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Underwater Image Rectification

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Abstract

In this paper, a novel rectifier method is presented for improving and recovering underwater image quality. The suggested approach combines red channel optimization, levelling of contrast, and colour adjustment. The values of the R, G, and B channels are updated to provide comparable histogram distributions in order to address the problem of colour shift. Instead of fine-tuning the transmittance using dark channel prior-based restoration, the best transmittance is determined utilising a normalisation of contrast technique. To further enhance brightness and contrast, a red channel optimization technique based on redlight propagation is used. The usefulness of the suggested strategy in comparison to other well-liked techniques is highlighted by experimental results that show a significant improvement in both subjective visual effect and objective evaluation .

Keywords: underwater image, restoration, color adjust, normalization of contrast, red channel optimization.

1.Introduction

Several problems arise when humans explore and use the ocean, especially when performing underwater missions. Optical images are a useful source of seafloor information. Water properties such as light scattering and attenuation. Nevertheless, the image captured by the camera sensor is degraded. These elements can cause color shifts, blurring, and loss of contrast. Other factors also affect visibility and image quality, but the physics of light emission in water play an important role. In addition to the physical properties of underwater lighting, other phenomena such as motion blur, noise, and sea snow also contribute to degradation of underwater photography. Use advanced imaging technology to capture the highest quality underwater photography. However, the high cost associated with such devices can be a major obstacle for users. An alternative approach to obtaining high-quality underwater images is to use image processing techniques that are characterized by high efficiency and low cost. Underwater image processing can be broadly divided into two techniques: image restoration and image

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enhancement. Image restoration is based on a physical model of the original image and the restored image, with emphasis on the degradation process. Image enhancement, on the other hand, aims to improve pixel quality according to subjective qualitative criteria. Compared to image restoration, image enhancement approaches are generally simpler, faster, and less computationally intensive. Various underwater image enhancement algorithms have been proposed over the last decade, such as histogram equalization, wavelet transform, and Retinex algorithm. These methods can effectively improve the quality of underwater images and have become a hot topic in underwater engineering**.**

2. Literature Survey:

Some researchers have proposed their own improvements, such as: B. Iqbal et al. 's[1] Histogram sliding stretch, Henke et al. 's[2] Color constancy hypothesis algorithm, Guraksin et al. 's[3] Wavelet transform and differential evolution algorithm, and Retinex-based refinement of Tang et al. These algorithms are effective at improving underwater photography, but they also have some fundamental flaws. For example, histogram equalization causes the top of the histogram to be over-amplified, losing some detail. There is likely to be. The Retinex method can cause halo effects in regions where the brightness varies significantly, while wavelet transforms may not perform well in deep water where red light is strongly attenuated. Although individual algorithms have limitations when it comes to improving underwater photography, recently fusion algorithms have gained popularity among researchers. These algorithms integrate many methods such as color correction, histogram stretching, and wavelet transforms. To improve the contrast of underwater images, Ghani [4] proposed a fusion approach that combines dual-image wavelet fusion with a recursively overlapping contrast-limited adaptive histogram formulation. Similarly, Ancuit [5] proposed a fusion approach that combines color correction, histogram stretching, and wavelet transform techniques. To improve the quality of underwater images, Qiao's approach uses wavelet transform and histogram equalization. Due to the characteristics of the underwater environment, it is difficult to restore underwater photographs. Light propagation models are often used to reconstruct underwater images. Based on a model of light propagation in water, Wang's method uses quadratic function fitting to remove the effects of backscattering. Wanger's [6] method of perceiving visual quality is based on a light propagation model. Shi [7] proposed a normalized gamma transform-based contrast-limited adaptive histogram equalization and color correction. Since foggy outdoor and underwater environments are similar, dehaze techniques are often used to create restored underwater photographs. The tidying algorithm is an improvement over the Dark Channel Prior (DCP) algorithm. Carlevaris-[8] Bianco's method of calculating scene depth exploited the difference in attenuation of the RGB channels. Yu [9] proposed a method for cluttering underwater images based on DCP and depth transmission maps, while Wang created his solution for patch-based dark channel cluttering of RS multispectral images. DCP limits the processing of photos with white backgrounds or objects. This work focuses on improving underwater image quality using state-of-the-art rectification algorithms. This procedure takes into account red channel optimization, contrast improvement, and color adjustment. Color correction is performed by reassigning the individual channel values of the three color channels. A single-channel average of the red channel serves as a basis for optimizing the algorithm. Optimal transmission is determined by an optimized contrast algorithm, not a standard. Improved DCP-based restore. Processing underwater photographs from various sources, such as the RUIE [10] dataset and the Internet, as well as experimentally acquired images, demonstrates the importance of the proposed approach. The results show that the proposed method significantly improves the quality of underwater photography by reducing color distortion and improving contrast and clarity.

Underwater Imaging Foundations:

Light behaves differently in water than in air, with many factors contributing to its attenuation and scattering. Other light backscattering can also be caused by airborne particles such as sea snow. Salinity and temperature also affect light scattering. For these reasons, underwater optical photography has lower contrast and is more blurry than images taken in air. The direct light, forward scattered light, and back scattered light components are what the underwater camera picks up. Using these added factors, we can get the total amount of light(Et) that the camera sensor represented as sum of forward scatter component, backscatter component(Eb) and direct component(Ed).

The direct component (Ed) can be computed by subtracting the quantity of light absorbed by the object from the amount of light reflected back to the camera sensor. Further considered are the reduction factor (c) and the separation between the object and sensor (d).

Direct component and point spread function are convoluted to produce the forward scatter component (Ef) (PSF). The PSF is used to forecast the performance of the imaging system and beam propagation.

The amount of light that is scattered back to the sensor after passing through the object can be used to define the backscatter component (Eb). It is determined by the amount of light that passes through the item and the backscatter coefficient (B) (1-t).

3. System Implementation

In order to improve the calibre of underwater photographs, three ways have been suggested. These techniques include a red channel optimization method that is based particularly on the red light, a color adjust algorithm, and a normalization of contrast algorithm.

Prerequisites

The following is necessary for the reader to follow along:

1. Jupyter notebook, Python installed on your computer.

2. The RUIE dataset provided in the form of set of photos.

I. COLOR ADJUST ALGORITHM

Since underwater photographs often resemble images taken in the fog, dehazing algorithms are occasionally applied to them. These algorithms, however, don't always perform effectively since fog and water have distinct ways of obstructing light. Whereas underwater photographs have variable quantities of light blocked in different colour channels and hence show colour distortion, foggy images have comparable grayscale values throughout all colour channels. In completely dark deep-sea conditions, the red channel vanishes from the histogram.

This approach starts by calculating the average single channel values of the three channel components R, G, and B, which are denoted by mR, mG, and mB, respectively. Second, the average scalar value of the R, G, and B channels' average single channel values can be calculated (m_{avg}).

The differences between the average single channel value m_R, m_G, m_B and the mean scalar value m_{ave} can be determined as:

$$DEV_R = m_{ave} - mR$$
$$DEV_G = m_{ave} - mG \quad (2)$$
$$DEV_B = m_{ave} - mB,$$

Eventually the single channel value of the three channels of R, G, and B can be moved to similar positions by:

$$R' = R + DEV_R$$
$$G' = G + DEV_G \quad (3)$$
$$B' = B + DEV_B,$$

where R', G', and B' are the pixel values of the R, G, and B channel components of the processed image

Algorithm 1: Color Adjust

Input: degraded underwater images

Output: underwater images after color adjust

Step 1: Determine the average value for a single channel for R, G, and B, correspondingly. then calculate the typical scalar value by(1).

Step 2: Compute the single channel difference by comparing the m_R, m_G and m_B, average single channel values. d_R, d_G, and d_B values by (2).

Step 3: Move the single channel values of the three channels to a similar position by considering the outcomes of step 2 and their single channel values. (3).

Step 4: Return processed images

II. NORMALIZATION OF CONTRAST ALGORITHM

In order to handle colour shift in underwater photographs, the research suggests a colour adjust method, however the contrast of the image still needs to be increased. To ascertain the transmittance and improve the contrast of the image, an improved contrast method that extends

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the dark channel before the dehazing process is utilised. In this we are using an contrast.enhance() method from ImageEnhance class .

In the ImageEnhance package of the PIL (Python Imaging Library) module's Contrast class. With this technique, the contrast of an image can be altered by varying the contrast between the light and dark tones in the image.

The factor parameter of the enhance method, which determines how the contrast will be enhanced, is the only one required. A factor of 1.0 means that the contrast hasn't changed, a factor of 1.0 or less means that the contrast has decreased, and a factor of 1.0 or more means that the contrast has increased. A positive floating-point number is required for factor's value.

A new Contrast object with the contrast-optimized image is returned by the enhance method. The image that was entered originally doesn't change. The difference between each pixel's value and the image's mean value is multiplied by the factor parameter, and the result is added to the mean value to produce the contrast-optimized image.

Algorithm: Normalization of Contrast Algorithm

Input: underwater images after color adjust.

Output: underwater images after image contrasting.

Step 1: Import the Image, ImageEnhance, ImageStat modules from the current package or directory.

Step 2: Use the ImageStat.Stat method from the ImageStat module to determine the supplied image's mean. To round the mean value to the nearest integer, convert it to an integer and add 0.3.

Step 3: Using the Image.new method from the Image module, produce a degenerate image. The degenerate image is a grayscale image filled with the mean value calculated in step 2 and the same size as the input image. The degenerated picture should be changed to the same mode as the source image.

Step 4: Use the putalpha method from the Image module to set the degenerate image's alpha channel to the input picture's alpha channel if the input image contains an alpha channel.

Step 5: Revert processed pictures

III. RED CHANNEL OPTIMIZATION ALGORITHM

Underwater image brightness and contrast are improved with this method. Red light in particular is selectively absorbed in water, which can cause image enhancement algorithms to overcompensate for the red channel. The weighting of red channel operation takes problem into account and it dependent on the intensity of the red light.

To assess the reduction of red light, a scalar value threshold R is specified. Then, the red channel's average single channel value, or Rave, is determined as follows:

$$R_{avg} = 1/n(\Sigma^{n}{}_{1} R_i) \qquad (4)$$

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Where n is the total number of pixels and Ri is each pixel's single channel value.

When Ravg is greater than or equal to R, the reduction in red light is considered to be slight; when Ravg is less than R, it is said to be heavy. Red channel optimization is carried out on three channels in cases of severe decrease. Red channel optimization only affects the G and B channels in the event of a minor reduction in red light. The algorithm uses the following algorithm:

$$\text{Icnew}\,(i,j) = \begin{cases} 0 & \text{Icold}(i,j) < \text{icmin} \\ 255\text{x}(\text{Icold}(i,j) - \text{icmin})/(\text{icmax} - \text{icmin}) & \text{Icmin} \leq \text{Icold}(i,j) \leq \text{icmax} \\ 255 & \text{Icold}(i,j) > \text{icmax}, \end{cases}$$

(5)

Imin is the maximum scalar value; imin is the minimum scalar value; I^{c}_{new} (i,j) represents updated scalar value; I^{c}_{old} represents original scalar value at the same point.

Algorithm: Red channel optimization Algorithm Based on Intensity of redlight.

Input: underwater images after optimized contrast.

Output: underwater images after Red channel optimization.

Step 1: Determine the red channel's average single channel value by utilising (4). Decide on a scalar value threshold of R and compare it to R.

Step 2: Set ht, as n*0.225%.

Step 3: Red channel optimization is done with respect to three channels employing RR, which is considered to be a minor reduction in red light (5)

Step 4: Red channel optimization is only done with the G and B channels if RR, the reduction of red light, is considered to be heavy (5)

Step 5: Return the red channel optimized images.

4. Results :

The three afore mentioned algorithms were created expressly to improve underwater image quality. Applying the colour adjust algorithm to the image in order to correct any colour distortion first. The optimum contrast algorithm is then employed to enhance the overall contrast of the image and lessen the backscatter impact. Finally, red channel optmization is used to boost the brightness and contrast of the image.

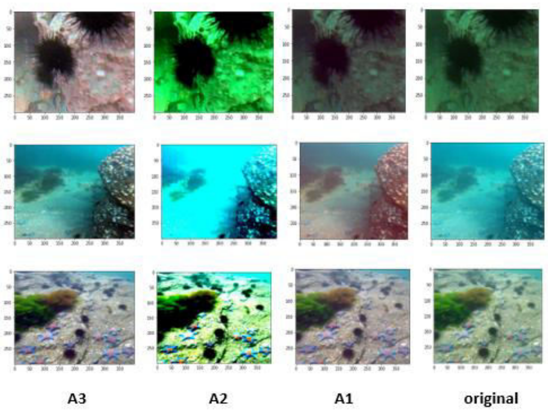

Fig:3 Albation experiments

The above image A3 is processed using an unique rectifier technique that combines red channel optimization, normalised contrast, and colour adjustment. For the photos in the second column marked with the number A2, colour correction and optimum contrast are kept by the ablation operation. Just colour adjust is used for the photographs in the third column with the designation A1.

The MSCR algorithm is utilised to compare the suggested algorithm.

As may be observed, the suggested innovative rectifier algorithm can produce good processing results.

5. Object Evaluation:

It is crucial to undertake objective evaluations in addition to subjective evaluations that could be influenced by individual perceptions in order to assure the validity of the enhancement measures used in image processing. To assess the visual effects of the picture enhancements, a set of traditional objective assessment markers was used in the study. like PSNR and SSIM, etc..

PSNR: It calculates the difference between the mean squared error between the original and processed images and the highest possible pixel value.

A higher PSNR value indicates better image quality.

SSIM: It evaluates the luminance, contrast, and structural similarity between the original and processed images.

Image	PSNR		SSIM	
	MSRCR	Proposed	MSRCR	Proposed
1	9.3480	15.1850	0.3547	0.6520
2	9.7693	15.1609	0.3066	0.6219
3	9.9341	14.8801	0.3353	0.6174

Table:1. Evaluation of metrics

From the above the proposed algorithm outperforms in general.

6. Conclusion

This article describes a novel rectifier algorithm that combines red channel optimization, colour adjustment, and levelling of contrast to restore and improve underwater photos. To remove colour variation, a novel colour correction algorithm is suggested. This is followed by an optimised contrast algorithm for dehazing. After that, contrast and clarity are enhanced using a modified histogram algorithm based on the red channel. The effectiveness of the suggested algorithm is assessed using objective metrics like PSNR and SSIM, and it is contrasted with more established algorithms like MSRCR. The proposed method performs better than existing algorithms in terms of capacity and resilience, according to the results. However, because it takes longer to process, preprocessing rather than real-time image processing is more appropriate for it. The effectiveness and adaptability of the suggested method are demonstrated by experimental results. Even though the proposed algorithm has improved performance, future research can be used to create even more effective algorithms that will reduce image noise and boost real-time performance. Additional research will focus on the detection and tracking of underwater objects based on the enhanced images.

7. References

[1] K. Iqbal, R. A. Salam, A. Osman, and A. Z. Talib (2007). underwater image enhancement with a combined colour model. 34(2), 239–244 in IAENG International Journal of Computer Science.

[2] The authors are Henke, B., Vahl, and Zhou (2013). removing colour cast from underwater images using the non-constant colour constancy theory. In the ISPA's 8th International Symposium on Image and Signal Processing and Analysis, published in September 2013 in Trieste, Italy

[3] Guraksin, G. (2019). Enhancing underwater photos using a wavelet transform-based method supported by a differential evolution algorithm. Springer, Cham, Switzerland.

[4] Isa, N. A. M., and Ghani, A. S. A. (2014). Rayleigh stretching and image plane equalisation are used to improve the quality of underwater images. 6(4), 840–866, International Journal of Naval Architecture and Ocean Engineering.

[5] C. Ancuti, C. O. Ancuti, T. Haber, and P. Bekaert (2012). a technique based on fusion for enhancing underwater photos and movies. 81–88 in Providence, RI, USA, Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, June 2012.

[6] Chen, X., Wang, N., Qi, L., Dong, J., Fan, H., and Yu, H. (2017). underwater picture restoration in two stages using a physical model. Article no. 102250R from the proceedings of the 8th International Conference on Graphics and Image Processing (ICGIP), held in Tokyo, Japan, in February 2017.

[7] Z. H. Shi, Y. N. Feng, M. H. Zhao, E. H. Zhang, and L. He published a work titled "Enhancing sand-dust images using normalised gamma transformation-based contrast-limited adaptive histogram equalisation with colour correction" in IET Image Process in November 2019.

[8] N. Carlevaris-Bianco, A. Mohan, and R. M. Eustice (2010). First findings for single image dehazing in underwater scenes. In OCEANS MTS/IEEE SEATTLE Proceedings, Seattle, WA, USA, September 2010, pp. 1–8.

[9] Liu, Z., Q. Lou, H. Yu, X. Liu, and C. Lei (2020). employing depth transmission maps and dark channel before to improve underwater photos. Applications and Multimedia Tools, 79(27-28), 20373-20390.

[10] Luo, Z., Zhu, M., Hou, M., Fan, X., Liu, R. (2020). Real-world underwater image enhancement under natural light: issues, standards, and remedies. p. 4861–4875 in IEEE Transactions on Circuits and Systems for Video Technology, 30(12).