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Contrast Enhancement For Underwater Image Using DCT Coefficient

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Abstract

Underwater image enhancement is essential and challenging pre-processing technique. It is very difficult to capture the good quality image as the depth of water increases. The problems vary according to the type of water, amount of light, depth of water, the distance between camera and object, etc. In this paper, a new technique for the enhancement of the underwater image is proposed. The proposed DCT coefficient based method is simplest method than the earlier enhancement methods. In this technique chromatic component are considered instead of the luminance component. Results show that proposed method is computationally efficient than the earlier methods and show the exceptional enhancement quality..

Keywords: *underwater, enhancement, chromatic component, luminance, contrast, resolution, DCT.*

1. Introduction

Underwater image enhancement is necessary for the better visualization of the images to help our visual perception. There are hundreds of reasons for why we need to pre-process the image data before displaying. The first and important reason is that the dynamic range of the intensity values of a pixel is very small due to strong background illumination and the insufficient lighting condition. Many times the dynamic range of the original image is large, which may be difficult to accommodate for the display device.

In the case of the underwater image, it is imperative to get the clear images of the underwater objects. The quality of the underwater images depends on the density of the water, depth of the water, distance between camera and object, artificial light, water particles, etc. Underwater images are affected by the light scattering effect and color change effect [1]. The good quality image is obtained when the water is clear and limpid. As we go deep into the water, the water becomes denser due to sand, planktons and minerals. Due to the increased density of water, camera light gets reflected back and sometimes it gets deflected by the particles before reaching towards the camera. Many times camera light get absorbed by the particles. Due to scattering effect, the visibility and contrast of the image get reduced. Wavelength of the light travel in the water determines the color change effect. The color with the highest wavelength goes the very short distance in water. Figure 1 shows the light penetration pattern in the clear water. Blue color has the shortest wavelength, so it travels very long in the deep water. That's why the blue color is more in underwater images [5]. As the degree of attenuation varies for different wavelengths, the color change effect occurs.

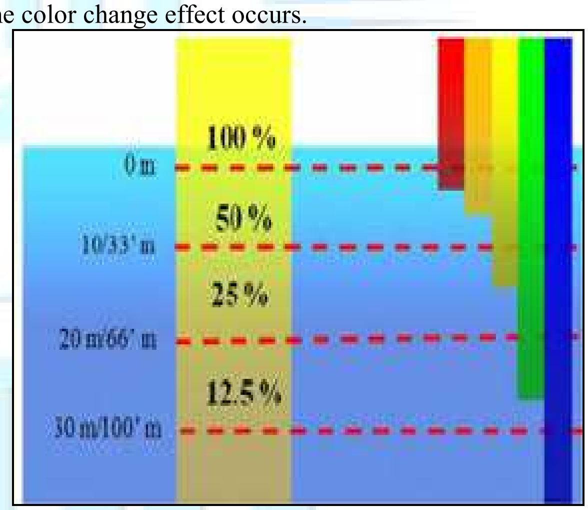

Fig. 1 Light Penetration in Clear water

The scattering effect and color change effect combined results in reduced visibility in underwater images. It affects the resolution and contrast attribute to degrade the quality of the image. Image enhancement is one of the pre-processing methods which improves the quality of an image by increasing the perception of information in it. This task is achieved by suppressing the undesired distortions like light scattering and color change effect to enhance image features relevant for further processing and analysis work.

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2. Literature Survey

Image enhancement is the lowest level pre-processing step to improve the quality or information of the image. This pre-processing method can be applied to the color image, grayscale image, underwater image, satellite image, etc. The papers here describe how underwater images get distorted, causes of underwater image distortion and methods or techniques to recover distorted image.

Underwater images can be improved using image enhancement techniques like Histogram Equalization, Dark-channel prior method, Wavelength Compensation & image dehazing (WCID). Histogram equalization increases the contrast of the distorted image, but it is not able to compensate light scattering problem. Dark channel prior method corrects the distorted image affected by light scattering or light attenuation. But this method is not useful when the object is similar to the background light. WCID overcomes all the problems related to light scattering and color change effect. The parameter like the distance between camera & object, artificial light source, underwater depth and image depth range calculations help to enhance the distorted image information with highest PSNR ration of 76.5044 [1]. Filtering is also a process to remove the noisy elements from an image. The edges of the degraded underwater image can be preserved using edge-preserving filters. The speckle reduction by anisotropic filter improves the image quality, suppresses the noise, preserves the edges in an image, enhances and smoothen the image. Homomorphic filtering is used to correct non-uniform illumination and to enhance contrasts in the image. Wavelet filter is also used to suppress the noise, i.e., the Gaussian noise which is naturally present in the camera images and another type of instrument images [2].

Some researchers proposed Unsupervised Colour Correction Method (UCM) and Contrast Limited Adaptive Histogram Equalization (CLAHE) technique for underwater image enhancement. Unsupervised Colour Correction Method (UCM) is based on color balancing and contrast correction of RGB and HSI color model. It balances the colors in the image, removes the color cast and improves the illumination with an increase in actual color [3]. Contrast Limited Adaptive Histogram Equalization (CLAHE) method works on RGB and HSV color models and both results are combined using Euclidean norm. The proposed system significantly improves the visual quality of underwater images by enhancing contrast as well as reducing noise and artifacts [4].

3. Proposed Methodology

The proposed methodology for the underwater image enhancement is divided into three steps. In the first step, background illumination is adjusted. The second step preserves the local contrast of the image. In the final step color of the image are preserved the color of the image. However, in the block DCT space, the localized information is obtained from the DCT coefficients.

3.1 Local Background Illumination Adjustment

Local background illumination is adjusted by using the DC coefficient of the Block. The mean value of the brightness distribution is obtained from this DC value. To obtained the local brightness distribution the mean value of the brightness is mappedto the desired range. Let I_{max} be the maximum brightness value of the image. In order to adjust the local background illumination we have to consider the DCT coefficient, which is obtained after applying the 2-D DCT on the image. The DCT of the 2-D image $x(m,n), 0 \le m \le N-1 \text{ and } 0 \le n \le N-1$ is given by.

$$C(K,l) = \frac{2}{N} \propto (k) \propto (l) \sum_{m=0}^{N-1}\sum_{n=0}^{N-1}\left(x(m,n)\right) * \cos\left(\frac{(2m+1)\pi k}{2N}\right) * \cos\left(\frac{(2n+1)\pi l}{2N}\right) \quad 0 \le k,l \le N-1 \tag{1}$$

Where $\propto (p)$ is given by.

$$\propto (p) = \begin{cases} \sqrt{\frac{1}{2}} & \text{for p=0;} \\ 1, & \end{cases} \tag{2}$$

Consider the DC coefficient for 8×8 block obtained from the DCT for the luminance component is given by. $\{Y(k,l), 0 \le k,l \le 7\}$. Then $Y(0,0)$ is the Dc coefficient and all other are AC coefficient. While adjusting the brightness of the image the obtained DC coefficient are mapped to the $\tilde{y}(0,0)$ with the help of monotonically increasing function$y = \{f(x), 0 \le x, y \le 1\}$in the interval [0,1] as follows.

$$\tilde{y} = I_{max}.f\left(\frac{\tilde{y}(0,0)}{I_{max}}\right) \tag{3}$$

3.2 Local Contrast Preservation

The definition for the enhancement factor of the block at the time of theadjustment of the luminance is.

$$\kappa = \frac{\tilde{y}(0,0)}{y(0,0)} \tag{4}$$

Where $\tilde{y}$ is mapped DC coefficient and $\tilde{y}$ is the original DC coefficient. When we multiply the coefficient of by then pixel values are also multiplied with the same factor. This complete process preserves the contrast of the block.

3.3 Color Preservation

To preserve the color we need to calculate the Dc coefficients of the block using Eq.(1). The $C(0,0)$ is the DC coefficient of the block and all other are Ac coefficient. Consider the DC coefficient of the C_b and C_r is.

$$U = \{U(k,l) | 0 \le k,l \le (N-1)\} \quad (5)$$

And

$$V = \{v(k,l) | 0 \le k,l \le (N-1)\} \quad (6)$$

Respectively and luminance y is uniformly scale by factor κ. And Color of the output Image preserve by the following equation.

$$\bar{U}(i,j) = \begin{cases} N\left(\kappa\left(\frac{U(i,j)}{N} - 128\right) + 128\right), i = j = 0 \\ \kappa U(i,j) \quad otherwise \end{cases} \quad (7)$$

$$\bar{V}(i,j) = \begin{cases} N\left(\kappa\left(\frac{V(i,j)}{N} - 128\right) + 128\right), i = j = 0 \\ \kappa V(i,j) \quad otherwise \end{cases} \quad (8)$$

4. Performance Analysis

The proposed image enhancement system is applied on the blurred or low-quality underwater images. The images are stored in JPEG format and are enhanced using image processing techniques through MATLAB. Performance of the proposed system is examined using different image quality measures.

1. Peak Signal to Noise Ratio (PSNR): To check the quality of the enhanced image, PSNR is used

$$PSNR = 10 \log 10 \frac{255^2}{\frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}[f(i,j) - f'(i,j)]^2} \quad (9)$$

where, $f(i, j)$ represent pixel value of the original image at location (i, j) and $f'(i, j)$ is the pixel value of enhanced image.

2. Mean: Mean is the average of the pixel intensity in an image which is required for finding out the standard deviation.

$$M = \frac{\sum\sum f(i,j)}{mxn} \quad (10)$$

Where $f(i,j)$ is the pixel value of image of size mxn

3. Standard Deviation: Standard deviation is obtained from the mean value of an image. Standard deviation gives the deviation of the image pixel from its mean value.

$$S = \sqrt{\frac{\sum(X-M)^2}{N-1}} \quad (11)$$

To improve the quality of image, these parameters should be high with less processing time (Table 1). Figure 2 shows an enhanced version of input images.

Table 1. Results of Proposed System

Image	PSNR (dB)	Mean	SD	Process Time (sec)
Image1	45.32	133.96	47.56	1.80
Image2	59.35	145.86	45.15	1.95
Image3	60.23	153.48	36.94	1.73
Image4	58.33	155.26	39.38	1.91

Input Image Output Image

Fig. 2 Enhanced Images

5. Conclusions

From the results, it is cleared that the proposed system gives properly enhanced underwater image output with less processing time. The higher value of observed parameters shows that the quality of the image is up to the mark regarding contrast. And lower processing time proves that the system is faster with the process time below 2 seconds.

References

[1] Bhanudas Sandbhor. G. U. Kharat, "A Review on Underwater Image Enhancement Techniques",International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 5, Issue 5, May 2015.

[2] Aanchal Garg, Nirvair Neeru, "Enhancement of Underwater Images: A Review",International Journal of Computer Science and Information Technologies, Vol. 5(4), 2014.

[3] Kashif Iqbal, Michael Odetayo, Anne James, Rosaline Abdul Salam, Abdullah Zawawi Hj Talib, "Enhancing the Low Quality Images Using Unsupervised Colour Correction Method", 978-1-4244-6588-0/10/$25.00 ©201 0 IEEE.

[4] MuhummadSuzuri Hitam, Wan Nural Jawahir Hj Wan Yussof, Ezmahamrul Afreen Awalludin, Zainuddin Bachok, " Mixture Contrast Limited Adaptive Histogram Equalization for Underwater Image Enhancement", 978-1-4673-5285-7/13/$31.00 ©2013 IEEE.

[5] Pooja Sahu, Neelesh Gupta, Neetu Sharma, "A Survey on Underwater Image Enhancement Techniques", International Journal of Computer Applications, Vol. 87 - No. 13, February 2014.

[6] Lijie Cao, "Singular Value Decomposition Applied To Digital Image Processing", Division of Computing Studies Arizona State University Polytechnic Campus Mesa, Arizona 85212.

[7] G. S. Singadkar, "Underwater Image Enhancement Using Diserete Wavelet Transform & Singular Value Decomposition", International Journal of Engineering and Generam Science, Volume 4, Issue 4, July-August 2016.