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# Image Enhancement of underwater Digital Image using L*A*B color space on Unsharp Masking

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**Abstract:** The underwater digital images generally suffer from blur, low contrast, non-uniform lighting, and diminished color. Digital image filtering in an important approach towards image enhancement. It involves the manipulation and interpretation of digital images. Images may get noisy due to various factors then filtering of images is become an important operation to de-noise the noisy images. Image sharpening must be performed to achieve it. This research paper proposed a preprocessing technique based on image to improve the quality of underwater digital images. We use Unsharp masking on l*a*b color s which sharpen the underwater digital image.

**Keywords:** Image enhancement, MIXED CLAHE, L*A*B color space, Unsharp masking, Pre-processing Underwater Image.

## I. INTRODUCTION

Poor visibility underwater is a major problem for oceanic applications of computer vision. This is mainly due to the presence of the considerable number of the suspended particles with significant size and density in the medium. These suspended particles cause the light generated from the air or environment and reflected from an object to be absorbed and scattered. It will make the visibility of underwater image undistinguishable [1]. Virtually no analytical evaluation has been carried out on underwater images. The light quantity is reduced once as we go deeper into the water and so colours disappear one-by-one depending upon the wavelength. The red color goes away approx. at depth of 3 meter. Orange colorization disappears at approximately 5m depth. At 10 m depth, the yellow color goes off and lastly the purple and green color disappears at depths which are beyond 10m. As the blue color has the shortest wavelength so, it travels more deeply in the water. The underwater digital images are consequently dominated by a mix blend of blue-green color. These underwater images enforce various problems mainly due to denser medium, light scattering, light absorption and light reflection. These problems lead to the poor visibility of the images. Light energy is removed by absorption and scattering modifies the light path direction. These effects are not only the result of water however also the result of various other components like floating particles and dissolved organic matter [2].

There are mainly 2 types of scattering:
1. Forward scattering
2. Backward scattering

This research paper suggests a new technique in L*A*B color space. The primary goal is to improve the quality of the image and sharpening the various underwater pictures. The following section highlights the literature review.

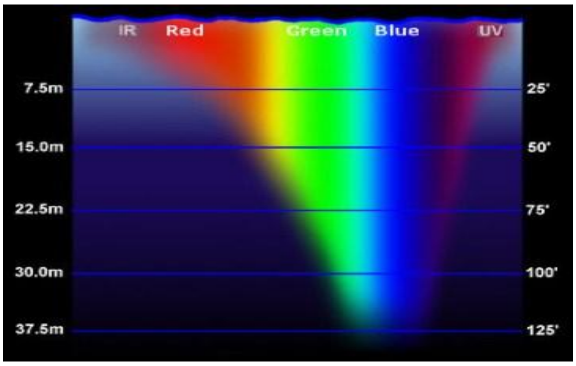


**Figure 1. How Color Changes as we go deeper in Underwater**

The next section shows the recommended methodologies. In section 4, comparative analysis is carried out by using different available techniques. And lastly the conclusion section of the proposed work.

## II. LITERATURE REVIEW

The work done by various researchers for image enhancement are discussed here, Muhammand Suzuri Hitam, Wan Nural Jawahir Hj Wan Yussof, Ezmahamrul Afreen Awalludin and Zainuddin Bachok presented in [3] “Mixture contrast limited adaptive histogram equalization color models for underwater image enhancement” anticipated that within the last decades, improving the quality of an underwater image has received considerable attention due to poor visibility of the image which is caused by physical properties of the water medium. They presented a new method called mixture contrast limited adaptive histogram equalization (CLAHE) color models that specifically developed for underwater image enhancement. Their method operated CLAHE on RGB

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and HSV color models and both results are mixed together using Euclidean norm. Haidi Ibrahim and Nicholas Sia Pik Kong suggested in [4] "Image sharpening using sub-region histogram equalization" anticipated that histogram equalization improves the contrast of an image by changing the intensity level of the pixels based on the intensity distribution of the input image. Their paper presented sub regions histogram equalization (SRHE). Kashif Iqbal,Michael Odetayo, Anne James, Rosalina Abdul Salam and Abdullah Zawawi Hj Talib presented in [5] "Enhancing the low quality images using unsupervised color correction method" anticipated that underwater images are affected but reduced contrast and non-uniform color cast due to the absorption and scattering of light in the aquatic environment. They proposed an unsupervised color correction method (UCM) for underwater image enhancement. UCM was based n color balancing, contrast correction of RGB color models and contrast correction of HIS color model.Hung-Yu Yang, Pei-Yin Chen and Yeu-Horng Shiau discussed in [6] "Low complexity underwater image enhancement based on dark channel prior" anticipated that blurred underwater image is always an annoying problem in the oceanic engineering. They proposed n efficient and low complexity underwater image enhancement method based on dark channel prior. Their method employed the median filter instead of soft matting procedure to estimate the depth map of image. Aziz Makandar and Bhagirithi Halalli presented in [7] "Image enhancement techniques using highpass and lowpass filter" anticipated that filtering helps to enhance the image by removing noise. The aim of their paper is to demonstrate the lowpass and highpass filtering techniques, however they are the filtering techniques used in Fourier and Wavelet Transformations. In Wavelet Transform these two filters play an important role in reconstructing the original image by using subband coding. Lowpass filter will produce a Gaussian smoothing blur image, in the other hand, high pass filter will increase the contrast between bright and dark pixel to produce a sharpen image.

## III. PROPOSED APPROACH

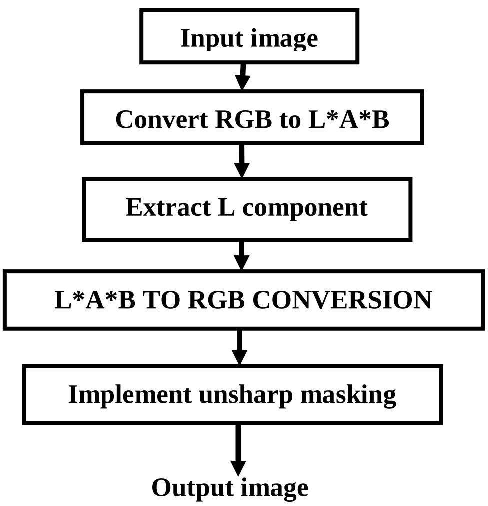


**Figure 2. Flowchart of proposed algorithm**

The comprehensive algorithm of the proposed technique is shown below:

**Step #1.** Pre-processing of input image: Initially, you need to preprocess the input image. This is due to the reason that underwater images impose some problems. These problems are due to light scattering, light absorption, denser medium and light reflection. These types of problems lead to poor visibility of the images. The amount of light is generally reduced once when we approach deeper into the water and so colors disappear one-by-one relying upon the wavelength. After this process, we calculate the size of the image by utilizing the following equation:

[p c d] = size F(x, y)

Where, p and c represents the number of rows and columns respectively, d represent the size of input image F (x, y).

**Step #2.**Convert RGB image to L*a*b color space- Converts the image color intensity values of the input image F (x, y) to the L* A* B* color space by making use of color transformation structure i.e. makecform. This transformation requires several parameters. This is the reason why RGB image do not produce good results. So in order to overcome this problem we apply L* A* B* for image enhancement.

L*a*b_img = applycform (inpt_img, makecform 'srgb2lab')

**Step #3.** Extraction of L component (light component)-replace the luminosity layer with the processed data and then convert the back to the RGB plane

image_adapthisteq = Lab_img;
image_adapthisteq(:,:,1) = adapthisteq(L)*max_luminosity;
image_adapthisteq = applycform(image_adapthisteq, lab2srgb);

**Step #4**.Implement unsharp masking: now apply sharpen filter in order to sharpen edges of the image without increasing noise or blemish. Implement USM (unsharp masking) on RGB plane

Output_image = sharpen filter (image_adapthisteq);

**Step #5**.You will get the final output image and this image is visibly stronger when compared to the input image

## III.EXPERIMENTAL RESULT

The quality of the enhanced underwater image is judged by both ways: subjective as well as objective. In subjective ways they take into account the visual appeal as well as the presence of superfluous color artifacts. The various types of underwater images are utilized for experimental result. The four metrics which are utilized to compare the underwater image quality of the enhanced images are listed beneath:


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- MSE (Mean Square Error),
- PSNR(Peak Signal Noise Ratio),
- MD(Maximum Difference),
- AD(Average Difference)

### A) Mean Square Error (MSE)

The Mean Square Error (MSE) is computed by the following formula:

$$\text{MSE} = \frac{\sum_{M,N}[IM_1(m,n) - IM_2(m,n)]^2}{M*N}$$

Where, IM1& IM2represents the original and enhanced image respectively. The size of the image must be compatible with each other and it is represented by $M * N$.

### B) Peak Signal Noise Ratio (PSNR)

In order to calculate the PSNR value, we make use of MSE .The PSNR is estimated by the following formula:

$$\text{PSNR} = 20\log_{10}\frac{2^{\beta}-1}{\sqrt{MSE}}$$

Where β represent the bit/sample. In this proposed work, we used β=8. The reason behind is color images which range from 0 to 255 are taken into account in this experiment

### C) Maximum Difference (MD)

Maximum Difference calculates the difference between any 2 image pixels in such a manner that larger image pixel appears right after the smallest image pixel. Larger value of MD shows that image has poor quality.

$$\text{MD} = \max E$$

Where E denotes the error.

### D) Average Difference (AD)

The AD corresponds to those image pixels which have values less than the image pixel in original input image. The AMD (Average Minimum Difference) represents those image pixels which have a value more than the image pixel in original input image. The AD is defined as the difference between maximum value and minimum value. The motive should be to minimize the average difference.

$$\text{AD} = \sum_{i-1}^{N}\sum_{j-1}^{M}\frac{E(i,j)}{M*N}$$

Here, M and N represents the number of rows and columns respectively. The parameter E is calculated by the following formula

$$E = I(i,j) - O(i,j)$$

The calculated values of AD, MD, PSNR and MSE are listed in following tables (i.e. Table 1-Table 4). It is understandable from the results that the modified L*A*B color space model not only gives better results, it also enhances the quality of the image. When we compare the MSE value with CLAHE-Mix, then we noticed that MSE value of proposed approach is decreased approximately in every case. The PSNR values has depicted that modified L*A*B is generally highest for all type of test images. If the MD has larger value then it signifies that image has poor quality. The Average Difference value has to be minimized.

## V. RESULT AND COMPARISION

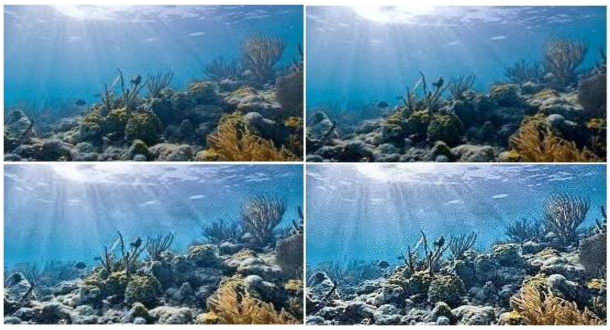

Figure 3 Implemented result of Image1 (a) shows the original image (b) Mixed CLAHE, (c) original L*A*B color space, (d) Proposed Image

Figure 4 Implemented result of Image2 (a) shows the original image (b) Mixed CLAHE, (c) original L*A*B color space, (d) Proposed Image

Figure 5 Implemented result of Image5 (a) shows the original image (b) Mixed CLAHE, (c) original L*A*B color space, (d) Proposed Image

Figure 6 Implemented result of Image1 (a) shows the original image (b) Mixed CLAHE, (c) original L*A*B color space, (d) Proposed Image

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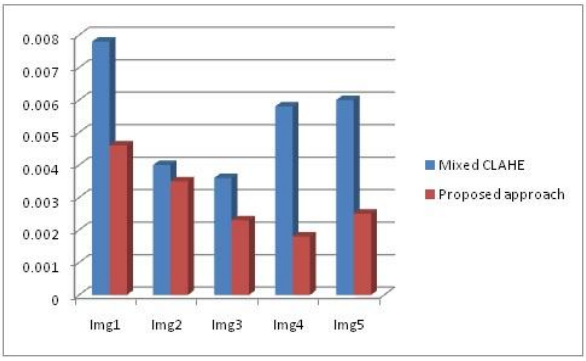
A) **MEAN SQAURE ERROR**
Table1. Comparison of Mean Square Error (MSE) with Mix CLAHE and Proposed Approach

| IMAGE | MIXED-CLAHE | PROPOSED APPROACH |
|---|---|---|
| **Img1** | 0.0078 | 0.0046 |
| **Img2** | 0.0040 | 0.0035 |
| **Img3** | 0.0036 | 0.0023 |
| **Img4** | 0.0058 | 0.0018 |
| **Img5** | 0.0060 | 0.0025 |

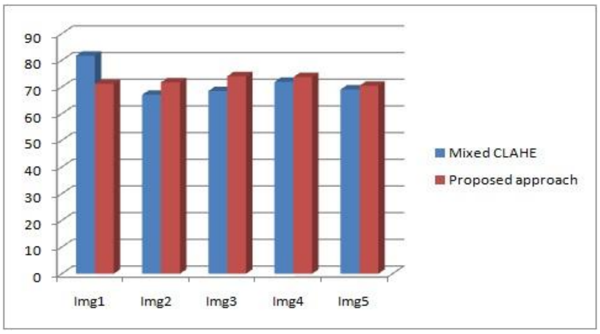
In Graph 1, we presented the quantized analysis of MSE corresponding to different underwater images by Mix CLAHE image enhancement and this is shown in Blue Color, whereas the quantized analysis of proposed modified L*A*B image enhancement approach is shown by Red color.



Graph 1 MSE Analysis of Proposed & Existing Approach for different underwater images

B) **PEAK SIGNAL NOISE RATIO**
Table2. Comparison of Peak Signal Noise Ratio (PSNR) with Mix CLAHE and Proposed Approach

| IMAGE | MIXED CLAHE | PROPOSED APPROACH |
|---|---|---|
| **Img1** | 81.73 | 71.1432 |
| **Img2** | 67.09 | 71.71 |
| **Img3** | 71.91 | 73.69 |
| **Img4** | 68.46 | 74.01 |
| **Img5** | 69.06 | 70.44 |



Graph 2 PSNR Analysis of Proposed & Existing Approach for different underwater images

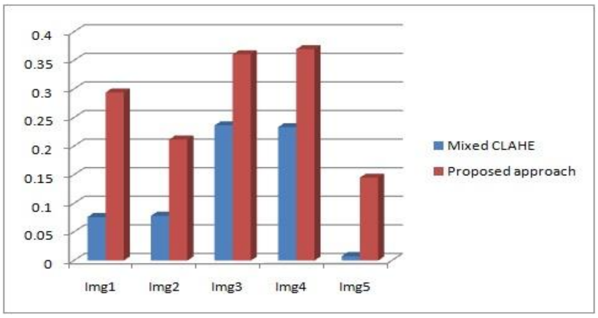
Graph 2 shows the quantized analysis of PSNR corresponding to different underwater images. The results of Mix-CLAHE image enhancement transform is shown in Blue Color, whereas the quantized analysis of proposed modified L*A*B image enhancement Approach is shown by red color.

It is clear from the above graph that there is increase in PSNR values as compared to Mixed CLAHE method of image enhancement. This increase in PSNR values shows that the enhancement is done in a proper way on underwater images and results are satisfactory in contrast to other enhancement methods. Higher value of PSNR means better image quality.

C) **MAXIMUM DIFFERENCE**
Table 3: Comparison of Maximum Difference (MD) with Mix CLAHE and Proposed Approach

| IMAGE | MIXED CLAHE | PROPOSED APPROACH |
|---|---|---|
| **Img1** | 0.0761 | 0.2941 |
| **Img2** | 0.0784 | 0.2118 |
| **Img3** | 0.2334 | 0.3697 |
| **Img4** | 0.2365 | 0.3609 |
| **Img5** | 0.0078 | 0.1451 |

Graph 3 shows the quantized analysis of MD corresponding to different underwater images. The results of Mix-CLAHE image enhancement transform is shown in Blue Color, whereas the quantized analysis of proposed modified L*A*B image enhancement approach is shown in Red color. The increase in Maximum difference value signifies the enhancement in image quality.



Graph 3: MD Analysis of Proposed & Existing Approach for different underwater images

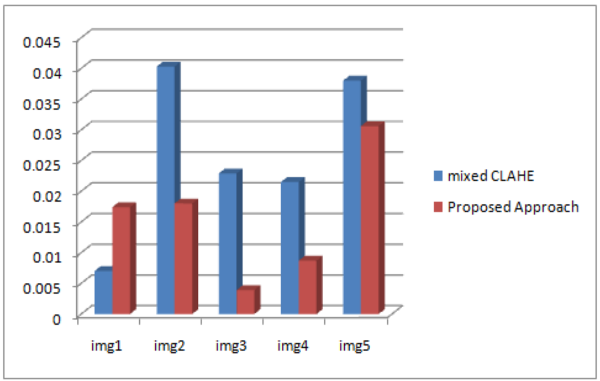
D) **AVERAGE DIFFERENCE**

Table4. Comparison of Average Difference (AD) with Mix CLAHE and Proposed Approach

| IMAGE | MIXED CLAHE | PROPOSED APPROACH |
|---|---|---|
| **Img1** | 0.0070 | 0.0174 |
| **Img2** | 0.0403 | 0.0180 |

| | | |
|---|---|---|
| **Img3** | 0.0229 | 0.0039 |
| **Img4** | 0.0215 | 0.0087 |
| **Img5** | 0.0380 | 0.0306 |

Graph 4 shows the quantized analysis of AD corresponding to different underwater images. The results of Mix-CLAHE image enhancement transform is shown in Blue Color, whereas the quantized analysis of proposed modified L*A*B image enhancement approach is shown in Red color.




Graph 4: AD Analysis of Proposed & Existing Approach for different underwater images.

## VI. CONCLUSION & FUTURE SCOPE

To resolve the various problems of existing methods a new image enhancement technique based on CLAHE and L*A*B color space is presented in this research paper. To overcome the problem of the uneven illumination in the CLAHE output image has been removed by utilizing the image enhancement unsharp masking filter. The key idea of the proposed technique is to enhance the edges of the different underwater image by using sharpen filter. We have highlighted various measures in this regard like MSE, PSNR, MD and AD. A comparative study is also performed in this research work.

In future a new algorithm can be proposed based on the use of joint trilateral filter in order to overcome the various limitations of the prior techniques. This can be done with the help of improved dark channel. This dark channel will make use of decision making which is totally based on the concept of fuzzy logic. It is the ability of fuzzy decision making that with the help of this you can identify different alternative for similar scene and from those alternatives, the best 1 will be chosen for final output. In order to develop numerous alternatives intended for fuzzy set theory, AHE (adaptive histogram equalization) plus dark channel with different various restoration levels will be utilized.

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