

Enhancement of Underwater Images Using CLAHE Algorithm

V.Vembuselvi¹, T.Murugan²

PG Scholar, Department of ECE, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India¹

Asst. Professor, Department of ECE, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India²

ABSTRACT : Underwater images usually face a problem of poor visibility and poor colour contrast. It occurs because of light scattering effect and light reflection when the medium changes. In this paper we propose a method in which CLAHE is applied to improve the visual quality of underwater images. To eliminate the uneven illumination, the output image got from CLAHE algorithm has been sent to image gradient based smoothing. The main aim of the proposed algorithm is to increase the quality of underwater images. Different images have been used to estimate the comparative improvement of the proposed technique over the previous techniques. This comparative analysis indicates the good improvement of the proposed method.

KEYWORDS : Image Enhancement, CLAHE Algorithm

I. INTRODUCTION

When light enters into water, the amount of light gets reduced and hence colours disappear according to the wavelength. Among all the colours, blue has the shortest wavelength and hence it reaches deepest in water. Therefore blue-green colour dominates the underwater images. Some factors that affect the underwater images are light absorption, reflection, scattering effect and denser medium. Light energy is removed by absorption and direction of light path is changed by scattering effect. There are two types of scattering which affects the direction of light path namely forward and backward scattering. Forward scattering results in blurring of image and backward scattering results in reduction of contrast.

II. PROPOSED METHOD

Detailed steps for the proposed method is given below.

Step-1

Image pre-processing

Underwater images undergoes several changes due to absorption of light, scattering effect and reflection. Pre-processing of image is done in which finding the image size is essential. This is calculated by using the equation

$$[RCd] = \text{Size } G(x,y)$$

Where R -> indicates row

C-> indicates column

d-> indicates dimensions

G(x,y) -> Input image

Step-2

RGB to L*A*B conversion

Input images in RGB format is converted into L*A*B colour space. This is achieved by using the colour transformation structure makeCform.

Lab_Image = applyCform(input_image, makeCform('Srgb2lab'))

Step-3

Apply CLAGE to Light

L component is separated and CLAHE is applied on L, i.e., Light only.

`Labclahe_opadapthisteq(lab_image(:, :, 1), 'NumTiles', ... [8,8], 'Cliplimit', 0.005);`

`Lab_op=cat(3,LABCLAHE_op,lab_image(:, :, 2), lab_image(:, :, 3)) ;`

Step-4

L*A*B to RGB conversion

`Final_image=applycform(lab_op,makecform('lab2srgb'));`

Step-5

Removal of uneven illumination

Uneven illumination can be removed by applying the image gradients based smoothing method. When gradient images are computed pixels that possess large gradient values become possible edge pixels. Trace the edge in the direction perpendicular to the direction of gradient. It is used to get hue component with accurate edges.

Step-6

Final image with good quality, compared to that of input image is achieved.

III. EXPERIMENTAL ANALYSIS

We can analyse the quality of enhanced image by considering visual appear, unwanted colour artifacts present in the image and from statistical values. For experimental analysis various types of underwater images has been taken. The factors to be considered are mean square error (MSE), Peak Signal Noise Ratio (PSNR), Root Mean Square Error (RMSE) Normalized Absolute Error (NAE).

The cumulative square error between original image and enhanced image is represented as MSE, and PSNR indicates the value of Peak error. To get enhanced image quality there must be a reduction in the root mean square error and the proposed algorithm showed comparatively good result than the previous methods. It is essential that the normalized absolute error must also be reduced and it is achieved with less NAE value over the previous methods.

To find MSE :

The formula used to calculate MSE is given below as,

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M*N}$$

Where M & N -> Size of the image

Where I₁ and I₂ indicates original and enhanced image respectively.

PSNR is calculated using the formula

$$PSNR = 20 \log_{10} \left(\frac{2^B - 1}{\sqrt{MSE}} \right)$$

B- indicates bit per sample

In this proposed method, B value is taken as 8.

RMSE is calculated using the formula

$$RMSE = \sqrt{\frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M*N}}$$

Maximum difference is denoted as MD and it is a measure of difference between two pixels in which larger pixels occurs after the smallest one. When the maximum difference value is larger means it indicates the image quality is poor.

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 5, Special Issue 2, March 2016

4th National Conference on Frontiers in Communication and Signal Processing Systems (NCFCSPS '16)

10th-11th March 2016

Organized by

Department of ECE, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India.

MD = max (E)

Where E -> indicates error of image.

The comparison values of MSE, PSNR, RMSE and MD are shown in table 1,2,3, 4. From the values we can find that CLAGE L*A*B model produces better quality images.



Fig 1. Comparison of methods . Upper left: original underwater image. Upper Right: Mix CLAHE image. Bottom left: L*A*B CLAHE image. Bottom Right: New Enhancement image



Fig 2. Comparison of methods . Upper left: original underwater image. Upper Right: Mix CLAHE image. Bottom left: L*A*B CLAHE image. Bottom Right: New Enhancement image

Table 1 MSE Comparison

Image	Mix CLAHE	Proposed
1.jpg	3139.90	163.35
2.jpg	3087.70	365.26
3.jpg	6148.32	574.03
4.jpg	3064.30	819.13
5.jpg	514.77	491.80

Table 2 PSNR Comparison

Images	Mix CLAHE	Proposed
1.jpg	13.16	25.99
2.jpg	13.23	22.50
3.jpg	10.24	20.54
4.jpg	13.26	18.99
5.jpg	12.78	30.26

Table 3 RMSE Comparison

Images	Mix CLAHE	Proposed
1.jpg	56.03	12.78
2.jpg	55.56	19.11
3.jpg	78.41	23.95
4.jpg	55.35	28.62
5.jpg	58.50	7.81

Table 4 MD Comparison

Images	Mix CLAHE	Proposed
1.jpg	74	186
2.jpg	127	180
3.jpg	60	92
4.jpg	17	98
5.jpg	74	99

IV. CONCLUSION

CLAHE based image enhancement technique is proposed in this paper. To remove the error because of uneven illumination image gradient based smoothing technique is used. The main aim of the proposed algorithm is to enhance the image quality of underwater images. Low MSE, highest PSNR can be achieved compared to the previous methods.

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 5, Special Issue 2, March 2016

4th National Conference on Frontiers in Communication and Signal Processing Systems (NCFCSPS '16)

10th-11th March 2016

Organized by

Department of ECE, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India.

REFERENCES

1. Mary Kim and Min Gyo Chung, "Recursively Separated and Weighted Histogram Equalization for Brightness Preservation and Contrast Enhancement", Volume:54, August 2008.
2. Zhen Jia, Hongcheng Wang, Rodrigo Caballero, Ziyou Xiong, Jianwei Zhao and Alan Finn, "REAL-TIME CONTENT ADAPTIVE CONTRAST ENHANCEMENT FOR SEE-THROUGH FOG AND RAIN", 14-19 March, 2010 IEEE International Conference.
3. Nyamlkhagva Sengee, Altansukh Sengee, and Heung-Kook Choi, "Image Contrast Enhancement using Bi-Histogram Equalization with Neighborhood Metrics", Volume 56, Issue 4, November 2010.
4. Zohaib Hameed and Chunyan Wang, "Edge Detection Using Histogram Equalization And Multi-Filtering Process", 2011 IEEE International Symposium, 15-18 May 2011.
5. Muhammad Suzuri Hitam, Wan Nural Jawahir Hj Wan Yussof, Ezmahamrul Afreen Awalludin, Zainuddin Bachok, "Mixture Contrast Limited Adaptive Histogram Equalization for Underwater Image Enhancement", 2013.
6. Prabakar and Praveen Kumar, "AN IMAGE BASED TECHNIQUE FOR ENHANCEMENT OF UNDERWATER IMAGES", Volume 3, Issue 4, 2011.