CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION FOR UNDERWATER IMAGE QUALITY ENHANCEMENT

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Abstract
Image enhancement techniques have been widely used in many applications of image processing where the subjective quality of images is essential for human interpretation. An important factor in any subjective evaluation of image quality is contrast. Underwater photography is the phenomenon of capturing photographs from below the water surface. Highlighting main details, improving features and quality of images and making images more visually clear called as enhancement. Focus of this research is underwater images. To enhance the quality of underwater images various existing techniques are available but some issues are there that still need improvement. This work proposes a method for enhancing the quality of underwater images. The proposed method consists of two stages. 1. High boost Filter
2. Contrast Limited Adaptive Histogram Equalization
These two techniques are used for enhancement of an underwater images. It gives better result as compare to existing methods.
Keywords: Image Quality, Image Processing, High Boost Filter, Histogram Equalization, Under water Images.

I. INTRODUCTION

Improving the image quality without any loss of information is known as quality enhancement of an Image. An enhancement is done to improve certain features of an underwater images. For research and exploration underwater image processing is a phenomenon with wide scope. so, image enhancement algorithms are of various types are already developed or exist and some are being developed. Enhancement techniques are application specific and accordingly, for a specific application, certain features needed to be focused are enhanced. When images are acquired in normal condition, various types of variations like Gaussian, Rayleigh, gamma, exponential, white and speckle noises may come into the image. When an image is taken in underwater environment, the quality of image taken is badly affected due to some factors like low contrast, limiting transmissibility of light in the water, limited range of propagation of image signal, non-uniform illumination and loss of color components within visible ranges .One of the important factors is reflection of light, absorption of light. The inherent topography of sea bed also affects the transmission process. When light falls on water surface, it cannot be fully transmitted, rather only a part of it is transmitted. Part of the light goes into reflection and diffusion, so only a certain part is transmitted. Fig. 1 shows the water surface effects.

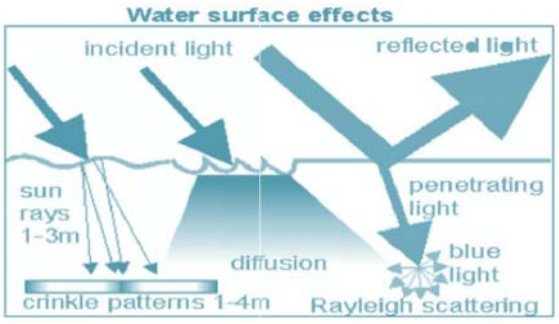


Figure 1: Water S urface Effects

Moreover, as the depth increases, different colors are absorbed by the surrounding medium depending on the wavelengths. In particular, blue/green colors dominant in the underwater ambience which is known as color cast. For further processing of the image, enhancement remains an essential preprocessing operation. Color equalization is a widely adopted approach for underwater image enhancement. Fig. 2 shows the variations in the color as depth increases.

The cause for underwater image distortion is color change. Color change is due to varying degrees of attenuation for different wavelengths. Blue colortravels longest distance in the water as it has the shortest wavelength. This is the reason why underwater images are dominated by blue color. And red colorhas highest wavelength, so it travels a very short distance in water. Suspendedparticles(sand, plankton, minerals) are responsible for the haziness in the underwater image.

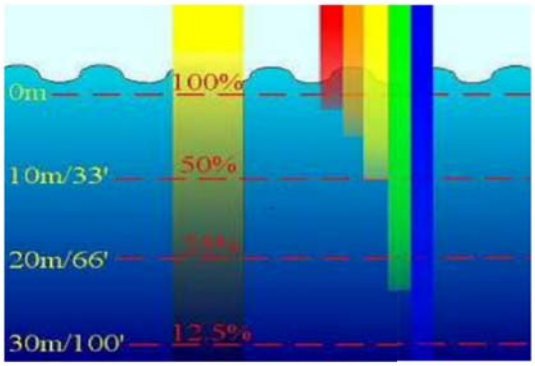


Figure 2: Color Variations in the Water

II. LITERATURE SURVEY

Paper 1 Improving Auto Level Method for Enhancement of Underwater Images[1]
In this paper[1], Author proposes a method for auto level enhancement, focuses on the automatic adjustable parameters. In this auto level is nothing but stretching the histogram. They used histogram equalization for three channels red, green and blue for color images. Proposed method yields the uniform distribution equalization that is similar with histogram equalization methods.

Performance Evaluation of Image Enhancement using Hybrid Binary bat Optimization [2] 2016, second paper. In this research work, the focus is on underwater images. Various existing techniques are available to enhance the underwater images but there are some issues that still need to be resolved. Author used hybrid method DWTSVD with binary bat optimization to improve the underwater images.
Paper 3 Mixture contrast limited adaptive histogram equalization for underwater image enhancement [3]In 2013, In the third paper, author used color models on the AHE and CLAHE i.e. Adaptive Histogram equalization and Contrast Limited Adaptive Histogram Equalization sequentially.

Such as light absorption, light reflection, bending of light and scattering of light. For instance, when discuss about light absorption, it is well known that water absorbs light in ways that air does not. The amount of light will drop off as it passes through water. Different wavelengths of light (blue, green, red) will penetrate water to a varying degree.
Illustration about the absorption of light by water is give in fig.2. For every 10m increase in depth the brightness of sunlight will drop by half. Nearly all red light is gone by 50m depth. That is why most underwater images are dominated by blue-green coloration. In adaptive histogram equalization (AHE) and contrast limited adaptive histogram equalization (CLAHE) author proposed to overcome the over amplification of noise problem.

Paper4 Significance level of image enhancement techniques for underwater images [4]

In 2012, In the fourth paper, It focuses on manual or auto correction techniques. An image processing is a technique in which thedata from an image are digitized in order to create an enhanced image thatcan be stored for future references study and human observer. Underwater imaging is quite a challenging in the area of photography. The importance of underwater activities to scientists for discovering, recognizing underwater imaging brings new challenges and enforce significant problems due to light absorption and diffusion effects of the light.

High boost Filtering

It is often desirable to emphasize high frequency components representing the image details (by means such as sharpening) without eliminating low frequency components representing the basic form of the signal. In this

case, the high-boost filter can be used to enhance high frequency component while still keeping the low frequency components. The high-boost filter is a simple sharpening operator in signal and image processing. It is used for amplifying high frequency components of signals and images. The amplification is achieved via aprocedure which subtracts a smoothed version of the media data from the original one.

IV. HISTOGRAM EQUALIZATION

Histogram equalization is a technique for adjusting image intensities to enhance contrast. Histogram equalization is one of the well-known enhancement techniques. In histogram equalization, the dynamic range and contrast of an image is modified by altering the image such that its intensity histogram has a desired shape. This is achieved by using cumulative distribution function as the mapping function. The intensity levels are changed such that the peaks of the histogram are stretched and the troughs are compressed. If a digital image has N pixels distributed in L discrete intensity level sand nk is the number of pixels with intensity level ik.

Contrast Enhancements

Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds. Contrast enhancements are typically performed as a contrast stretch followed by a tonal enhancement, although these could both be performed in one step. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, whereas tonal enhancements improve the brightness differences in the shadow (dark), midtone (grays), or highlight (bright) regions at the expense of the brightness differences in the other regions.

Contrast Limited Adaptive Histogram Equalization

In contrast limited histogram equalization (CLHE), the histogram is cut at some threshold and then equalization is applied. Contrast limited adaptive histogram equalization (CLAHE) is an adaptive contrast histogram equalization method , where the contrast of an image is enhanced by applying CLHE on small data regions called tiles rather than the entire image. Theresulting neighboring tiles are then stitched back seamlessly using bilinear interpolation. The contrast in the homogeneous region can be limited so that noise amplification can be avoided.

V. PROPOSED SYSTEM ARCHITTECTURE

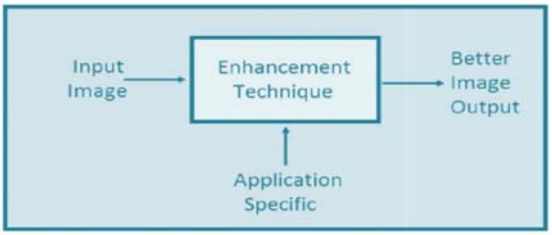


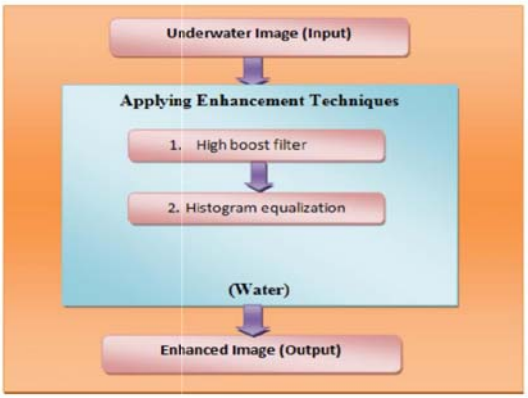
Figure 3: Proposed Architecture of System

In this System architecture we provide the underwater image as an input image. Image enhancement is only for application specific. By applying enhancement techniques of image processing on the input image and we will get better image as an output.

VI. PROPOSED METHOD

In proposed method we used high boost filtering on given input image after that we apply histogram equalization as a contrast limited adaptive histogram equalization i.e. (CLAHE).

Fig. 4: Block Diagram of image enhancement



VII. RESULTS

Input image:

Figure 4: Input for proposed system

After performing proposed operations on the input images we get the result as with enhancement of an image.

Output image:

Figure 5: Enhanced Image

VIII. COMPARISION WITH EXISTING METHOD

TABLE I. COMPARISON OF MSE

	HE	AHE	CLAHE-RGB	CLAHE-HSV	CLAHE-Mix
R1	8981.2	1096.9	1768.1	1672.7	839.2
R2	8231.7	9568.6	2209.7	1980.2	948.0
B1	10990	10796	5573.5	6324.9	5481.4
B2	4944.2	6154.6	3.113.6	4288.0	2788.1

TABLE II. COMPARISON OF PSNR

	HE	AHE	CLAHE-RGB	CLAHE-HSV	CLAHE-Mix
R1	8.60	7.73	15.66	15.90	18.89
R2	8.98	8.32	14.69	15.16	18.36
B1	7.72	7.80	10.67	10.12	10.74
B2	11.19	10.24	13.20	11.81	13.69

IX. CONCLUSION

The underwater images suffer from low contrast and resolution due to poor visibility conditions, hence an object identification become typical task. This proposed model helps in achieving the quality enhancement of underwater images. The images which are not clear to see become more clearer and objective specific. Contrast Limited Adaptive Histogram Equalization (CLAHE) was originally developed for enhancement of low contrast underwater images. It is a generalization of Adaptive Histogram Equalization (AHE). CLAHE differs from ordinary AHE in its contrast limiting. CLAHE limits the amplification by clipping the histogram at a user-defined value called clip limit. The clipping level determines how much noise in thehistogram should besmoothed and hence how much the contrast should beenhanced. The enhancement method effectively improves the visibility of underwater images and produces the lowest MSE and the highest PSNR values. For future work, we will consider to apply CLAHE on other color models and make comparison on them.

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