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Literature Survey on Underwater Image Enhancement

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ABSTRACT

Underwater image enhancement is a challenging task and has gained priority in recent years, as the human eye cannot clearly perceive underwater images. We introduce an effective technique to develop the images captured underwater which are degraded due to the medium scattering and absorption. Our proposed method is a single image approach that does not require specialized hardware or knowledge about the structure of the hardware or underwater conditions. We introduce a new underwater image enhancement approach based on multi-scale fusion strategy in this paper. In our method, we first obtain the restored image on the base of underwater image model. Then we get the white balance and contrast enhancement image of the restored image respectively. Finally, these two derived inputs are blended by multi-scale fusion approach, using saturation and contrast metrics to weight each input. To avoid the sharp weight map transitions that create artifacts in the low frequency of the reconstructed image, multistage fusion strategy is adapted. Experimental results on real-world as well as mock underwater images demonstrate that the proposed method is a simplified approach on different underwater scenes and outperforms the existing methods of enhancement.

KEYWORDS: *Image enhancement, Multiscale fusion*

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I. INTRODUCTION

The image enhancement approach is used for recovering perception of information in underwater images. There are many factors within underwater and these factors can easily affect captured images. In other words, clarity of image can be corrupted by diffusion and light inclusion. Eventually, a single colour can dominate the whole image. On another note, underwater images can be affected by some other types of degradation such as noise due to floating particles, skewing, colour loss and blurring or low contrast. Besides underwater photography, underwater imaging has also been an important area of interest in different branches of scientific research such as detection of man made objects, inspection of underwater infrastructures and cables, control of underwater vehicles, marine biology research, and archeology. In order to deal with underwater image processing, we have to consider first of all the basic physics of the light propagation in the water medium. Physical properties of the medium cause degradation effects not present in normal images taken in air. Underwater images are essentially characterized by their poor visibility because light is exponentially attenuated 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 attenuation process is caused by absorption and scattering. The absorption and scattering processes of the light in water influence the overall performance of underwater imaging systems The absorption substantially reduces the light energy, while the scattering causes changes in the light propagation direction. They result in foggy appearance and contrast degradation, making distant objects misty. Absorption and scattering effects are due not only to the water itself but also to other components such as dissolved organic matter or small observable floating particles. The presence of the floating particles known as "marine snow" (highly variable in kind and concentration) increase absorption and scattering effects. The visibility range can be increased with artificial lighting but these sources not only suffer from the difficulties described before (scattering and absorption), but in addition tend to illuminate the scene in a non uniform fashion, producing a bright spot in the center of the image with a poorly illuminated area surrounding it. Finally, as the amount of light is reduced when we go deeper, colors drop off one by one depending on their wavelengths. The blue color travels the longest in the water due to its shortest wavelength, making the underwater images to be dominated essentially by blue color. In summary, the images we are interested on can suffer of one or more of the following problems: limited range visibility, low contrast, non uniform lighting, blurring, bright artifacts, color diminished (bluish appearance) and noise. Therefore, application of standard computer vision techniques to underwater imaging requires dealing first with these added problems. In practice, in common sea water images, the objects at a distance of more than 10 meters are almost undecidable, and the colors are faded because their composing wavelengths are being cut according to the water depth. Acquisition of clear underwater images is of great importance for ocean engineering as well as ocean research where the autonomous and remotely operated underwater vehicles are widely used to explore and interact with the marine environments. However, raw underwater images seldom meet the expectations concerning image visual quality. Naturally, underwater images are degraded due to the adverse effects of light absorption and scattering due to the particles in the water which includes micro phyto-plankton colored dissolved organic matter and nonalgal particles. When the light propagates in an underwater scenario, the light received by a camera is mainly composed of three types of light: direct light, forward scattered light, and back scattered light. The direct light suffers from attenuation resulting in loss of information of underwater images. The forward scattering light has a negligible contribution to the blurring of the image features. The backscattered light reduces the contrast of underwater images and suppresses fine details, edges and patterns. Additionally, the red light disappears first, followed by the green and blue lights. As a result, most underwater images will be dominated by a bluish or greenish tone. These absorption and scattering problems hinder the performance of understanding underwater scene and computer vision applications such as aquatic robot inspection and marine environmental surveillance. Therefore, it is necessary to develop effective solutions which can improve the visibility, contrast, and color properties of underwater images for a superior visual quality and appeal. There have been several attempts made to restore and enhance the visibility of such degraded images. Since the deterioration of underwater scenes results from the combination of additive and multiplicative processes [1] traditional enhancing techniques like gamma correction, histogram equalization appear to be strongly limited for such a task. In contrast, we introduce a novel approach to remove the haze in underwater images based on a single input image captured with a conventional camera. Our approach builds on the fusion of multiple input images, but derives the two inputs images to combine by correcting the contrast and by sharpening a white-balanced version of a single original input image. The white balancing stage aims at removing the color cast which is induced by underwater light scattering, so as to produce a natural appearance of the sub-sea images. The multi-scale implementation of the fusion process results in an artifact-free blending. The next section briefly surveys the optical specifications of the underwater environment, before summarizing the work related to underwater dehazing. Then we present our novel white-balancing approach, especially designed for underwater images. The main components of our fusion-based enhancing technique, include inputs and associated weight maps definition.

II. PROBLEM DEFINITION

Over the previous years, underwater image processing has established considerable recognition due to its challenging nature and its significance. The quality of underwater images are worse than that of images shot outside and images usually appear foggy and hazy. Underwater scenes are characterized by their poor visibility due to the fact that it gets exponentially attenuated as light travels deeper into the water . This results in images that are hazy, dark and have bad contrast. Underwater images has applications in several fields of scientific research and study. However processing these images is highly challenging task. Underwater images suffer from poor visibility resulting from the propagated light being attenuated mainly due to absorption and scattering effects. Degradation effects are caused by the physical properties of the medium which are not present in normal images taken in the air. Underwater images are principally characterized by their deprived visibility because light is exponentially attenuated as it travels in the water and the scenes results in poorly contrasted and hazy image. Light attenuation limits the visibility distance at about twenty meters in clear water. Many researchers have attempted in past to process such degraded underwater images in order to restore their natural visual appearance. In much of the previous works, the problem has been tackled by using specialized hardware and polarization filters. These methods provide significant improvement, however they suffer from a number of issues such as cost of equipment and processing time which reduces their practical applicability. Another group of researchers proposed single or multiple image methods using a blend of statistical and fusion based techniques. The results shows better efficiency both in terms of visual appearance as well as processing time required. However they suffer from poor edge quality, amplified noise and unnatural look. Therefore there is a need of an efficient method which can restore natural visuals of images captured under deep sea.

III. RELATED WORK

The existing underwater dehazing techniques can be grouped into several different classes. One of the important class corresponds to the methods using specialized hardware, [2], [3]. For example, the divergent-beam underwater Lidar imaging (UWLI) system [2] uses a laser-sensing or an optical technique to capture the turbid underwater images. Although there are rapid developments of underwater robotic vehicles in recent years, the underwater visual sensing and underwater imaging is still regarded as a major challenge, particularly in turbid water condition. Currently, a divergent-beam underwater Lidar imaging also known as UWLI system has been finished. The end result is highly improved intensity and contrast of the detected images. Based on our newly designed series targets, we propose to demonstrate UWLI in a small 3 m water tank, and show the fast range-gated phenomenon in water much more clearly. The attenuation coefficients in turbid waters are 1.0 m and 0.23m, respectively.

A second class consists of polarization-based methods. These approaches use several images of the same captured scene with different degrees of polarization. For instance, Schechner and Averbuch make use of the polarization associated to back-scattered light to estimate the transmission map. Although being effective in recovering distant regions, the polarization techniques are not applicable of video acquisition, and are therefore of limited help while dealing with dynamic scenes.

A third class of approaches employs multiple images or an approximation of the scene model. Narasimhan and Nayar made use of changes in intensities of scene points under different weather conditions in order to detect depth discontinuities in the scene. Deep Photo system is able to restore images by employing the existing geo referenced digital terrain and urban 3D models. Since this additional information (images and depth approximation) is generally not available, these methods are not practical for common users.

There is a fourth class of methods which exploits the similarities between light propagation in fog and under water. Recently, several single image dehazing techniques have been introduced to restore images of outdoor foggy scenes. These dehazing techniques reconstruct the intrinsic brightness of objects by inverting the visibility model by Koschmieder. Despite this model was initially formulated under strict assumptions, some works have relaxed those strict constraints and have shown that it can be used in heterogeneous lighting conditions and with heterogeneous extinction coefficient as far as the model parameters are estimated locally. However, the underwater imaging appears to be more challenging, due to the fact that the extinction due to scattering depends on the light wavelength, i.e. on the color component.

IV. PROPOSED SYSTEM

In this section, we briefly discuss about the proposed approach. The image enhancement method implements a two step strategy, combining image fusion and white balancing, to intensify underwater images without resorting to the explicit inversion of the optical model. Two images which are derived from a white balanced version of the single input image, are merged based on a (standard) multi-scale fusion algorithm. The novelty of our approach lies in the proposed pipeline, but also in the definition of a white-balancing algorithm that is suited to our underwater enhancement problem. In this process, white balancing targets at compensating for the colour cast caused by the selective absorption of colours with depth and image fusion is considered to improve the edges of the scene, to ease the loss of contrast resulting from backs catering.

White balancing aims to advance the image aspect principally by removing the undesired colour castings due to numerous illumination and medium attenuation properties. Underwater as the light penetrates the water, the attenuation process affects selectively the wavelength spectrum, thus affecting the intensity and the appearance of a colour surface. In field practice the attenuation and the loss of colour also depends on the total distance between the observer and the sample. The large spectrum of existing white balancing methods were also considered. Most of those methods make a specific assumption to estimate the colour of the light source, and then achieve colour constancy by dividing each colour channel by its corresponding normalized light source intensity. Among those methods, the Gray world algorithm [4] assumes that the average reflectance in the scene is achromatic and computes the scene illumination colour by applying the Minkowski p-norm on the derivative structure of image channels. Despite its computational simplicity, this approach has been shown to obtain comparable results than state-of-the-art colour constancy methods.

In this work, we improvise on the multi-scale fusion principles to propose an image underwater dehazing solution. Image fusion has shown usefulness in several applications such as image compositing, multi-spectral video enhancement, defogging and HDR imaging [5]. Here, we aim for a simple and fast approach that is able to increase the scene visibility in a wide range of underwater images. Our framework builds on a set of inputs and weight maps derived from a single original image. As the colour correction is critical in underwater, we first apply our white balancing technique to the original image. This stage targets at enhancing the image form by discarding unwanted colour casts caused by various illuminants. In water deeper than 30 feet, white balancing suffers from noticeable effects since the absorbed colours are difficult to be recovered. As a result, to obtain our first input we perform a gamma correction of the white balanced image version. Gamma correction aims at rectifying the global contrast and is relevant since white balanced underwater images tend to look too bright. This correction increases the difference between darker/lighter regions at the cost of a loss of details in the under-overexposed regions.

Following the old-fashioned multi-scale fusion approach, each source input is decomposed into a Laplacian pyramid[6] while the normalized weight maps Wk are decomposed using a Gaussian pyramid. Both pyramids have the same number of levels, and the mixing of the Laplacian inputs with the Gaussian normalized weights is performed independently at each level l. In field practice, the number of stages N depends on the image size and has a direct impact on the visual quality of the blended image. The dehazed output is obtained by summing the fused contribution of all levels, after appropriate up sampling. Through independently performing a fusion process at each scale level, the potential artifacts due to the sharp transitions of the weight maps are minimized. Multiscale fusion is motivated by the human visual system, which is very sensitive to sharp transitions appearing in smooth image patterns, while being much less sensitive to variations occurring on edges and textures. Interestingly, a recent work has shown that the multi-scale process can be approximated by a computationally efficient and visually pleasant single-scale procedure.

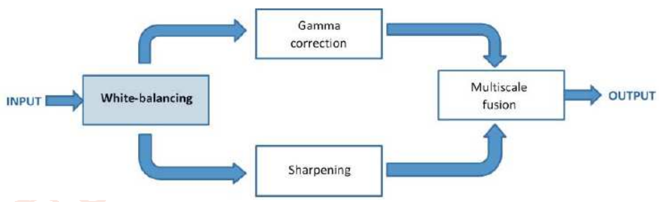

Fig.1. A block proposed system.

CONCLUSION AND FUTURE WORK

The recent Kerala floods have shown us the need for technologies that can dynamically enhance the underwater images for the purpose of identification, rescue and survey. Underwater image enhancement has also been an area of major concern in the recent times. We have presented an alternative approach to enhance underwater videos and images and to implement this on a remote controlled device. Apart from common images, underwater images suffer from poor visibility resulting from the attenuation of the propagated light, mainly due to the absorption and scattering effects. The absorption substantially reduces the light energy, while the scattering causes changes in the direction of light propagation. They result is foggy appearance and contrast degradation, making distant objects appear misty. Our strategy builds on the principle of fusion and does not require additional information than the single original image. We have shown in our experiments that our approach is able to enhance a wide range of underwater images with high accuracy, being able to recover important faded edges and features. In future we can explore new techniques and methods including object detection to incorporate so as to increase the efficiency of the proposed system.

REFERENCES

[1] R. Schettini and S. Corchs,(2010),"Underwater image processing: state of the art of restoration and image enhancement methods ", EURASIP J. Adv. Signal Process., vol. 2010.

[2] D.-M. He and G. G. L. Seet,(2004), "Divergent-beam LiDAR imaging in turbid water ", Opt. Lasers Eng., vol. 41, pp. 217–231.

[3] M. Levoy, B. Chen, V. Vaish, M. Horowitz, I. McDowall, and M. Bolas,(2004), "Synthetic aperture confocal imaging ", in Proc. ACM SIGGRAPH, Aug. 2004, pp. 825–834.

[4] G. Buchsbaum,(1980), "A spatial processor model for object colour perception ", J. Franklin Inst., vol. 310, no. 1, pp. 1–26, Jul. 1980.

[5] T. Mertens, J. Kautz, and F. Van Reeth, (2009), "Exposure fusion: A simple and practical alternative to high dynamic range photography ", Comput. Graph. Forum, vol. 28, no. 1, pp. 161–171, 2009.

[6] P. Burt and T. Adelson, (1983), "The laplacian pyramid as a compact image code", IEEE Trans. Commun., vol. COM-31, no. 4, pp. 532–540, Apr. 1983.