Image Enhancement Using Novel Piece wise Maximum Entropy Histogram Technique

[1]Anjali Kumawat, [2]Dr. Pushpneel Verma
[1]Research Scholar, [2]Associate Professor
[1]Computer Science and Engineering
[1]Bhagwant University, Ajmer, India

Abstract : For the image improvement and standardisation of digital pictures, bar chart effort (HE) is an indispensable tool. In some cases, bar chart effort might not cause smart results. Therefore, in recent times, a piecewise most entropy (PME)histogram technique was planned by the researchers to beat the disadvantages of HE. PME technique additionally has some limitations specified less dynamic vary issues. within the planned work an Extended PME method is conferred that reflects higher end in a comparison of the traditional one and produces a lot of dynamic vary, therefore, higher distinction improvement of a picture is obtained. MATLAB simulation has performed for the planned technique for image improvement and comparison of the results with the present techniques on the idea of benchmark parameter: peak signal to noise quantitative relation (PSNR), absolute mean brightness error (AMBE), variance values and entropy is additionally conferred.

***IndexTerms* - AMBE, MATLAB, HE, PME, PSNR.**

I. INTRODUCTION

Histogram effort and bar graph specification are with success employed in digital image process over the years. principally used as a picture sweetening technique, strategies like bar graph effort (HE) will yield smart distinction with virtually no effort in terms of inputs to the algorithmic program or the machine time needed. a lot of elaborate histograms will wrestle issues featured by HE at the expense of getting to outline the ultimate histograms in innovative ways in which might need some additional interval however square measure still quick enough to be thought-about for period of time applications. To additional proof our religion in bar graph specification techniques, we tend to conjointly discuss strategies to switch pictures, e.g., to assist segmentation approaches. Thus, as advocates of those techniques, we'd prefer to emphasize the pliability of this image process approach to doing over enhancing pictures [1, 2].

Conventional bar graph effort is not any doubt, is one in every of the foremost effective technique to method the digital pictures for distinction sweetening, however not for all pictures. In some cases, ancient bar graph effort will cause dangerous results. there's a remedy that takes over the normal bar graph effort that proposes a method and in line with that, we've got to switch our image. The projected analysis work deals with bar graph effort with a metameric approach known as metameric bar graph equalization(SHE)which reflects an improved result than the standard one. additional a comparison are going to be created between variety of techniques like brightness pre-serving bi-histogram equalization(BBHE),brightness protective bar graph effort with most entropy (BPHEME), piecewise most entropy(PME), on the premise of Absolute mean brightness error (AMBE) and Peak Signal to Noise Ratio(PSNR)values [3,4, 5, 6].

This paper introduces a replacement metameric approach for image sweetening to replicate an improved result than the standard one. Recently, Piecewise most Entropy (PME) bar graph technique was projected, however still with some limitations since it possesses less dynamic vary drawback. within the projected analysis work associate Extended PME technique that reflects higher result than the standard one is applied for image sweetening. Experimental results square measure compared with existing techniques to ascertain the effectiveness of the projected techniques.

II. HISTOGRAM SPECIFICATION AND HISTOGRAM EQUALIZATION

In image transformation technique the histogram of an image is transform to another desired histogram. One of image transform technique is histogram specification. It is useful for the jobs i.e., contrast enhancement, image enhancement and inversion of histogram [1, 2]. Modifying an image such that its histogram has a uniform distribution usually yields a better contrast. The technique is known as the HE. The histogram of an image with gray levels in the range [0, N-1] is describe as

$$h(r_k) = v_k$$

wherer_k is k^{th} gray level and v_k is the no. of pixels in the digital image with gray level. Normalization of the histogram can be done by dividing each of value by total no of pixels and is given as

$$p(r_k) = v_k/n \quad \text{for } k= 0,1,2,3\ldots\ldots\ldots\ldots N-1.$$

where $p(r_k)$ is the gray level's probability of occurrence.

Global appearance of the image is done with histogram processing. This paper deals with the HE in a segmented form. In HE, output image in the uniform distributionform and give better contrast and the transformation T(r) needed to obtain this equalization can be formulated as

In continuous form:

$$s = T(r) = \int_0^w p_r(r)dw \qquad (1)$$

where s and r are the transformed image and intensity value. $p_r(r)$ is probability distribution function (PDF) of the input image. The HE is obtained through the cumulative density function (CDF).

In Discrete form equation (1) becomes:

$$s_k = T(r_k) = \sum_{j=0}^{k} p_{r}(r_j) \qquad for \quad k = 0, \frac{1}{N-1}, \frac{2}{N-1}, \dots \dots \dots, 1 \qquad (2)$$

Histogram equalization employs a monotonic nonlinear mapping that reassigns the intensity values of pixels in an input image, such that the output image contains a uniform distribution of intensities (i.e., a histogram that is constant for all brightness values). This corresponds to a brightness distribution where all values are equally probable. Unfortunately, we can only achieve the approximation of this uniform distribution for a digital image. This technique is often used in image comparison because it is effective in detail enhancement and in the correction of nonlinear effects introduced by a digitizer or a display system. In general, since the histogram equalization causes the dynamic range of an image to be stretched, the density distribution of the resultant image is made flat, so that the contrast of the image is enhanced. However, the histogram equalization method causes some problems. Since the contrast is enhanced by stretching the dynamic range, background noise is simultaneously increased by the equalization, and the image quality in a near-constant region may be degraded.

Section III of the paper deals with the shortcomings of the conventional histogram equalization. Section IV depicts a novel technique known as extended PME. Simulation results and comparison of performance on the basis of PSNR, AMBE, Entropy and Standard Deviation are given in section V followed by conclusion in section VI.

III. Problems of Histogram Equalization Technique

Histogram equalization can produce undesired or bad results for contrast enhancement in the images having huge area conquered by a particular gray level value, and in the cases when histogram is containing a strong peak. For the images having constant background, the HE techniques are sometimes not able to obtain good results.

HE produces an output image with level of brightness close to 0.5 whatever is the shape of the input image. Fig. 1 depicts that HE produces a brighter result. Fig. 1 shows input image having a strong peak in lower side and its histogram while on the right side it shows histogram equalized image with its histogram.

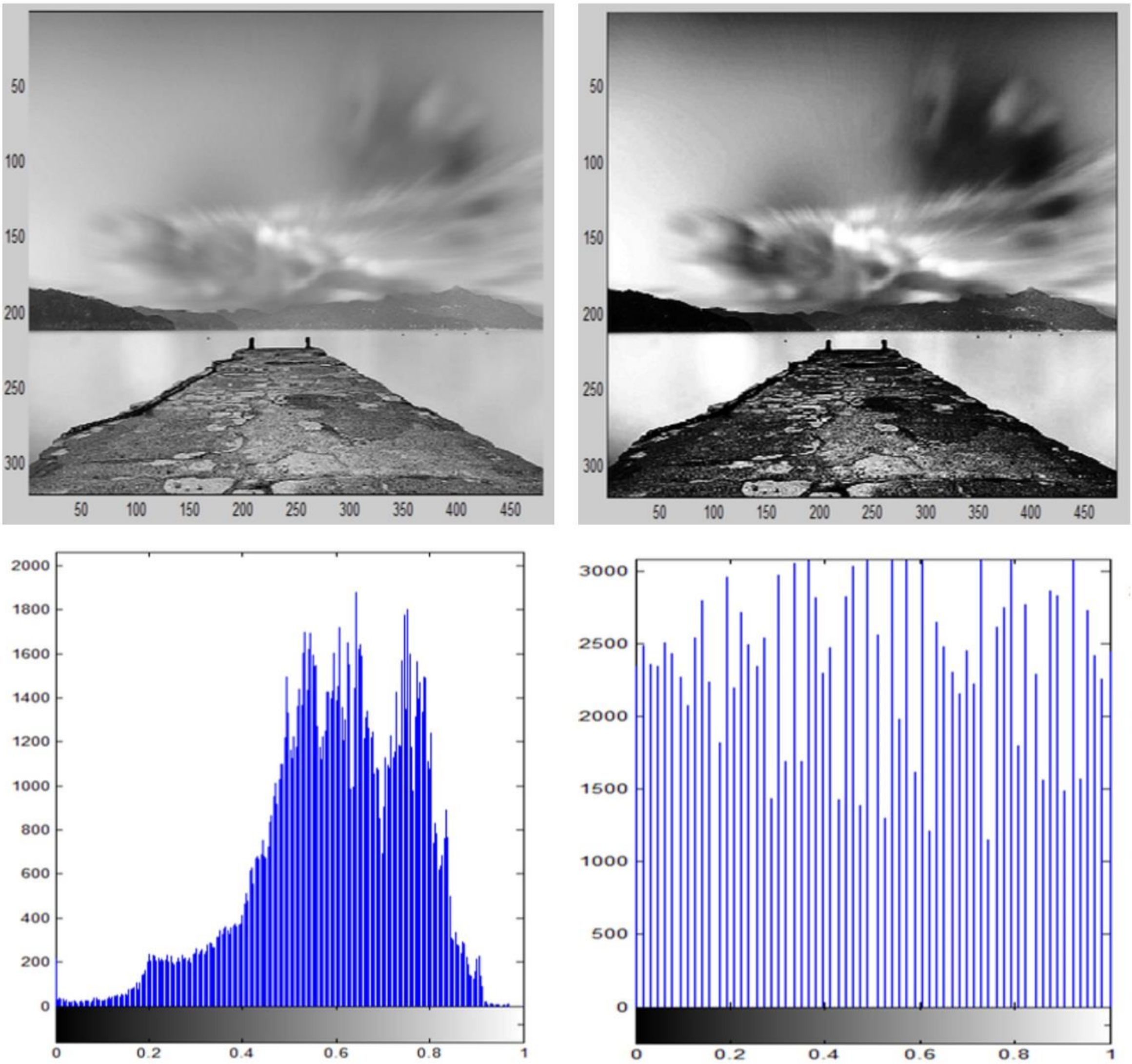

Fig. 1(a) Input image and its Histogram (b) Equalized image and its histogram

IV. Proposed Contrast Enhancement Technique Based on PME

Algorithm of the proposed technique Protracted PME consists of following steps [7,8,9]:

(i) Suave the histogram using Gaussian low pass filter.
(ii) To discover the major valleys of the flattened histogram.
(iii) Based on the valley positions segment the flattened histogram.
(iv) Piecewise Maximum Entropy (PME) basedhistogram.
(v) Contrast Expansion linearly.

Following subsections describe each section indetail.

(i) Suave the histogram using Gaussian low pass filter

The original histogram in this method first filtered outby one dimensional Gaussian low pass filter with standard deviation σ_G. Let a histogram H(X), if H(X) < H(X+1) and H(X) < H(X-1) than gray level (X) is understood to be a valley and uppermost point between the two valleys is termedas peak. Whole histogram can be assumed as a combination of multiple Gaussian peaks or modes. On the foundation of valley locations it can be segmented. On the behalf of widths between successive valleys spanned between 0 to W_{max}, histogram of distances $h_d$can be find out. Standard deviation of the LPF$\sigma_G$is calculated based on the most frequent distance analogous to maximum value in the histogram.

(ii) To discover the major valleys of the flattened histogram

Bypartitioningtheoriginalhistogram, flattenedhistogramis obtained. Afterwards, various sub-histograms are obtained by dividing theoriginalhistogrambasedonlocationsofvalleys.Let H_s (X) is asmoothed histogram, ifH_s (X) <H_s (X+1)and H_s (X) <H_s (X-1) at that timegray level Xwill be a valley. To find major peaks and valleys,first derivative of smoothed histogram's signs are calculated. Thearrangement of six sequential negative signs trailed by two sequential positive sign is observed. The verge from negative to positive sign will be called a valley since a valley is well-defined as negative to positive verge in the first derivative of flattened histogram. Whilepositive to negative vergeis known as peak.

(iii) Based on the valley positions segment the flattened histogram

Corresponds to the valley locations, assume v0, v1, v2………vn-1 are n gray levels.Original histogram is inevitable between [0, 255] that is [X_{min}, X_{max}]. Now the first segment has the range of [X_{min} + 1, v0] and similarly the last one will be [vn-1 + 1, X_{max}].

(iv) Piecewise Maximum Entropy (PME) based histogram

The difficulties of the certain type of images can be overcome by this method. In this technique the idea of the separation of the modes is used and offers good results. But also can encounter some problems by shifting the mode. That is moreover far from the original means [4]. So, a piecewise transformation function is proposed [4,5] instead of using a linear transformation. In this transformation, segments produce the original means of the modes and then maximizing their entropy.

(v) Contrast Expansion linearly

Even after the histogram equalization,in severalsituations, gray level of pixel is strenuous in particular narrow interval of histogram. Such imagesare then devouring low contrast. Contrast expansion linearly resolves the brightness saturation difficulty. Contrast improvement of the entire image is lengthened in the full range levels [0, 255]. Let A_{max} and A_{min} are the range of original histogram then it is expanded intoB_{max} and B_{min}such that [0, 255].

MATLAB simulations of the proposed technique are performed and it is tested on the various gray scale and colored images and improved results are obtained.

V. SIMULATION RESULTS AND DISCUSSIONS

Figure 2 and 3 show the results of test image with proposed algorithm. Enhancement is more in darker areas as associated to brighter areas in comparison to HE.

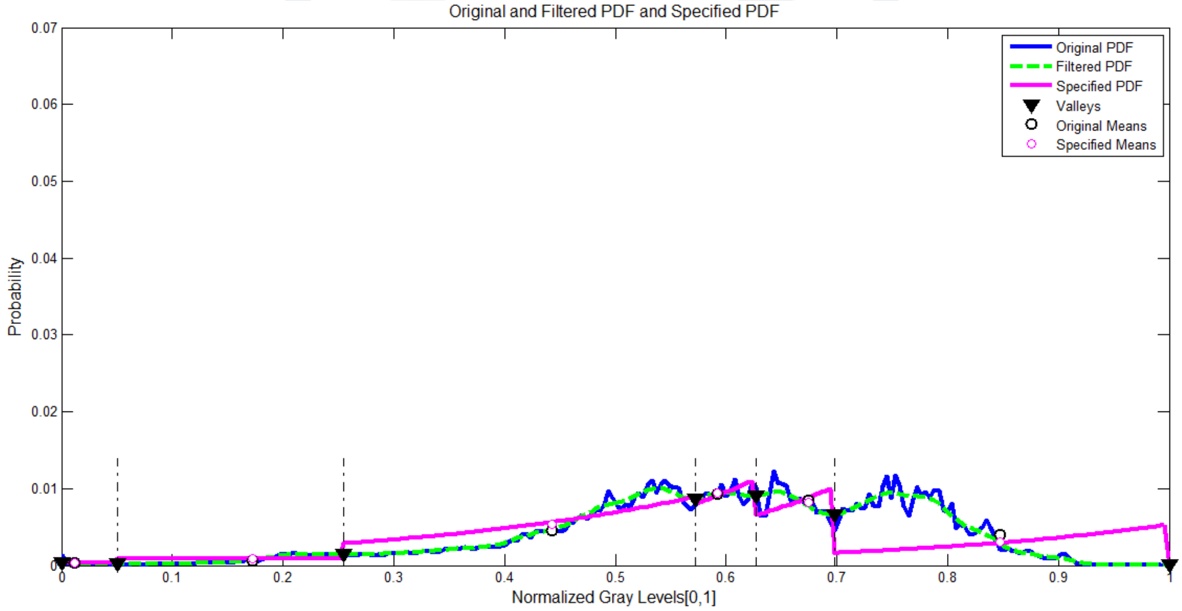

Fig.2 Processed image with PDF and valley positions with PME

The spread of histogram is also compared which is additionalusing Extended PME than the using PME which shows better dynamic range. To verify the effectiveness of proposed technique, some existing techniques have been compared with the proposed technique for some standard images in terms ofPSNR, entropy, standard deviation and AMBE.

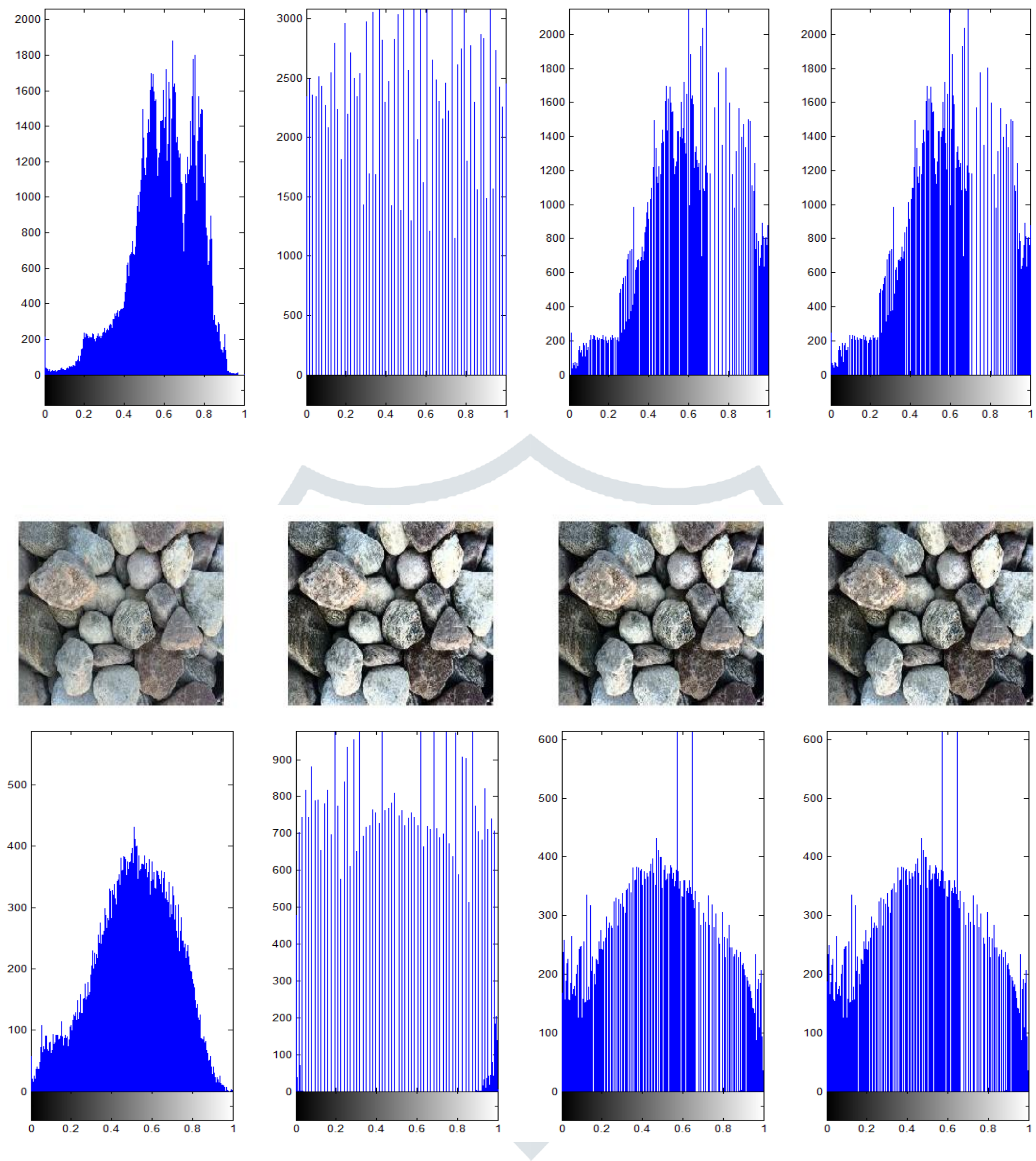

Fig. 3 Input image with its histogram in left most column, HE image with its histogram, PMEprocessed image with its histogram, Extended PME with its histogram in right most column.

PSNR can be expressed as:

$$PSNR = 20\,log_{10}\frac{(N-1)}{RMSE} \quad (3)$$

where (N-1) is the max. gray level.

$$RMSE = \frac{1}{MN}\sum_{x=0}^{M}\sum_{y=0}^{N}\left(U(x,y) - V(x,y)\right)^2 \quad (4)$$

Where M, N are the dimensions of the image and U is the original image and V is image after enhancement. Higher PSNR shows better image quality and similarity of images [10-12].

The parameter AMBE (absolute mean brightness error) shows the brightness preservation of an image [13, 14].The mean of absolute differential gray levelbetweenthe enhanced image and original image is given by AMBE. Better brightness preservation is showed by lower values of AMBE.

$$AMBE = abs[mean(U(:)) - mean(V(:))] \quad (5)$$

Deflection of gray levelsfrom its mean value is represented by standard deviation. It also shows the spread of image PDF [15-17]. Dynamic range of an image will be better if spread is good, and then contrast of image will improved. Standard deviation can be depicted as

$$\sigma^2 = \frac{1}{N-1}\sum_{j,k=0}^{N-1}(x_{j,k} - \mu)^2 \quad (6)$$

where μ is mean and gray levels are stored in $x_{j,k}$.

Parameter Entropy defines by the gray levels adopted by individual pixels. It is used to evaluate the spread of states of the image. Higher value of entropy represents higher no. of states. If all of the pixels have the similar values, the value of entropy will be zero. Entropy will be low for threshold image with two occupied states. Entropy will be maximum for aperfect histogram equalized image [18, 19]. The formula of entropy is as follows:

$$H = -\sum_{k=0}^{n-1}(p_k log_2 p_k) \quad (7)$$

Where p_k is the probability of gray level k and M represents number of gray levels.

Table 1 show the comparison of AMBE and PSNR values among proposed method, PME and HE techniques for four standard test images (Dark, Room, blind, Cloud). Proposed technique attains the lowest AMBE and highest PSNR.

Table 1: Comparison of AMBE and PSNR values for standard images.

Test Image	Parameter	Extended PME	PME	HE
Dark	AMBE PSNR	13.55 23.06	17.18 21.55	23.70 16.66
Room	AMBE PSNR	50.8 8.78	62.6 8.34	55.22 8.55
Clouds	AMBE PSNR	8.23 18.78	10.12 17.84	11.66 14.78
Blind	AMBE PSNR	1.15 25.04	3.12 24.56	38.12 12.97

Table 2 shows the comparison of standard deviation and entropy among proposed method, PME and HE techniques for standard images. The proposed technique obtained better values than PME technique but slightly less values of standard deviation and entropy than traditional HE method.

Table 2: Comparison of Entropy and Std. Deviationvalues for standard images.

Test Image	Parameter	Original Image	Extended PME	PME	HE
Dark	Entropy Std. Deviation	7.33 0.16	7.73 0.243	7.68 0.238	7.44 0.18
Room	Entropy Std. Deviation	5.66 0.056	7.39 0.277	7.3 0.25	7.42 0.29
Clouds	Entropy Std. Deviation	7.02 0.132	7.7 0.25	7.6 0.22	7.92 0.29
Blind	Entropy Std. Deviation	6.93 0.172	7.66 0.24	7.6 0.23	7.71 0.29

VI. Conclusion

A novel histogram equalization method for image enhancement is presented that is relatively more effective in darker areas than the brighter areas. Table 1 and Table 2 show the effectiveness of the proposed method with increased dynamic range. The value of parameters Absolute mean brightness error, Peak Signal to noise ratio, Standard Deviation and Entropy are obtained better in comparison to PME method. This proposed method is easy to contrivance as other HE methods. For further work, other modifications can be reconnoitred.

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