UGC Approved Journal

IJIREEICE

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified

Vol. 5, Issue 9, September 2017

A Review on Underwater Image Scene Enhancement and Restoration using Image Processing

Ms. Tejal R. Haware[1], Prof. P. R. Gumble[2]

PG Student, Department of Electronics and Telecommunication, Sipna COET, Amravati, India[1]

Associate Professor, Department of Electronics and Telecommunication, Sipna COET, Amravati, India[2]

Abstract: Getting clear images and videos in underwater environments is an important issue in ocean engineering. Restoration and enhancement of underwater images and videos are difficult tasks because of variations of physical properties. The scattering and absorption are the main causes in the underwater environment to make the images and videos decrease their visibility, for example, blurry, colour distortion, low contrast, and reducing visual range. In this work, we proposed a method to estimate underwater scene depth and enhance it using CLAHE (contrast-limited adaptive histogram equalization) to restore real and synthesized underwater images and video and will show better performance.

Keywords: Underwater image, light scattering, light absorption, image enhancement, image restoration.

I. INTRODUCTION

Underwater exploration has become very important in recent years with increasing application demands. As the technology advances in manned and remotely operated submersibles allowing people to collect images and videos from a wide range of the undersea world. Waterproof cameras have become popular, allows to easily record underwater images and videos for various applications such as studies of marine species, wreckage exploration, inspection of underwater cables and pipelines, underwater scene analysis, search and rescue. Even though there are many image enhancing techniques developed, such as white balance, color 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.

Fig. 1(a) depicts a simplified image formation model (IFM) to describe an underwater scene. Here I(x), the observed intensity at pixel x, consists of the scene radiance J(x) blended with the background light (BL) B according to the transmission map (TM) t(x). The TM describes the portion of the scene radiance that is not scattered or absorbed and reaches the camera. Therefore, a closer scene point has a larger value in the TM. Fig. 1(b)-(f) shows five underwater images with different BL. Noises present in under water image or video diminish the details that could contain significant information. Thus, noise free super-resolving underwater speckled images are important for ocean observation. Captured underwater 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.

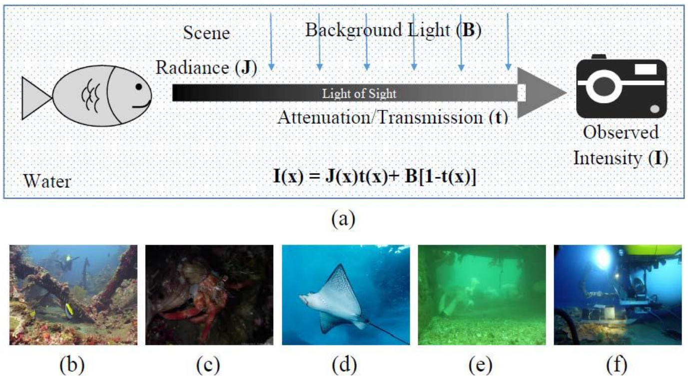

Fig 1.(a) Simplified image formation model. (b)– (f) Examples of underwater images having different underwater color tones.

UGC Approved Journal
IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2017

The scattering effect is brought by the suspended particles in the water that reflect the light rays into the other direction, which makes image blurry. The absorption is caused by the medium of water that degrades the energies of light rays according to their wavelength, which makes the image visually losing in contrast and reduces the visible ranges. The absorption is depend on the density and turbidity of water. Therefore, it is desirable to develop an effective method to restore color and enhance contrast for these images.

II. LITERATURE REVIEW

For the last few years, a flourishing movement has been started towards the direction of the improvement of underwater scene using image processing. Various authors proposed methods in order to restore color and enhance contrast for such images.

Yan-Tsung Peng and Pamela C. Cosman [1] presented a method which uses image blurriness and light absorption based on depth estimation for the image restoration. Rather than estimating depth using image blurriness alone, that method use both image blurriness and light absorption. Background light is determine by the candidate background lights estimated from blurry regions.

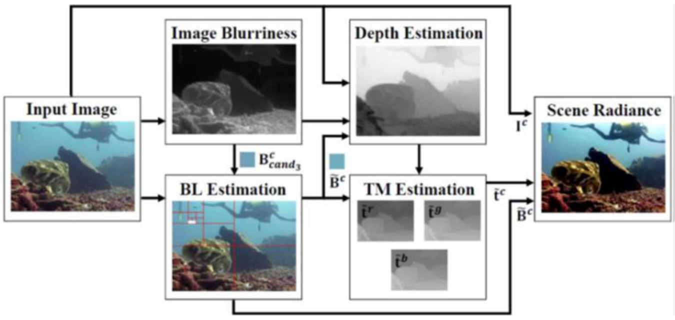

Fig 2. Flowchart for the image restoration based on image blurriness and light absorption.

Above figure shows the flowchart for the image restoration based on image blurriness and light absorption. Where BL is background light and TM is transmission map. The most comprehensive comparison is presented to date of underwater image restoration techniques, using no-reference quality assessment tools as well as two full-reference approaches based on synthesized underwater images with scaled and shifted known depth maps.
Shu Zhang, Ting Wang, Junyu Dong, Hui Yu[3] presented a novel method for underwater image enhancement inspired by the retinex framework, which simulates the human visual system .This method, namely LAB-MSR, is achieved by modifying the original retinex algorithm. It utilizes the combination of the bilateral filter and trilateral filter on the three channels of the image in CIELAB color space according to the characteristics of each channel. The workflow of this method can be divided into three main parts, the pre-processing, the multi-channel enhancement with a combination of filters and the post-processing. In this method they firstly calculate the original proportions of all three channels of the underwater image in RGB color space then convert the underwater image from RGB color space to CIELAB color space. After that apply convolutions with bilateral filter to the L channel of the underwater image to estimate and remove the luminance component in this channel of the image and apply convolutions with Trilateral Filter to the A and the B channels of the image respectively to estimate and remove the luminance components in these two channels of the image. Convert the underwater image back from CIELAB to RGB color space. Then adjust the proportions of three channels to make them close to the original ones.
Yakun Gao, Haibin Li, and Shuhuan Wen [4] presented a method for underwater images restoration and enhancement which was inspired by the dark channel prior in image de-hazing field. In this method bright channel prior of underwater environment is proposed.

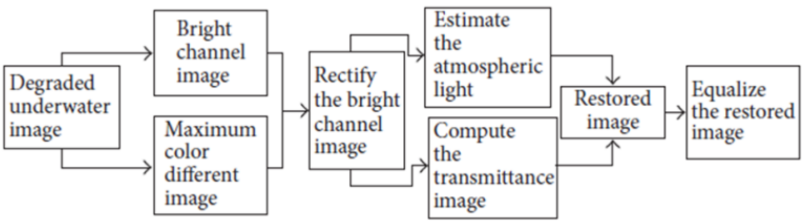

Fig 3. Flowchart for restoration and enhancement of images based on bright channel prior

UGC Approved Journal
IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2017

Above diagram shows the flowchart of the method based on bright channel prior By estimating and rectifying the bright channel image, estimating the atmospheric light, and estimating and refining the transmittance image, eventually underwater images were restored. Then in order to rectify the color distortion, the restoration images were equalized by using the deduced histogram equalization.

G. Sowmiyadevi and Dr. G. Kavitha [5] presented the RGB Color Dependability Algorithm(UCDA) for an Underwater Image Restoration . This algorithm is applied both on light illumination and shades color models to enhance underwater images. This paper developed an interactive software tool to be used for underwater image enhancement. First of all, it performs contrast stretching on RGB color model. Secondly, it performs saturation and intensity stretching on Weibull histogram color model. The advantage of applying two stretching models is that it helps to equalize the color contrast in the images and also addresses the problem of lighting.

Huimin Lu, Yujie Li, Yudong Zhang, Min Chen, Seiichi Serikawa, Hyoungseop Kim [6] proposed a comprehensive review of underwater image processing. Various underwater image-processing approaches are presented such as underwater image de-scattering, underwater image color restoration, and underwater image quality assessments. They review two categories of underwater image de-scattering methods: hardware based approaches and software-based approaches. Then, they summarize four typical underwater image color restoration methods: a light absorption recovering method, a hyper spectral imaging and mathematical stability model, a light attenuation inversion method and model the spectral response function of a camera as a function of the wavelength of the light. Next, they cover two underwater image quality assessment methods: reference-based indexes and non-reference indexes.

Yan-Tsung Peng, Xiangyun Zhao and Pamela C. Cosman [7] proposed a method for single under water image enhancement using depth estimation based on blurriness. The proposed depth estimation includes three steps. First, the pixel blurriness estimation, in this the difference between the original and the multi-scale Gaussian-filtered images is calculated to estimate the pixel blurriness map. Second, the rough depth map generation, in this the max filter is applied to the pixel blurriness map by assuming the depth in a small local patch is uniform. And third, depth map refinement, in this CMR and the guided filter is used to refine the depth map. By combining image blurriness with image formation model, they presented pleasing enhanced images.

Rubi Mandal, Prof. Sitendra Tamrakar [8] proposed a method for restoration and enhancement of underwater image based on wavelength compensation and image dehazing technique. Light scattering and color change are two major sources of distortion for underwater images. They presented a wavelength compensation and image dehazing technique to balance the color change and light scattering respectively. It also removes artificial light by using depth map technique. Water depth is estimated by background color. Color change compensation is done by residual energy ratio method.

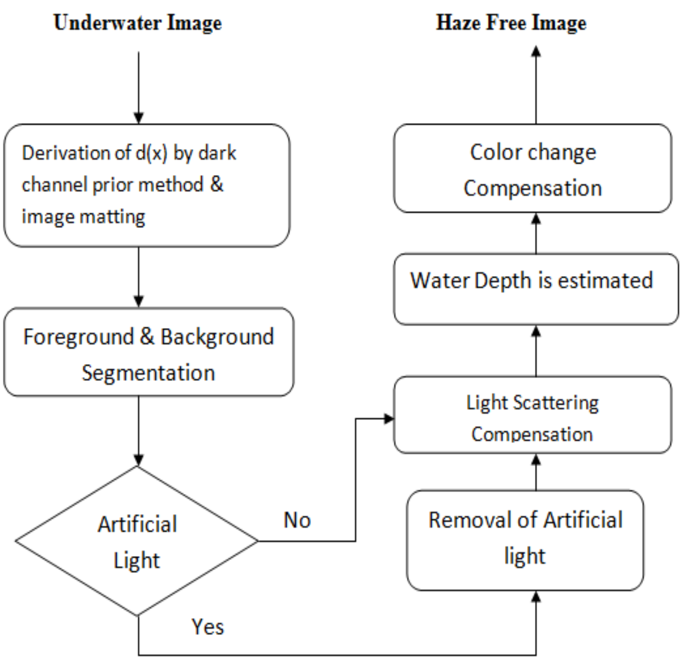

Fig 4. Flowchart of wavelength compensation and image dehazing algorithm

UGC Approved Journal

IJIREEICE

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified

Vol. 5, Issue 9, September 2017

Above diagram shows the flowchart of wavelength compensation and image de-hazing algorithm an original idea to reconstruct a submerged object distorted by moving water surface. The Wavelength compensation and de-hazing technique is employed to recover the phase of the true object.

III. CONCLUSION

In this paper, we presented a review on underwater image processing. Underwater image scene distortion mainly occurs due to the scattering and absorption effect. We proposed a method to estimate underwater scene depth and enhance it using CLAHE (contrast-limited adaptive histogram equalization) to restore real and synthesized underwater images and video. We carry out some pre-processing on underwater images to remove the noises present in it for getting the image without any loss of important information.

REFERENCES

[1] Yan-Tsung Peng and Pamela C. Cosman, "Underwater Image Restoration Based on Image Blurriness and Light Absorption" in IEEE Trans. Img. Proc. Vol. 26, No. 4, April 2017.

[2] K. Natarajan , "A Review On Underwater Image Enhancement Techniques" in International Research Journal of Engineering and Technology (IRJET) Vol. 04,Apr -2017.

[3] Shu Zhang, Ting Wang, Junyu Dong and Hui Yu, "Underwater image enhancement via extended multi-scale Retinex" in Elsevier in January 2017.

[4] yakun Gao, Haibin Li, and Shuhuan Wen," Restoration and Enhancement of Underwater Images Based on Bright Channel Prior" in Hindawi Publishing Corporation Mathematical Problems in Engineering Volume 2016, Article ID 3141478.

[5] G. Sowmiyadevi and Dr. G. Kavitha, "UCDA: An Underwater Image Restoration using RGB Color Dependability Algorithm" in National Conference on Innovations in Computing and Communication (NCICC- 2016).

[6] Huimin Lu1, Yujie Li, Yudong Zhang, Min Chen, Seiichi Serikawa, Hyoungseop Kim, "Underwater Optical Image Processing: A Comprehensive Review"

[7] Y.-T. Peng, X. Zhao, and P. C. Cosman, "Single underwater image enhancement using depth estimation based on blurriness," in Proc. IEEE Int. Conf. Imag. Process. (ICIP), Sep. 2015, pp. 4952–4956.

[8] Rubi Mandal, Prof. Sitendra Tamrakar, "Restoration and Enhancement of Underwater Image based on Wavelength Compensation and Image Dehazing Technique" in IOSR Journal of Computer Engineering (IOSR-JCE) Volume 16, Issue 6, Ver. IV (Nov – Dec. 2014).

[9] C. Ancuti, C. O. Ancuti, T. Haber, and P. Bekaert, "Enhancing underwater images and videos by fusion," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., Providence, RI, USA, Jun. 2012, pp. 81–88.

[10] S. Q. Duntley, "Light in the sea," J. Opt. Soc. Amer., vol. 53, no. 2, pp. 214–233, 1963.

[11] Y. Y. Schechner and N. Karpel, "Recovery of underwater visibility and structure by polarization analysis," IEEE J. Ocean Eng., vol. 30, no. 3, pp. 570–587, Jul. 2005.

[12] S. G. Narasimhan and S. K. Nayar, "Chromatic framework for vision in bad weather," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), vol. 1. Jun. 2000, pp. 598–605.

[13] S. G. Narasimhan and S. K. Nayar, "Vision and the atmosphere," Int. J. Comput. Vis., vol. 48, no. 3, pp. 233–254, 2002.

[14] R. Fattal, "Single image dehazing," ACM Trans. Graph., vol. 27, no. 3, pp. 721–729, 2008.

DOI 10.17148/IJIREEICE.2017.5906