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Underwater Image Enhancement Using Wavelet Fusion

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Abstract: The underwater images are a good source of information which explores idea about sea creatures, to study about seafloor hydrother-mal vents. Low contrast, color distortion and poor visual appearance are the major issues that an underwater image has to undergo. Such problems were caused by dispersion and refraction of light as they penetrate from rarer to denser media. The scattering of light reduces color contrast. The influence of water in underwater images is not only due to scattering but also due to the presence of underwater organisms. Here we introduce an improved method for underwater image enhancement based on the fusion method that is capable to restore accurately underwater images. The proposed work takes a single image as the input and a sequence of operations such as white balancing, gamma correction and sharpening are performed on the input image. Finally wavelet image fusion of the inputs is done to obtain the resultant output. In the initial stage, color distorted input image is white balanced to remove the color casts maintaining a realistic subsea image. In the second stage, CLAHE is performed on the gamma corrected image. CLAHE plays a significant role in luminance enhancement of underwater images. At the same time, histogram equalization is performed on the sharpened image and finally performed the wavelet fusion.

I. INTRODUCTION

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 (which removes light energy) and scattering (which changes the direction of light path). The absorption and scattering processes of the light in water influence the overall performance of underwater imaging systems. Forward scattering (randomly deviated light on its way from an object to the camera) generally leads to blurring of the image features. On the other hand, backward scattering (the fraction of the light reflected by the water towards the camera before it actually reaches the objects in the scene) generally limits the contrast of the images, generating a characteristic veil that superimposes itself on the image and hides the scene. 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, and 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.

II. LITERATURE SURVEY

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III. PROPOSED SYSTEM

Wavelet transforms provide a framework in which a signal is decomposed, with each level corresponding to a coarser resolution, or lower frequency band. There are two main groups of transforms, continuous and discrete. Discrete transforms are more commonly used and can be subdivided in various categories. The below figure 3.2 shows the decomposition process of wavelet transform.

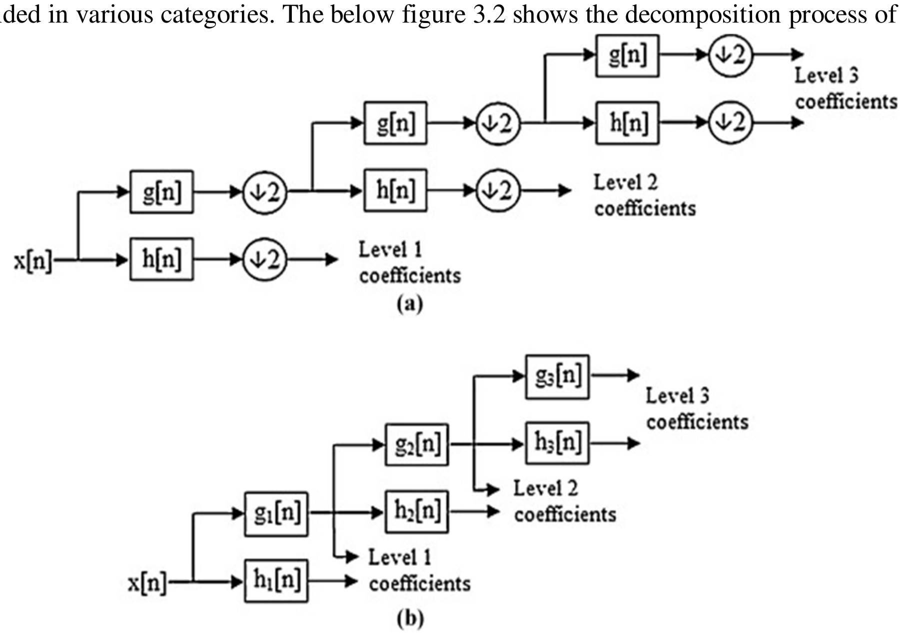

Figure Implementation of Discrete Wavelet Transform

Based on the idea given in figure , we combine/fuse the images which are obtained from color balancing procedure using “Symlet4” based DWT as shown in figure

IV. IMPLEMENTATION

The purpose of enhancing the underwater image is to benefit autonomous underwater navigation , underwater target tracking , and key feature point matching . To verify the application effect of our method after image enhancement using the key feature point matching as an example.It shows feature matching results using SIFT on the original and enhanced images. It is not difficult to see that more feature matching points can be obtained under the same threshold condition by using our method to enhance the image

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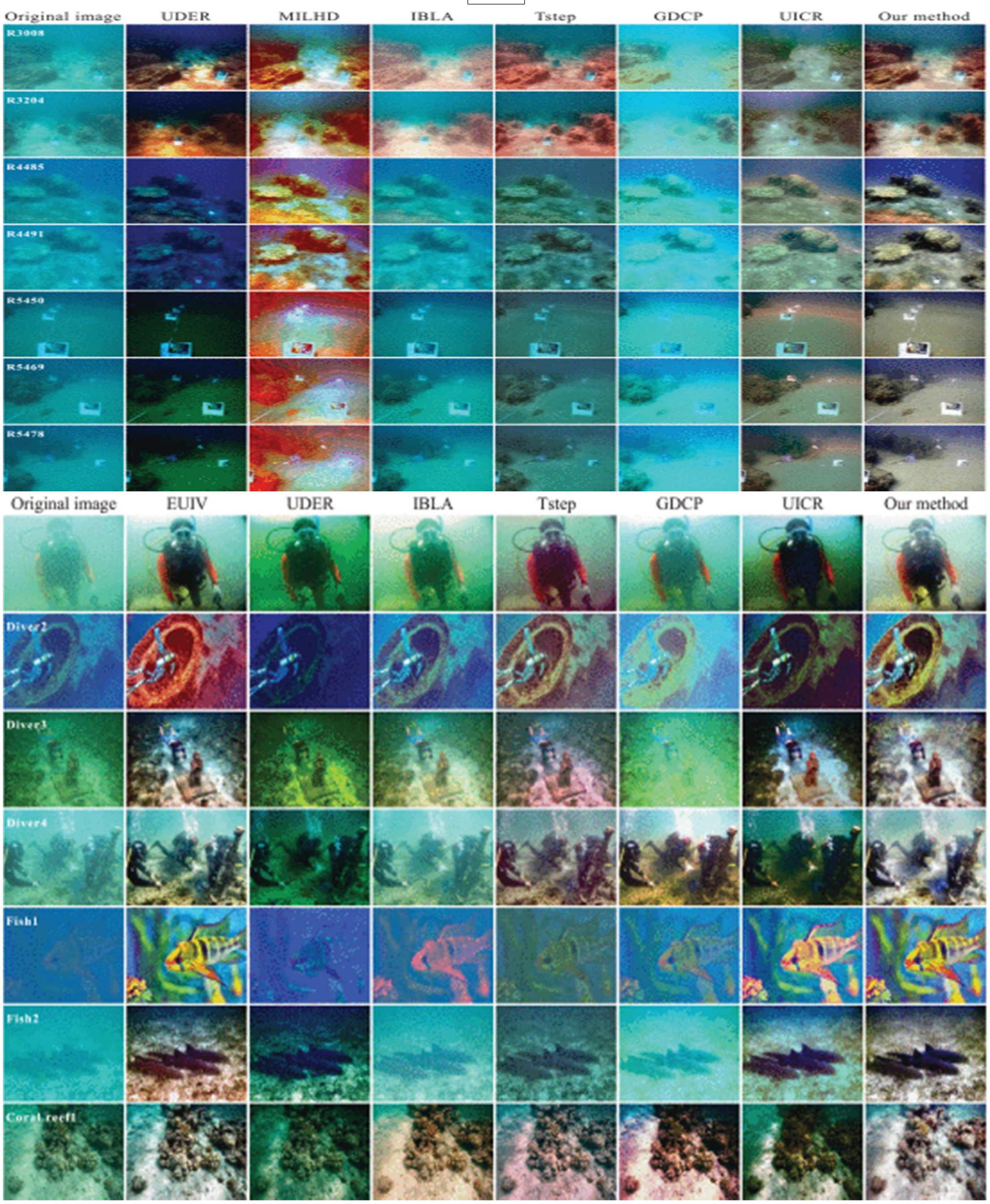
V. RESULTS

	UDER			MILHD			IBLA			Tstep			GDCP			UICR			Our method		
	IE	AG	UIQM	IE	AG	UIQM	IE	AG	UIQM	IE	AG	UIQM	IE	AG	UIQM	IE	AG	UIQM	IE	AG	UIQM
R3008	6.87	2.87	0.97	6.94	2.95	1.01	7.02	1.84	1.02	7.48	2.94	0.99	7.14	2.29	1.05	7.38	2.65	1.00	7.86	5.42	1.22
R3204	6.75	1.37	0.82	7.22	1.61	0.93	7.10	1.33	1.00	7.57	2.07	0.94	6.95	1.34	0.95	7.17	1.37	0.89	7.83	2.97	1.14
R4485	5.89	1.96	0.91	5.99	5.33	1.00	6.21	1.57	1.09	6.83	1.96	0.94	6.38	2.14	1.05	6.70	3.31	1.18	7.85	6.67	1.2
R4491	5.71	1.96	0.81	6.17	9.25	1.10	6.42	2.11	1.14	7.17	2.99	0.95	6.25	2.52	1.06	5.92	7.49	1.13	7.88	8.13	1.31
R5450	5.38	0.66	0.83	5.66	3.64	0.93	5.71	0.60	1.04	6.28	0.72	0.89	5.68	0.67	0.91	5.69	1.56	1.05	7.25	1.75	1.03
R5469	5.93	1.09	0.90	6.12	4.51	0.95	6.28	0.93	1.07	6.75	1.09	0.91	6.11	1.20	0.96	5.91	2.11	1.00	7.43	2.84	1.12
R5478	5.81	0.92	0.89	5.88	4.58	0.94	6.09	0.76	1.05	6.72	0.96	0.91	5.84	0.96	0.94	5.02	1.85	0.96	7.70	2.71	1.07
Average	6.05	1.55	0.88	6.28	**4.55**	0.98	6.40	1.31	1.06	6.97	1.82	0.93	6.34	1.59	0.99	6.26	2.91	1.03	**7.69**	**4.36**	**1.16**

The image part with relationship ID rId10 was not found in the file.



VI. CONCLUSION

We propose an underwater image enhancement method, which mainly includes four parts: color compensation, color correction, detail sharpening, and contrast enhancement. Our proposed method realizes the color compensation from multi-channel to color correction. It solves the detail blurring and low contrast by the detail sharpening of the Gaussian differential pyramid and the local contrast enhancement of CLAHE. Experimental results show that our method improves contrast, detail information, and color correction by multi-scale Retinex (MSR) based on auto-levels. In particular, our method maintains the advantages of both qualitative and quantitative metrics and has fast and highly efficient performance.

VII. FUTURE SCOPE

Many real imaging processes involve SV linear degradation. Thus, a single PSF is not enough to characterize the blur in the observation model, and a local PSF for each spatial location must be considered. In this study, a least squares optimal deformable filtering approximation is introduced as an efficient tool for linear SV filtering, in the context of restoring SV-degraded images. Based on this technique a new formalism for linear SV operators has been proposed, that highlights difference between IKs and PSFs. This formalism helped us to formulate an efficient way to implement the transposed SV-filtering based uniquely on the PSFs. We also have proposed a method for implementing an approximation of the filtering of a SV-matrix regularized inverted, under the assumption of having smoothly varying kernels, and enough regularization. We applied these techniques to implement a SV-version of a recent successful sparsity-based image deconvolution method. A high performance (high speed, high visual quality and low mean squared error, MSE) is demonstrated through several simulation experiments (one of them based on the Hubble telescope PSFs), by comparison to two state-of-the-art methods. As a initial test, synthetic star cluster images have been processed with the same set of obtained parameters for natural images, in order to check optimized parameters' robustness in a case with a very different image statistics. Results were comparable to the ones obtained with other methods. We have also adapted the underlying statistical model by proper training with typical real astronomical images (from Kitt Peak observatory) with different blurs and noise levels; as we expected in this case, results are clearly better than the previous ones (in a range between 1 and 3 dBs). So, it is recommended to choose properly statistical parameter values to achieve a very high-performance in each application (astronomical data, natural images in photography, micrography, medical images, etc.).

Whereas we have used the SVD as a key tool for the proposed SV-filtering techniques, the fact of using it over the set of centered PSFs, instead of on the PSFs at their original locations, as previous studies have done, makes a huge difference in efficiency and accuracy terms. By means of this extra degree of efficiency, for a given accuracy, we have been able to include these SV-filtering techniques as part of an iterative non-linear deblurring method which is much more powerful than classical linear approaches, in a similar computation time.

As future study, it is still pending to explore efficient ways to deal with image boundaries. Finally, in this first part of the article we only deal with simulations, because of the complexity to process real images when the PSF field is unknown. The second part of this article provides an in-depth study with real astronomical data.

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