

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

Submerged Image Restoration Based on Image Fogginess and Light Absorption

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ABSTRACT: Image restoration is based on Digital image processing it is a method to perform some operations on an image, to get an enhanced image or to extract some useful information from it. Underwater images often have severe quality degradation and distortion due to light absorption and scattering in the water medium. Such images with different color tones can be shot in various lightning conditions, making restoration and enhancement difficult. This paper proposes a depth estimation method for underwater scenes based on image fogginess and light absorption which can be used in the Image Formation Model to restore and enhance underwater images. This method underwater scene depth more accurately. The simulation results show better performance that it outperforms other IFM-based underwater image restoration methods.

I. INTRODUCTION

Underwater imaging has found important applications in diverse research areas such as marine biology, underwater surveying and mapping and underwater target detection. However, captured underwater images are generally degraded by scattering and absorption[1]. Therefore, it is desirable to develop an effective method to restore color and enhancement contrast for these images.

Even though there are many image enhancing techniques developed, such as white balance, color correction, histogram and fusion based methods, they are not based on a physical model underwater, and thus are not applicable for underwater images with different physical properties. It is challenging to restore underwater images because of the variation of the physical properties[1] [2]. Light attenuation underwater leads to different degrees of color change, depending on wavelength, dissolved organic compounds, water salinity and concentration of phytoplankton. In water, red light with a longer wavelength is absorbed more than green and blue light. Also scattered background light coming from different colors of water is blend with the scene radiance along the light of sight, resulting in underwater scenes often having low contrast and color distortions[14].

Underwater images are enhanced or restored mainly by two kinds of algorithm or techniques which, includes image-based methods and physics-based methods[2]. The former methods modify image pixel values via image processing to improve the contrast and brightness of hazed images[10]. Physics based method restore underwater images by considering the basic physics of light propagation in the water medium and the theory of underwater imaging. The purpose of restoration is to deduce the parameters of the physical model and then recover the underwater images by reserving compensation processing[11] [12] [13]. Due to the hazing effect of underwater images caused by light degradation and scattering, a phenomenon is similar to the effect of heavy fog in the air[6]. When a person takes a photo in foggy climate conditions, the procured picture endures with poor visual quality as a matter of course[2][19]. The objects that are far from the camera can lose the contrast and once in a while get obscured with their environment. Dark channel prior [20] method can produce a natural haze free image[10]. The working principle of DCP is that in the non-sky region of the input image, atleast onechannel contains low intensities at some pixels[14][20].

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Image restoration [2] is the operation of taking corrupt or noisy image and estimating the clean, original image. Corruption may come in many forms such as motion blur, noise and camera miss focus. Image restoration is performed by reversing the process that blurred the image and such is performed by imaging appoint source and use the point source image, which is called the point spread function to restore the image information[1-10].

Image restoration is different from image enhancement in the latter is designed to emphasize features of the image that makes the image more pleasing to the observer, but not necessarily to produce realistic data from a scientific point of view. Image enhancement techniques like contrast stretching or de-blurring by a nearest neighbor procedure provided by imaging packages use no prior model of the process that created the image. Image processing techniques[13] are performed either in the image domain or frequency domain. The most straightforward and a conventional technique for image restoration technique is de-convolution, which is performed in the frequency domain and after computing the Fourier transform of both the image and the PSF undo the resolution loss caused by the blurring factor.

The main challenges in underwater imaging, is to develop efficient restoration methods with high quality and increasing the significance of the image[21].

II. RELATED WORKS

In this section, we present numerous methods to enhance underwater degraded images in the past decade.

Shuqi Qiu, Jia[3] present one simply underwater image restoration model combined with total variance regularize Richardson-Lucy Algorithm. An adaptive image restoration strategy by ISNR is then made full use of to undertake the underwater image restoration.

C.Nagarajan *et al.*[5] [9] [21] proposed to detect and then remove artificial lightning by comparing the mean luminance of the foreground and the background. However, this approach classifies foreground and background pixels based on the depth map using DCP, which is often ineffective because of incorrect depth estimation. Meng Wu [7] proposed a novel underwater image restoration method based on color correction and image de-hazing. Estimated the global background light using an, hierarchical search based on Quad tree subdivision combined with the ocean optical properties also used multi-channel guided image filter to refine the depth image. Ahmad Shahrizan Abdul Gania, [17] proposed the method to integrates the modification of image histogram into two main color models: Red-Blue-Green (RGB) and Hue Saturation value. The color channel between the dominant and inferior color channels is stretched to both directions within the whole dynamic range. It follows the Rayleigh Distribution. Galdran *et al.*[4] proposed the Red channel method, whose DCP is based on green, blue and inverted red channels and dealt with artificial lighting by incorporating the saturation prior into $DCP_{r,gb}$. Instead of using the DCP, Carlevaris-Bianco *et al* adopted the maximum intensity prior that uses the difference between the maximum intensity of the red channel and that of the green and blue channels to estimate the TM. However, these methods frequently perform poorly because the light absorption and different lightning conditions existing in underwater images make many exceptions to those priors.

Ziang Hu and Qingsong Zhu [23] proposed a more accurate transmission estimated method for image haze removal based on any transmission extraction prior. The de-hazing result is restored from the refined transmission and atmospheric scattering model. Karen Panetta, Chen Gao [24], find that the background color of underwater images has a relationship with the inherent optical properties of water medium.

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III. PROPOSED FRAMEWORK

A New restoration method based on both image blurriness and light absorption, where more accurate background light and depth estimation are provided. Based on the BL, the depth map and the TMs are obtained to restore scene radiance.

Preprocessing

Pre-processing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. The aim of preprocessing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing, although geometric transformations of images are classified among pre-processing methods here since similar techniques are used[12]. It is the process of removing noise exists in the captured image. The noise may, occurred in image acquisition process due to different weather, environmental conditions. The variation of these, pixels are considered to be noise. Noise removal is the first step in any image processing applications.

Background Light Estimation

To estimate the background light according to the properties in undersea environments. In the majority of underwater images, the dominating color due to light diminishing and the presence of planktonic algae is green to blue[10]. BL determines the color tone of an underwater image as well as its restored scene radiance. Restoring an underwater image with dim BL would result in bright scene radiance while using bright BL leads to an opposite result. The value for estimated BL of an underwater image is chosen from far scene points with high intensity.

Depth Estimation or Extraction [18] refers to the set of techniques and algorithms aiming to obtain representation of the spatial structure of a scene. In computer vision [15] the set of algorithms implemented to process images or video in a complex way, the human visual system has been an important source of inspiration[12], [22]. Thus, we will find many algorithms trying to achieve some human capabilities among others, the depth estimation. The depth map is refined and smoothed by either soft matting or guided filtering. The estimated depth map can be regarded as a map of normalized relative distance for the scene points of the input image[18].

Transmission Map Estimation in the haze removal process, the transmission estimation accuracy is the most dominant factor for the de-hazing performance[14][16]. In the atmospheric scattering model, the transmission describes a light portion that reaches the camera. When the light is scattered and the transmission attenuated, haze occurs in an image. For underwater environments this attenuation occurs under significantly biased ambient light, which produces color saturation in the hazy region. Therefore, transmission map estimation accuracy has significant effect in original scene radiance estimation.

Underwater images were employed to evaluate the restoration performance of the proposed framework in comparison with the state-of-the-art methods. Although the TRM and ERD methods solved the haze problem, the results were somehow dark. The proposed algorithm effectively recovered the shell-like structures with better contrast and brighter colors that were generally more pleasing than methods.

Histogram Equalization is a widely used spatial domain technique, in which all the pixel values are normalized to increase the contrast of a given input image. Histogram equalization is also called as histogram flattening. Consider an image which is having low contrast or poor visibility, then the histogram of the input image should be skewed together. It means that all the details of the image are compressed in to one position in the histogram[3]. All the pixels are to be adjusted towards to the other end, so that all the intensity values should be within a specified range.

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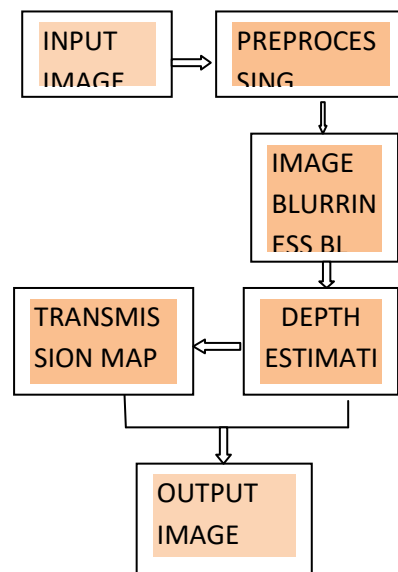


Figure 1: Proposed Framework

IV. SIMULATION RESULT

The simulation of our proposed work is based on image fogging, blurriness and light absorption against the DCP and the MIP based methods. The proposed method attains a more accurate TM and BL selection and presents a more precise color restoration result. It is better in all the tested underwater color tones.



Figure 2: Input Image

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Figure 3: Depth Estmiated Image



Figure 4: Haze removed Image1

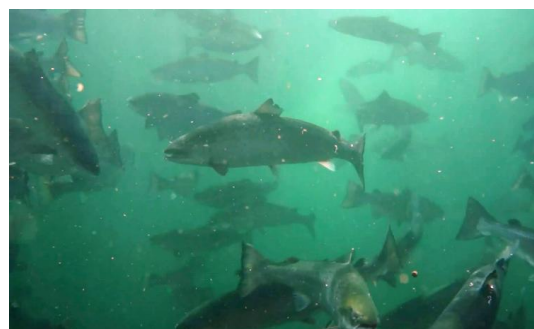


Figure 5: Haze removed Image 2

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Figure 6: Output Image

V. CONCLUSION

In this paper, the underwater image is extracted using image blurriness, fogginess and light absorption to estimate the scene depth and transmission map. These techniques are helpful in various applications such as sea side monitoring and object detection in the underwater environment. The proposed method can produce better restoration and enhancement results in different underwater color tones and lightning conditions compared to other IFM-based underwater image restoration methods.

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