Review on under Water Image Enhancement by Filtering and Optimization Approaches

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Abstract- Underwater imaging is demanding due to the physical properties obtainable in such environments. Distinct from common images, underwater images suffer from poor visibility because of the attenuation of the propagated light. The light is diminished exponentially with the distance and depth mainly because of absorption and scattering effects. In this paper review of approaches of different way to remove blureness, hazenessetc from under water images and also review Filtering is used for the edge smoothening and preserves the edges with non-linear combination of nearby values. This filtering is non-linear, simple and local. Gray levels or colors are combined by the bilateral filter based on both their geometric closeness and their photometric similar, and prefers close values to distant values in both domain and range

Keywords- filter, blurness, optimization, hazeness, image processing

I. INTRODUCTION

The absorption significantly minimize the light energy although the spreading causes changes in the light direction. The random reduction of the light is the main cause of the foggy emergence although the fraction of the light scattered back from the medium along the sight noticeably reduce the scene contrast. These properties of the underwater medium yields scenes identify by poor contrast where distant objects emerge misty. Basically, in common sea water, the objects at a distance of more than 10 meters are almost identical although the colors are faded because their feature wavelengths are cut according to the water depth [11, 12].

Fig.1: Underwater Imaging

Underwater vision is one of the research area of investigation for researchers. Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV) are normally engaged to confine the data such as underwater mines, shipwrecks, coral reefs, pipelines and telecommunication cables from the underwater environment. Underwater images are basically specify by their poor visibility because light is exponentially diminish as it travels in the water, and the scenes result poorly contrasted and hazy. Light attenuation limits the visibility distance at about twenty meters in clear water and five meters or less in turbid water. The light reduction process is caused by absorption and scattering, which impact the whole performance of underwater imaging systems [1,2][5].

1.1 Dark Channel Prior

This techniques is used to estimate the atmospheric light in the dehaze image to get the real result [12, 13]. It is mostly used in non-sky patches, in one color channel have very low intensity at few pixels. The low intensity in the dark channel is predominant because of three components:

- Colorful items or surfaces
- Shadows(shadows of car, buildings etc)
- Dark items or surfaces(dark tree trunk, stone)

1.2 CLAHE

Contrast limited adaptive histogram equalization short form is CLAHE (Xu, Zhiyuan et al, 2009). CLAHE is used for enhancement of low contrast images. It does not require any predicted weather information for processing of fogged images. Firstly, the image captured by the camera in foggy condition is converted from RGB (red, green and blue) color space is converted to HSV (hue, saturation and value) color space. The images are converted because the human sense colors similarly as HSV represent colors.

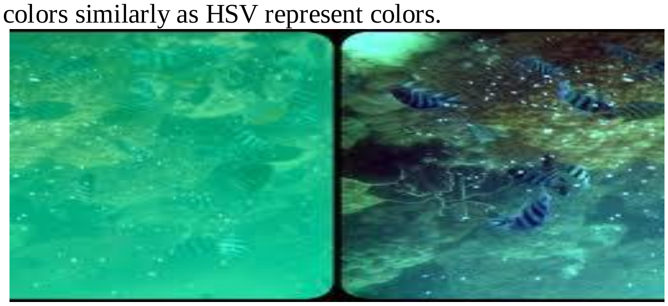

Fig.2: CLAHE Effect

1.3 Bilateral Filtering

Bilateral Filtering is used for the edge smoothening and preserves the edges with non-linear combination of nearby values. This filtering is non-linear, simple and local. Gray levels or colors are combined by the bilateral filter based on both their geometric closeness and their photometric similar, and prefers close values to distant values in both domain and range. Bilateral filter smooth edges towards piecewise constant solutions. Bilateral filter does not provide stronger noise reduction. Figure (3) illustrates the processing of foggy image and establishment of it into original image by using bilateral filter.

Fig.3: Bilateral Filtering

1.4 MIX-CLAHE

The presented method to enhance underwater images using a mixture Contrast Limited Adaptive Histogram Equalization. The enhancement method effectively improves the visibility of underwater images and produces the lowest MSE and the highest PSNR values. Thus, it has shown that the mix-CLAHE based method is promising for classifying coral reefs especially when visual cues are visible.

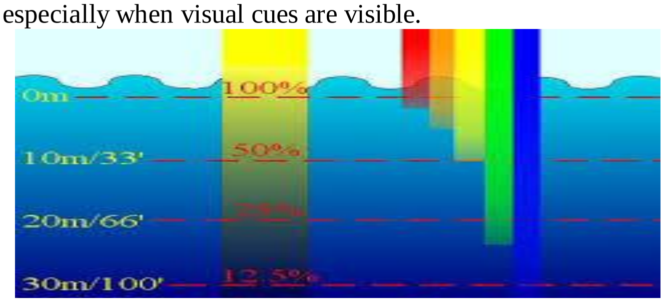

Fig.4: Absorption of light By Water

Figure 4 shows an illustration about the absorption of light by water. For every 10m increase in depth the brightness of sunlight will drop by half. Nearly all red light is gone by 50% from the surface but blue continues to great depth. That is why most underwater images are dominated by blue-green coloration.

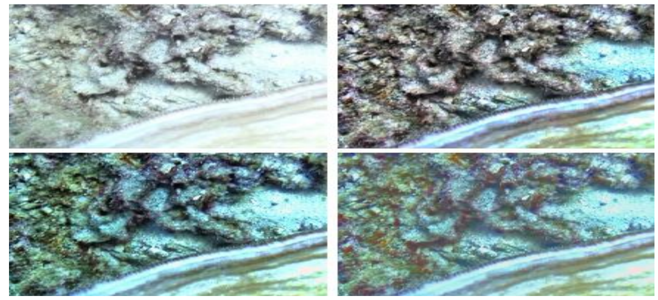

Fig.5: Comparison of CLAHE method on B2

CLAHE-Mix first normalizes the result of CLAHE-RGB. Figure5 illustrates the results of CLAHE technique operating on RGB and HSV color models and the result of Mix-CLAHE operating on Image. As can be seen from the figure, when CLAHE operated on RGB color model, it corrupts the human sense of color. A more logical approach is to spread the color values uniformly, leaving the colors themselves (e.g., hues) unchanged. The result from CLAHE-HSV shows that the overall color is more sensible than CLAHE-RGB. To reduce the undesired artifacts as well as brightness in CLAHE RGB and CLAHE HSV images we introduce a new method which mixes the results of CLAHE-RGB and CLAHE-HSV.

1.5 Trilateral Filtering

This filtering smooth's images without influencing edges, by means of a non-linear combination of nearby image values. In this filter replaces each pixel by weighted averages of its neighbor's pixel. The weight allotted to each neighbor pixel decreases with both the distance in the image plane and the distance on the intensity axis. This filter helps us to get result faster as compare to other. While using trilateral filter we use pre-processing and post processing steps for better results. Histogram stretching is used as post-processing and histogram equalization as a pre-processing.

1.7 Underwater Visibility Estimation & Image Enhancement

The goal of this research is to allow real-time enhancement of underwater images which are naturally lit and degraded due to relatively high turbidity and other visibility reducing phenomena. Enhancement of underwater images requires modelling and estimation of the water absorption and scattering characteristics to remove haze [3,4]. However it also requires a scene depth map. In our approach, we use stereo images in a two-stage enhancement process to improve overall image quality allowing visibility and range estimation.Underwater Light Propagation Modelling Underwater light models generally follow a standard attenuation model [8-10] to accommodate wavelength attenuation coefficients. In this study the Koschmieder Model was adopted which has been established as a description of the atmospheric effects of weather on the observer. In outdoor clear weather conditions, the radiance from a scene point would reach the observer nearly unaltered. However when imaging underwater the irradiance observed by each pixel of the camera (E) is linear combination of directly transmitted scene object radiance that will be attenuated in the line of sight and scattered ambient light towards the observer as depicted in Figure 6.

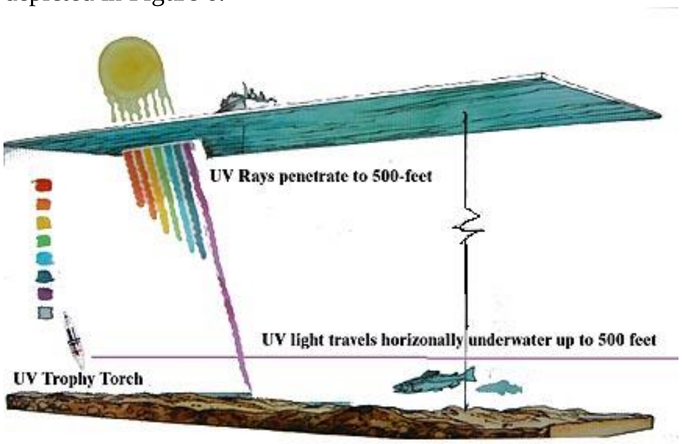

Fig.6: Underwater Light Model

Water splitting is an important reaction that can be used to harvest and store solar energy. In nature, the process produces reactive protons, building up a concentration gradient to power dark reactions which turn CO2 to organic molecules. In laboratories, a simplified version of the reaction has been conceived to produce O2 and H2, the latter promising a solution to problems caused by the combustion of fossil fuels. In a variation, artificial CO2 reduction can in principle be powered by sunlight to produce solar fuels. Although the detailed chemical mechanisms of these reactions vary, they share the same key features of harvesting solar energy and storing it in chemicals. Essential components necessary to enable the conversion include an antenna to absorb photons and to produce excited electrons, a mechanism to physically move the excited electrons away from the site where they are generated, and an efficient catalyst to drive chemical reactions selectively. Because of the existence of a band gap and the typical band bending formed when in contact with an electrolyte, semiconductors are good candidates for solar water splitting or CO2 photo reduction. Other appealing aspects of using semiconductors for solar fuel for an underwater image, the radiance of the scene point attenuates exponentially with the propagating distance, according to Beer–Lambert law. The light attenuation in water is caused mainly by absorption and scattering. From red to violet, the wavelength becomes shorter gradually. According to the selective absorption of water, visible light is absorbed at the longest wavelength first. So red light is much easier to be absorbed than shorter wavelengths such as the blue and green. On the other hand, based on Rayleigh scattering theory, scattering intensity is inversely proportional to the fourth power of wavelength, so that shorter wavelengths of violet and blue light will scatter much more than the longer wavelengths of yellow and especially red light [4].

II. RELATED WORK

Ancuti, Codruta O., et al. [2018] in this paper, the author proposed color balance and fusion for under water image enhancement. This method is proposed on single image and not required any additional hardware. In this associate weight maps are used to transfer the edges and color contrast to output image. Artifacts are created in low frequency component of reconstructed images. This method improves the global contrast, edges sharpness and reduced dark regions. Huang, Dongmei, et al. [2018] in this paper, the author proposed relative global histogram stretching for water image enhancement approach. This approach consists of two parts that are color correction and contrast correction. In contrast correction method RGB color space is used and redistributes each RGB channel histogram. These dynamic parameters are related to intensity distribution of original image and wavelength attenuation of different color underwater. To reduce the noise from the image bi-lateral filtering is used and enhances the local information of shallow water image. Li, Chongyi, et al. [2018] under water image enhancement is done by image color correction method which is based on weakly supervised color transfer. This approach solved the problem of color distortion. In this approach multi-term loss function is used for measure adversial loss, similarity index measure loss, and cycle consistency loss. The results of the proposed approach are better in image enhancement and it improves the performance of vision tasks. Hu, Haofeng, et al. [2018] underwater images are degraded by scattering of light and noise in the water. In this work polarization information is used which has efficiency to improve the quality of image in scattering medium. Non-uniform optical field image recovery method is proposed in this paper. This method enhance the quality of image and gives better performance from existing method. Lu, Huimin, et al. [2018] The approach proposed in this paper is used to solve the problem of underwater depth map estimation problems that are occurring in low intensity of light. This problem is solved by using deep neural network by depth estimation. The results of the proposed approach outperforms and effective. Zhang, Shu, et al. [2017] Underwater image enhancement is attractive research area due to the degradation occurred by scattering and absorption of light. In this paper, the author proposed Retinex method which is a combination from retina and cortex. This method uses bi-lateratel and tri-lateral filters for the images. Performance evaluation of the proposed method is done by comparing with existing method. Chang, Cheng-Hao, et al. [2017] in this paper, the author design and implement a low-cost guided image filter for underwater image enhancement. This method is based on TSMC and CMOS technology and operates on high power to support full HD image enhancement. It provides high throughput and effective frame rate. Emberton, et al. [2017] underwater image and video dehazing is done by using Haze region segmentation approach. It improves the visibility in images and videos by detecting and segmenting image regions. Illuminant elimination is done by using white balancing approach. This method reduces the color cast and enhances the image contrast. The computation consumption is low in the proposed method.

Table.1 Existing Scheduling Model

Author's Name	Year	Methodology Used	Proposed Work
Huang, Dongmei, *et al.*	2018	Color and contrast correction method	Proposed relative global histogram stretching for water image enhancement approach.
Hu, Haofeng, *et al.*	2018	Non-uniform optical field image recovery method	In this work polarization information is used which has efficiency to improve the quality of image in scattering medium.
Chang, Cheng-Hao, *et al.*	2017	TSMC and CMOS technology	The author design and implement a low-cost guided image filter for underwater image enhancement.
Wang, Yafei, *et al.*	2017	Frequency domain fusion based strategy	Underwater image enhancement is done by using wavelet decomposition. This fusion process gives two inputs that are color corrected and contrast enhanced images which are extracted from the original underwater image
Li, Yujie, *et al.*	2016	Deep Neural Network	Introduced image de-scattering and classification by using deep neural network. This method removes the scatter from the images and preserves the color

Perez, Javier, et al. [2017] the approach proposed in this paper is used to solve the problem of underwater depth map estimation problems that are occurring in low intensity of light. This problem is solved by using deep neural network by depth estimation. The results of the proposed approach outperforms and effective. Wang, Yafei, et al. [2017] Underwater image enhancement is done by using wavelet decomposition. In frequency domain fusion based strategy is applied. This fusion process gives two inputs that are color corrected and contrast enhanced images which are extracted from the original underwater image. These images are divided into low and high frequency component by wavelet operator. Average weight is given to the low frequency for fusion and high frequency component by Multi-scale fusion process. Rajendran, Rahul, et al. [2017] Underwater imaging is done to explore the underwater image environment. These images are used for microscopic detection, mine detection,

telecommunication cables, and underwater vehicles. These images are disrupted by noise, color distortion and scattering of light which causes blurness and greenish tone. Underwater image enhancement is divided into two methods that are image dehazing and image color restoration. This paper presented a detailed survey of the approaches and methods that used in underwater image enhancement and summary on underwater image processing methods. Li, Xiu, et al. [2016] in this paper, the author proposed image enhancement by using dark channel prior and luminous adjustment. Color distortion in images occurred due to absorption degrees changes according to light wavelength. The result of the paper shows the improved global contrast and better image preservation. Li, Yujie, et al. [2016] introduced image de-scattering and classification by using deep neural network. This method is based on the color correction which enhances the high turbidity in the underwater images. This method removes the scatter from the images and preserves the color. It also proposed quality assessment index for performance comparison. This index combines the color distance index and SSIM index. The classification is done by using support vector machine and convolution neural network.

III. CONCLUSION

This paper has presented a novel approach for stitching images acquired underwater which is able to tackle the problems that arise when using common image stitching methods on underwater images. In the first step, dehazing is used to improve the aesthetic quality of images as well as to improve data quality for the task of feature detection. Guided image filtering is used to speed up the process of dehazing the images. Then SIFT is used to find and match features between images and a single homography per image was used to perform alignment. In the next step, a graph cuts-based seam cutting method in the image gradient domain is used to find the optimal cut between two images in order to reduce visible seams in the overlapped regions

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