

Underwater Image Quality Enhancement using new proposed Image HSI stretching and Median Filter (HSMF) method

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ABSTRACT

Underwater environment generally cause color cast or color scatter while photography. Color scatter is due to haze effects appearing when light reflected from an object is absorbed or scattered several times by particles present in water. This paper presents a novel procedure which is a special integration for various available techniques; also it has new approach for image stretching and image equalisation. Proposed procedure enhances shallow ocean optical images or videos using stretching cum equalizing cum median filter and also as per wavelength properties. Our key contributions are proposed including a novel shallow water imaging model that compensates in order to attenuate discrepancy along propagation path and an effective underwater scene enhancement scheme. Recovered images are characterized by a reduced noise level, better exposure for dark regions, and global contrast where finest details and edges are enhanced significantly.

1. Introduction

The work done in area for underwater image enhancement till now is either using mean or median filters or using various colour stretching methods or by using equalizing, however no one has presented a model which is integrated for various technique. This paper presents a novel procedure which is a special integration for various available techniques also it has new approach for image stretching and image equalisation [5]. Proposed procedure enhances shallow ocean optical images or videos using stretching cum equalizing cum median filter and also as per wavelength properties.

2. Methodology

The proposed method in this paper include a novel shallow water imaging model that compensates wavelength in order to attenuate discrepancy along propagation path and an effective underwater image enhancement scheme. Recovered images are characterized by a reduced noised level, better exposure for dark regions, and global contrast where finest details and edges are enhanced significantly. Figure 1 below shows design work flow proposed by ACCLAHE [1].

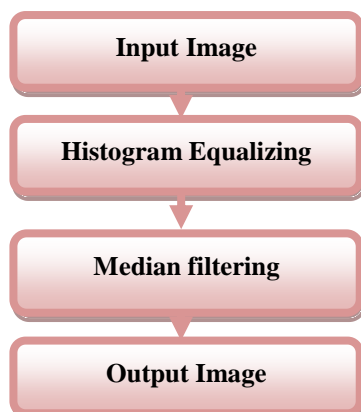


Fig 1: Design flow proposed by ACCLAHE [1]

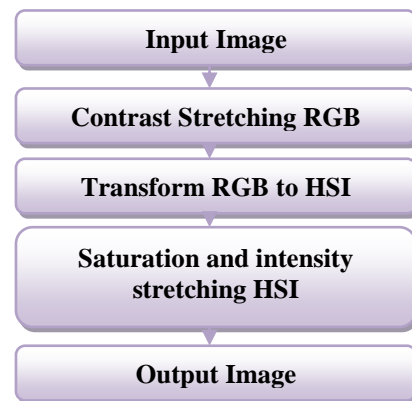


Fig 2: Design flow proposed by WCID method [3]

This work proposes a procedure to reconstruct underwater image which is a combination of wavelength compensation and de-hazing algorithm (WCID) [3]. The distance between object and camera is determined using dark channel prior, and then haze effects caused by Color scatter can be removed by de-hazing algorithm [1]. Next, the photography scene depth is estimated by using residual energy ratios for each wavelength. According to attenuation for every wavelength, reverse compensation conducted to restore all distortion from Color cast. Proposed work has used slide stretching in order to de-haze the image.

Firstly, proposed work uses contrast stretching for RGB algorithm in order to equalize color contrast in images. Then, applies intensity stretching and saturation HSI to improve true color and then resolve problem with lighting using wavelength compensation.

Using this technique, contrast ratio in underwater images can be controlled either by decreasing or increasing value. This is carried out by employing a histogram for digital values in order to enhance an image and redistributing stretching value

over image variation for maximum range for possible values [14]. Furthermore linear stretching from 'S' value may provide stronger values to each range by looking at less output values. Here a percentage for saturating image may be controlled in order to perform better visual display [15].

The contrast stretching algorithm is used to enhance contrast of an image. This is carried out by stretching range for color values to make use for all possible values. Contrast stretching procedure uses linear scaling function in order to normalize pixel values. Every pixel is scaled using following function below:-

$$P_o = \frac{(P_i - c)(b - c)}{(d - c)} + a$$

Where,

P_o is normalized pixel value;

P_i is considered pixel value;

a is minimum value for desired range;

b is maximum value for desired range;

c is lowest pixel value present in image;

d is highest pixel value present in image"

It can be observed from figure 1 and figure 2 that proposed work is unique combination of work in ACCLAHE & Homomorphism filtering [1] and Underwater Image Enhancement by Wavelength Compensation and De-hazing [4] with modified equalizing and stretching approach.

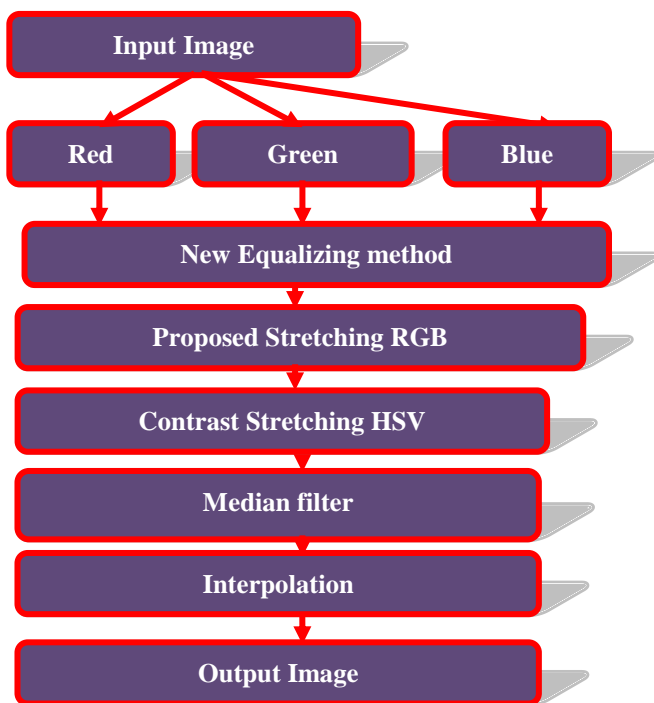


Fig 3: Proposed design flow processes

Figure 3 shows the flow chart for proposed work. The first block is input image which may be any underwater image in any format jpg or bmp or anything else, next is RGB component isolation. A new equalizer has been developed in order to equalize RGB components that pull up all RGB components which are less than 50 by a specific factor given to it and also performs contrast stretching, after that a new RGB stretching method is performed in which R_p>>R_g & R_p>>R_b so R_p will

pull up to 200 and R_g and R_b will pull down to 50, R_p>>R_g & R_p>>R_b so R_p will pull up to 200 and R_g and R_b will pull down to 50, R_p>>R_g & R_p>>R_b so R_p will pull up to 200 and R_g and R_b will pull down to 50. After RGB stretching HSV stretching is performed and at last median filter for order 6 has been used, this unique combination of various available methods results in a very high quality output image as compared to original underwater image. This paper has worked on three test images "gold fish", "white fish" and "water grass" given below.



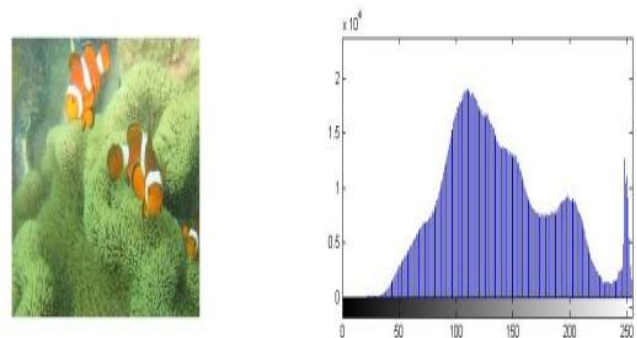
Fig 4: Test images

3. Result

Based on our methodology, this paper has developed the results of underwater images using a software tool MATLAB and enhances quality for underwater images. In this tool proposed work uses an object oriented programming language. Simulations have been done for various underwater images and quality of all these images is improved with a very good amount in this research work.



Fig 5: Original test images for gold fish



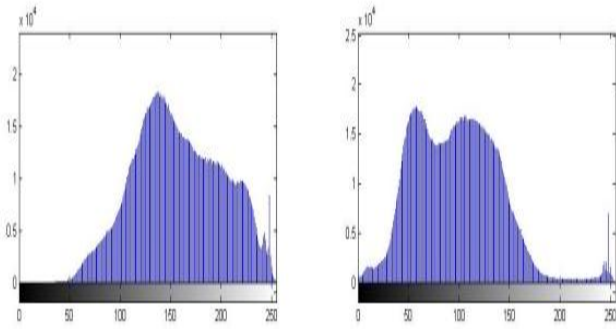


Fig 6: histogram for underwater gold fish

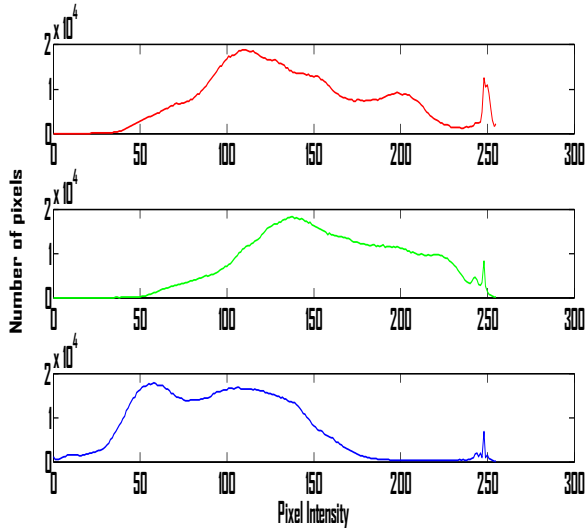


Fig 7: color component underwater gold fish

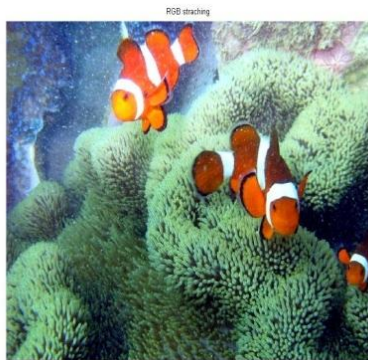


Fig 8: After equalization and RGB stretching on underwater gold fish



Fig 9: After equalization and RGB stretching and HSV stretching on underwater gold fish



Fig 10: After equalization, RGB stretching, HSV stretching and Median filter on underwater gold fish



Fig 11: Test image gold fish image analysis

Figures 4, 5, 6, 7, 8, 9 and 10 shows result in order to test image underwater gold fish at various implementation level and as may be seen that overall quality of image as compare with original gold fish image has been improved.

Table-1
Observed results

Test image	MSE	SNR
Gold fish	4.68×10^{-9}	48.54
White fish	3.33×10^{-9}	47.06
Water grass	2.73×10^{-9}	46.20

Table 1 above shows results observed in order to three test images. Table 2 shown below shows comparative results in which our proposed design result are been compared with other work for same goal.

Table-2
Comparative Results

Method		MSE	PSNR
Proposed	Gold fish	4.68×10^{-9}	48.54
	White fish	3.33×10^{-9}	47.06
	Water grass	2.73×10^{-9}	46.20

ACCLAHE and Homomorphism filtering[1]	Water grass	-	26.96
WaterGAN [2]	Gold fish	-	19.72
WCID[3]	Gold Fish	-	5.55
	Water grass	-	9.6

It can be clearly observed from table and figure above that the proposed work achieves highest PSNR (Peak Signal to Noise ratio) as compared with previous research papers [1][3]. for all three test images. In the previous research paper gold fish test image has been taken and they achieve PSNR of 26.96 [1] and in other research paper in order to test image of gold fish they achieve PSNR for 9.6 only however in proposed work it is 46.2 which is much higher than those results in previous research papers, same results may be seen in figure 11 which prove that proposed work is better than all base work.

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4. Conclusion

The results shows that Image De-hazing and Wavelength Compensation (IDWC) simultaneously resolves the problem of Color scatter and Color casting, also enhanced image contrast and calibrated Color cast and produces high quality underwater images or videos. In this paper, slide stretching algorithm has been used, which applies on both RGB and HSI color models in order to enhance underwater images. The main advantage for using two stretching models is that it helps to equalize color contrast of any image and also reduces the problem with lighting. Proposed approach has produced good results. Quality of images can be statistically observed through histograms. Future work will include further evaluation for proposed approach. It may be clearly seen that proposed procedure is best among different available procedure with very high PSNR. This means, it significantly removes noise with reduced level of MSE, hence it has very low error.