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Underwater Image Enhancement

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Abstract- **Images shot underwater are not always clear since they are taken in water and light behaves differently there. When trying to capture distant objects, underwater photographs are particularly prone to color distortion and a pronounced blue color predominance. Both light attenuation and light scattering have an impact on this. Even after restoring the image, I still need to use the histogram equalization approach to improve the colors. Depending on the working approach chosen and the resources at the designer's disposal, testing the outcomes can be done in a variety of ways. In our project, using wavelet fusion and CLAHE, we will demonstrate how to get rid of image interference and attempt to capture the precise colors of the item submerged. Because photos taken underwater are vulnerable to light dispersion and refraction, resulting in hazy images with little details, this project will assist individuals in performing object detection even if the image input is not particularly clear.**

Index Terms- **Wavelet fusion, CLAHE, Interference, Enhanced, Attenuation, Histogram Equalization**

I. INTRODUCTION

As there is an increasing need for high-quality images in various applications, underwater image processing has developed a separate identity in the research community. It is difficult and requires specialized equipment to take a good photo in an underwater environment. Without specialist hardware, we receive a poor image that needs to be improved. Remaking a digital image involves enhancing it, and the resulting image can then be used for better display or research purposes. The fundamental goals of image improvement are to brighten visual elements like boundaries, edges, or contrasts and to lessen ringing artefacts. The quality of the image or video degrades owing to scatters when we take pictures or videos underwater. [2]. Light is diminished in an undersea environment as a result of water molecules, suspended particles, and other pollutants. As light travels deeper into the water, attenuation rises. In such a setting, less irradiance from the scene's objects reaches the camera during the picture generation process, changing the genuine colors of the objects. The range of the visible spectrum colors depends on both their wavelength and the depth of the water. Shorter wavelengths can go farther before being absorbed by water, whereas longer wavelengths do [1]. As a result, images have high absorption, poor contrast, noise, and low visibility. For some purposes, these underwater photos therefore need to be enhanced. Diverse domains, such as mine detection, underwater microscopic detection, autonomous underwater vehicles, communications cable terrain scanning, etc., have experienced an increase in the uses of underwater image processing in recent years.

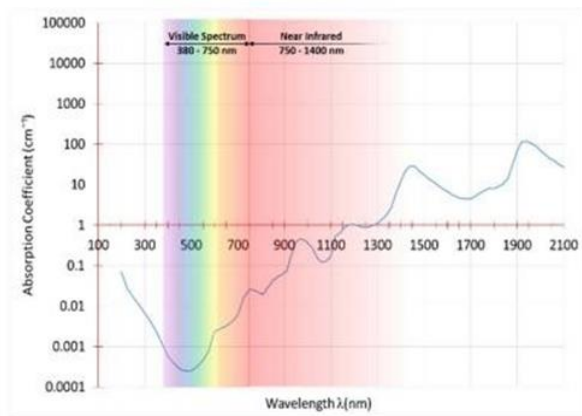

Fig: Visible light's water absorption coefficient [2].

This suggests that image enhancement could be significant. Digital image processing offers a variety of image enhancing methods, including color correction, white balancing, the dark channel before, the fusion-based method, and Histogram equalization. These methods are insufficient for a physical model of the ocean, however, hence they cannot be employed for the processing of underwater images. Consequently, numerous researchers have proposed a wide range of strategies for improving underwater image quality. [8]. An enhancement techniquebased on wavelets fusion is implemented in this project. The basic idea behind wavelet-based image fusion is to combine the wavelet decompositions of the two original images by employing fusion techniques on the details and approximations coefficients. And few other techniques such as CLAHE is alsobeing used [9].

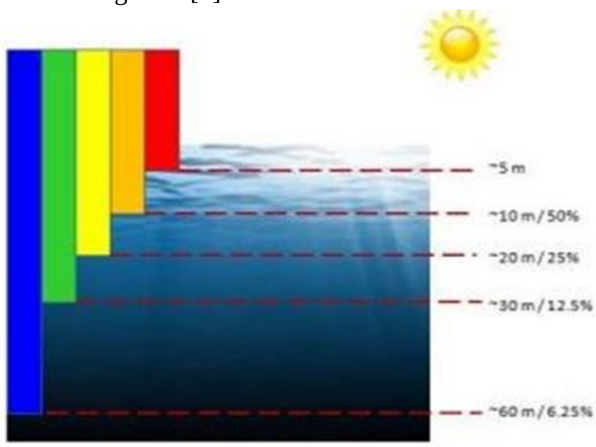

Fig: Water's Light Absorption

II. LITERATURE SURVEY

Haibin Li, Shuhuan, and Yakun Gao Wen suggested a new technique for restoring and enhancing underwater photographs that was modelled after the dark channel technique used in the field of image dehazing before. They suggested using the light channel before the underwater environment in order to restore the image. Secondly, the restoration images were equalized to rectify the color distortion using the inferred histogram equalization outcomes of the experiment demonstrated that the suggested technique might significantly improve the quality of underwater photographs. The strategy they used was to provide technologies that can improve the quality of images without taking into account the physics model. The physics model of image generation serves as the foundation for image restoration techniques. The bright tunnel before the underwater environment was their first suggestion. The final reconstruction of the underwater photographs required the use of the bright channel image, ambient light, transmittance image estimate, and enhancement. Then, in order to further rectify the color distortion, we equalized the restored photos using the histogram equalization that was calculated. As a result of this constraint, they determined that the dark channel images in underwater photographs are different from those in air. While distant or sky-filled scenes always include prominent dark channels in the air, this phenomenon does not apply to dark channels in underwater photographs. We can therefore conclude that the dark channel before did not effectively restore the underwater image. They believed that the derived histogram equalization method would be employed in the future to address the color distortion issue. This method may not be the best because it could result in one channel being over-equalized, despite the fact that this research shows how effective it is. Therefore, one should try to find a solution to the color distortion problem for future improvements. [3].

Kashif Iqbal, Rosalina Abdul Salam, Azam Osman and Abdullah Zawawi Talib proposed a development work on the techniques and methods for image enhancement. They briefly touch on a few issues, such as light absorption and the sea's innate structure, that relate to underwater photographs. Additionally, we go through how color influences pictures taken underwater. Slide stretching was the foundation of their strategy. To balance color contrast in the images, RGB algorithm contrast stretching is applied first. Secondly, to improve true color and alleviate lighting concerns, HSI saturation and intensity stretching are used. They discovered that the HSI model offers a greater color range by managing the image's color components. Intensity and saturation work together to provide a wider color range. When the "S" and "I" values govern the blue color element in the image, for example, the range of the blue color can be increased from pale blue to deep blue. By adjusting the value, one can use this technique to change the contrast ratio in underwater photographs. They discovered that the technique was limited since it had not yet achieved the necessary level of success. For instance, the movement of autonomous underwater vehicles diminishes visibility when taking images underwater with an optical camera because it produces shadows on the scene. According to a future enhancement, the advantage of employing two stretching models is that it aids in balancing the color contrast in the images and also resolves the lighting issue. The histograms provide statistical evidence of the photographs' quality. Further analysis of the suggested strategy will be part of our future study.[4]

Syed Saad Azhar Ali*, Aamir Saeed Malik, Atif Anwer proposed a wavelet-based fusion technique has been developed to address color and contrast concerns in fusion and inverse composition. Here, image processing uses fusion to address a variety of issues. This technique is based on merging photos using discrete wavelet transform to improve underwater images. Their proposed approach addresses low contrast and color attenuation of hazy images. Therefore, we are applying the CLAHE and histogram stretching methodologies for contrast improvement and color correction.

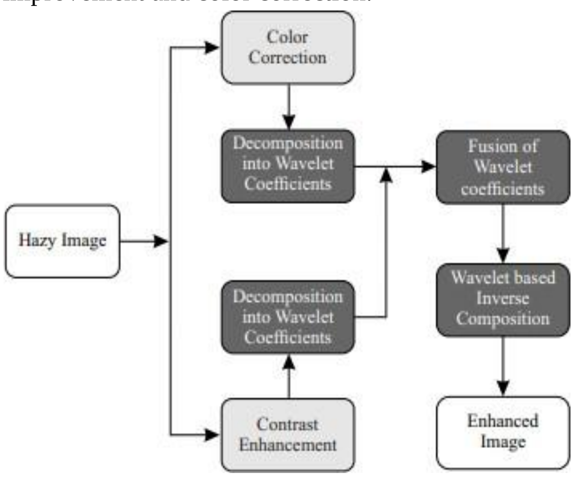

Figure: A wavelet-based fusion method for improving underwater image quality

They also found that four statistical measures, including the Root Mean Squared Error (RMSE), the Peak Signal to Noise Ratio (PSNR), the Structural Similarity Index Measure (SSIM), and the Measure of Entropy (MoE), are calculated to quantitatively evaluate the procedure. Additionally, the improved photos are qualitatively compared to contemporary image enhancing techniques. Here color and contrast enhancement are also done. Along with that decomposition, inversion and inverse composition is also done to get enhanced image. They found that this model reaches a limit when the mosaic vanishes and the color content largely decreases when the wavelet scale reaches the size of the image. Larger the scale of wavelet, more degradation. Smaller the scale of wavelet, mosaic appears. Future research will compare the proposed approach in-depth with cutting-edge quantitative analytic methods. [2]

Ezmahamrul Afreen Awalludin proposed a novel approach called Mixed Contrast Limited Adaptive Histogram Equalization (CLAHE) color models, which focuses primarily on enhancing the contrast and lowering the noise in the image. Here, a novel methodology was developed that merged two CLAHE results from applications to the two distinct color models RGB and HSV. The major objective is to significantly minimize the noise introduced by CLAHE to facilitate the following processing of underwater photos. He also investigated how CLAHE limits amplification by clipping the histogram at a user-specified threshold known as the clip limit. The histogram's noise smoothing level dictates how much the contrast should be increased based on the clipping level. Adaptive histogram clip (AHC), a version of the contrast limiting approach, can also be used. Both contrast-limited adaptive histogram equilibration (CLAHE) and adaptive histogram equilibration (AHE) were discovered to have limitations. These techniques are different from traditional histogram equalization in that they operate on discrete, tile-sized portions of the image and compute multiple histograms, each of which corresponds to a different area of the image. They then redistribute the image's brightness values using these histograms. AHE and CLAHE improve local contrast in an image by highlighting more features than does classic histogram equalization, while they still have a tendency to make the image noisier. Underwater image visibility is effectively increased by the enhancing technique. As a result, it demonstrates that the suggested strategy, particularly when visual signals are present, is promising for identifying coral reefs. Applying CLAHE to various color models and comparing the results will be the focus of future effort.[5]

Er. Charanjeet Kaur, Er. Rachna Rajput suggested a typical histogram equalization, each pixel is given the same modification derived from the image histogram. This functions well if the distribution of pixel values is uniform across the entire image. However, if the image has regions that are substantially lighter or darker than the remainder of the image, the contrast in those places won't be appropriately increased. The goal is to maintain image brightness while enhancing underwater image contrast. [6]

Dithee Dev K, Mr. S.Natrajan suggested contrast limited adaptive histogram equalization (CLAHE) approach which is recommended as effective methods for enhancing underwater images. The dark channel is calculated from the underwater input image and processed using image segmentation. then ascertain whether artificial light has had any impact on it. If so, remove it using the proper procedure before employing the CLAHE approach. By improving contrast as well as noise and artefacts, the experimental results of this technique considerably improve the visual quality of underwater photos.[7]

III. CONCLUSIONS

Improving underwater images is a work in and of itself because there are so many distinct factors that can impact the image that is produced. The use of various image enhancement techniques like AHE, GC, BBHE, CLAHE, Wavelet fusion etc. can be applied to enhance the visual quality of the obtained photos. In order to improve an image, the technique selection is crucial. Therefore, the impacts of noise, blurring, and restricted visibility on an image can be diminished. In the future we would like to work on building an algorithm with best and suitable which helps to reconstruct images taken under other liquids, wherein the amount of wavelength absorbed by the liquid is different when compared to water. So that it helps in many ways and in many areas of research.

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