive background light estimation and

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dark channel prior algorithms." IEEE Access 7 (2019): 165318-165327.

[27] Han, Ruyue, et al. "Underwater Image Enhancement Based on a Spiral Generative Adversarial Framework." IEEE Access 8 (2020): 218838-218852.

[28] Mondal , D. (2021). Green Channel Roi Estimation in The Ovarian Diseases Classification with The Machine Learning Model . Machine Learning Applications in Engineering Education and Management, 1(1), 07–12.

[29] Thomas Wilson, Andrew Evans, Alejandro Perez, Luis Pérez, Juan Martinez. Integrating Machine Learning and Decision Science for Effective Risk Management. Kuwait Journal of Machine Learning, 2(4). Retrieved from http://kuwaitjournals.com/index.php/kjml/article/view/208

[30] Li, Yujie, et al. "Underwater image high definition display using the multilayer perceptron and color feature-based srcnn." IEEE Access 7 (2019):83721-83728

[31] substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[32] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[33] Electronic Publication: Digital Object Identifiers (DOIs):
Article in a journal:

[34] D. Kornack and P. Rakic, "Cell Proliferation without Neurogenesis in Adult Primate Neocortex," Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.
Article in a conference proceeding:

[35] H. Goto, Y. Hasegawa, and M. Tanaka, "Efficient Scheduling Focusing on the Duality of MPL Representatives," Proc. IEEE Symp. Computational Intelligence in Scheduling (SCIS 07), IEEE Press, Dec. 2007, pp. 57-64, doi:10.1109/SCIS.2007.357