UNDER WATER IMAGE ENHANCEMENT USING ADAPTIVE RETINAL MECHANISMS

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Abstract *This study propose an underwater image enhancement model inspired by the morphology and function of the teleost fish retina. We aim to solve the problems of underwater image degradation raised by the blurring and nonuniform colorbiasing. In particular, the feedback from color-sensitive horizontal cells to cones and a red channel compensation are used to correct the nonuniform color bias. The center-surround opponent mechanism of the bipolar cells and the feedback from amacrine cells to interplexiform cells then to horizontal cells serve to enhance the edges and contrasts of the output image. The ganglion cells with color-opponent mechanism are used for color enhancement and color correction. Finally, we adopt a luminance based fusion strategy to reconstruct the enhanced image from the outputs of ON and OFF pathways of fish retina.*

Our model utilizes the global statistics (i.e., image contrast) to automatically guide the design of each low-level filter, which realizes the self adaption of the main parameters. Extensive qualitative and quantitative evaluations on various underwater scenes validate the competitive performance of our technique. Our model also significantly improves the accuracy of transmission map estimation and local feature point matching using the underwater image. Our method is a single image approach that does not require the specialized prior about the underwater condition or scene structure.

Key Terms—*Underwater image processing, biologically inspired vision, color correction*

1. INTRODUCTION

Underwater imaging is an important area in research and present technology. There are several rare attractions in underwater environment such as amazing landscapes, marine animals and mysterious shipwrecks. Scattering and absorption of light are the major reasons for low contrast and low clarity of underwater images. Absorption considerably reduces light energy and it depends upon many factors such as salinity and turbidity of water, amount of suspended particles etc. Light scattering causes deflection of the ray from a straight path due to irregularities in the propagation medium, particles etc.

They results in foggy appearance, low contrast and fading of colors. Also image captured in underwater is hazy due to several effects of underwater medium. These effects are caused by the suspended particles in underwater. Water absorbs light wavelength to different degrees. Longer wavelengths get absorb in water first and shorter wavelength appear at a long distance. Water depth is highly correlated with color perception. The penetration of the visible spectrum colors depends on the depth of the water and wavelength. Disappearance of color in underwater occurs in the same order as they appear in the color spectrum and therefore it results in bluish tone of underwater images.

There are many strategies and methods for enhancing and restoring underwater images. Traditional enhancing techniques such as histogram equalization and gamma correction show strong limitations. It is also possible to enhance images using specialized hardware, wavelength compensation, wavelet strategy and dark channel dehazing. These all strategies can enhance images but not much efficient for practicability due to some limitations.

Proposed method is an effective approach which is able to remove the haze and enhance image based on a single image captured with a conventional camera. It builds on the fusing of two images that are directly derived from color compensated and white-balanced version of the original degraded image. The white balancing stage removes undesired color cast induced by underwater light scattering and produce natural appearance of underwater images. It reduces the quantization artifacts introduced by domain stretching. A well-known white balancing method GrayWorld algorithm is used which can achieves good visual performance for reasonably distorted underwater images. The reddish appearance of high intensity regions in the image is also well corrected since the red channel is better compensated.

Multi-scale implementation of fusion is an effective fusion based approach, relying on gamma correction and sharpening to deal with the hazy nature of the white balanced image. The weight maps such as Laplacian contrast weight, saliency weight, saturation weight maps are used during blending in such a way that pixel with a high weight value are more represented in the final output image. It also can enhance the quality of the underwater images. The enhanced image after applying proposed method is given in Fig -1

Fig 1 Degraded and enhanced underwater image

2. LITERATURE REVIEWS

Yan-TsungPeng et al. proposed an accurate depth estimation method for restoring underwater images based on image blurriness and light absorption. It can be used in the image formation model to enhance and restore the degradedunderwater image. It is possible to restore underwater images properly because scene depth is not estimated via color channels. The proposed method is provided with more accurate BL and depth estimation. First, BL is selected from blurry regions in an underwater image.

Hung-Yu Yang et al. proposed low complex and efficient underwater image enhancement method based on dark channel prior. This approach consists of two main procedures. First, estimation of airlight by calculating dark channel prior and depth map is generated by using median filter. Second, to further enhance the visual quality of underwater image, an unsupervised color correction method is used to improve the color contrast of the object.

3. DIGITAL IMAGE PROCESSING

Digital image processing is the use of algorithms to perform image processing of digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modelled in the form of multidimensional systems.

With the fast computers and signal processors available in the 2000s, digital image processing has become the most common form of image processing and generally, is used because it is not only the most versatile method, but also the cheapest.

Digital image processing technology for medical applications was inducted into the Space Foundation Space Technology Hall of Fame in 1994.

Image processing in its broadest sense is an umbrella term for representing and analyzing of data in visual form. More narrowly, image processing is the manipulation of numeric data contained in a digital image for the purpose of enhancing its visual appearance. Through image processing, faded pictures can be enhanced, medical images clarified, and satellite photographs calibrated. Image processing software can also translate numeric information into visual images that can be edited, enhanced, filtered, or animated in order to reveal relationships previously not apparent. Image analysis, in contrast, involves collecting data from digital images in the form of measurements that can then be analyzed and transformed.

Originally developed for space exploration and biomedicine, digital image processing and analysis are now used in a wide range of industrial, artistic, and educational applications. Software for image processing and analysis is widely available on all major computer platforms. This software supports the modern adage that "a picture is worth a thousand L

Fig 2: Standard processing of space borne images

4. SOFTWARE USED

MATLAB

MATLAB® is a excessive-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment wherein issues and answers are expressed in familiar mathematical notation. Typical uses encompass.

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5. RESULTS

Example 1 results

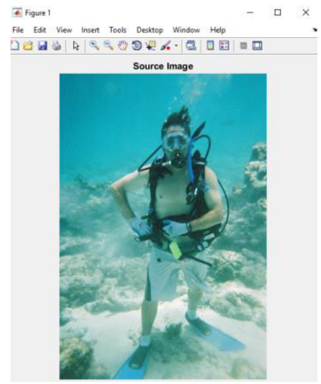

Fig 3: Source image

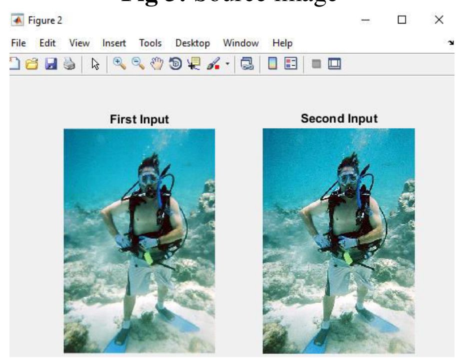

Fig 4: First input and second input

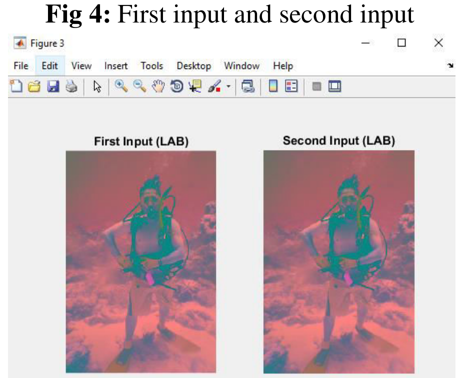

Fig 5: First input and second input (LAB)

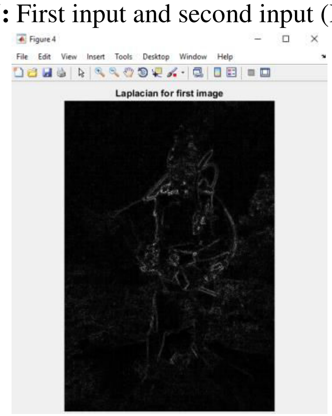

Fig 6: Laplacian for first image

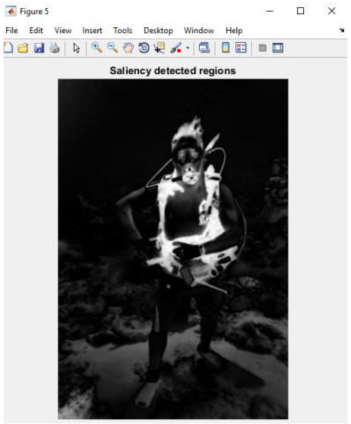

Fig 7: Saliency detected regions

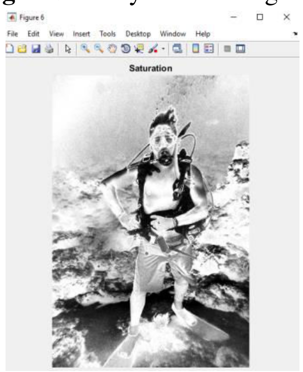

Fig 8: Saturation image

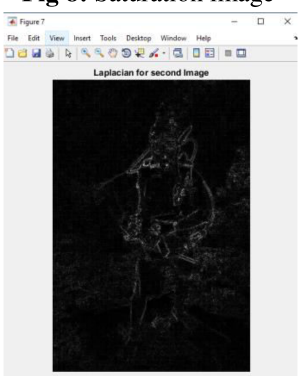

Fig 9: Laplacian for second image

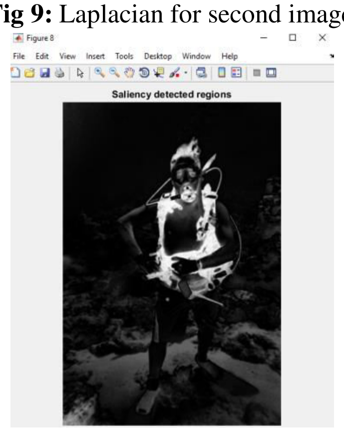

Fig 10: Saliency detected regions

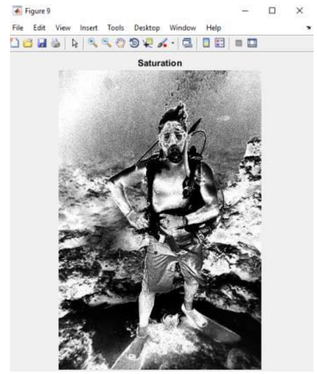

Fig 11: Saturation image

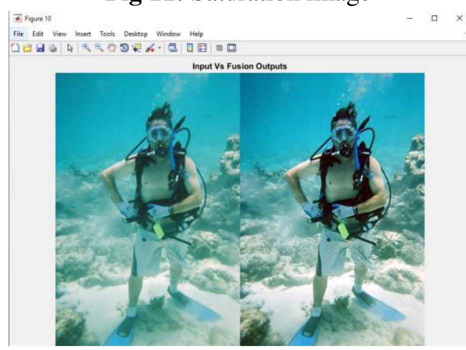

Fig 12: Input vs fusion outputs

Example 2 results

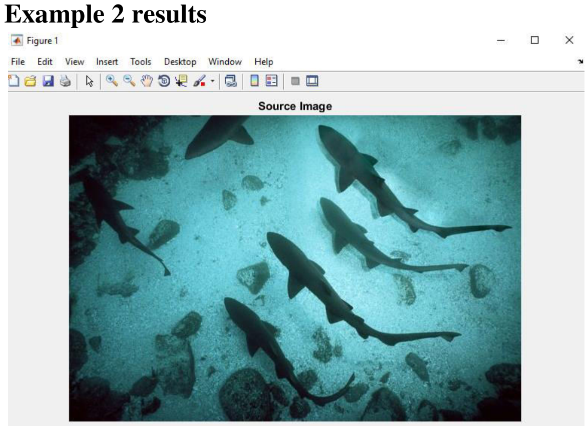

Fig 13: Source image

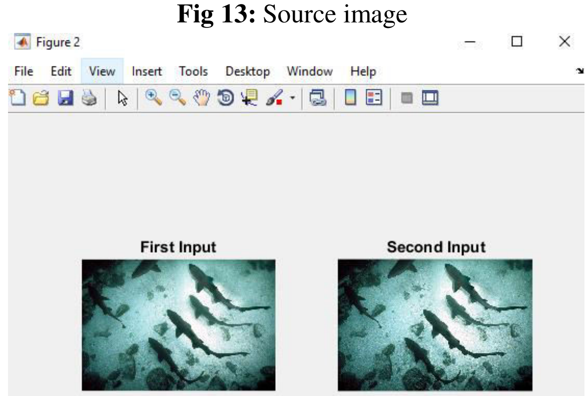

Fig 14: First input and second input

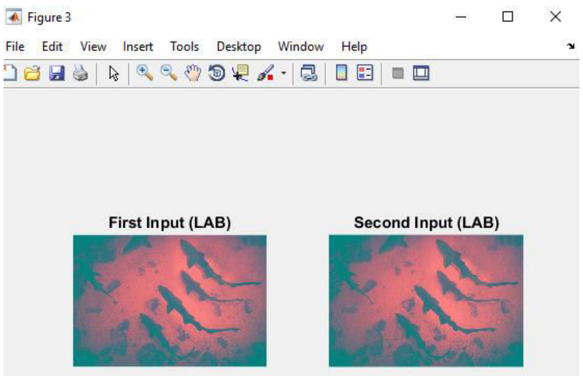

Fig 15: First input and second input (LAB)

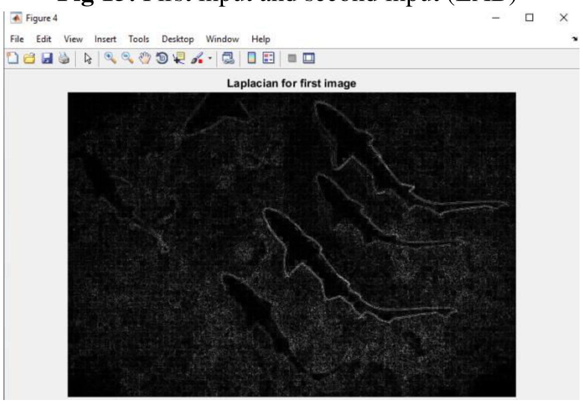

Fig 16: Laplacian for first image

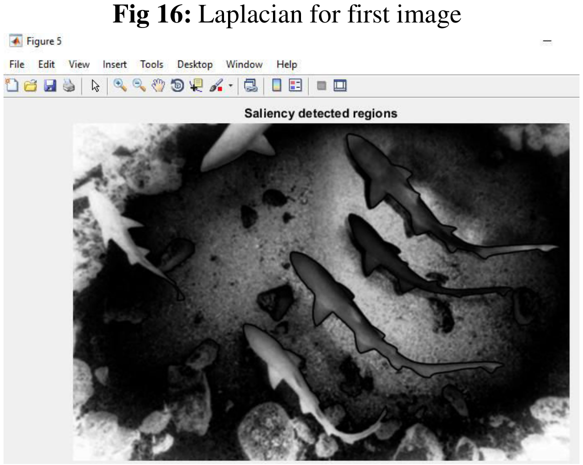

Fig 17: Saliency detected regions

Fig 18: Saturation image

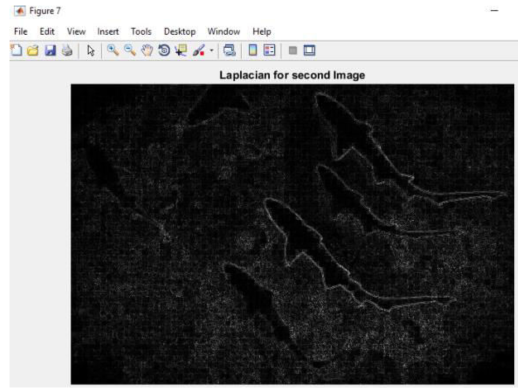

Fig 19: Laplacian for second image

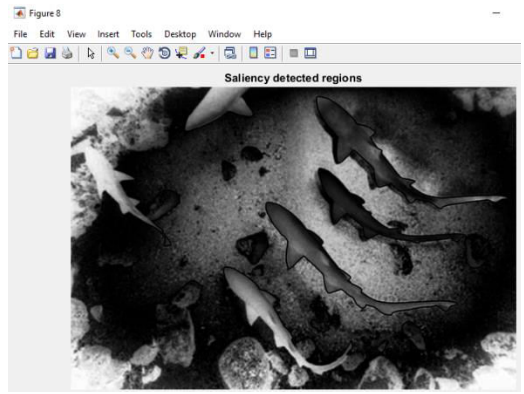

Fig 20: Saliency detected regions

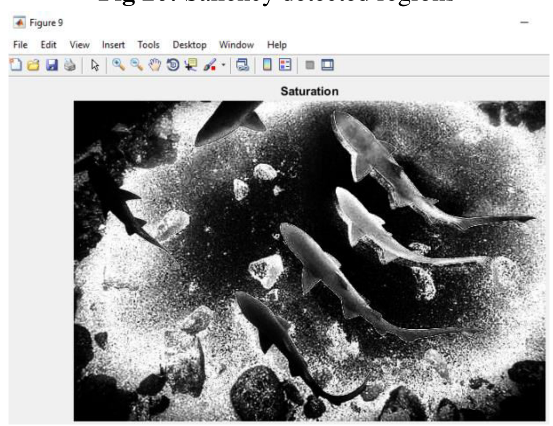

Fig 21: Saturation image

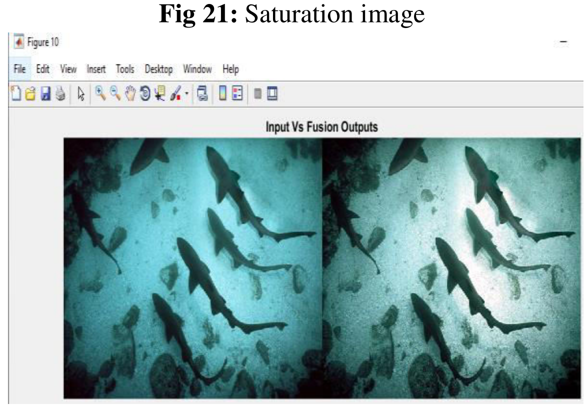

Fig 22: Input vs fusion outputs

6. CONCLUSIONS

In this work, we proposed a new underwater image enhancement model by carefully considering the features of the underwater environments and the adaptive mechanisms of the teleost fish retina. Extensive experiments on different underwater datasets show that our method can simultaneously eliminate the haze and the non uniform color bias. Compared to the SOTAs, our technique produces very competitive performance in terms of both qualitative and quantitative evaluations. Moreover, for the first time, we demonstrate the values of modeling the visual mechanisms of underwater creatures for the challenging underwater image processing tasks. We attribute the promising results of this work to the following differences between this work and other existing methods for underwater image processing.

1. We introduced a non uniform color correction algorithm, which could well handle the non uniform color cast in underwater images compared to the existing methods that were usually built on the uniform color cast condition
2. We imitated the adaptive retinal mechanisms to control the model parameters of each low-level filter according to the global contrast of a given image, which overcomes the need for ad-hoc or dataset-dependent parameters (and in this sense, it is fully automatic).
3. We exploited the color-opponent mechanisms to flexibly adjust the color appearance of underwater images during image enhancement.
4. Our algorithm introduced the complementary fusion of luminance information given by the ON and OFF pathways of the retina, which is different from those fusion based methods using various weights (e.g., Laplacian contrast weight, saliency weight, saturation weight).

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