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Color Balance And Fusion For Underwater Image Enhancement

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Abstract: We introduce an effective technique to enhance the images captured underwater and degraded due to the medium scattering and absorption. Our method is a single image approach that does not require specialized hardware or knowledge about the underwater conditions or scene structure. It builds on the blending of two images that are directly derived from a color-compensated and white-balanced version of the original degraded image. The two images to fusion, as well as their associated weight maps, are defined to promote the transfer of edges and color contrast to the output image. To avoid that the sharp weight map transitions create artifacts in the low frequency components of the reconstructed image, we also adapt a multiscale fusion strategy. Our extensive qualitative and quantitative evaluation reveals that our enhanced images and videos are characterized by better exposedness of the dark regions, improved global contrast, and edges sharpness. Our validation also proves that our algorithm is reasonably independent of the camera settings, and improves the accuracy of several image processing applications, such as image segmentation and keypoint matching.

Keywords*:* Underwater image enhancement, Image fusion, White balance, Saliency map

I. Introduction

Underwater imaging is a significant area of current research and technology. Amazing scenery, aquatic wildlife, and mystery shipwrecks are just a few of the unusual attractions in the underwater world. The main causes of low contrast and clarity in underwater photographs are light scattering and absorption. Absorption significantly reduces light energy and is influenced by a variety of elements such as water salinity and turbidity, the amount of suspended particles, and so on. Because of abnormalities in the propagation medium, particles, and other factors, light scattering causes the beam to divert from a straight path. They cause a hazy look, low contrast, and colour fading. Also, due to many characteristics of the underwater medium, the image captured underwater is fuzzy. The suspended particles in the water generate these effects. Water absorbs different wavelengths of light to varying degrees. Longer wavelengths are absorbed first in water, followed by shorter wavelengths at a great distance. Color perception is highly associated with water depth. The wavelength and depth of the water determine the colour penetration of the visible spectrum. Color disappears in the exact sequence in which it appears in the colour spectrum underwater, resulting in a bluish tone in underwater photographs.

Enhancing and repairing underwater photographs can be done in a variety of ways. Traditional image enhancement approaches like histogram equalisation and gamma correction have significant drawbacks. Specialized hardware, wavelength compensation, wavelet technique, and dark channel dehazing can also be used to improve photos. These solutions can all improve photos, but they aren't very practical due to various constraints.

The proposed method is a useful way for removing haze and enhancing images from a single image acquired with a typical camera. It is based on the fusion of two images produced directly from a color-corrected and white-balanced version of the original degraded image. The white balancing stage removes the unwanted colour cast caused by underwater light scattering, giving underwater photographs a more natural appearance. It eliminates domain stretching-induced quantization artefacts. GrayWorld algorithm, a well-known white balancing approach, is utilised to ensure good visual performance for reasonably distorted underwater photos. Because the red channel is more compensated, the image's reddish look of high intensity regions is likewise well corrected.

To deal with the hazy character of the white balanced image, multi-scale implementation of fusion is an effective fusion based technique, relying on gamma correction and sharpening. During blending, weight maps such as Laplacian contrast weight, saliency weight, and saturation weight maps are employed so that pixels with high weight values are more represented in the final output image. It can also improve the quality of underwater photographs.

III Proposed Method

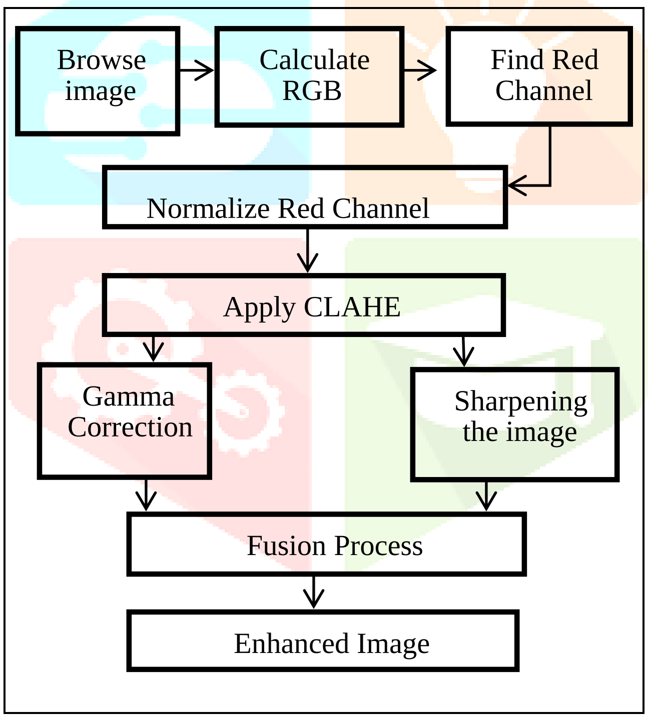

Fig 1: Proposed System Overview

IV. WHITE BALANCE METHOD

This white balance method focuses on restoring colours that have been damaged owing to water absorption of white light. The biggest issue with underwater photographs is the greenish-blue colour caused by wave scattering as depth increases. Waves with longer wavelengths are absorbed first. As a result, red will absorb first, followed by blue, and so on. The colour loss is proportional to the observer's distance from the plane. The first step is to compensate the red channel, and the second is to use the Gray-World Algorithm to produce the white balanced image. Four observations are used to compensate the red channel. 1) The red channel degrades first in water, but the green channel is largely unaffected due to its lower wavelength than the red channel. 2) Making amends To restore the natural appearance of the underwater photographs, compensate the red channel by adding the percentage of the green channel to the red channel. 3) The mean values of the green and red channels are used to compensate for the red channel using the green channel. To get a balanced output, the difference between the mean values of the green and red channels must be proportionate.4) To prevent red channel deterioration during the Gray World stage, apply red channel compensation first, affecting the small red channel pixel values. That is, where the red channel information is already important, the green channel pixel information will not be transmitted to the red channel. As a result, the appearance of reddish in the over regions uncovered by the Gray World algorithm should be avoided. The highly damaged red channel will be compensated, but the less attenuated red channel close to the observer will not require compensation due to less red channel degradation.

Calculating and restoring the illuminant colour cast using the Gray-World method assumption. Despite the importance of white balance, it is necessary to recover the colours that are lost when light flows through water. This is insufficient when dealing with edges and trying to tackle the dehazing problem using scattering effects. As a result, an effective fusion based on CLAHE, gamma correction, and sharpening was introduced to reduce the fogginess of the white balanced image.

V. FUSION METHOD: The underwater photographs are enhanced using the fusion approach. The fusion process is carried out in a variety of ways. We can improve the underwater image enhancement by employing the laplacian pyramid method to eliminate back scattering effects. There will be two input photos for the fusion procedure. Our underwater picture improvement technique consists of three steps: inputs, white balancing, and CLAHE, weight map definition, and weight map and input fusion.

A. Inputs for Fusion Process:

In underwater photography, colour correcting is crucial. White balance procedures are used to fix the colour. To receive the initial input, use CLAHE (Contrast-Limited Adaptive Histogram Equalization) to make the image brighter and improve the overall contrast. Then, focus on global contrast adjustment with gamma correction. The second input comes from the white balanced section's sharper rendition of the image. So, to blurred or unsharp, apply the Gaussian filter, which is based on the unsharp masking concept. The sharpened picture S = I +(I G I), where I is the image to be sharpened, GI is the Gaussian filtered version of I, and is a parameter, is not straightforward to calculate. A small fails to sharpen image I, but a big results in over-saturated regions with darker shadows and brighter highlights.

B. Weights For Fusion Process:

Weight maps are utilised throughout the blending process to ensure that pixels with high weights appear in the final image. They're based on image quality and saliency measurements.

Laplacian contrast weight (WL): To compute the global contrast, the Lapacian filter's value is applied to the input luminance channel. Although this effectively distinguishes between flat and ramp zones, it is insufficient for underwater image improvement. Contrast metric assessment is employed to compensate for this added weight.

Saliency weight (WS): concentrate on recovering the important object that was lost in the underwater image. We can compute the saliency level using Achantay et alapproach .'s saliency estimator. This weight was primarily applied to areas that had been brightened. For the observation, I obtained a new weight map. To avoid the problem of focusing on the brightened areas, the saturation was reduced in brighter sections.

Saturation weight (WSat) : By utilising the advantages of heavily saturated regions, the fusion method is used to accept the chromatic information. Calculate the weight map for each input image using the derivation between the luminance Lk of the kth input and the Rk,Gk,Bk colour channels.

Using two inputs and the weight map exposedness helps to reduce overall complexity by amplifying the relevant artefacts.

C. Fusion Process:

The fusion method is used to reconstruct every pixel of input images with defined weight maps. The reconstructed image R(x) is formed by fusing the input images with weight maps at each pixel location(x):

Rl(x)={ k(x}L1{Ik(x)),

where Ik is the normalised weight mappings k's weighted input. This approach produces unwanted halo effects. The Laplacian pyramid technique is often employed to circumvent this problem. In the multiscale fusion approach, an image is decomposed into band-pass images that are represented in the shape of a pyramid. The low-pass Gaussian kernel G is employed at each level of the pyramid to filter the input images and decimate the images that have been filtered by a factor of two in both directions. The low pass image is then created by subtracting from the input. The inverse laplacian technique is then used using the decimated low-pass image as the input for the necessary levels of the pyramid. Gl was first used to describe a sequence of N layers of l low-pass filtering and decimation, followed by l upsampling procedures. The Ll of the pyramid is written as:

I(x)=I(x) −G1{I(x)} +G1{I(x)} L1{I(x)} +G1{I(x)}

=L1{I(x)}+G1{I(x)} −G2{I(x)} +G2{I(x)}

= L1{I(x)} +L2{I(x)}+G2{I(x)}

= N l=1 Ll

Ll and Gl represent the lth level of the Laplacian and Gaussian pyramids, respectively. Gaussian normalised weights are calculated independently at each level l: Rl(x)={ k(x}L1{Ik(x)) Where k signifies the number of layers in the pyramid and l denotes the number of input photos. The image size usually determines the number of levels N. Multi-scale fusion is a method for detecting edges and sharp regions that are triggered by human visual systems. This improves the quality of the underwater image enhancement

VI. RESULT AND DISCUSSIONS

An enhanced image for the underwater image is obtained utilising this procedure. This is accomplished by integrating several techniques, including white balance, fusion, and CLAHE.

Fig-2: Input Image

Fig-3: White Balanced image

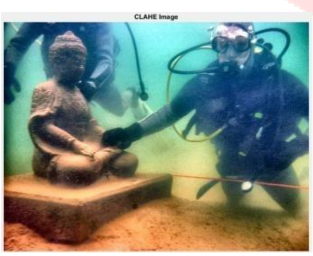

Fig-4: CLAHE image

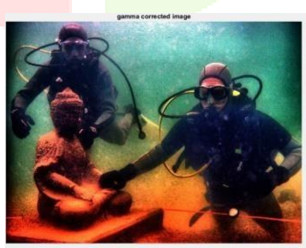

Fig-5: Gamma Corrected image

Fig-6: Sharpened image

Fig-7: Enhanced image

V. CONCLUSION

To decrease undesired colour casts caused by attenuated wavelength, fogginess, blurriness, and other variables, a technique for improving underwater pictures was presented. In this method, white balance and fusion are applied. The Laplacian fusion strategy is used here, which is a human visual system impulse that lowers backscattering effects and is suitable for underwater images. As a result, the product is of greater quality.

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