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Performance Analysis of Underwater Image Enhancement with CLAHE 2D Median Filtering Technique On the Basis Of SNR, RMS Error, Mean Brightness

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Abstract*— The objects in the underwater images are faint, difficult to view and analyze because the images of such environment loses the details of the objects. In this paper a method of RMS error reduction & SNR improvement is presented for underwater images with keeping Mean brightness preserved in which the image quality is first enhanced using Contrast Limited Adaptive histogram equalization method and 2d median filter , and then histogram thresholdding is used for segmentation of the objects for analysis. The method is tested on various type of underwater image environment and signal to noise ratio (SNR), RMS error and mean brightness is used for comparison for various images and it is found that using this method is advantageous as it improves the SNR to greater values even after segmentation while RMS error represented by ERMS gets reduced leading to better visualization and keeping mean brightness constant.

***Keywords*— Image intensification, Contrast limited Adaptive Histogram Equalization, median filter, Image Partitioning, Global Thresholding, Multi level Thresholding.**

I. INTRODUCTION

No partition technique is universally applicable, which works equally well for all kinds of images. Therefore, various partitioning approaches [1], [12], [15], and [16] have been developed which perform differently for different applications as well for different types of images. It is difficult to partitioning in underwater environment without losing the details of the objects. Although the low light in camera develops fast in recent years, and imaging velocity and image resolution ratio are improved greatly. But underwater images still have low contrast; unbalance gray scales and fuzzy edge of objects under the influence of the imaging condition and some character of water media. In underwater environment image get blurred due to poor visibility conditions and effects like "absorption of light", "reflection of light", "bending of light, "denser medium (800 times denser than air)", and "scattering of light" etc. hence it is required to enhance the quality of the underwater images before processing. There is lot of research done for the improvement of image quality as [4], [12], [13], and [14]. The researchers have reviewed several techniques related to images intensification viz "contrast stretching" "histogram equalization" [6] "contrast limited adaptive histogram equalization (CLAHE)" [5]. Here we are going to compare three intensification techniques on the basis of SNR and mean square error as parameter.

After enhancing the image quality partition is performed to extract the desired objects. Partitioning is typically associated with pattern recognition problems. It is considered the first phase of a pattern recognition process and is sometimes also referred to as object isolation as shown in Fig. 1. In this paper histogram thresholding is used for segmenting the background and objects in underwater environment. Then performance of global, local and multilevel thresholding is compared for different underwater environments. It found that with the combination of CLAHE method partitioning performs well for most of the images.

The remaining of the paper is organized as follows: Next Section describe the various type of image intensification method and algorithm, section II describe the contrast 'stretching histogram equalization techniques, section III describe CLAHE method and its flow chart. Section IV discusses the partitioning methods and, In Section V gives conclusion and future work.

II. IMAGE INTENSIFICATION

Image intensification is a process of improving the quality of image by improving its features. Here we have given three method of image intensification for underwater images (i) Contrast stretching (ii) Histogram equalization and Contrast limited adaptive histogram equalization. A number of contrast measures were proposed for complex images as underwater images.

In local Contrast Stretching method, the Contrast is stretched between the limit of lower threshold and upper threshold. It is an intensity based contrast intensification method as $I_o(x,y) = f(I(x,y))$, where the original image is I(x,y), the output image is $I_o(x,y)$ after contrast intensification, and f is the transformation function. Another contrast based method is histogram equalization. Histogram is defined as the statistic probability distribution of each gray level in a digital image. Histogram equalization (HE) is one of the well-known methods for enhancing the contrast of given images, making the result image have a uniform distribution of the gray levels. It flattens and stretches the dynamic range of the image's histogram and results in overall contrast improvement. HE has been widely applied when the image needs intensification however, it may significantly change the brightness of an

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input image and cause problem in some applications where brightness preservation is necessary.

It is an intensity based contrast intensification method as $Io(x,y) = f(I(x,y))$, where the original image is $I(x,y)$,the output image is $I_o(x,y)$ after contrast intensification, and f is the transformation function. The contrast stretching is a method to make brighter portion more brighter and darker portion darker.

There are many applications, wherein we need a flat histogram. This cannot be achieved by histogram stretching. so we use Histogram Equalization. Histogram equalization maps grey levels r of an image into grey levels s of an image in such a way that grey levels s are uniform. This expands the range of grey levels (contrast) that are near the histogram maxima, and compresses the range of grey levels that are near the histogram minima.

To equalize the histogram first its PDF is calculated and then cumulative density function (CDF) is calculated. The CDF of the probability function is flat as shown in Hence transformed gray levels are equalized. Using histogram equalization can be a good approach when automatic intensification is desired, although there are still situations where basing image intensification on a uniform histogram may not be the best approach. In these situations, histogram equalization effects may be too severe. So other histogram techniques may need to be used, such as adaptive histogram equalization.

In this paper, a novel Contrast limited adaptive histogram equalization (CLAHE) intensification method is proposed which can yield the optimal equalization and also limit the contrast of the image. The suggested method is very useful for the video image broadcasting, where the brightness requirement is high such as in geographical channels.

III. CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION (CLAHE)

CLAHE was originally developed for medical imaging and has proven to be successful for intensification of low-contrast images such as portal films. The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to each one. This evens out the distribution of used grey values and thus makes hidden features of the image more visible. The full grey spectrum is used to express the image.

Contrast Limited Adaptive Histogram Equalization, (CLAHE) is an improved version of AHE, or Adaptive Histogram Equalization. Both overcome the limitations of standard histogram equalization. A variety of adaptive contrast limited histogram equalization techniques (CLAHE) are provided. Sharp field edges can be maintained by selective intensification within the field boundaries. Selective intensification is accomplished by first detecting the field edge in a portal image and then only processing those regions of the image that lie inside the field edge. Noise can be reduced while maintaining the high spatial frequency content of the image by applying a combination of CLAHE, median filtration and edge sharpening. A variation of the contrast limited technique called adaptive histogram clip (AHC) can also be applied. AHC automatically adjusts clipping level and moderates over intensification of background regions of images .The expression of modified gray levels for standard CLAHE method with Uniform Distribution can be given as

$$g = [\, g_{max} - g_{min} \,] * P(f) + g_{min} \qquad (1)$$

Where g_{max} = Maximum pixel value

g_{min} = Minimum pixel value

g is the computed pixel value

$P(f)$=CPD

(Cumulative probability distribution)

For exponential distribution gray level can be adapted as

$$g = g_{min} - \left(\frac{1}{\alpha}\right) * \ln[1 - P(f)\,] \qquad (2)$$

Where α is the clip parameter.

CLAHE method operates on small regions in the image, called "*tiles*", rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the histogram specified by the Distribution type. The comparison of the contrast based intensification method is given in Table 1

IV. MEDIAN FILTERING

In image processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image)

V .PARTITIONING

Image partitioning is a image-processing task that aims at partitioning an image into homogenous regions .It involves partitioning an image into groups of pixels which are called segments/partitions. Various histograms thresholding based segmentation methods. Viz. Global, local and multilevel partition.

A. Global Partitioning

This is concerned with segmenting a whole image. In global thresholding we partition the histogram of image by using single thresholding function.

T = T(f(x, y))

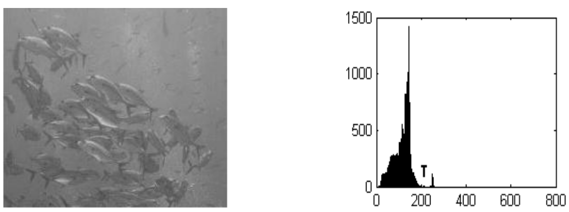

Fig.2 Histogram of sea fish image

This kind of thresholding can be accepted to succeed only if the histogram is well partitioned.

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B. Local Partitioning

Difficulties of Global thresholding methods are that it use the same threshold for every pixel in an image. Dynamic threshold could be used based on the histogram of an appropriately sized sub-image encompassing each pixel. This is known as adaptive, variable or local thresholding.Here we divide entire image into the sub images of size of A, an d select separate threshold for the each sub image A.

$$T = T[x,y\ A(x,y)\ ,f(x, y)]$$

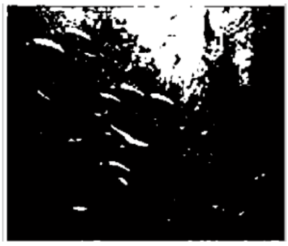
C. Multilevel Partitioning

If for example an image is composed of two types of light objects on a dark background, three or more dominant modes characterize the image histogram In such a case the histogram has to be partitioned by multiple thresholds.

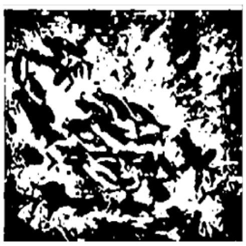
VI. PROPOSED METHODOLOGY

Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see discussion below) After performing clahe enhancement then filtering the image using 2d median filter improves the overall SNR of the image along with less error and noise reduction due to the image of median filter and then we apply partitioning methodology.

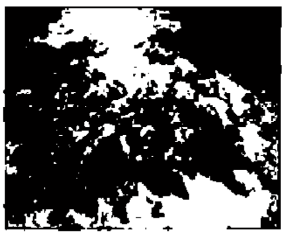
VII. RESULTS



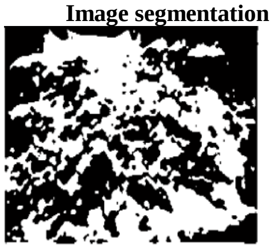
a)Original Image



b)CLAHE+2d Median Image segmentation



a)Original Image



b)CLAHE+2d Median Image segmentation

S No:	Images	Constrast Stretching	Histogram Equalization	CLAHE+ Media Filter
1	Sea Fish	2.001	2.0345	3.5041
2	Sea Surface	2.012	3.0879	5.9005

Table1 Comparison of SNR

S No:	Image	Constrast Stretching	HE	CLAHE + Media Filter	Only CLAHE
1	Sea Fish	73.08	47.64	24.75	25.31
2	Sea Surface	57.40	56.87	32.74	33.06

Table2 Comparison of RMS Error

S No:	Image	Constrast Stretching	HE	CLAHE + Media Filter	Only CLAHE
1	Sea Fish	140,20	141.20	140.18	140.18
2	Sea Surface	140.52	105.52	104.51	104.51

Table 3 Comparison of mean brightness

S No:	**Images**	**CLAHE+ 2D Media Filter**	**Global segmentation**
1	**Sea Fish**	**5.9005**	**1.3151**
2	**Sea Surface**	**3.5041**	**0.8371**

Table 4 Comparison of SNR after clahe median segmentation & Global segmentation

VII. CONCLUSION & FUTURE SCOPE

As comparison of enhancement methods, It is found that CLAHE method with 2D median filter not only improve the contrast but also equalizes the image histogram efficiently. It is observed that SNR is improved with CLAHE &2D median filter method in comparison with other method like contrast stretching histogram equalization and CLAHE method. This method is applicable only for Gray images & Future work may be done on variable images and videos.

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REFERENCES

[1] A. Daskalakis, D. Cavouras, P. Bougioukos, S Kostopoulos, and George Nikiforidis, “An efficient CLAHE based, spot adaptive, image segmentation technique for improving microarray genes’ quantification”, 2nd Int.l Conference on experiments Process System Modeling/Simulation & Optimization 4-7 July, 2007

[2] Sos S. Agaian,,, Blair Silver, and Karen A. Panetta,, “Transform Coefficient Histogram-Based Image Enhancement Algorithms Using Contrast Entropy , IEEE Transaction on image processing, VOL. 16, NO. 3 MARCH 2007.

[3] R. Dale-Jones and T. Tjahjadi, “A study and modification of the local histogram equalization algorithm,” Pattern Recognition, vol. 26, no. 9, pp. 1373–1381, 2007.

[4] Tristan J. Lambert,” Digital Enhancement Techniques for Underwater Video Image Sequences”, submitted at School of Computing In Nov.2005.

[5]. K. Zuiderveld, "Contrast Limited Adaptive Histogram Equalization", Graphics Gems IV, pp. 474-485.

[6] B. Silver, S. S. Agaian, and K. A. Panetta, “Logarithmic transform coefficient histogram matching with spatial equalization,” presented at the SPIE Defense and Security Symp., Mar. 2005.

[7] B. Silver, S. S. Agaian, and K. A. Panetta, “Contrast entropy based image enhancement and logarithmic transform coefficient histrogram shifting, presented” at the IEEE ICASSP, Mar. 2005.

[8] Etta D, Pisano, S. Zong, R. E Jhonston “Contrast limited adaptive histogram equalization image processing to improve the detection of simulated speculation in Dense Monograms”, Journal of Digital Imaging, vol. 11, No. 4, pp 193-200, Nov. 1998

[9]. R. Gonzalez, R. Woods, “Digital Image Processing”, 2nd Edition, Prentice Hall, 2002.

[10] Gonzalez, RC, Woods, RE & Eddins, SL 2004, Digital Image processing using MATLAB, Pearson Prentice Hall.

[11] Kashif Iqbal, Rosalina Abdul Salam, Azam Osman and Abdullah Zawawi Talib “Underwater Image Enhancement Using an Integrated Color" Model “,IAENG International Journal of Com.