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 preprocessing
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.
\[
\text{Labclahe_opadapthisteq(lab_image(:, :, 1),'NumTiles', \\
[8,8],'Cliplimit',0.005);
\]
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,
\[
\text{MSE} = \frac{\sum_{M,N}|I_1(m,n)-I_2(m,n)|^2}{M*N}
\]
Where M & N -> Size of the image
Where \( I_1 \) and \( I_2 \) indicates original and enhanced image respectively.

PSNR is calculated using the formula
\[
\text{PSNR}=20log10\left(\frac{\text{B}}{\sqrt{\text{MSE}}}\right)
\]
B- indicates bit per sample
In this proposed method, B value is taken as 8.

RMSE is calculated using the formula
\[
\text{RMSE}=\sqrt{\frac{\sum_{M,N}|I_1(m,n)-I_2(m,n)|^2}{M*N}}
\]
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.
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.

Table 1 MSE Comparison

<table>
<thead>
<tr>
<th>Image</th>
<th>Mix CLAHE</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.jpg</td>
<td>3139.90</td>
<td>163.35</td>
</tr>
<tr>
<td>2.jpg</td>
<td>3087.70</td>
<td>365.26</td>
</tr>
<tr>
<td>3.jpg</td>
<td>6148.32</td>
<td>574.03</td>
</tr>
<tr>
<td>4.jpg</td>
<td>3064.30</td>
<td>819.13</td>
</tr>
<tr>
<td>5.jpg</td>
<td>514.77</td>
<td>491.80</td>
</tr>
</tbody>
</table>
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.
REFERENCES