Multi Stage Integrated Color Intensity Based Deep Sea Image Enhancement

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Abstract - The deep sea image enhancement is the trends among the ocean engineering researchers to make the information clearer after capturing the images in deep sea or ocean images. The deep sea imaging is important from exploring point of view of various researchers to find out the hidden treasures beneath the sea. The exploration can be done in terms of pictures and videos by the divers later these could help to find out the objects, species, and plants to study the deep sea habitat or scenario. Usually the pictures taken from the high quality cameras the picture are affected by the several effects like fading, color degradation, light reflection and deep sea objects etc. For better and efficient information exploration of the deep sea situations there picture should be as clear as possible in terms of color as well the clarity. In this paper the same context has been taken into consideration and the high quality image enhancement technique is proposed which is based on the perceptible RGB weighted approach to enhance the color quality as well as clarity in the image pixels. The proposed approach utilizes mainly two stage to restore the deep sea image one is color enhancement and second is contrast toning, which adjust the effects of light reflections and low light situation. From the simulation outcomes the proposed approach proved better than the previous methodologies from the enhancement it made.

Keywords - Image Enhancement, deep sea degradation, low light images, oceanic imaging.

I. INTRODUCTION

During the last few years, underwater imaging has been an area of interest for researchers. The main reason for this is that underwater imaging can be applied to many different fields as well as existing systems. Topics of interest, pertaining to underwater imaging, include the discovery of objects in liquids or the image analysis needed to identify targets submerged in a liquid. There have also been studies that attempted to identify targets suspended in a solution. These studies could be useful for defense applications or in underwater explorations. One intriguing part of these studies is the various approaches that were used in image acquisition and processing. While some approaches used polarization others used various illumination sources such as lasers or broadband light sources. Other approaches had moving receivers and a few approaches even used an entirely mobile system [5]. All of these approaches were fascinating but the ones that showed the most promise for future research and field applications were those that yielded the high contrast results and combined some of the aspects that were listed above, such as polarization, but also used image processing, after image acquisition, to further increase image quality.

Scattering

The presence of organic and inorganic particles suspended in the volume of water intersected by the field of view of the camera and the illumination source is the cause of the light scattering phenomenon. It can be strongly noticeable when caused by a suspended sediment load (also known as turbidity). The degree of scattering depends on the distance, the wavelength, and the characteristics of the particles (i.e. shape, density and refractive index). There are two types of scattering. On the one hand, backward scattering is an additive noise in the form of "marine snow" patterns which appear due to the reflection of the light from a given natural or artificial source on the suspended particles in the direction of the camera. On the other hand, forward scattering appears due to the inter-reflections of local light among the particles, and becomes the most significant source of image degradation leading to a non uniform loss of contrast, definition and color fidelity. The scattering phenomenon can significantly affect the acquisition of images at a short distance from seabed. The vehicle carrying the camera may also cause the displacement of particles or soil lying on the ground, increasing the probability of backward scattering.

Challenges of underwater optical imaging

The underwater picture (Figure 1.4) was taken by William Thompson in February 1856 in Dorset (England). The photographer lowered a housed 5" x 4" plate camera to the seabed in Weymouth Bay and operated the shutter from an anchored boat. The exposure time used to acquire the picture was 10 minutes during which time the camera flooded, however the film was salvaged. Scuba diving, which can be intuitively considered as a more conventional way to acquire underwater images, did not exist as a common activity until several years later.

Acquiring optical images underwater is significantly more difficult than performing conventional land photography. Submerging a camera underwater using an adequate housing and maneuvering it appropriately is a complex task by itself. However, the most important challenges are imposed by the underwater medium properties affected by several phenomena which condition the acquisition procedure. The two main underwater phenomena strongly affecting image quality and consequently the acquisition task are light attenuation and scattering.

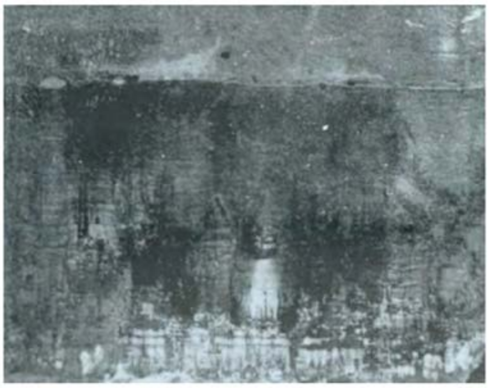


Fig. 1.1: The first underwater image.

Apart from these two main phenomena, the camera parameterization is another key point affecting image quality. When acquiring images underwater using a still camera, the automatic adjustment mechanism may try to slow the shutter speed and increase the aperture in order to better deal with the low light conditions. This setup is very sensitive to camera movement and thus, unsuitable for a camera mounted on an AUV or ROV. When the acquisition is performed in shallow waters, the ambient light can be sufficient to acquire quality images, but when performed in deep waters high power artificial light sources are required. Using artificial light, typically consisting of one or more directional sources, leads to another problem affecting images, especially when registering them to build a mosaic, which is non uniform illumination of the scene. Finally, when using artificial lighting, the shadows induced on the scene create an apparent motion which is opposite to the real motion of the camera.

II. PROPOSED METHODOLOGY

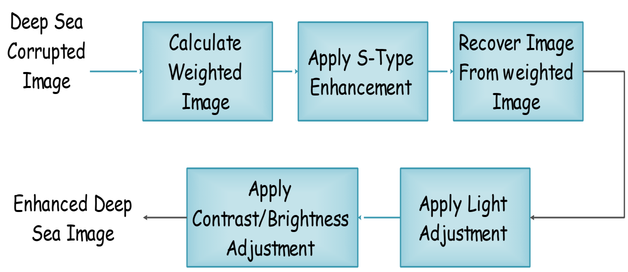


Fig. 1.2: Block Diagram of Proposed Methodology.

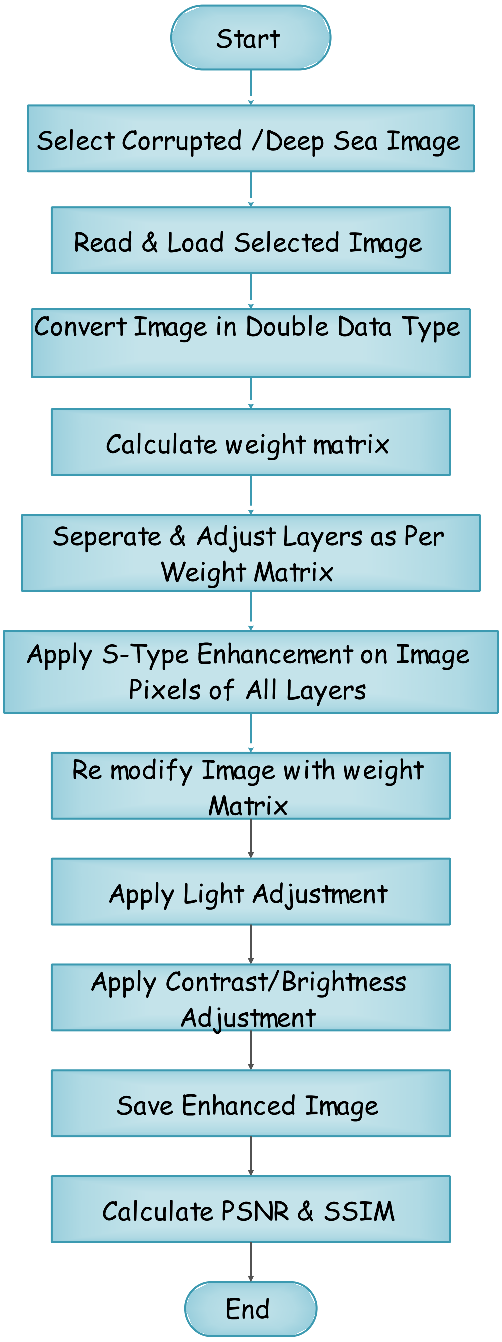


Fig.1.3: Flow Chart of the simulation Process.

III. SIMULATION RESULTS

The proposed image enhancement for deep sea images if explained in this work is performed on various images which shows the efficiency of the proposed algorithm. The simulation outcomes are shown in the below figures.

(a)

(b)

(c)

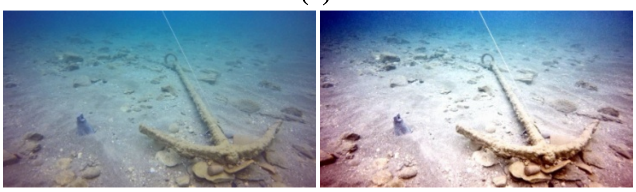
(d)

(e)

(f)

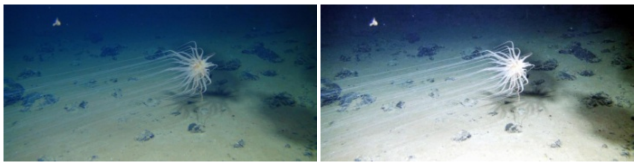
(g)

(h)

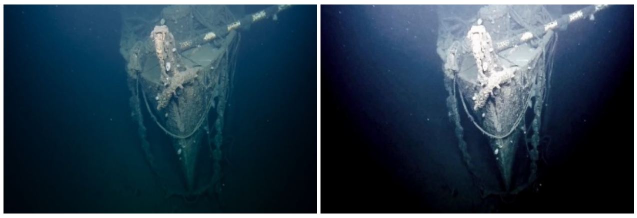


(i)

(j)



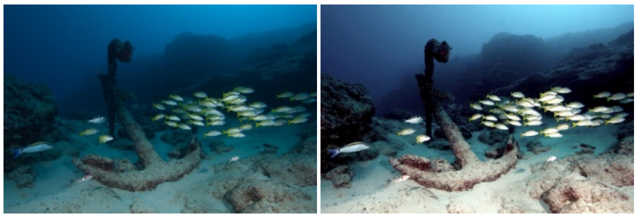
(k)



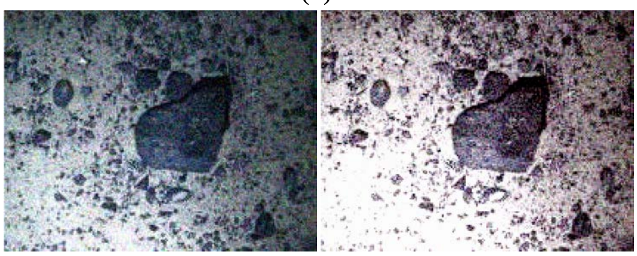
(l)

(m)

(n)



(o)



(p)

Fig.1.4: Corrupted Deep Sea Image vs Enhanced Image from (a) to (p), 1.jpg to 15.jpg and Basepaper.jpg respectively

The above shown corrupted deep sea images and their enhanced images using proposed methodology is compared and peak signal to noise ratio (PSNR) and structural similarity index (SSIM) are shown in below table.

Table 1: PSNR and SSIM of Images

Image	PSNR	SSIM
1.jpg	10.51 dB	0.86
2.jpg	12.34 dB	0.90
3.jpg	12.30 dB	0.83
4.jpg	10.01 dB	0.82
5.jpg	11.04 dB	0.85
6.jpg	12.35 dB	0.57
7.jpg	16.18 dB	0.90
8.jpg	10.05 dB	0.69
9.jpg	13.79 dB	0.93
10.jpg	11.72 dB	0.63
11.jpg	12.60 dB	0.84
12.jpg	16.96 dB	0.58
13.jpg	12.81 dB	0.87
14.jpg	9.25 dB	0.64
15.jpg	13.71 dB	0.70
BasePaper.png	13.64 dB	0.89

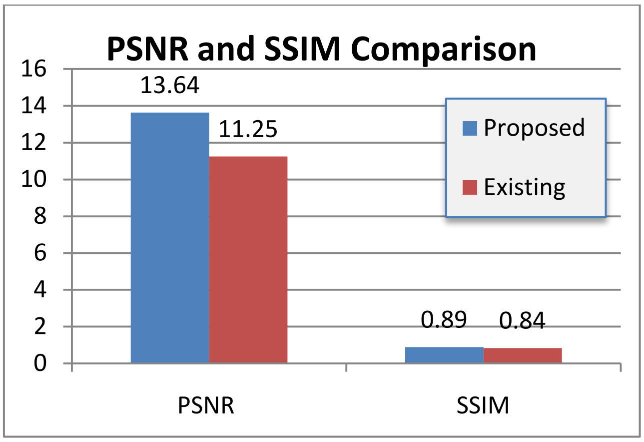


Fig. 1.5: Graphical Comparison of Proposed and Existing Results

The efficiency of the proposed methodology than existing technique compared in the above graph and its numerical values shown in the below table. This analysis clear shows the proposed approach is quite better than the previous approach used in [1].

Table 2: PSNR and SSIM of Base Paper Image

Method	PSNR	SSIM
Proposed	**13.64 dB**	**0.89**
Existing	11.25 dB	0.84

IV.CONCLUSION AND FUTURE SCOPE

In the previous section the simulation outcomes are explained and from that it can be summarized that the proposed multi stage color integration approach for deep sea image enhancement significantly improved the colors with contrast and brightness of the corrupted deep sea images than the previous methods. Many images are simulated during experiments and each one is listed with the PSNR and SSIM values and is shown in the simulation results to show the robustness of the proposed methodology. The explained technique is showing its effectiveness and robustness against the different deep sea effects, which will be helpful in the general image enhancement applications or imaging needs except underwater noisy situations where environmental effects are making images visually unreadable or observable.

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