Mitigating the Blurriness of Underwater Images and Quality Enhancement

P. Ajanya, R. Balakrishna, A. Sajeev Ram

Abstract--- ***Capturing an apparent picture from the bottom of the water bodies had been an important concern and challenge from the past. While alleviating the artifacts of underwater pictures, some contrast enhancement can be missing due to sharpening artifacts. Because of Multi scale fusion's complexity and much execution time, we proposed color attenuation prior model based on depth & scattering restoration, color balance and modified white balance technique and Multi-scale cascaded CNN for restoration of the pictures as well. We tried to increase the underwater images definitions by using proposed methods and modified adaptive histogram equalization which, still continues as the best.***

Keywords--- ***Fast Guided Filter, MSE, Multi-scale Cascaded CNN, PSNR, SSIM.***

I. INTRODUCTION

A. Image Enhancement

Commonly, image enhancement aim to improve the interpreting ability or perception of datum in images for audience. When comes to human comprehension; there is no general theory for determining what 'good' image enhancement is.

The world of underwater contains copious resources. As we have already told in [2], when we compare two images, one ordinary and other taken from the underwater, it shows blurriness. The underwater picture always suffers poor visibility and ensuing from the light propagation attenuation as well.

Owing to the light absorption effects and scattering it may happen. The planned methodology aims to reinforce the underwater image quality for the better infrastructure of the underwater pictures when compared to our existing paper. The images captured under the water suffer from least visibility due to scattering and merging leads to contrast distinction and color distortion. Due to the absorption and dispersion nature of ocean water, it's laborious to accumulate viewable images in underwater. Eliminating these effects has been the main target and concern of the underwater imaging research areas and community for decades. However, recently some advanced software, hardware and logarithmic ways has led to some enhancements in many application areas.

The quality of picture, gets from the underwater has always played a crucial role in scientific missions like observance ocean life, taking population census, and figuring out geologic or biologic atmosphere. It's always difficult to get clean and clear beneath ocean images. The reason is the reverberation of light, scattering and deflection which causes dimness and the color change occurs due to the sunlight attenuation. Haze, which is like blurry, foggy, or misty, which can form by the suspended particles like minerals, sand, which is seen in lake, seas, rivers etc.

II. MATERIALS AND METHODS

Owing to absorption and scattering effects, underwater images abide from lower visibility. In respect that, we proposes a method aims to alleviate the artifacts and improve the underwater image quality for underwater infrastructure. Multi scale fusion strategy and colour attenuation prior model were the previously used methods [2], but they failed to get through some limitations like image contrast reduction due to multi scale fusion method, blurriness, performance reduction, feature degradation due to fusion mismatch. Some problems identified from the previously identified paper [1] were,

1. Missing of some kind of contrast enhancement due to sharpening artifacts by using weight maps,
2. They aren't able to use much weight maps due to edge losses
3. Multi scale fusion is more complexity and also increase much execution process
4. Due to this they are taking only two input images for fusion

To overcome the above problems and enhance, we proposed some modified existing methods, colour attenuation prior model based on Depth & Scattering restoration and colour balance, modified white balance technique, multi-scale cascaded convolution neural network (CNN), instead of multi scale fusion, for restoration of the images or attenuation and depth based model and modified adaptive histogram equalization (still is the best)

A. Image Acquisition

The process of getting an input image using image processing algorithm for various underwater image enhancements. This stage is the first stage of any vision system. After obtaining the image, some kinds of processing methods can be applied to the image for performing different vision tasks.

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B. Pre processing

The purpose of pre processing is to meliorate the data in the image by crushing the unwanted image data distortions or raising some image features which are vital for further processing.

C. Fast Guided Filter

This is for edge-aware, edge-preserving image filtering, which has high speed, nice visual quality, and easy implementation as well. It enhances the contrast and the definition of edges in each region of an image. We use fast guided filter imaging for smoothening the image.

D. De hazing Algorithm

Basically, haze can often cause from the suspended particles like sand and plankton, minerals, which mainly exists in lakes, rivers, and oceans. When the scenes with bright objects which cause gauzy light and transmission estimation methods fail, the current de hazing approaches often obstructs.

We will create a model firstly, which is linear, for finding out the depth information and learning the parameters. Now, we will create a depth map from this. The accurate expressional, linear model creation is as follows:

$$\mathbf{k\ (x) = \beta 1 + \beta 2d(z) + \beta 3f(z) + \varepsilon(z)}$$

Where,

x - Position lies in the image
k - Scene depth
d - Component of brightness
f – Component of saturation

$$\left.\begin{matrix}\beta 1\\ \beta 2\\ \beta 3\end{matrix}\right\}\text{Unknown linear cofficients}$$

E. Scene Depth Restoration

The influence of the air light will also increase, when the haze dense is high. Then we may able to find the difference in the luminance and saturation and for finding haze intensity as well. As the concentration of the haze increases, the difference found here also increases. The white or gray light, increases brightness and reduces saturation. The haze intensity raises along with the scene depth change, by assuming that they both are positively related.

F. Transmission map estimation

This is finding the value of pixels inside the depth map. Then we generate the random atmospheric light which has edge preserving property. The scattering (atmospheric) model has been rampantly used to amplify the hazy or blurred image H(z) formation, where x is the index of pixel, is shown as:

$$H(z)*R(z)*m(z) + K\{1- m(z)\}$$
$$m(z) = e\text{-}\beta d\ (z)$$

Where,

H - Hazy image
R - Scene radiance representing the haze-free image
K - Atmospheric light
T - Transmitting medium,
m**(z)** **-** Transmitting medium indicating the portion of the light
e – Atmospheric scattering coefficient
d - Scene depth

G. Atmospheric Light Estimation

The white objects that are seen in an image have, eminent luminance value and low saturation value. So our proposed system here tend to focus on the image object with white colour as distant, but this may lead to incorrect or inaccurate calculations of depth By taking into account, each neighborhood pixel we will be able to solve it. The repaired or solved maps are composed of dark colors in regions with less haze and vice versa.

H. Scene Radiance Recovery

The estimation of the medium transmission and repairing of scene radiance is by knowing about the image depth and the atmospheric light, In order to recover the scene radiance, we use the equation as:

$$\mathbf{R\ (z) = \{(H(z) - K)\ m(z)\} + K}$$

K - Atmospheric Light
m(z) - Transmission Map

I. Dark channel prior

At some pixels, at least one color channel has low intensity and it is based on the haze-free images, especially in the outdoor areas mainly the non sky areas. That is, any of the Red, Green, Blue colors may give less intensity in color images. So, in such areas, minimum intensity should have very low value for Image I.

Idark (a)= min x€(r,g,b)(min p

J. White Balancing

White Balancing aims, suppressing uncalled color casts, due to various illuminants and ameliorating image appearance.

III. RESULTS AND DISCUSSIONS

A. Contrast Enhancement

For amelioration of the local contrast and meliorating the definitions of ridges in each and every region of an image, the Adaptive Histogram Equalization (AHE) method is suitable. Though, sometimes in relatively homogeneous regions of an image, AHE has a proneness to over amplify noise.

This tendency can be precluded by restricting the amplification by using a variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) . By transmitting each pixel with a transmission function occurred from a neighborhood. The adaptive histogram equalization (AHE) improves on this. The cumulative distribution function (CDF) of pixel values in the neighborhood is proportional to the transformation function. Pixels near the image boundary have to be treated specially, because their neighborhood would not lie completely within the picture.

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B. PSNR (Peak Signal to Noise Ratio)

PSNR is basically an SNR, when the maximum possible value equals all the pixel values.

Basically it is for measuring the image quality based on the differences in two image's pixels and also termed as ratio of a signal and degrading noise. PSNR is an approximation to human comprehension of rebuilding quality.

PSNR can be defined as:

$$\mathrm{PSNR} = 10\ log\frac{p^2}{MSE}$$

Where,

p = pixel value 255 for an 8-bit image.

The definition of PSNR is the same with 3 RGB values per pixel, for color pictures. The image is converted to a different color space alternately, for color images. Provided the bit depth is 8 bits, where better is higher, exemplary values for the PSNR in video compression and lossy images are about 30 to 50 decibels (dB), and for a 16-bit, values are 60 to 80 decibels(dB). Wireless transmission quality loss acceptable values are about 20 dB to 25 dB considerably.

C. MSE (Mean Square Error)

Mean Square Deviation (MSD) of an estimator used for, measuring the average of the errors' squares, between the compressed and the original image. The value will be always positive and values nearby zero will be expedient. Because of the representation of grey-value error contained in the entire image, and the mathematical amenability, degree of image distortion measurement is by using widely by MSE and PSNR for a long time. However, they both are copiously used for the image deformation degree measurement for a long time**.** By making the mean of input and output images' pixels (original and resultant respectively), Mean Square Error can be calculated accurately

$$\mathrm{MSE} = \frac{1}{\mathrm{AB}}\sum_{b\,=\,0}^{B\,-\,1}\sum_{a\,=\,0}^{A\,-\,1} e(b,a)^2$$

Where,

$e(b,a)^2 -$ Squared difference between the original and distorted images.

D. SSIM (Structural Similarity Index)

Structural Similarity Index (SSIM) is a metric used for quantifying the corruption of quality of the pictures. The corruption or degradation may occur due to the compression of data or transmission losses and is capable of forecasting quality of digital television, digital images, and videos and also for finding the similarities between two images and its measurement as well.

Three samples are introducing here, say, luminance(l),contrast(c),and structure(s), and this formula measurement is on the base of 3 comparison measurements, between the samples of m and n. The individual comparison functions are:

$$l(m,n) = \frac{2\alpha_m\,\alpha_n + k1}{\alpha^2 m +\ \alpha^2 n + k1}$$

$$c(m,n) = \frac{2\beta_m\,\beta_n + k2}{\beta^2 m +\ \beta^2 n + k2}$$

$$s(m,n) = \frac{\beta_{mn}\ + k3}{\beta m +\ \beta n + k3}$$

Fig. 1: Input Image 1

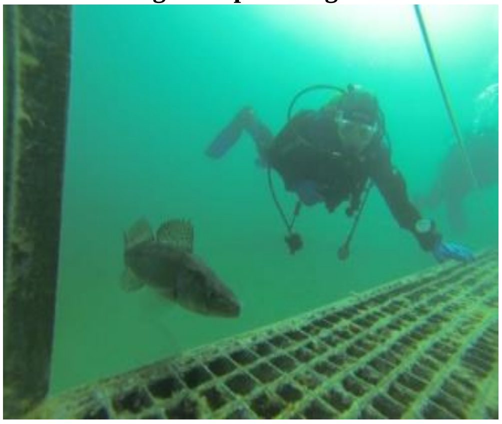

Fig. 2: Input Image2

Fig. 3: Input Image 3

Fig. 4: Input Image4

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Table I: PSNR, MSE, SSIM values from figures

	PSNR	*MS (:, :, 1)*	*MS (:, :, 2)*	*MS (:, :, 2)*	SSIM
Fig 1	*15.842*	*0.514*	*0.975*	*1.123*	*0.56*
Fig 2	*25.55*	*0.148*	*0.811*	*0.533*	*1.40*
Fig 3	*20.728*	*0.354*	*0.833*	*0.783*	*0.466*
Fig 4	*22.658*	*0.365*	*0.837*	*0.561*	*0.758*
Fig 5	*32.957*	*0.037*	*0.583*	*0.354*	*81.386*

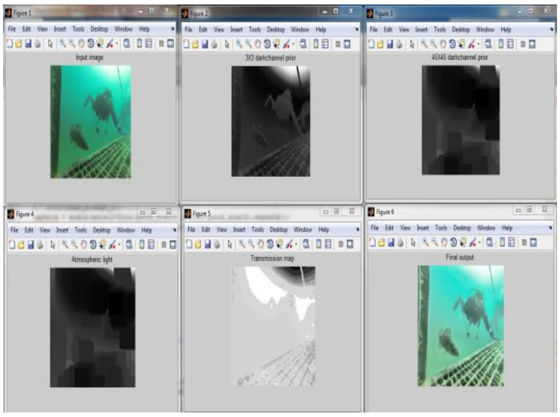

Fig.6: Enhancement of Images

Fig. 5: Output Image

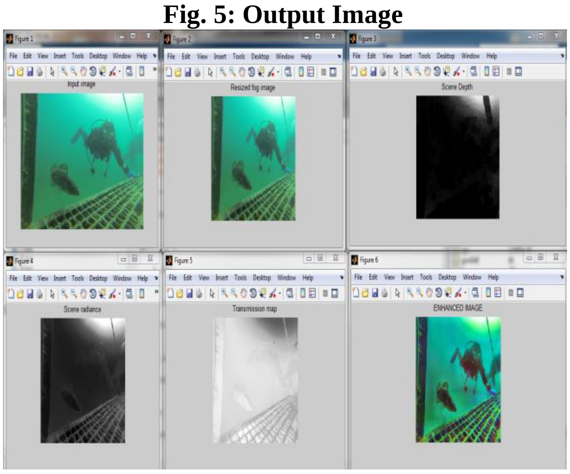

Fig.7: Final Output Images after enhancement

IV. CONCLUSIONS

Under water image enhancement is done using colour attenuation prior, scene depth recovery, transmission mapping and contrast enhancement. These algorithm provides an efficient way for underwater image enhancement. It is very useful to view the underwater image clearly. Our method improves greatly in uplifting the visibility of underwater images and outperform the other methods.

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