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RESEARCH ARTICLE

A NOVEL UNDERWATER IMAGE ENHANCEMENT USING BPDHE TECHNIQUE WITH LUMINANCE CONTRAST STRETCH

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ABSTRACT

Image enhancement is the process of improving the quality of the input image. Underwater images mainly suffer from the problem of poor color contrast and poor visibility. These problems occurred due to the scattering of light and refraction of light while entering from rarer to denser medium. Scattering causes the blurring of light and reduces the color contrast. So many authors proposed different methods on under water images. In the process of enhancement brightness will alter, it is required to preserved. Here proposed a enhancement method for underwater using BPDHE with contrast stretch. Experiments are carried out on different images to evaluate performance of the proposed method, in terms of quality metrics like Mean Square Error (MSE), peak signal-to-noise ratio (PSNR), Absolute Mean Brightness Error (AMBE), Contrast Improvement Index (CI) and image visual quality.

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INTRODUCTION

Underwater images are affected by reduced contrast and non-uniform color cast due to the absorption and scattering of light in the aquatic environment. This affects the quality and reliability of the image processing and therefore color correction is a necessary pre-processing stage. Many techniques are available for image contrast enhancement. The techniques that use first order statistics of digital images (image histogram) are very popular. Global Histogram Equalization (GHE) (Gonzalez and Woods, 2002) is one of the widely used techniques. GHE is employed for its simplicity and good performance. while it introduce major changes in the image gray level its histogram spread is not significant and cannot preserve the mean image-brightness. To overcome this, several brightness preserving histogram modification approaches, such as bi-histogram equalization (Kim, 1997; Chen and Ramli, 2003), multi-histogram equalization, Contrast limited adaptive histogram equalization (CLAHE) and histogram specification (4-6) have been proposed in literature. Dynamic Histogram Equalization method, proposed by Abdullah-Al-Wadud, *et al*., partitions the global image histogram into multiple segments based positions of local minima, and then independently equalizes them. This technique claims to preserve the mean image brightness. But this method has the limitation of remapping the peaks which leads to perceivable changes in mean image brightness. To avoid peak remapping, Ibrahim and Kong, in their Brightness Preserving Dynamic Histogram Equalization (BPDHE) technique, use the concept of smoothing a global image histogram using Gaussian kernel followed by its segmentation of valley regions for their dynamic equalization. These techniques process the crisp histograms of images to enhance contrast.

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Existing methods

i) Histogram Equalization:

Histogram equalization is a technique for adjusting image intensities to enhance contrast. To transfer the gray levels so that the histogram of the resulting image is equalized to be constant. Its purpose is to equally use all the available gray levels and for further specification of histogram. This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. The method is useful in images with backgrounds and foregrounds that are both bright or both dark.

ii) Adaptive Histogram Equalization:

Adaptive histogram equalization (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image.

iii) Contrast Limited Adaptive Histogram Equalization

Contrast Limited AHE (CLAHE) differs from ordinary adaptive histogram equalization in its contrast limiting. In the case of CLAHE, the contrast limiting procedure has to be applied for each neighborhood from which a transformation function is derived. CLAHE was developed to prevent the over-amplification of noise that adaptive histogram equalization can give rise to. This is achieved by limiting the contrast enhancement of AHE. This is proportional to the slope of the neighborhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value. CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF.

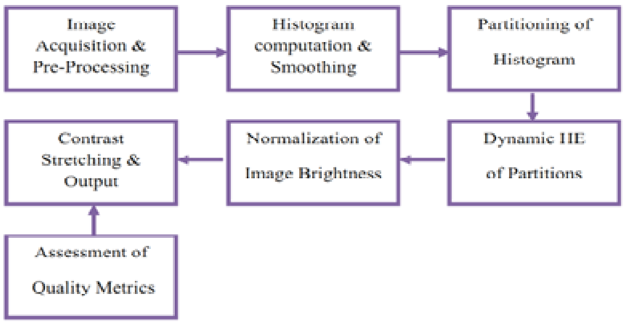

Figure 1. Flow diagram Proposed Method

PROPOSED METHOD

Brightness Preserving Dynamic Histogram Equalization

The BPDFHE this technique manipulates the image histogram in such a way that only redistribution of gray-level values in valley portion between two consecutive peaks takes place and no remapping of the histogram takes place. The BPDFHE technique consists of following operational stages:

- Histogram Computation.
- Partitioning of the Histogram.
- Dynamic Histogram Equalization of the Partitions.
- Normalization of the image brightness.

i) Histogram Computation

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for an each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance.

ii) Partitioning of the Histogram

The local maxima based partitioning of the histogram, to obtain multiple sub-histograms, is performed in this step. This way every valley portion between two consecutive local maxima forms a partition. When the dynamic equalization of these partitions is performed the peaks of the histogram do not get remapped and this results in better preservation of the mean image brightness while increasing the contrast.

a) Detection of Local Maxima

The smoothed histogram is only used in the process of splitting the original histogram. The histogram is divided into sub-histograms based on local maximums as shown in Fig.2. We choose to use local maximums as the separating intensities rather than local minimums because this selection is better in maintaining the mean brightness. First, the signs of the first derivative of the smoothed histogram are calculated.

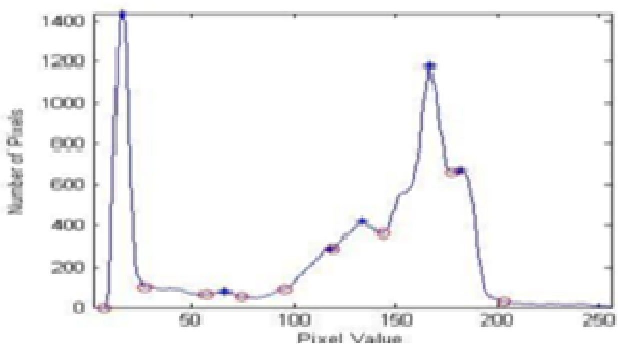

Figure 2. Detecting Local Maxima points

b) Creating Partitions

The local maxima points in the histogram can now be used to form the partitions. Let (r+1) intensity levels corresponding to the local maxima, detected in the previous stage of operation, be denoted by {q0, q1, q2,….qn}. Assuming the original histogram to have a spread in the range of (Tmin, Tmax), then the (r+1) sub-histograms obtained after partitioning are {(Tmin,q0), (q0+1, q1),…(qn+1, Tmax)}.

iii) Dynamic Histogram Equalization of the Partitions

The sub-histograms obtained are individually equalized by the DHE technique. The equalization method uses a spanning function based on total number of pixels in the partition to perform equalization. It involves two stages of operation, namely, mapping partitions to a dynamic range and histogram equalization.

a) Mapping Partitions to a Dynamic Range

The equalized version of these sub-histograms does not assure a very good enhancement, because sub-histograms with small range will not be enhanced significantly by HE. Hence, following the same concept as DHE, BPDHE spans each sub-histogram first before the equalizations are taking place as shown in Fig.3.

b) Equalizing Each Sub-histogram

Global HE method is used to equalize each sub-histogram. The remapped values are obtained for the ith sub histogram as

$$y(j) = start_i + range_i \sum_{k=start_i}^{i} \frac{h(k)}{M_i}$$

Where y (j) is the new intensity level corresponding to j^{th} intensity level on the original image. h(k) is the histogram value at k^{th} intensity level on the histogram.

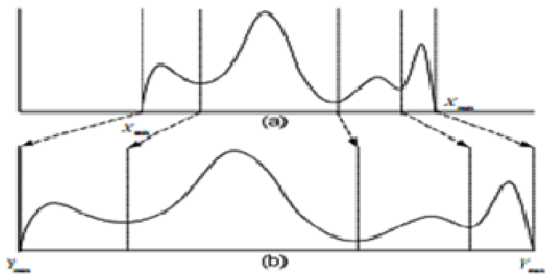

Figure 3. Range Extension a) Original Histogram b) New Histogram

iv) Normalization Of Image Brightness

After DHE of each sub-histogram the image obtained has the mean brightness slightly different than input image. To overcome this normalization of output image is done. In this proposed method Normalization is obtained by contrast stretch on Luminance component as shown Fig.4.

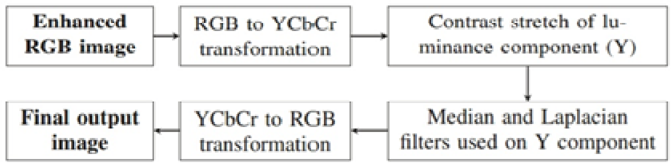

Figure 4. Enhanced Image normalization process

Experiment Results

Experiments are carried out different under water images performances of proposed method with existing methods.

(a)

(b)

(c)

(d)

(e)

f

g)

Figure 5. a) Input Image b) Gray scale image c) HE d) AHE e) CLAHE f) BPDHE g) Proposed (BPDHE with Contrast

Table 1. Assessment of Quality metrics

Quality Metrics	HE	AHE	CLAHE	BPDHE	Proposed
MSE	2.0170	11.9758	14.9335	35.9501	1.1486
PSNR	35.8567	37.3818	36.4232	32.6078	47.5631
AMBE	24.0025	4.8643	6.8909	1.2157	0.4400
CI	0.45	0.76	0.85	0.92	1

For comparative evaluation commonly used so many metrics. Some of them are used for evaluate proposed method. They are Peak Signal-to-Noise Ratio (PSNR), Root Mean Square Error (RMSE), Absolute Mean Brightness Error (AMBE), Contrast Improvement Index(CI). And also visual quality used for comparison.

Conclusion

This paper proposed a enhancement technique for under water image. The experimental results shows proposed method is more effective than the existing methods. The same technique can also applicable for haze images like fog images.

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