INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 3 - V7I3-1358)
Available online at: https://www.ijariit.com

A comparative study and classification on different underwater image enhancement techniques

Swathy N.
swathynarayan044@gmail.com
College of Engineering, Kidangoor, Kerala

ABSTRACT

Underwater images play a vital role in marine engineering, marine research etc. These images can be used for control of underwater vehicles, study of corals, fishes and other specious. Underwater images suffer poor visibility and some important details may loss because of scattering and absorption. Obtaining a clear underwater image is very important and it is difficult too. Underwater image enhancement has been an active research topic over many years and several techniques has been proposed. This paper introduces a study on various techniques used to enhance the underwater images and classified the techniques into four categories.

Keywords— *Underwater images, Image enhancement, Enhancement techniques*

1. INTRODUCTION

Nowadays underwater images are very important because these images will help in so many fields such as marine engineering, research, study of ocean species etc. So, obtaining a clear underwater image is very important and difficult task too. Researchers found that the scattering and absorption effects of light in water are the major causes for the poor visibility in underwater. Since water is approximately 800 times denser than air, so when light enters from air to water, it encounters reflection phenomenon at the surface due to which only partial amount of light enters into water. Then the light suffers scattering effect when it strikes sand particles and minerals dissolved in water. Scattering deviates the light in different directions which reduces the amount of light falling on the object to be captured. The ultimate result of scattering effect is that the underwater captured images are dark in appearance. Another issue contributing to the haziness of image is that the water molecules absorb certain amount of light when light strikes on them. The scattering of light can be forward scattering and backward scattering. The reason for backward scattering is the light that is reflected back before reaching the target object and the reason for forward scattering comes from the object. The absorption reduces the light energy. To reduce the effects of these scattering and absorption is a difficult task. The underwater image enhancement techniques enhance the faded portion of the image. These techniques will try to restore or improve some important faded features of the images.

Fig. 1: A sample Input and Output Images: (a) Original underwater image, (b) Enhanced image

In figure 1(a) the image is a pure underwater image. So, the image is blurred and the green channel component is very high, but figure1(b) undergoes some image enhancement techniques and obtain a clearer image.

2. LIGHT PROPAGATION IN UNDERWATER

For a perfect transmission medium, the light is affected for the most part by the properties of the objective article and the camera focal point qualities. But in the case of underwater, the light propagation depends on the following factors.

- The interaction between the sun light and the sea surface is affected by the time of the day.
- The shape of the interface between air and water.

In the first point is all about the time, that is the availability of the light different for morning, afternoon and evening. So, this will affect the propagation of light or availability of light. In the second point says about the water surface. For example, in the case of an ocean sometimes the sea is calm and sometimes it is rough. This will also affect the light propagation in underwater. Another thing is about the wavelength spectrum. The wavelength of different color channel is different. The light transmits through the underwater affects the wavelength spectrum. The red channel has the highest wavelength which will lose first in underwater. Then affect the orange color, yellow color etc. and finally it will affect the blue color which has the lowest wavelength.

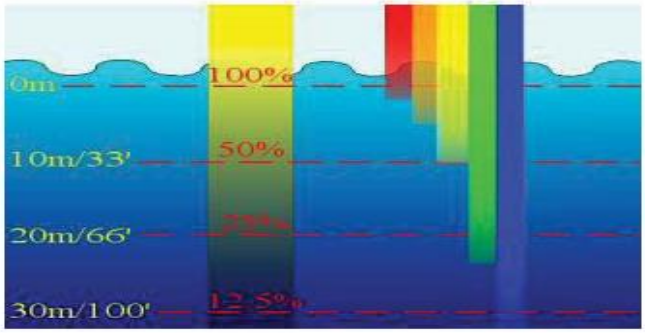

Fig. 2: Colour appearance in underwater

Figure 2 shows a wavelength spectrum and the order of colors dis appear in underwater. In 2 to 10m the red color will disappear completely. Up to 20m orange, yellow color will lost completely. Blue color is highly preserved in water.

3. UNDERWATER IMAGE ENHANCEMENT TECHNIQUES

The ongoing progression in computer vision innovation equipment, programming and arithmetical techniques has promoted upgrades in few constant application regions incorporates the underwater image improvement. Several studies have been made on the underwater image. Based on that the techniques can be classified in to four main categories.

3.1 Filtering Method

Filtering method is a simple method. This method just filters out some portions from the image. For these Different types of filters are used. In [1] a GIF (Guided Image Filter) is used. GIF use six mean filtering processes to obtain an enhanced image. In [2] a bilateral filter is used. The main steps of this paper are first calculating the min color components and estimate the atmosphere light. Then yielding an initial atmospheric veil use a median filter. Then use a bilateral filter to get the reference image. By taking the reference image to receive corrected atmospheric scattering light. Then it calculates the transmission and finally recovers the image. The disadvantage of this paper is when there is some object whose color is similar to the atmospheric light in the scene the color will become very dark.

The two-step approach [3] uses two steps to obtain the enhanced image. First improve the image contrast by using defog model. Then the image detail layer and base layer are separated by image filtering. They are calculated and mapped independently and finally merged to obtain an enhanced image. The main drawback of this method is noising.

3.2 Fusion Method

This is the second category of classification. Fusion is simply means combining the result of two or more things. A white balancing [4] and multi scale fusion technique [4] is used to enhance the underwater images. White balancing is mainly used to compensate the color cast fusion is considered to upgrade the edges and details of the scene. This will reduce the back scattering. In white balancing first compensate the loss of red channel in the image. The red channel is compensated by adding the opponent colors i.e., blue and green. Using this method, the red color of high intensity areas are better balanced. The output of white balance technique is a too bright image. The fusion technique has two inputs one is the Gamma corrected version of the white balanced image and the second is the sharpened version of the white balanced Image. The figure shows a sample input and its corresponding enhanced image. In the fusion steps the Laplacian pyramid of the inputs and Gaussian pyramid of the weight map are calculated. Pyramid representation decomposes an image in to a sum of band pass filters.

In [5] first the input image is given to a white balancing [4] section and also perform a contrast enhancement. For each input three weight mapping is calculated. Here chromatic weight map, saliency weight map and luminance weight map are used. Then these weight maps are fused together. In [6] the authors perform the fusion process with three inputs. One input is the defog image, second is a color transferred image and the last one is the attenuation weight map. In [13] a weakly supervised model for underwater image color correction is used. It maps the color of underwater scenes to the color of air scenes. Takes an underwater image as the input and directly outputs an image, which has the content and structures the same as the input, but the color as if the image was taken without the water. For this a CycleGAN technique is used. In [14] the image is decomposed in to 3 levels-detail level, structure level, and illuminance level. Obtain two inputs from the original image. First input is a white balanced one and the one is filtered one. Then weight map is calculated. Here Global contrast, Local contrast and saliency weights are used. Finally, these weight maps are fused together to obtain the final output.

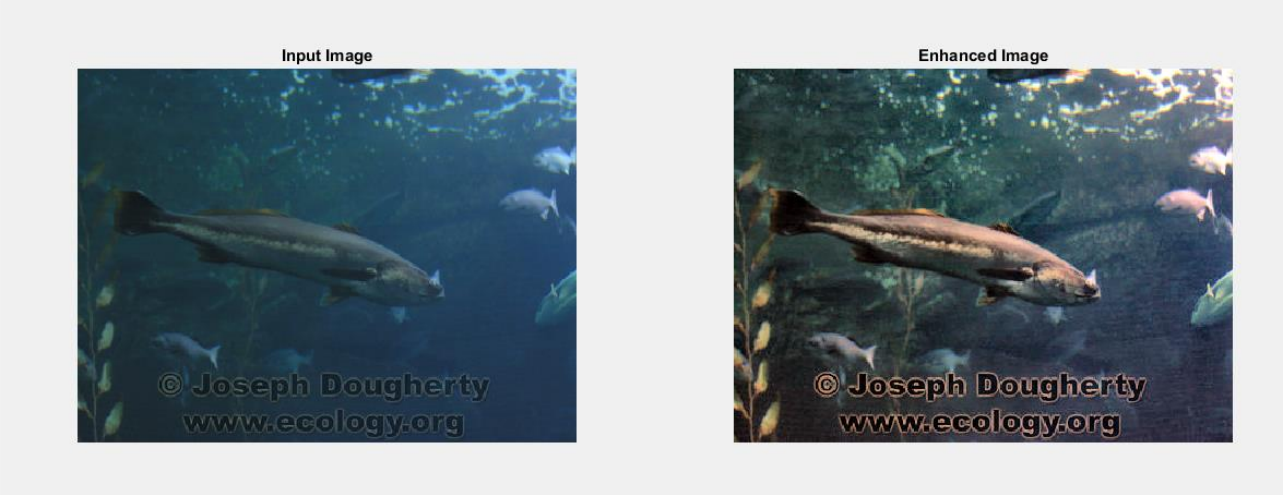

Fig. 3: A sample input and output for fusion process

3.3 Non-Uniform Illuminated Image

This is the third category. The methods will reduce the non-uniform effects and enhance the images. AFELCE [7] is specifically designed to reduce the problem of non-uniform illumination and low-contrast images. The input image will be classified into three main regions (i.e., over-, well-, and under-exposed) using the ALEBRD technique. The regions are transferred from the spatial domain to the fuzzy domain by fuzzifying each region. A modified fuzzy membership function is applied on each region individually to fuzzily that region before each region is de-fuzzified to attain the enhanced image. Each region is enhanced individually by applying three different nonlinear contrast enhancements. The proposed AFELCE will combine the three enhanced regions to produce the resultant image. If the output is not the expected one, then the process is repeated. So, the process is an iterative process.

In [8] a new underwater image formation model, which takes the properties of underwater imaging and light into account. Then, a medium transmission estimation method for underwater image based on joint prior is proposed. According to the medium transmission of scene and the optical properties of underwater imaging, predict the medium transmissions of three-color channels of an underwater image, respectively. Restore the degraded underwater image with the obtained model parameters. In [15] the authors first compute the backscattered light by searching for the brightest location along each image patch. The size of the patch should depend on multiple parameters characterizing the captured underwater scene. First image is derived using a smaller patch to better restore the contrast. For example, a 20*20 patch size is selected for 800*600 size image. Second image is derived based on a large patch size, which makes it possible to consistently recover regional color. For example, 60*60 patches are selected for 800*600 size image. To obtain the final output fusion process is done.

3.4 Deep Learning Method

Deep learning method is the fourth classification. It uses neural network for training the data set. In [9] a deep residual frame work is used. It uses CycleGAN [9] technique for training the data set. The main problem of CNN in underwater images is to obtain a clear ground truth image of corresponding underwater image. But CycleGAN technique creates an image pair known as synthetic image pair. It converts the in-air image to an underwater style image. Then VDSR is used for resolution application. The VDSR model has 20 convolution layers. Each convolution layer uses 3*3 size filters. Except for the first and the last layers, each convolution layer has 64 channels. The first layer receives three-channel image data as input. Then generates 64-channel feature maps, and transmits them to the main body of the network. The last layer is the reconstruction layer. It receives 64-channel feature maps and outputs three-channel residual images. In [10] SRCNN is used. SRCNN composed of three convolution layers to improve the input image. The method consists of three steps. The first step is to divide the low-resolution image into three separate images with three RGB channels. In the second step, the three images are trained by a convolutional neural network to obtain three output images. In the third step, the obtained three images are fused to obtain the final high-resolution image reconstruction.

4. CONCLUSION

Underwater images are very important now a days. It is used in variety of fields like marine engineering, research etc. The study of underwater image enhancement helps to obtain clear idea about most of the methods and classified them in to different category. The category 1 uses different filters and second category uses fusion method and third one uses methods to avoid the effect of non-uniform illuminance and the last one uses deep learning method.

5. REFERENCES

[1] Sonal Dixit, Sandeep Kumar Tiwari, Pankaj Sharma, "Underwater Image Enhancement using DCP with ACCLAHE and Homomorphism Filtering", International conference on Signal Processing, Communication, Power and Embedded System.
[2] Nasir Muhammad, Arini, Feri Fahrianto,"Underwater Image Enhancement Using Guided Joint Bilateral Filter", The 6th International Conference on Cyber and IT Service Management,2018.
[3] Marcello Calisti1, Member, IEEE, Gaetano Carbonara1 and Cecilia Laschi1, Senior Member, IEEE,"A rotating polarizing.

[4] Codruta O. Ancuti, Cosmin Ancuti, Christophe De Vleeschouwer , and Philippe Bekaert, "Color Balance and Fusion for Underwater Image Enhancement", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 27, NO. 1, JANUARY 2018.
[5] Ritu Singh, Manthosh Biswas, "Contrast and Color Improvement based Haze Removal of Underwater Images using Fusion Technique",4th IEEE International Conference on Signal Processing, Computing and Control (ISPCC 2k17), Sep21-23, 2017].
[6] Codruta O. Ancuti, Cosmin Ancuti, Christophe De Vleeschouwer and Rafael Garcia, "Locally Adaptive Color Correction for Underwater Image Dehazing and Matching", IEEE Conference on Computer Vision and Pattern Recognition Workshops 2017.
[7] Abdullah Amer Mohammed Salih, Khairunnisa Hasikin, and Nor Ashidi Matisa, "Adaptive Fuzzy Exposure Local Contrast Enhancement", October 31, 2018.
[8] Mohua Zhang and Jianhua Peng, "Underwater Image Restoration Based on A New Underwater Image Formation Model", October 31, 2018.
[9] Peng Liu (Member, IEEE), Guoyu Wang, Hao Qi, Chufeng Zhang, Haiyong Zheng, (Member, IEEE), and Zhibin Yu, (Member, IEEE),"Underwater Image Enhancement with a Deep Residual Framework", July 31, 2019.
[10] Yujie Li, chunyan Ma, Tingting Zhang, Jianru Li, Zongyuan Ge, Yun Li, and Seiichi Serikawa, "Underwater Image High De nition Display Using the Multilayer Perceptron and Color Feature-Based SRCNN", July 12, 2019.

