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A Hybrid Technique For Underwater Image Enhancement Using Uwb And Log Filter

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Abstract
Underwater captured images often suffer from the extant literature may be broadly classified into two groups based on the use of the underwater picture generation model: underwater image enhancement and restoration. Objective evaluations have demonstrated that these existing methods may perform well, but they fall short in accounting for multiple degradation and the loss of crucial data the conditions in which they can be used. Restoration algorithms are heavily reliant on accurate previous assumptions and need more prior knowledge about the imaging circumstances. But unlike in the atmosphere, most scenarios in the complex and dynamic undersea world are hard to generalize based on a priori assumptions. So, it could lead to low resilience and subpar outcomes. When it comes to improvement algorithms, red artifact production is a frequent issue having two main deteriorations—scattering and absorption—causing low visibility. Our proposal in this research is a hybrid method for improving underwater images by combining underwater white balance and Laplacian of Gaussian Filtering. To further accommodate for attenuation differences throughout the propagation line and eliminate unwanted color casts, we have implemented the updated underwater white balance (UWB) algorithm with gamma correction in our approach. On the basis of the improved outcome from UWB, a Laplacian of Gaussian (LOG) model is also created. Improved saturation and contrast, together with the removal of scattering-induced haziness, are the main benefits of the LOG model. In order to expedite the solution of the LOG model, we have devised a quick Gaussian pyramid strategy. In terms of color correction, haze reduction, and detail clarity, our technique performs better. The efficacy and broad possibilities of our suggested strategy are confirmed by further application testing.
Keywords: *Hybrid technique, dehazing, underwater white balance, Laplacian of Gaussian Filter*

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I. INTRODUCTION

A growing amount of study has focused on the use of marine resources due to the grave issues brought about by the depletion of terrestrial resources, population growth, and environmental degradation. However, due to complex underwater imaging conditions, inadequate visibility occurrences are common in underwater image capture, creating a few difficulties in finding maritime resources. Establishing a framework is crucial that permits dependable and efficient approaches to underwater image processing to address the difficulties associated with beneath the surface

photography. In an effort to improve image visibility and clarity, several techniques have been proposed to solve the problem of underwater picture degeneration. While providing significant cases for underwater exploration. Even though objective evaluations have shown the high performance of these solutions, there are only a few scenarios in which they are truly relevant due to the lack of thorough consideration for multiple degradation and crucial information loss. The right prior hypotheses play a major role in restoration algorithms, since they need more prior information about the imaging conditions. Nonetheless, a previous theory, like in the atmosphere, finds it difficult to generalize most scenarios in the complex and dynamic undersea world. That might therefore lead to low resilience and subpar outcomes.

The production of red artifacts is a frequent issue with improvement algorithms. We provide a unique Variational framework for color adjustment and saturation and contrast enhancement in order to solve these issues. Optical attributes are used to build an enhanced underwater white balance (UWB) algorithm. This method compensates for scattering-induced contrast loss and eliminates color casts brought on by artificial or natural light. Next, using the UWB result as a guide to supply some crucial previous reference data, we develop a Laplacian of gaussian filter (LOG) model. In conclusion, the primary things we have contributed are:

(1) A better underwater white balance method that effectively integrates the histogram stretching technique to uniformly produce three color channels is suggested in an effort to lower color estimate error.
(2) To get haze-free results, a variational model including two regularized terms and a data term is built. This model requires a minimal number of iterations.
(3) To solve the suggested variational model, a quick Gaussian pyramid-style method is developed in order to increase the iteration efficiency.
(4) When compared to previous approaches, the suggested method can perform better in real color and have higher resilience in various challenging circumstances.

II. Background Work

Based on a detailed analysis of McGlamery and Jaffe's underwater image formation model, back scattering, forward scattering, and direct composition make up the three parts of the entire incident light in the undersea medium that enters the image plane. The light that an object directly reflects is known as the direct component.—that is, without dispersing into the water. These are the direct elements at position x, expressed as follows

It expresses the brightness of the target scene, J(x). The length d(x) between the camera at coordinate point x and the target scene is provided. represents a wavelength- related parameter known as the attenuation coefficient. that is sometimes regarded as a constant. Another two significant sources of deterioration are backward and forward scattering. The former is caused by light transmission being altered by microparticles in the medium. Fuzzy edge or random variation is the root cause of the detrimental impact. A direct component convolution is typically used to replicate the influence of this component. On the other hand, the latter results from light being The camera captures light that has been reflected by particles floating on the water's surface.

where B represents the light dispersed backward. Underwater image contrast loss and color distortion are typically caused by backscattering, with forward scattering's effects being overlooked. Next, the device's overall received irradiance is simplified as:

in preceding equations. The overall intensity is denoted by $e^{-\tau d}$. The target scene's irradiation is J. The transmission map, denoted by t, is what the previous equations depict. The underwater picture creation model of (3) and the air deterioration model are formal equivalents. Unfortunately, this model is faulty because It fails to acknowledge that, as the wavelength value increases, the attenuation rate of the beam of light component traveling via water steadily decreases.

RELETED WORK

It is difficult to use underwater photos for subsequent tasks such segmentation, and image detection. Numerous studies have been conducted on recovering true color, boosting contrast, and increasing visibility for underwater- degraded photos. We'll give a quick overview of these works in this subsection.

In order to retrieve the radiation from the actual scene

, the underwater picture restoration algorithms invert the underwater picture deterioration procedure by using the latent parameters inferred from prior knowledge. Because of its efficiency and simplicity, the simplified picture model of formation of (3) is frequently employed. Hou et al.'s endeavoured to blend conventional image restoration techniques with underwater optical characteristics. Calculating the light scattering parameters was utilized to execute underwater image deconvolution, Considering the idea that light scattering from water and suspended particles is what's causing the underwater image to become blurry. The large variation in attenuation between the three underwater image channels was used by Carlevaris-Bianco et al to determine the scene's depth. Suppression of the scattering influence is possible based on the depth map obtained. The image taken in murky water was restored by Lu et al.using wavelength compensation and a fresh underwater image creation paradigm. Image blurriness as well light absorption were used by Peng et al. to calculate the transmission maps, depth of scene, and background light. improved color accuracy. By estimating two extra parameters, Berman et al. By an analysis of the many spectral characteristics of various water conditions, the underwater picture restoration problem was simplified to a single image dehazing task.. Wang and colleagues suggested a restoration technique predicated on an adjustable prior for the attenuation curveSaturation restrictions are also employed to alter the transmission map in order to avoid saturation and minimize noise.

studied. By three channels using the local minimum to calculate the amount of spatially homogenous haze, He et al. initially presented this prior knowledge in the context of dehazing natural terrestrial images. Liu et al. enhanced evaluation of both the dehazed picture and the depth map using He's technique. Constructing a framework using total generalized variation (TGV) as the basis. In order to enhance the reconstructed image's visual quality, particularly in the sky area, Shu et al. suggested a hybrid variational approach. In, three different types of variation frameworks for picture dehazing and denoising were presented. DCP and TV together served as the foundation for these frameworks. In this area, DCP is regarded as a notable innovation. This earlier research also offered a novel approach to underwater dehazing because the optical image generation model in the atmosphere and undersea are identical. A dehazing technique was integrated with a wavelength adjustment by Chiang and Chen to restore underwater photos. An underwater dark channel prior (UDCP) was put forth by Drews, Jr., et al. based on the hypothesis that claims the color channels for green and blue are the primary sources of graphic data under water.

Relative to the distance from the camera, the red component rises, as seen by Galdran et al. recovering the hues connected to short wavelengths, they created a red channel prior (RCP), This is an alternative to the dark channel prior. Peng et al.'s, generalized dark channel prior (GDCP) and adaptive color correction were included in an image creation model. A unique variational framework for estimating RCP and quad-tree subdivision are included in the transmission map and back-scattered light that were produced in.

Underwater picture enhancement differs from restoration in that it uses information taken from the image to modify pixel values. These techniques are varied and adaptable; the majority of them seek to enhance image quality by raising visibility and sharpness. Conventional image enhancing techniques often yielded good results in typical atmospheric photos during the earliest stages of research. However, it was more challenging for these conventional enhancing techniques to produce satisfying results for underwater photographs with more intricate features. For instance, serious distortions and enhanced noise on the light propagation channel arose when standard histogram equalization as well as its derivatives were submitted for underwater photography. Regarding photos with inadequate light, applying the Gray-World Hypothesis as well as certain conventional algos for white balancing could result in significant color distortion. Furthermore, the lack of visual edge and low contrast will make the Gray-edge assumption illogical. Although certain domain- transform techniques were successful in mitigating noise in underwater photos, they were unable to resolve the problems with contrast loss and color divergence. Put simply, without examining the underlying cause, the conventional picture enhancing techniques are not able to handle the many deteriorations of underwater photos.

With the increased interest in underwater image processing techniques Previously, in the past, numerous studies been conducted to solve traditional enhancing methods' shortcomings In both RGB and HSI color spaces, Iqbal et al. employed the histogram stretching method., showing encouraging improvements in contrast and color deviation. Luminosity, contrast, chroma, and weight maps of saliency were the four weight maps that Ancuti et al. used to improve the underwater picture's quality. Improved results were obtained by fusing the original image's color-corrected and contrast-enhanced versions at many scales.Fu et al utilized a Retinex-based variational framework to extract the CIE Lab the undersea image's spatial brightness component after color correction Ji et al. applied image structure decomposition to improve the damaged photos and found a solution to the uneven illumination issue in the underwater image by keeping some structure and features intact. Using a number of color correction techniques, Ghani and Isa improved the saturation and contrast by stretching matching components in HSV space, while also reducing the color deviation using the Rayleigh distribution. Two steps, including color correction and contrast augmentation, were suggested for the improvement of underwater images. Based on the prior histogram distribution and little information loss, Li et al. created a single underwater image enhancing technique in.

Dehazing and contrast enhancement algorithms are integrated with the proposed technique. Li and colleagues (2019) subsequently presented a weakly supervised color transfer technique as a means of addressing perception distortion. In order to successfully correct the color deviation for underwater photos, Ancuti et al. has presented a two-step fusion technique that combines the white balance algorithm and the image fusion algorithm.

Our effort aims to improve underwater damaged photos by creating a hybrid variational framework. There are two improved outcomes that can be produced by the suggested technique. One variation serves as a guided image; it has vibrant color and a natural aspect. The output that was produced, free of haze and enhanced in terms of saturation and contrast, is the other version. The suggested method is also less likely to create red artifacts and more resilient to a variety of challenging underwater scenes than the single image enhancing and dehazing techniques now in use. In fact, even for underwater images with significant light attenuation, our technology may produce an aesthetically acceptable result. The suggested approach, in contrast to current methods, is intended for single image improvement and does not necessitate several photos or specialist gear. It also does not require any prior knowledge of the undersea environment

III. PROPOSED METHOD

Both underwater white balance and Laplacian of Gaussian filtering augmentation make up the suggested method. The specific steps in Fig. 1 are depicted in a flowchart.

UnderWater White Balance

It is commonly recognized that the old methods of white balancing light sources primarily rely on assumptions to estimate their color. Once color constancy is achieved, The normalized light source intensity for each color channel is separated into appropriate parts. If there is color divergence in an underwater photograph, this assumption usually turns out to be false, even with its strong performance for outdoor photographs. Furthermore, by averaging each channel independently, the classical gray world approach approximated The light source's color dispersion under the assumption that the scene's mean reflectance is achromatic. In terms of eliminating color variation, this method works effectively. However, a certain number of artifacts will be generated due to overcompensation when it is directly applied to underwater photos, particularly in areas with significant color departure. Having compensated for the color loss before using this approach, this issue can be avoided. simultaneously make up for the fading of the red and blue elements in a variety of underwater environments; b) Combing histogram stretching can decrease error compensation and ensure that the three-color channel distributions are uniformly distributed throughout the region in the event of insufficient or excessive compensation.

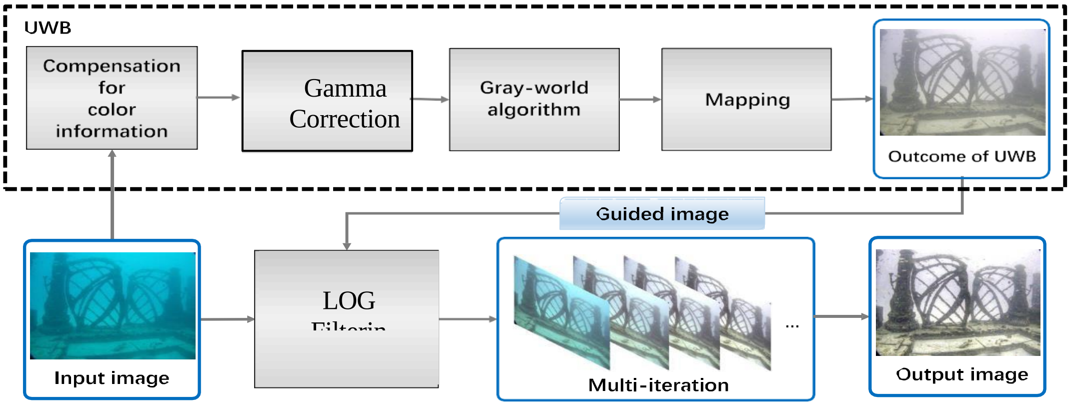

Figure 1:- Block Diagram of UWB and LOG Filter

It is possible to restore the intensities of decaying channels by using an integrated method that combines histogram stretching and additive compensation, as suggested by these observations.
It can be expressed mathematically in this way:

In this case, c stands for the color channels; c ∈ {R, G, B}. I represents the original picture, and ¯I stands for the average of I's three-color channels. One common assignment for the control parameter η is 1. Lower bound pixel value an is and upper bound pixel value b. The maximum and minimum intensity levels are denoted by the letters c and d, respectively. The values of a, b, c, and d may be fixed given an input picture. In order to streamline the implementation process through the design of an integrated operation, several channels' compensation is combined into a single formula (4). The following Gray-world assumptions (6–9) can be applied to rectify the color distortion once attenuation has been adjusted.

And the Gray-world algorithm's output is denoted by I_(W3,). Ω is the entire picture region, while I_(W) represents the UWB strategy's output. The improvements of the suggested UWB are demonstrated by presenting our results together with the relevant Gamma correction and those of Ancuti et al. Ancuti et al.'s approach has a tendency to excessively boost the red channel, which visually distorts the results' red tone. The red component of Ancuti et al. shows higher gray level distributions that are more concentrated than those of the blue and green components, as is evident from this observation. Furthermore, it seems that their approach makes the problem of back scattering worse. Our approach, in contrast to Ancuti et al.'s plan, can successfully remove the color cast and produce outcomes that are more aesthetically acceptable. Furthermore, our improved results show a more uniform histogram distribution, which indicates a more harmonious arrangement of the three elements, with no one taking center stage. Unlike directly stretching degraded pictures in the domain, our results prevent quantized artifacts since we adaptively adjust for the loss of color intensity prior to stretching. Furthermore, our UWB approach lowers the error compensation and significantly minimizes the disparity across the three-color channels. This ensures that, when implemented in different undersea conditions, our suggested technique will grow more resilient. Here c represents the channels of color, where c ∈ {R, G, B}. I represents the original picture, and ¯I stands for the average of I's three-color channels. One common assignment for the control parameter η is 1.

LOG Filter

A measurement of an image's second spatial derivative that is 2-D isotropic is called the Laplacian. For further details, see zero crossing edge detectors. The Laplacian of an image is frequently employed for edge detection since it identifies areas of fast intensity change. As a result, the two versions will be discussed together here. The Laplacian is frequently used to smooth a picture that has previously been somewhat processed with a Gaussian smoothing filter in order to reduce noise sensitivity. A single grayscale image is typically the operator's input, while the output is another grayscale image.

Convolution filters are useful for computing this.

The input picture is represented as a sequence of discrete pixels, hence a discrete convolution kernel that can approach the second derivatives in the Laplacian formulation has to be determined. displays a pair of frequently utilized tiny kernels.

Due to the associative nature of the convolution process, we may actually accomplish the desired outcome by convolving Gaussian smoothing filter and Laplacian filter first, followed by this hybrid filter and the picture. There are two benefits to going this route:

Given that the Gaussian and Laplacian kernels are usually considerably smaller than the picture, this method usually requires a large reduction in the number of arithmetic operations.

By precalculating the LoG (or "Laplacian of Gaussian") kernel, fewer convolutions are needed to process the image at run-time.

IV. CONCLUSION

Underwater Image enhancement is done by our algorithm that image is enhanced by using the two techniques called UWB and LOG model so that this can be performed to get the good results of underwater images ,it extracts the object that present in the image and gives the enhanced image as an output

V. Future Scope

This can be performed by the qualitative and quantitative analysis by comparing the images obtained by using different methods

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