Low Contrast Color Images Enhancement Using Recursive Histogram Enhancement Algorithm

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Abstract: In this paper, the low contrast color images are enhanced in two steps. Firstly the RGB image is transformed into YCbCr format. The Y component represents the luminance part of the image, which is similar to gray scale version of original image. So, only Y component is enhanced for better visualization. In Second step, the Y component is enhanced using Recursive Histogram Equalization Algorithm (RHEA). The RHEA algorithm has advantage that the image is enhanced according to exposure value. Also, the comparative analysis of existing work is done with proposed algorithm.

Introduction

With the latest advancement in technology, digital images have been extensively used for documenting life experiences, and distribution with people in a multiplicity of communal networks. Though, in spite of the enhanced excellence of digital cameras in mobile devices, the artificial imaging system still cannot fight with the human visual system (HVS) which is well recognized to have wonderful abilities in lightness color alteration and visual content prejudice under composite natural environments. The man-made imaging system is exaggerated significantly by a number of mortifying factors, such as a partial active array, an objectionable or unsatisfactory ambient lighting, and inappropriate weather surroundings. Dishonored images may have a low disparity, a dim color and dark/bright regions that veil facts of vital contents.

1.1 Various Enhancement Techniques

i) Contrast Stretching: An augmentation practice of stretching the amount values to augment the dissimilarity of the image
ii) Histogram Equalization:
Histogram: a graphical representation of data distribution that gives a rough density estimation of underlying data distribution as shown in Fig. 1

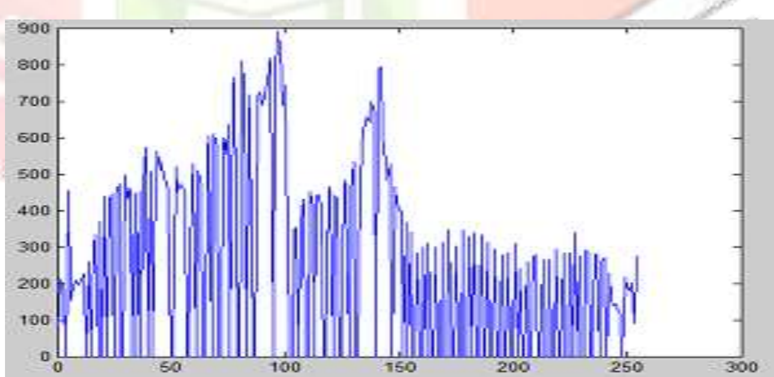


Fig. 1: Histogram

Histogram Equalization: It distributes the image intensities thus increasing the global contrast of the image by flattening the probability distribution and stretching the dynamic range of grey levels.
The rest of the paper is organized as follows: Section 2 describes the literature survey of the work done. Section 3 presents the proposed algorithm and associated flow chart. Results are discussed in section 4and section 5 contains the Conclusion.

II. Related Work and Motivation

2.1 **Literature Survey**

Kuldeep, *et al.* [3], proposed two recursive histogram equalization methods for underwater image enhancement. In the first method, the histogram is divided into under exposed and over exposed regions and successive recursive operations are applied for histogram equalization. In the second method, two exposure values were calculated and successive recursive operations on each sub histogram were applied for histogram equalization till the exposure threshold value of each sub histogram becomes less than exposure threshold value of the complete histogram.

GwanggilJeon [4], discussed how different color formats are used for contrast enhancing. They workon YCbCr, HSV format for contrast enhancing in color images and conclude that HSV format give the favorable results.

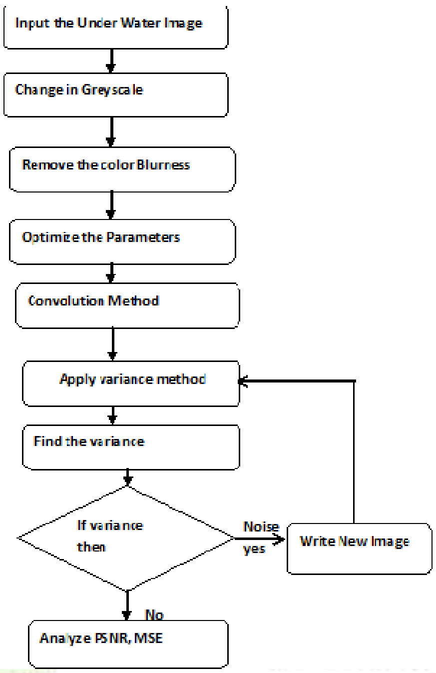
Chiang, *et al.* [5], discussed that separately enhancing the luminance and saturation, make the image unnatural. So they work on YCbCr format and proposed a technique in which image have vivid and contrast.

2.2 **Motivation**

From the literature survey, we take the motivation that, enhancing the color image in YCbCr format never lose the naturalness of the image as compared to HSV format. Also in YCbCr format, Y component shows the luminance part. So, enhancing this component enhances the overall image. On the other hand in RGB format, all planes are simultaneously enhanced for better visualization.

III. PROPOSED ALGORITHM

In this section the proposed work, overall flow and process and algorithm are defined.



Flowchart

This section describes the proposed methodology steps and the working through the algorithm that is used in the proposed work.
Step 1: Input the underwater images.
Step 2: Change the input image into the grey scale.
Step 3: Remove the color blurrness of the image.
Step 4: Optimize the parameters of the image.
Step 5: Apply the Convolution method after the optimization process.
Step 6: Compute the total variance method after the convolution.
Step 7: If variation is present then write new image otherwise calculate the PSNR and MSE.

Algorithm

Step 1: Categorizing the image (exposure value range between 1 and 0) by exposure threshold value. The image intensity exposure value equation is given below:

$$Exposure\_value=\frac{\sum_{k=0}^{L-1} h(k)*k}{L\sum_{k=0}^{L-1} h(k)} \quad (1)$$

where h(k) represents image's histogram and G represents the number of grey levels.

Step1.1: The exposure for the images that contain the majority of the low exposure region is in between 0 to 0.5. Whereas the exposure value of high exposed images is in between 0.5 to 1.

Step1.2: Parameter Xa is the grey level boundary value that divides the image into under exposed and over exposed sub images.

Xa=G(1-Exposure_value) (2)

Step 2: Calculating the global stretching:

$$Stretching = \frac{F(x,y)-min}{max-min} x255 \quad (3)$$

Step 2.1 According to exposure value, the stretching is done in controllable manner as stretch the 10% lower region towards the high intensity level and reduce the 10% higher region towards the low Intensity level

Stretching_under_exposed_area=$\frac{F(x,y)-10}{Exposure\_value-10} x255$ (4)

Stretching_Over_exposed_area=$\frac{F(x,y)-0}{max-0} x250$ (5)

Step 3: Equalizing the histogram value according to the exposure value. The histogram divided into two parts according to exposure value. The $P_L(k) and\ P_U(k)$ are the PDF of sub images.

$P_L(k)=\frac{h(k)}{N_L}$ for $0 \le k \le Xa-1$ (6)

$P_U(k)=\frac{h(k)}{Nu}$ for $Xa \le k \le L-1$ (7)

Step 3.1: Calculate CDF of sub Images from equations (6) and (7).

$C_L(k) \sum_{K=0}^{X_a-1} P_L(k)$ (8)

$C_U(k) \sum_{K=Xa}^{L-1} P_{LU}(k)$ (9)

IV. RESULTS and DISCUSSION

Images Enhancement using old method

Figure 4.1: Image 2 enhancement by Old Method

In figure 4.1 shows the difference of image enhancement after histogram stretching.In this image still blurriness exists.

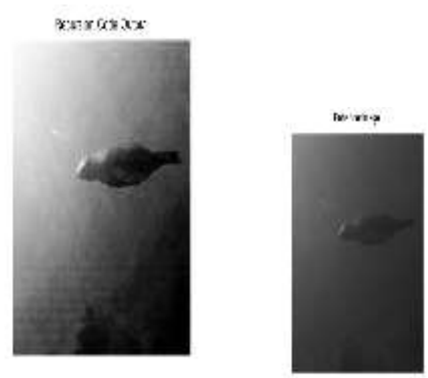


Figure 4.2 Images 3 by Old Method

In figure 4.2 and 4.3 show the difference of image enhancement after histogram stretching. In this image still blurriness exist because of unequalness of histogram.

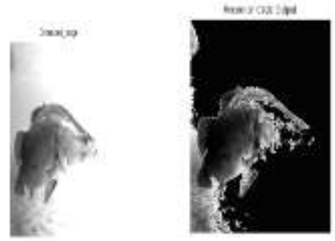
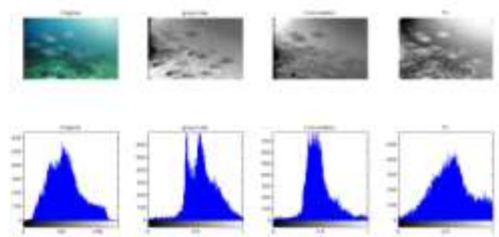


Figure 4.3 Images 4 by Old Method



4.3 Images Enhancement using new method

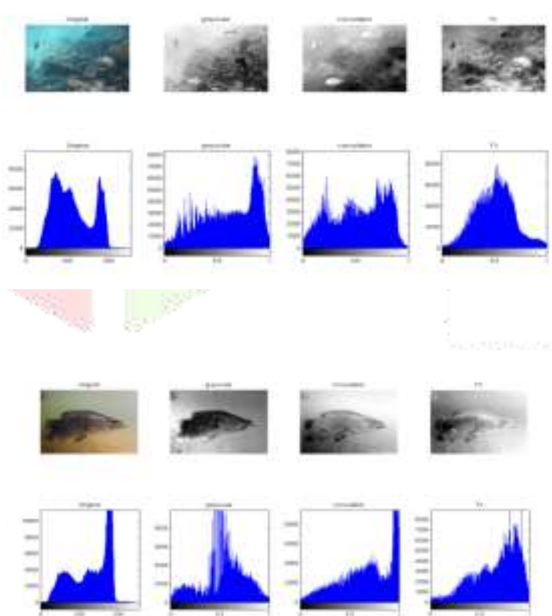


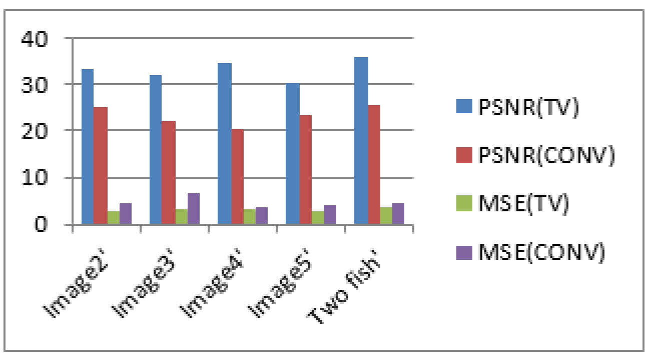
Figure 4.4: Underwater convolution with total variation

In figure 4.4 shows the histogram distribution change in difference enhancement changes by different distribution by different methods but blurriness level very low and MSE reduce.

When analysis above given images then old method enhanced the images but not improve as much because of color noise but proposed method enhanced the images in two steps first reduce the color noise by convolution and then iterative refine the images by total variation method.

Images	PSNR(TV)	PSNR(CONV)	MSE(TV)	MSE(CONV)
Image2	33.209	25.209	2.6902	4.56
Image3	32.3	22.206	2.89	6.78
Image4	34.67	20.5	3.23	3.46
Image5	30.23	23.56	2.56	3.78
Two fish	36.23	25.67	3.67	4.56

Table 4.3: Comparison between total variation and convolution method



Graph 2.6: Graph showing different images with both method on PSNR and MSE.

Table 4.3: Comparison between total variation and convolution method

The underwater image processing region has received substantial focus within the last decades, viewing significant achievements. This paper has a review on some of the most current methods that have been purposely urbanized for the underwater scenarios. These methods are skilled of extending the series of underwater image processing, civilizing image contrast level and declaration quality. After consideration of the basic physics of the light propagation in the water medium, we focus on the different methods available in the previous articles. The situation for which all of them have been firstly developed are highlighted as well as the quality assessment methods used to evaluate their perform acne. The graph 2.6 shows that the value of PSNR is increased in by using convolution with total variation method. And MSE is reduced in this method as shown in graph

CONCLUSION

In this work a hybrid technique is proposed for better enhancement of underwater low exposure images. The proposed technique has two phases: image transformation and contrast stretching. The images obtained as output are much more natural and visually pleasing than the images obtained using the already existing techniques. The quantitative and qualitative results show that the proposed technique is superior to the already existing techniques.

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