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Cleansing And Refinement Of Sub-Aquatic And Soft Light Images Using Retinex Color Recovery

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Abstract: **The images from the ocean are unclear in unsettling and can cause issues while studying it. The basic underwater image causes such a problem because the light reflects back from the surface of the ocean or gets absorbed. In this paper, we make an attempt to clear hazy underwater images using the Multi-Scale Retinex with Color Restoration (MSRCR) algorithm, compare the output with different variances, and see how to get better results. We also discuss the best fit variance, and to achieve it, we have used the peak signal-to-noise ratio (PSNR).**

Index Terms: **Retinex, Multi-Scale Retinex with Color Restoration (MSRCR), Variance,Underwater, best fit variance, peak signal-to-noise ratio (PSNR).**

1. INTRODUCTION

The ocean is a hub of wonders, it can provide us with medicine, provide oxygen absorb 50% of the carbon dioxide, and many other things. To extract maximum profit, one needs to study the ocean. The more we go to depth the less clear are the images. In this paper, we clean the ocean images with the help of some changes that are made in the Multi-Scale Retinex with Color Restoration (MSRCR) algorithm. MSRCR is an algorithm that enhances images taken under a wide range of nonlinear illumination conditions to the level such that it is perceived in real-time.

2. LITERATURE REVIEW AND INFERENCE DRAWN FROM IT

2.1. Literature Survey

Retinex is an algorithm that was proposed by Edwin Land to account for color sensation in real senses. The word retinex comes from the word Retina and Cortex whose coordination with each other makes the color perception of the human eye more accurate. A triplet of L, M, S (Long, Medium, Short) cone reaction can emerge in any color [5]. In this paper, we will be using MSR (Multi-Scale Retinex) which uses (Dynamic Range Compression) DRC [6].

Edwin Land through his experiment in 1959 [4] concluded that “The classical laws of color mixing conceal great basic laws of color vision”. In other words, he proposed that a multicolored picture can result with only two primary colors, which was in contrast with James Clerk Maxwell. Let us take an image and pass it through the red, green, and blue filters separately. And when the three black-white transparencies are projected onto each other through the respective filters the colors of the objects in the original image are recreated. This was Maxwell’s experiment which is still used on computer screens, mobile phones, and other digital devices, he also verified the chromaticity of human color vision.

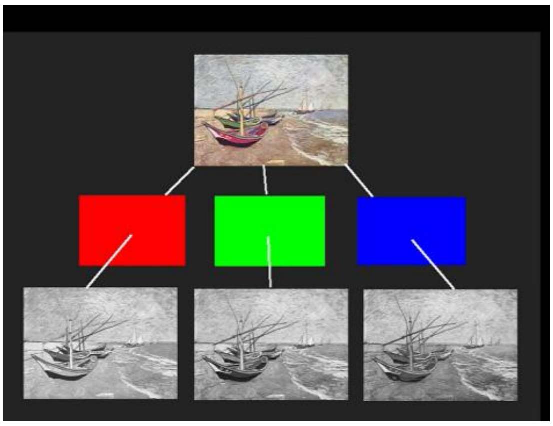


Fig 2.1. Combination of RGB

Fig 2.1. Shows that if any image is passed from red, blue, and green filter sepratly will result in a black and white image.

Sir Edwin skipped the blue record and projected the green without a filter and still received the full range of colors. By selecting one color of all three colors say green and superimposing it on the red one, (r, 0, 0) + (g, g, g) we receive some more diverse colors.

Ana Bel´en Petro , Catalina Sbert, and Jean-Michel Morel have provided us with a brief introduction to Multi-Scale Ratinex in their paper “Multiscale Retinex”[1] where they improved the existing color correction part as a final step. In the future author, Ke Liu and Yongquan Liang have discussed the

MSRCR for increasing the contrast and sharpness of the image in their paper name “Dual-purpose method for de-hazing and enhancement of underwater and low-light images”[2], they also performed it on ocean images. Further changes in this model were made with different approaches in this field by Sashuang Sun, Huaibo Song, Dongjian He, and Yan Long in their paper “An adaptive segmentation method combining MSRCR and mean shift algorithm with K-means correction of green apples in the natural environment”[3].

2.2. Inference Drawn from Literature Survey

a. Colours can be generated if we are able to restore only two of them to a better level.
b. Deep ocean images can have low light and more glare.
c. The value for MSR should be in a way that it doesn’t distort the original images
d. Addition color correction in the image should also be provided in order to restore the original form.

3. PROBLEM STATEMENT

The images that are taken in the ocean are blurred and unclear this is because the light from the sun or other sources is eighter absorbed or scattered. The cleaning of underwater images will help in a better study in the field of oceanography. While testing on an image we have to make sure that the colors are restored, and the blur in the images gets removed. Moreover, the objects and creatures in the images should be recognizable.

4. ANALATICAL SOLUTION

In single-scale Retinex the output is determined by the difference between the center (Input Value) and an average of the surrounding.

$$R_i(x,y) = \log(I_i(x,y)) - \log(I_i(x,y) * F(x,y))$$

Fig 4.1. Equation for Single Scale Retinex.

Fig 4.1 shows equation for single scale retinex where, I_i is the input image and F is the normalized surrounded filter.

Some researchers have placed the surrounded filter before the surrounded convolution and some after it. Jobson et al [8]. have confirmed that the results are better if we put it after the logarithmic function.

$$R_i(x,y) = \log(I(x,y)) - \log(I(x,y)) * F(x,y)$$

Fig 4.2. Logarithmic function after the surrounding.

Fig 4.2. shows us the better one of the two form of single scale retinex equation which was confirmed by Jobson et al [8].

From the equations given by [1],

$$G_\sigma * u = \sum_{k=0}^{M-1}\sum_{l=0}^{N-1} \widehat{u}_{k,l} G_\sigma * \exp\left(i\frac{2\pi k}{M}x + i\frac{2\pi l}{N}y\right) =$$
$$= \sum_{k=0}^{M-1}\sum_{l=0}^{N-1} \left(\widehat{G}_\sigma\left(\frac{2\pi k}{M}, \frac{2\pi l}{N}\right)\widehat{u}_{k,l}\right) \exp\left(i\frac{2\pi k}{M}x + i\frac{2\pi l}{N}y\right)$$

Fig 4.3. Exact Gaussian Convolution of an image.

Fig 4.3. shows, exact gaussian convolution of an image as per Ana Bel´en Petro et al. [1].

We test it on different values of sigma for multi-scaleretinexcolor restoration to see how the color of the image changes.

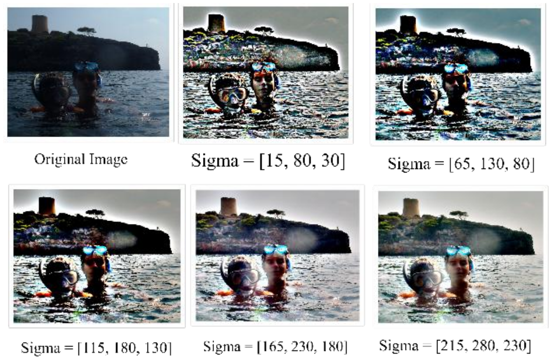


Fig 4.4. Image change in different sigma values.

Fig 4.4. Shows, how for different sigma values the color of the image changes.

PSNR is the ratio between power of the signal and power of distorting noise that influence the quality of representation [7].

$$PSNR = 10\log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Fig. 4.5. Equation for PSNR.

Fig. 4.5. shows the equation of PSNR and Mean Square Error (MSE). MSE shows how close is a fitted line is to a data pointed.

Now we have change the variance for different images and calculate it peak signal-to-noise ratio (PSNR) and selects the one with heightest value. Here the original image is taken as the ground image and enhanced images are taken as the compressed/ decompressed one.

Variance	PSNR
[15, 80, 30]	27.8418825764312 dB
[65, 130, 80]	27.807998452742 dB
[115, 180, 130]	27.8713604136684 dB
[165, 230, 180]	27.9565773988479 dB
[215, 280, 230]	27.900339487143178 dB
[265, 330, 280]	27.90855221744348 dB
[315, 350, 280]	27.922174976805433 dB

Table 4.1. PSNR values for different variance.

Table 4.1. shows how PSNR changes for different variances. After one limit we see that PSNR value dicreases. If we plot the values onto the graph we will see that the values of the rise and fall in graph till a peak and then the fall.

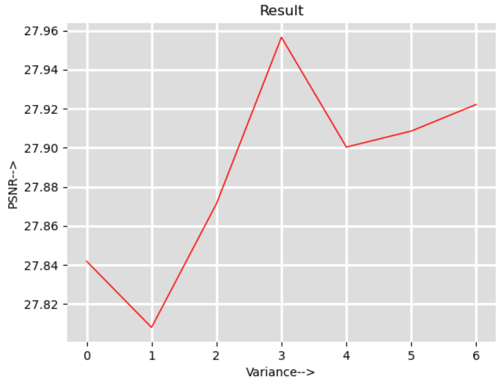


Fig. 4.5. Graph of Variance vs PSNR.

Fig. 4.5. shows the graph of variance vs PSNR, here the graph starts from [15, 80, 30] and gives best result at [165, 230, 180].

4.1. Algorithm and Its Working

Here we take an image, implement MSCR to it with increasing variance and calculate its PSNR value continuously till we notice that the value of the PSNR has been under the previous value more than 4-5 times. Then we choose the variance that provides the highest PSNR, which will provide us with an image with comparatively less noise. This is a lengthy approach but can provide us with the best-fitted variance.

5. CONCLUSION AND FUTURE WORKS

5.1. Conclusion

The MSRCR algorithm with the required configuration clears the image and makes it more visible.

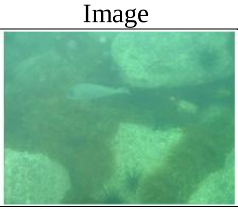
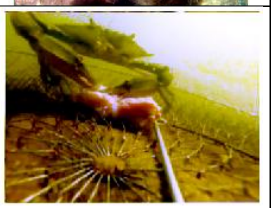
Image	Enhanced
	
	

Table 5.1. Correction in Images

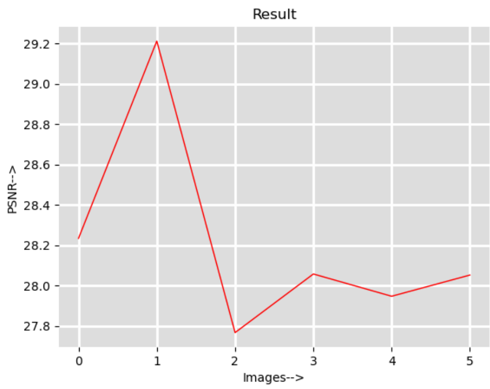


Fig. 5.1. PSNR value of Images

Fig. 5.1. Shows improvement in the visibility of the image after MSRCR.

5.2. Future Works

No matter how much an algorithm is efficient there is always room for improvement. In this paper, further improvements can be made by controlling the glare and the blur. We have also seen the high value for variance can cause distortion in some images and which shows that this algorithm fails when tested on less unclear images.

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