Comparative Analysis of Histogram Equalization Techniques

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***Abstract*— Histogram Equalization (HE) is one of the techniques which is used for Image enhancement. This paper shows the comparative studies of Global Histogram Equalization, Local Histogram Equalization and Fast Quadratic Dynamic Histogram Equalization based on the execution time, mean squared error and Peak Signal to Noise Ratio (PSNR). This paper shows the experimental results for these three methods with graphical representation.**

***Index Terms*— global histogram, local histogram, histogram equalization, Fast Quadratic Dynamic Histogram Equalization, Peak noise to Signal noise Ratio, Mean squared error.**

I. INTRODUCTION

Image enhancement sharpens the image features which can be used further for specific application includes image analysis, feature detection like edges, boundaries and so on. Due to enhancement of the features the dynamic range of the features increases without changing the inherent content of the image.

Histogram of the image is the graphical representation of the probability of occurrences of the intensities versus Intensity values in the given image. Histogram equalization of the image is a method to equalize the distribution of probability of occurrence of intensity values in the image [1].

II. GLOBAL HISTOGRAM EQUALIZATION

Low contrast image is taken as input that has gray level ranges from 0 to L-1, now probability of pixel with intensity value k is given by

$$P_k = n_k/N \quad (1)$$

Where n_k is the number of occurrences of k^{th} intensity in the image, k is the intensity value ranging from 0 to L-1; N is the total number of pixels in an image. Cumulative distribution function (CDF) is expressed in terms of probability distribution function by formula

$$Cdf = P_1+P_2.....P_{L-1} \quad (2)$$

But GHE is not perfect solution when the pixel values having high probability because these pixels get over enhanced and pixel value with low probability get low enhanced which may result in the degraded target object quality in image [2].

III. LOCAL HISTOGRAM EQUALIZATION

Global histogram equalization (GHE) is based on the global information of image. In Local Histogram Equalization (LHE) under Block Overlapped Histogram Equalization [3], first a window is considered for the input image I (i,j). Traversing starts such that center point of the window will be the first pixel of the image. Equalize the center point and shift the window to the adjacent pixel to do equalization, this procedure is repeated pixel by pixel for all pixels in the input image. After performing LHE, the input image is converted to the high contrast image.

However LHE also is not an Ideal method because the image gets over enhanced and this procedure becomes more complex as the image size increases.

IV. FAST QUADRATIC DYNAMIC HISTOGRAM EQUALIZATION

This paper focuses on the enhancement process that should be fast such that the output of the image is not affected except the quality. FQDHE has 3 processes: Histogram partitioning, Gray level range allocation, Histogram Equalization [4]. Histogram partitioning is based on the local maxima where the histogram will be partitioned in to two parts and divide the sub histograms again to another two small histograms, this procedure is similar to Recursive Sub Image Histogram Equalization (RSIHE). So in total histogram of image is divided into four parts.

Partitioning Points P_1, P_2, and P_3 are the intensities set to 0.25, 0.50, and 0.75 respectively for the histogram of original image.

To do enhancement of the sub histogram FQDHE allocate a new gray level range for each sub histogram on the bases of gray level span. This procedure is similar to dynamic histogram equalization (DHE) [5].

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$$Span_k = P_{k+1} - P_k \quad (3)$$

$$Range_k = (L-1) * span_k / (span_{1+} span_{2+} span_{3+} span_4) \quad (4)$$

$Range_k$ is a dynamic gray level range for sub histogram ranging $[Start_k, Finish_k]$, for first partition start=0

$$Start_k = (range_1 + ... + range_{k-1}) + 1 \quad (5)$$

$$Finish_k = range_1 + \dots + range_k \quad (6)$$

The final step is to perform the histogram equalization to each and every sub histogram, subH(x)

$$subH(x) = (start_k - finish_k) * cdf(subhistogram) + start_k \quad (7)$$

V. EXPERIMENTAL RESULTS AND COMPARISON

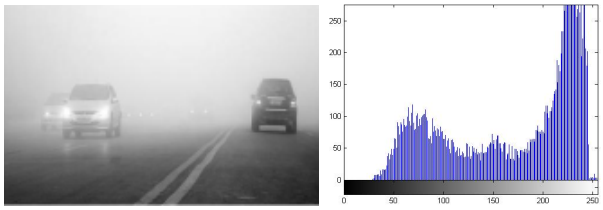

Fig. 1. Original Image (to left) and Histogram (to right)

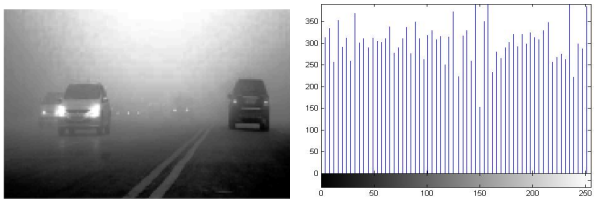

Fig. 2. Output Image (to left) and histogram (to right) for Global Histogram Equalization

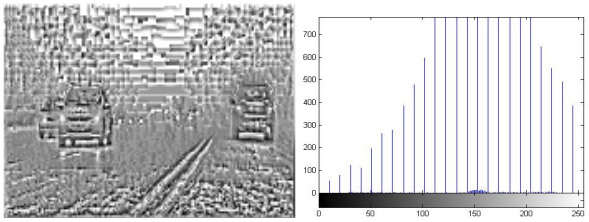

Fig. 3. Output Image (to left) and histogram (to right) for Local Histogram Equalization

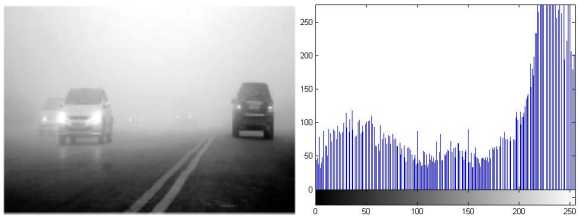

Fig. 4. Output Image (to left) and histogram (to right) for Fast Dynamic Histogram Equalization.

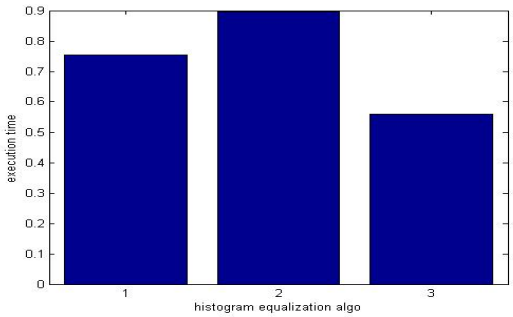

Fig. 5. Execution Time Graph

TABLE I. PERFORMANCE COMPARISON FOR DIFFERENT HE METHODS

Table Head	Histogram Equalization Methods		
	GHE	***LHE***	***FQDHE***
Mean Square Error	4.37	3.93	4.06
PSNR	11.72	12.19	12.05
Execution Time	0.91	1.07	0.69

VI. CONCLUSION

This paper gives the overall review of GHE, LHE, and FQDHE, compare these three enhancement techniques with the help of PSNR, MSE and execution time. FQDHE is faster algorithm as compare to GHE and LHE.

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