An Extensive Review on Visual Quality Restoration & Enhancement of Underwater Images

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Abstract- An image is an artifact that plays important role in depicting and visualizing the physical appearance of a given object. In terms of computer vision, digital image refers to the representation of 2D rectangular array of quantized sample values of an image. These quantized values are referred to picture elements, image element, or pixels. Most often, the low-level attributes of a given object such as color, geometrical shape, and other physical conditions could be acquired from the corresponding image representation. Different natural environments around the world experience different levels of perturbation. This is simultaneously related to the physical composition of the environment and the interaction with external elements. This leads to visibility degradation that could lead to serious consequences. Haze is an atmospheric phenomenon where turbid media obscure the scenes. Haze brings troubles to many computer vision/graphics applications. It reduces the visibility of the scenes and lowers the reliability of outdoor surveillance systems; it reduces the clarity of the satellite images; it also changes the colors and decreases the contrast of daily photos, which is an annoying problem to photographers. In this brief an extensive survey of literature on Visual Quality Restoration & Enhancement of Underwater Images has presented.

Keywords- Haze removal, underwater image processing, Visual Quality Restoration, Image Enhancement, HSV filter.

I. INTRODUCTION

With the rapid development of social productivity and improvement of technology, the limited space and resources of land cannot satisfy the gradually increasing requirements of human. However, ocean occupies 71% superficial area of earth, which contains huge energy, luxuriant mineral resources and biological resources. In order to maintain the survival and development of human, people start to explore the ocean. As ocean exploration increased, the area of underwater image processing has drawn more and more attention over the last years, since video and image are the important ways to obtain and record information nowadays, and the implementation of video and image processing becomes more and more wide. But taking videos and images is easily affected by the environment factors, such as light condition, air humidity and quality, haze and so forth, which cause the existence of information loss and different degree of degradation in different environments. For underwater environment, because of its complexity and particularity, videos and images taken under such condition often show extremely serious distortion and noise, which can not be used to do analysis and measurement directly. So, underwater image processing plays a significant role in ocean engineering.

It is known that acquiring distinct and high contrast underwater images is an important task for ocean engineering and their quality also acts as a crucial role in different scientific researches, such as navigation of autonomous underwater vehicles, monitoring marine organism, taking census of popularities of marine organism, analyzing the geological or biological environments, object recognition and so forth. However, challenges associated with capturing images underwater have been difficult to overcome, due to the existence of haze and color casting. Since the haze is caused by light, which is deflected and scattered by dusk-like particles underwater while color casting due to varying light attenuation degrees of different light wavelengths. In general, color cast and light scattering cause the color derivation and contrast degradation in images and videos acquired underwater.

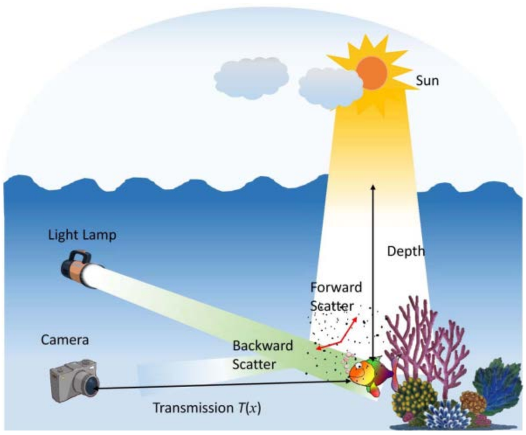

Figure 1.1 Underwater Imaging Systems.

Optical imaging sensors can be provided much information at high speed. They are commonly used in many terrestrial and air robotic application. However, because of the interaction between electromagnetic waves and water, optical imaging systems and vision systems need to be specifically designed to be able to use in underwater environment. Figure 1.1 shows the underwater imaging system.

Underwater images have specific characteristics that should be consider during the gathering process and processing process. Light attenuation, scattering, non-uniform lighting, shadows, color distortion, suspended particles or abundance of marine life on top or surrounding the target are frequently found in typical underwater scenes.

Image enhancement methods for underwater degradation images usually include exploring the underwater optical model and compensating the bad effects caused by water and particles, or merely using image processing methods to restore the performance of distorted images. The state-of-arts are mostly designed for single image restoration, since multi-images input may limit the implementation range and slow down the processing speed. Intuitively, in order to handle this issue well, the underwater optical model should be studied and explored at first. Among various underwater imaging algorithms.

One effect of the inherent optical properties (IOP) of ocean is that it becomes darker and darker with the water depth increases. As the water depth increases, the light from the sun is absorbed and scattered. For example, in the clean ocean water, the euphotic depth is less than 200 meters [16]. In addition, the spectral composition of sunlight also changes with the water depth. Absorption is larger for long wavelengths (red color) than for short (green color); therefore, most of underwater images taken by natural light (sunlight) will appear blue or green on images or videos. Consequently, for the application of deep-sea or turbidly water, additional illumination is required.

II. UNDER WATER IMAGE ENHANCEMENT

Recently, because of the energy exhausted in the world, ocean observing systems have been developed. Along with the development of underwater technologies, autonomous underwater vehicles (AUVs) and unmanned underwater vehicles (UUVs) have been used for deep-sea exploration. Sonars sensors also have been widely used for detecting and recognizing objects for underwater environments. However, for short-range identification, vision sensors must be used instead of sonars, because the images of sonars are low signal to noise ratio, low resolution.

Compared with normal images, underwater optical images suffer from poor visibility due to the medium, because the medium causes scattering, color distortion, and absorption. For example, large suspended particles cause scattering in turbid water. Color distortion occurs because different wavelengths are attenuated to different degrees in water. At the same time, light is absorbed in water and its intensity is reduced. The random attenuation of light causes a hazy appearance. In particular, underwater objects which 10 meters away from the camera lens are almost indistinguishable. In order to obtain clear images, image enhancement becomes very important.

The aforementioned methods can enhance the images, but they have many shortcomings which reduce their practical applications. Firstly, the imaging equipment is difficult to use in practice. Secondly, multiple input images are required. At last, lack of intelligence.

Underwater Image Enhancement Techniques

a. Homomorphic Filtering

Homomorphic blocking is often a frequency filtering approach. These technique all of us used by correcting not for uniform miniature. It truly is promotes the particular comparison from the photograph. Homomorphic filtering provides improvement over some other tactics as it corrects not consistent easy as well as hones the advantage at the same time. Homomorphic filtering utilizes two variables called while light gene along with coefficient of reflection issue. Brightness gene symbolizes very low frequencies inside Fourier convert on the impression along with coefficient of reflection component presents substantial wavelengths.

b. Wavelet DE noising

In camera images along with critical photos Gaussian noise is usually provide. Gaussian sounds are definitely additional amplified by homomorphic filtering. A step involving p-noising is important in order to curb the idea.In comparison to additional delaware-noising methods rippling denoising present's best effects. The idea doesn't restore one levels believe the coefficients usually are separate. Normal filtration system can be used pertaining to rippling p- noising. Wavelet denoising is needed for you to reduce the actual noise termed Gaussian sound which can be seen in digital image documents and as well inside important image.

c. Contrast Stretching and Color Correction

Comparison stretch is usually often known as standardisation. This is a simple advancement technique in which comparison within the picture is improved upon through extending kids regarding high intensity ideals. Comparison can be worked out between bound of decrease patience as well as upper patience. It is deemed an high intensity primarily based line sweetening process. that will generate a increased production impression data. This particular algorithmic rule makes shiny amounts lighter in addition to dim parts more dark. Coloring static correction is performed simply by equalizing each and every colour suggests.

d. Histogram Equalization

Histogram is defined as the statistical probability distribution of each gray level in a digital image. Histogram equalization is a technique inside impression control of contrast modification while using the images histogram. This process normally enhances the global contrast of countless photos, particularly your useful data on the impression data is represented by near compare values. A great impression offers similar quantity of pixels to all it's dull quantities. This method are known as as Histogram Equalization (He / she).That flattens along with stretches the particular dynamic selection of the whole image histogram as well as ends in boiler suit distinction enhancement.

f. Polarizing Filter

This kind of filtering deals with the situation associated with rear scatters instead of blurs. The particular polarizing filtering in combination with most contemporary cams is often a sale paper polarizer. The very first leg in the polarizer is an analogue separate out which filters away mild that is certainly linearly polarized inside a specific route.

g. Bilateral Filtering

Bilaterally symmetrical filtration is a borders-preserving along with sound lowering removing separate out. Bilaterally symmetric blocking smoothness the photographs while keeping edges, through a not-along blend of neighbourhood picture ideals. Taking that approach main bilaterally symmetrical blocking would be to liquidate the number of the effigy what exactly classic filter systems waste the knowledge domain, This kind of weight will be based upon Gaussian submission technique.

III. PRIOR WORK

SR. NO.	TITLE	AUTHORS	YEAR	APPROACH
1	Visual quality restoration & enhancement of underwater images using HSV filter analysis	S. K. Dewangan,	2017	A solution for challenging environmental conditions which creates a complication in image matching and analysis.
2	Visual enhancement of underwater image by white-balanced EMD,	S. Mallik, S. S. Khan and U. C. Pati,	2017	Empirical Mode Decomposition (EMD) with a white balanced input to enhance the visual quality of the under-water images.
3	Underwater Image Enhancement by Dehazing With Minimum Information Loss and Histogram Distribution Prior	C. Y. Li, J. C. Guo, R. M. Cong, Y. W. Pang and B. Wang,	2016	A systematic underwater image enhancement method, which includes an underwater image dehazing algorithm and a contrast enhancement algorithm,
4	Underwater Depth Estimation and Image Restoration Based on Single Images	P. L. J. Drews, E. R. Nascimento, S. S. C. Botelho and M. F. M. Campos	2016	method based on a physical model of light propagation that takes into account the most significant effects to image degradation
5	Automatic restoration of underwater monocular sequences of images,	P. Drews, E. R. Nascimento, M. F. M. Campos and A. Elfes,	2015	A novel optical flow method, which is capable of dealing with scattering media, and a new technique that robustly estimates the medium parameters
6	Comparative analysis of underwater image enhancement methods in different color spaces	S. L. Wong, Y. P. Yu, N. A. J. Ho and R. Paramesran,	2014	A comparative analysis of three different enhancements techniques: contrast stretching (CS), histogram equalization (HE) and contrast limited adaptive histogram equalization (CLAHE)
7	Simultaneous underwater visibility assessment, enhancement and improved stereo	M. Roser, M. Dunbabin and A. Geiger,	2014	a novel method for the simultaneous underwater image quality assessment, visibility enhancement and disparity computation to increase stereo range resolution.

S. K. Dewangan, [1] Underwater vision contains a difficulty of poor visibility conduction. According to most computer vision method like stereo triangulation or on structure from motion cannot be employed directly. This exploration has discussed a solution for such challenging environmental conditions which creates a complication in image matching and analysis. Computer vision method are being used in a different areas e.g. detection of mines, inspecting underwater power and inspection of telecommunication cables, pipelines, nuclear reactor and also for research in marine biology, mapping, archaeology.

S. Mallik, S. S. Khan and U. C. Pati,[2] In this work, an algorithm has been proposed based on Empirical Mode Decomposition (EMD) with a white balanced input to enhance the visual quality of the under-water images. Generally, the underwater images are whisked by blurring effect, scattering effect etc. because of poor lighting condition. EMD is a signal decompose algorithm which is particularly useful for non-stationary and non-linear signals. First of all, the image is processed through the Gray World technique which is a white balance approach to enhance the contrast of the image and to remove the unwanted color cast in the image. Then, each R, G and B channel of the resultant image is decomposed into its Intrinsic Mode Functions(IMFs). Final enhanced image has been constructed by combining the IMFs of each channel with different optimised weights. The EMD algorithm is implemented on the resultant image of White balanced process to restore the color. Experimental results enhance the contrast of the image by reducing noise as well as artifacts in the image. To show the quantitative enhanced result, Gray Level Cooccurrence Matrix(GLCM), Peak Signal to Noise Ratio(PSNR) and Mean Square Error(MSE) are calculated and compared with different conventional enhancement methods. The proposed method results in superior enhanced image with increased visual quality compared to conventional methods.

C. Y. Li, J. C. Guo, R. M. Cong, Y. W. Pang and B. Wang, [3] Images captured under water are usually degraded due to the effects of absorption and scattering. Degraded underwater images show some limitations when they are used for display and analysis. For example, underwater images with low contrast and color cast decrease the accuracy rate of underwater object detection and marine biology recognition. To overcome those limitations, a systematic underwater image enhancement method, which includes an underwater image dehazing algorithm and a contrast enhancement algorithm, is proposed. Built on a minimum information loss principle, an effective underwater image dehazing algorithm is proposed to restore the visibility, color, and natural appearance of underwater images. A simple yet effective contrast enhancement algorithm is proposed based on a kind of histogram distribution prior, which increases the contrast and brightness of underwater images. The proposed method can yield two versions of enhanced output. One version with relatively genuine color and natural appearance is suitable for display. The other version with high contrast and brightness can be used for extracting more valuable information and unveiling more details. Simulation experiment, qualitative and quantitative comparisons, as well as color accuracy and application tests are conducted to evaluate the performance of the proposed method. Extensive experiments demonstrate that the proposed method achieves better visual quality, more valuable information, and more accurate color restoration than several state-of-the-art methods, even for underwater images taken under several challenging scenes.

P. L. J. Drews, E. R. Nascimento, S. S. C. Botelho and M. F. M. Campos,[4] In underwater environments, the scattering and absorption phenomena affect the propagation of light, degrading the quality of captured images. In this work, the authors present a method based on a physical model of light propagation that takes into account the most significant effects to image degradation: absorption, scattering, and backscattering. The proposed method uses statistical priors to restore the visual quality of the images acquired in typical underwater scenarios.

P. Drews, E. R. Nascimento, M. F. M. Campos and A. Elfes,[5] Underwater environments present a considerable challenge for computer vision, since water is a scattering medium with substantial light absorption characteristics which is made even more severe by turbidity. This poses significant problems for visual underwater navigation, object detection, tracking and recognition. Previous works tackle the problem by using unreliable priors or expensive and complex devices. This inverstigation adopts a physical underwater light attenuation model which is used to enhance the quality of images and enable the applicability of traditional computer vision techniques images acquired from underwater scenes. The proposed method simultaneously estimates the attenuation parameter of the medium and the depth map of the scene to compute the image irradiance thus reducing the effect of the medium in the images. This approach is based on a novel optical flow method, which is capable of dealing with scattering media, and a new technique that robustly estimates the medium parameters. Combined with structure-from-motion techniques, the depth map is estimated and a model-based restoration is performed. The method was tested both with simulated and real sequences of images. The experimental images were acquired with a camera mounted on a

Remotely Operated Vehicle (ROV) navigating in a naturally lit, shallow seawater. The results show that the proposed technique allows for substantial restoration of the images, thereby improving the ability to identify and match features, which in turn is an essential step for other computer vision algorithms such as object detection and tracking, and autonomous navigation.

S. L. Wong, Y. P. Yu, N. A. J. Ho and R. Paramesran, [6] A difficult challenge in obtaining clear images in underwater environment is because of poor visibility of objects due to light attenuation and color distortion. A solution to this is to do some form of enhancement of the image that eventually leads to better visualization. This exploration presents a comparative analysis of three different enhancements techniques: contrast stretching (CS), histogram equalization (HE) and contrast limited adaptive histogram equalization (CLAHE) in the RGB and HSV color spaces for underwater images. Besides visual inspection, two different quantitative performance evaluation metrics, namely the Edge Contrast (EC) and BRISQUE, are used to assess the quality of the enhanced underwater images. Experimental results show that the CLAHE method performs better than CS and HE methods in both color spaces from the quality scores obtained in the EC as well as with the subjective evaluations.

M. Roser, M. Dunbabin and A. Geiger, [7] Vision-based underwater navigation and obstacle avoidance demands robust computer vision algorithms, particularly for operation in turbid water with reduced visibility. This work describes a novel method for the simultaneous underwater image quality assessment, visibility enhancement and disparity computation to increase stereo range resolution under dynamic, natural lighting and turbid conditions. The technique estimates the visibility properties from a sparse 3D map of the original degraded image using a physical underwater light attenuation model. Firstly, an iterated distance-adaptive image contrast enhancement enables a dense disparity computation and visibility estimation. Secondly, using a light attenuation model for ocean water, a color corrected stereo underwater image is obtained along with a visibility distance estimate. Experimental results in shallow, naturally lit, high-turbidity coastal environments show the proposed technique improves range estimation over the original images as well as image quality and color for habitat classification. Furthermore, the recursiveness and robustness of the technique allows implementation nboard an Autonomous Underwater Vehicle for improving navigation and obstacle avoidance performance.

IV. ROBLEM STATEMENT

Many outdoor computer vision applications like video surveillance, object detection, object recognition, tracking, intelligent vehicles and remote sensing systems etc. , assume that the input images have clear visibility. Unfortunately, this is not always true in many situations, in particular, haze and fog weather occurring more and more frequently. Outdoor images or videos are usually degraded by light scattering and absorbing from the aerosols, such as dust, mist, and fumes in the atmosphere, here regarded as haze. The captured scenes suffer from poor visibility, contrast, brightness, luminance and distorted color. With the help of Atmospheric optics theories, one can explain the effects that haze has on the visibility of a scene and eventually of an image taken of that scene. Moreover, with the development of computer graphics technology, it is possible to improve the visibility in terms of range, color verisimilitude and feature separation in digital images. Herein the term ”dehazing” means to produce an image of a scene that does not contain haze effects although the source of that image originally comprised haze,

V. CONCLUSION

When image are taken in turbid media such as underwater, hazy or noise conditions, the visibility of the scene is degraded significantlyThis is due to the fact that the radiance of a point in the scene is directly influenced by themedium scattering. Practically, distant objects and parts of the scene suffer from poor visibility, loss of contrast and faded color. Recently, it has been seen a growing interest in restoring visibility of images altered due to such atmospheric conditions. Recovering this kind of degraded images is important for various applications such as oceanic engineering and research in marine biology, archaeology, surveillance etc. Various challenges are thee are in underwater imaging system. Underwater visibility has been typically investigated by involving acoustic imaging and optical imaging systems. Acoustic sensors have the major advantage to penetrate water much easily despite of their lower spatial resolution in comparison with the optical systems. optical systems despite of several shortcomings such as poor underwater visibility, have been applied recently by analysing the physical effects of visibility degradation.

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