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Under Water Image Restoration

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Abstract -- People collect images and videos from a wide range of the undersea world. Waterproof cameras have become popular, allowing people to easily record underwater creatures while snorkelling and diving. These images or videos often suffer from color distortion and low contrast due to the propagated light attenuation with distance from the camera, primarily resulting from absorption and scattering effects. Therefore, it is desirable to develop an underwater scene depth more accurately. Experimental results on restoring real and synthesized underwater images demonstrate that the proposed method outperforms other IFM-based underwater image restoration methods.

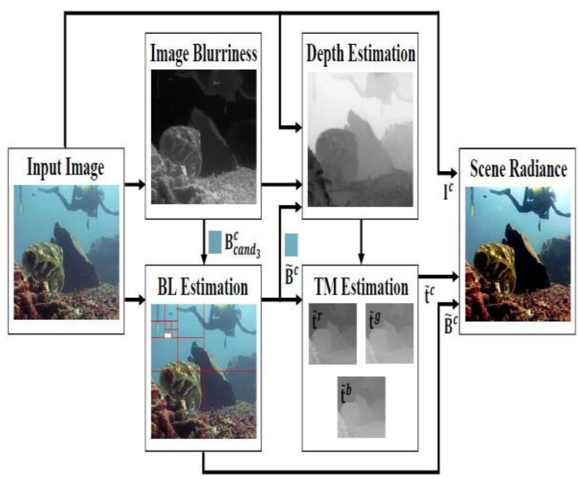
Index Terms— Underwater image, image restoration, color distortion, snorkelling, scattering effects, blurriness, light absorption.

I. INTRODUCTION

Technology advances in manned and remotely operated submersibles allow people to collect images and videos from a wide range of the undersea world. Waterproof cameras have become popular, allowing people to easily record underwater creatures while snorkelling and diving. These images or videos often suffer from colour distortion and low contrast due to the propagated light attenuation with distance from the camera, primarily resulting from absorption and scattering effects. Therefore, it is desirable to develop an effective method to restore colour and enhance contrast for these images.

Even though there are many image enhancing techniques developed, such as white balance, colour correction, histogram equalization, 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 physical properties. Light attenuation underwater leads to different degrees of colour 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 colours of water is blended with the scene radiance along the light of sight, resulting in underwater scenes often having low contrast and colour distortions.

II. BLOCK DIAGRAM:



A Blurness Estimation:

It includes three steps

- The initial blurriness map

$$P_{init}(x) = \frac{1}{n}\sum_{i=1}^{n} |I_g(x) - G^{r_i,r_i}(x)|,$$

- Rough blurriness map

$$P_r(x) = \max_{y \in \Omega(x)} P_{init}(y).$$

- Refined blurriness map

$$P_{blr}(x) = F_g\left\{C_r\left[P_r(x)\right]\right\}$$

B Background Light Estimation:

- BL determines the color tone of an underwater image as well as its restored scene radiance.
- Largest blurriness being replaced by lowest variance and without considering Pblr .

In BL–ESTIMATE, we determine BL for each color channel between the darkest and brightest BL candidates according to the percentage of bright pixels.

C Depth Estimation Based on Light Absorption and Image Blurriness:

Three depth estimation methods are presented

- First estimate of depth from red channel= dR = 1 − Fs (R);

$$F_s(\mathbf{V}) = \frac{\mathbf{V} - \min(\mathbf{V})}{\max(\mathbf{V}) - \min(\mathbf{V})},$$

- Second estimate of depth is

$$\widetilde{d_D} = 1 - F_s\left(D_{mip}\right)$$

- Depth estimation from image blurriness

$$\widetilde{d_B} = 1 - F_s\left(C_r(P_r)\right).$$

D TM Estimation and Scene Radiance Recovery

- distance d0 between the closest scene point and the camera

$$\widetilde{d_0} = 1 - \max_{x, c \in \{r,g,b\}} \frac{|\widetilde{B^c} - I^c(x)|}{\max(\widetilde{B^k}, 1 - \widetilde{B^k})},$$

FINAL SCENE DEPTH

$$\widetilde{d_f}(x) = D_\infty \times \left(\widetilde{d_n}(x) + \widetilde{d_0}\right),$$

- D=scaling constant for transforming the relative distance to the actual distance.
- TM for the red channel

$$\widetilde{t^r}(x) = e^{-\beta^r \widetilde{d_f}(x)}$$

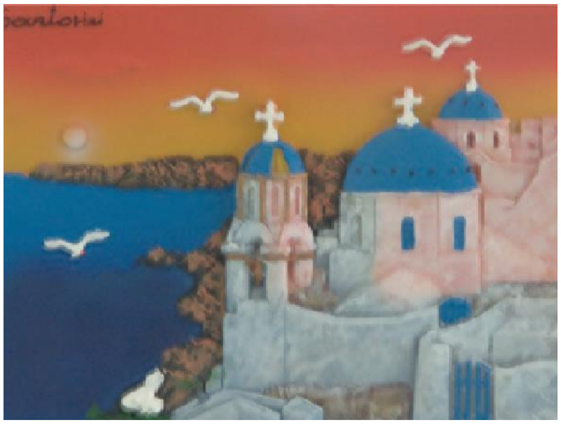
E Combining Ifm-Based Restoration And Histogram

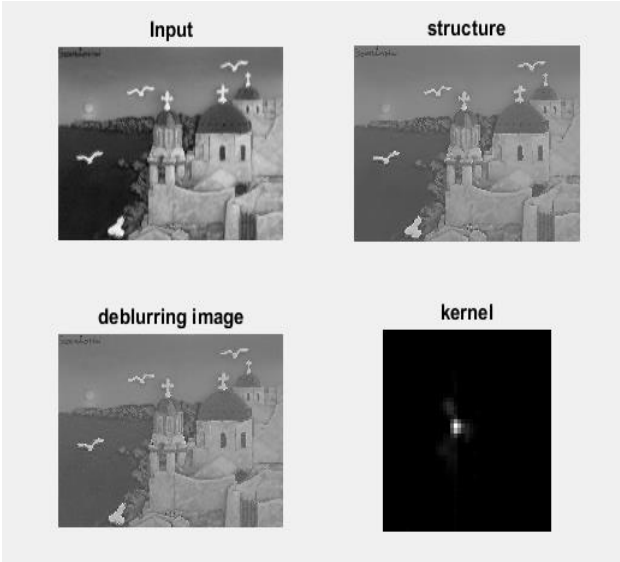
EQUALIZATION

Methods based on the IFM, such as ours, have the goal of restoration, rather than enhancement. This paper first aimed to demonstrate that our IFM-based method outperforms other IFM-based methods both for synthesized images (for which a ground truth is available, and full-reference fidelity metrics such as psnr can be used).

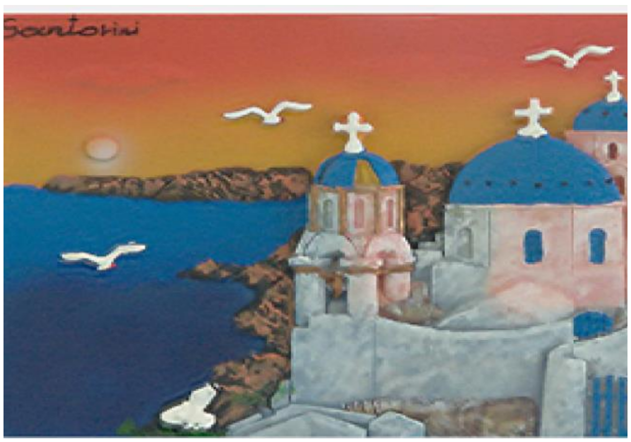
INPUTIMAGE

OTHER FORMS OF THE IMAGE





FINAL OUTPUT



III. CONCLUSION

For underwater image restoration, we have proposed to exploit image blurriness and light absorption to estimate the background light, scene depth, and transmission maps instead of using the DCPs or MIP. Using both synthesized and real underwater images with different color tones and contents, we demonstrated satisfying restored and enhanced underwater images. The proposed depth estimation works well for a wide variety of underwater images. Both the subjective and objective experimental results showed that the proposed method can produce better restoration and enhancement results in different underwater color tones and lighting conditions compared to other IFM-based underwater image restoration methods.

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