Low quality underwater image enhancement through DIRS-CLAHS method.

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Abstract: Attenuation of light that travels through a water medium causes underwater images to several number of problems. Because of poor contrast and color performance, images appear unclear and lose important information. Because of this, it is very much difficult to differentiate objects from background. This paper proposes a new method called Dual-Intensity Rayleigh-Stretched Contrast-Limited Adaptive Histogram specification (DIRS-CLAHS), which is the combination global and local contrast correction. Our main aim is to increase details in an image while enhancing image contrasts. DIRS-CLAHS can provide better results as compared to current state of art methodologies. Two main steps in this proposed method are contrast and color corrections.

Index Terms **- Underwater image processing, DIRS-CLAHS, Contrast enhancement, Color improvement, Noise reduction, Histogram stretching**

I. INTRODUCTION

As light travels in water medium, light intensity is exponentially lost depending on the wavelength of the color spectrum. Light attenuation limits the visibility distance to 20 m in clear water and up to 5m or less in turbid water [2]. Some part of light which travels in air medium is reflected back after entering water; the direction and effects varies based on the structure of the water surface [3]. Water motion also generates waves that diffuses the light entering into the water to create crinkle type patterns [4]. Light is attenuated exponentially with distance and depth because of absorption and scattering effects [5]. Hence, quality of underwater image mainly degrades because of poor contrast, effect of blurring, diminished color of objects in an image, random particles in water and improper lighting. These factors lead to improper illumination.

II. LITERATURE REVIEW-

Underwater image processing can be mainly categorized into two procedures: (i) image restoration and (ii) image enhancement. First technique is very time consuming and needs a certain parameters that denotes turbidity of water. From the literature survey, methods like contrast limited adaptive histogram specification (CLAHS) diminishes the colour of the output image. Also, much noise is produced in the image. CLAHE-Mix method improves image contrast. However, this method generate output images with more noise as compared to other methods. Pixel distribution shifting colour correction (PDSCC) was suggested for analysing digital colour images. The resultant images exhibited good contrast and brightness in some cases. But this method does not improve image contrast, unlike methods such as CLAHS and CLAHE-Mix. Integrated colour model (ICM) and the unsupervised colour correction techniques (UCM) are also used in many studies and their result states that the images are under-enhanced in many areas. These methods increase image contrast effectively as compared to CLAHE-Mix and PDSCC methods do. UCM method produces excessive red colour. Hence, the resultant image appears red and yellow. Underwater images normally have a high percentage of blue, followed by green and red colour. Hence, most of underwater images looks bluish or greenish in colour given that blue and green are the dominant colour forming the over-all image colour. Red is the inferior colour channel, and its percentage is generally lower compared to those of the other two colour channels [6]. CLAHS is commonly combined with other techniques like CLAHE-Mix method. CLAHS is used because of its excellent results in image contrast improvement. Certain parameters like clip limit, distribution parameter and number of tiles, should be set accordingly to improve the resultant image contrast.[6]

III. PROBLEM STATEMENT-

Underwater images normally consists under-enhanced and over-enhanced sections. Two images with such areas are to be generated from a single image. The histograms of underwater images are mostly concentrated on a certain dynamic range based on their color channels. Under-enhancement and over-enhancement problem cannot be eliminated totally by global histogram stretching throughout the division and stretching processes. However, its effects can be theoretically reduced. For improving process of enhancement, the proposed method is combined with local contrast correction, which is explained in further section. The proposed method is specifically for low-contrast underwater images which are mostly dominated by green and blue color channels. Problems with underwater images cannot be solved by using only one general technique. Enhancing image contrast results in an over enhanced image that appears reddish or too much bright which leads to the blue-green illumination effect. Also,

output images appear unnatural or unreal. All of these problems which are mentioned above and in literature survey can be addressed by proposed technology. This approach can give better results compared to current state of art techniques.
The proposed DIRS-CLAHS method can be used for improvement of underwater image by using global contrast correction at the start of the process to improve the overall image contrast. In addition to Rayleigh distribution, the combination of local contrast correction (CLAHS) into the proposed methodology can be used to improve local contrast of the image and to reduce image noise. The use of dual-intensity image in the HSV color model by the division and composition of S and V components can improve image color.[6]
DIRS-CLAHS method consists of two important stages, namely,

(i) Contrast correction and
(ii) Colour correction.

In contrast correction, DIRS-CLAHS uses global and local contrast correction method. Global contrast stretching is used in a manner which varies from the conventional process. The original histogram is divided at its midpoint to create two different regions which 1) lower region 2) upper regions. These histogram regions are stretched to a limit of 5% from the minimum or maximum point. The lower regions are stretched towards the upper region of the intensity level (min. 5% from lower value). By contrast, the upper regions are stretched toward the lower region of intensity [6]. These limits are set to weaken the effect of dominant colors channel and to enhance weaker color channel. After that, image is processed through local contrast correction technique. The CLAHS technique is applied to the image. The image is processed with the color correction method. The image is converted into the HSV (Hue, Saturation and Value) model, in which S and V can be varied directly to address under-enhancement and over-enhancement. These components are stretched to create two different histograms with different levels of saturation or brightness. These histograms are then combined to generate an output histogram by taking average values. [6]

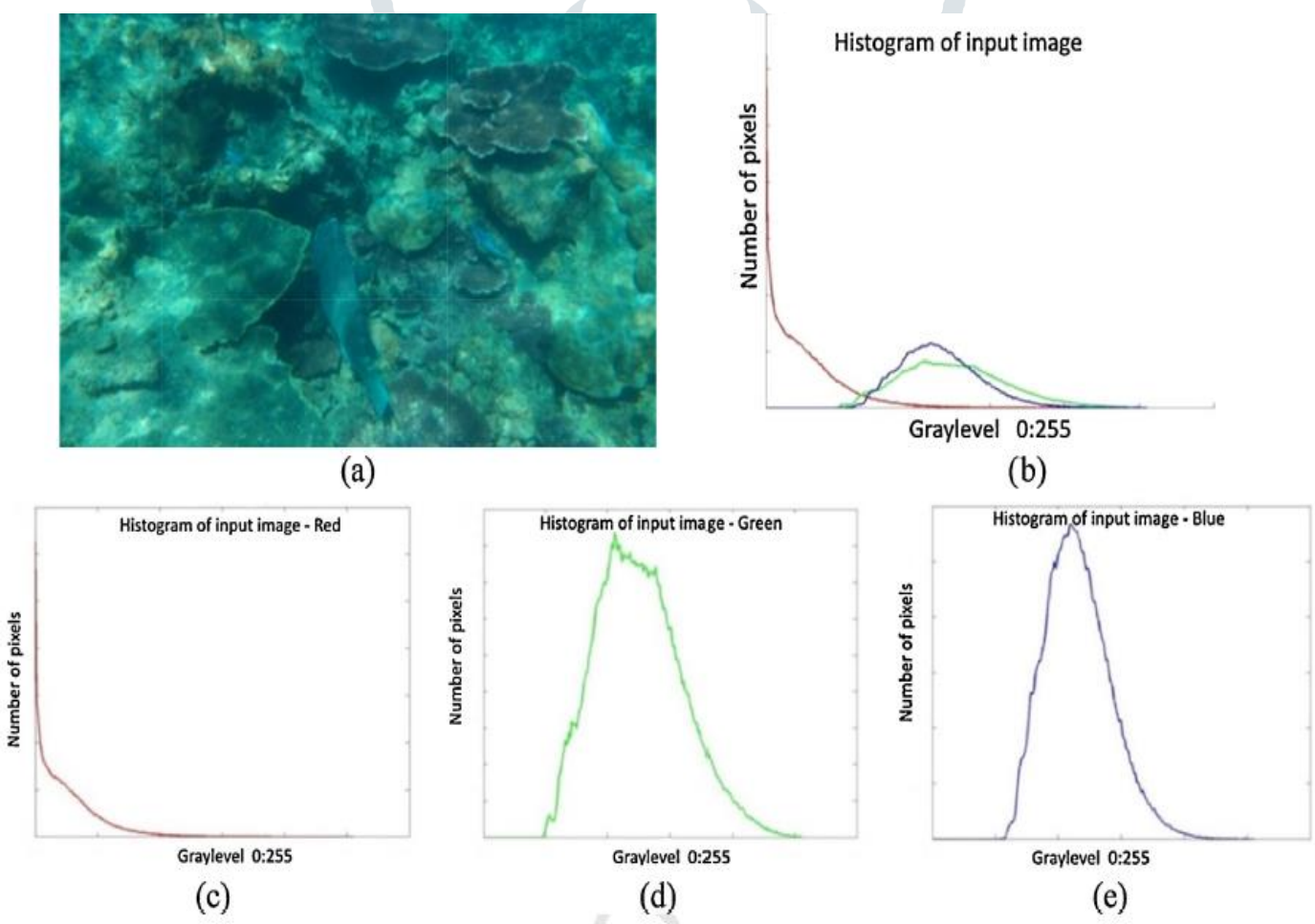

Figure 1.Sample underwater image (a) original image, (b) pixels distribution of Red, Green & Blue color channel pixels, (c) red color channel pixel distribution, (d) green color channel pixel distribution and (e) blue color channel pixel distribution. [6]

Figure 2 shows block diagram of proposed system. As shown in figure, input image goes through global and local contrast correction followed by color correction method.

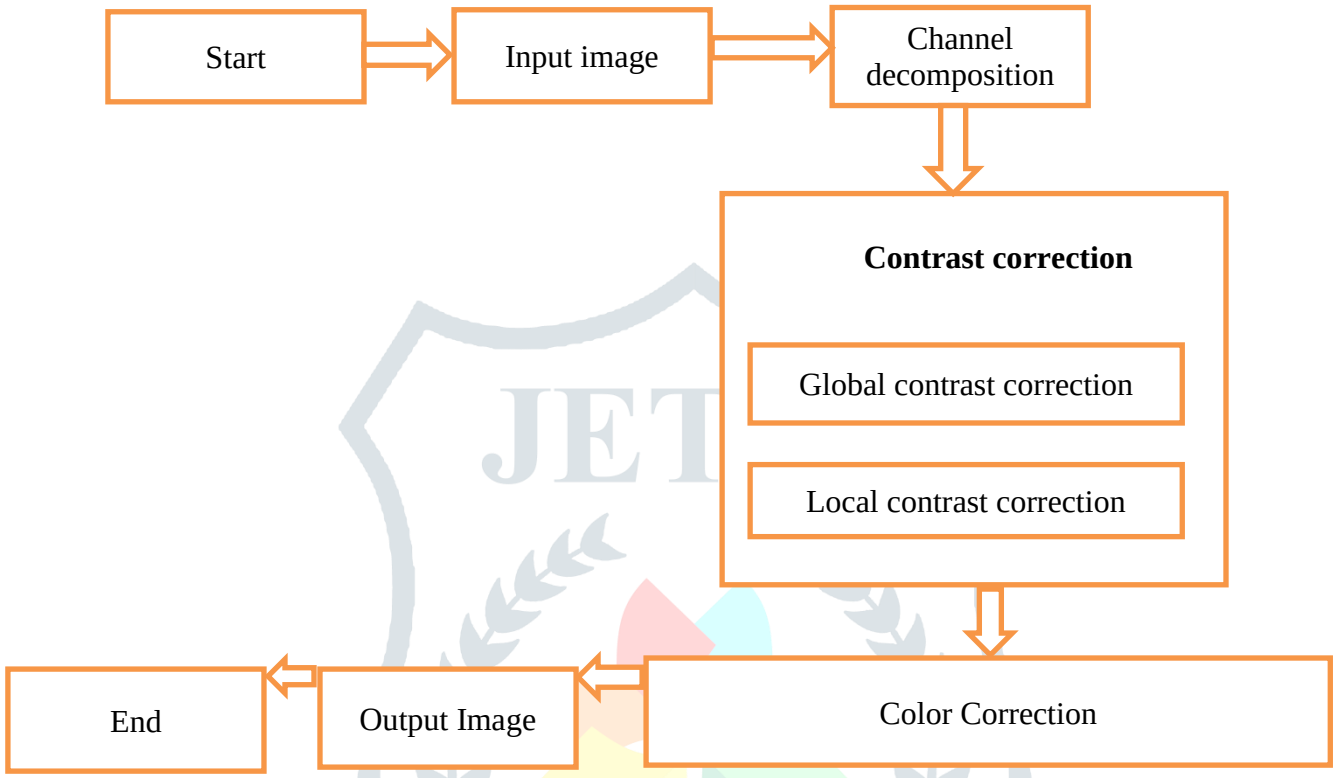

Figure 2. Block diagram of proposed system

IV. CONCLUSION-

The proposed method can be evaluated for qualitative observation and analysis to check whether it can solve or reduce the problems with underwater images. The proposed method can be examined in terms of entropy, MSE, PSNR, natural image quality evaluator (NIQE) and Sobel edge detection through quantitative analysis. Entropy represents information in an image and is used for quality assessment. A high entropy value reveals that an image contains much information. Sobel edge detection can be also used in quantitative evaluation for image analysis that is evaluated based on the total number of bright pixels. A high Sobel edge value is preferred which states that objects that can be detected in an image. The proposed DIRS- CLAHS method combines contrast correction and color correction methods. In the contrast correction, this method makes use of two processes i.e global and local contrast stretching to improve image contrast. The color correction step enhances the image color performance. Results for DIRS-CLAHS method can be compared with several techniques like UCM and ICM, CLAHE mix, PDSCC, etc.

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