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Contrast Enhancement of Images and videos using Histogram Equalization

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***Abstract*—**Image enhancement is the process of enhancing or extending quality of noisy and poor image. Contrast factor is a method to find finer details of an image or video file. Contrast enhancement plays a principal arrangement in the development and improvement of visual quality for pattern recognition, computer vision and the processing of digital images. Histogram equalization is an efficient and widely used technique for contrast enhancement. Conservative HE results in unnecessary contrast enchantment which in turn gives processed image and unnatural look and also creates visual artifacts. In this paper varied flavors of poor quality of images and videos with law lightning conditions and foggy or videos with noisy environment are taken. In this paper HE based algorithm is applied on various images and videos have been analyzed using both subjective and objective fidelity criteria. For contrast enhancement of image and video proposed method is preferable.

Keywords- *Contrast Enhancement, Histogram Equalization, Image Enhancement*

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I. INTRODUCTION

In terms of medical science, forensic science, or in crime investigation department there is a need to improve the quality of images for further analysis, or to improve the quality of some law lightning illumination condition videos, or to enhance the degradation of video file capture from CCTV camera, or video taken from any external sources. Another situation consider that during the capturing of video there may be heavy rain, or environment becomes cloudy, or foggy, there is snowfall then the result of captured To solve all the mentioned real life problems and situations of image and video file, different image enhancement techniques are implemented.

Image enhancement is a subjective process; it involves some cosmetic changes in the brightness and contrast. Image enhancement process start with the image quality. For image quality many factors are responsible including contrast, brightness, spatial domain and noise. The image enhancement is one of the prominent approaches in digital image processing. Image enhancement is performed on an image to improve its visible results [1]. Image enhancement is considered as a pre processing step in many areas like video/image processing application such as speech recognition, texture synthesis etc [2].

Video needs enhancement techniques. Contrast is created by the difference in luminance reflectance from two adjacent surfaces. In our visual perception, contrast is determined by the difference in the color and brightness of an object with other objects [3]. Contrast enhancement of any image is measured with contrast index factor. The higher CI value signifies better contrast improvement in the output image [4]. Other factors to improve the quality of image and video are brightness. The HE technique is a global operation hence; it does not preserve the image brightness [3].

There are many Histogram Equalization (HE) methods for digital image contrast enhancement. One of the most significant HE methods is Global Histogram Equalization (GHE), which is also known as Traditional HE, and Classical HE, Conventional HE and Typical HE [5].

The contrast enhancement of the video frame is achieved by mapping the diagonal elements of the 2D input histogram to the diagonal elements of the 2D target histogram which is easy to implement and is thus suitable for real-time Contrast enhancement applications [6]. The rest of the paper is organized as follows: Section 2 describes the algorithmic process of HE, Section 3 expresses contrast enhancement of images and videos using HE, Section 4 shows the experimental results, Section 5 discuss parametric analysis and finally the conclusion is shown in Section 6.

II. HISTOGRAM EQUALIZATION

Proposed System having poor quality of image or under the low lightning conditions, heavy fog condition, or impact of blur environment the contrast of the videos gets despoiled and undergo from deprived visibility. The system applied existing histogram equalization techniques based on quantitative parameter for contrast effect of video file. The system's algorithm is capturing of image or video file from existing image database or videos into the system respectively, extract the frame, generate histogram and apply histogram equalization, and solved the problem with contrast stretching of histogram equalizations. Histogram equalization is a method in digital image processing to enhance the contrast or it is a technique to adjust the image intensities for brightness or contrast enhancement. Histogram equalizations work step by-step in following approach. The approach is to design a transformation T(.) such that the gray values in the output is uniformly distributed in [0, 1].

Step 1: Let us assume for the instant that the input image to be enhanced has continuous gray values, with r = 0 representing black and r = 1 representing white.

Step 2: We need to design a gray value transformation based on the histogram of the input image, which will enhance the image. s = T(r)

Step 3: We assume that:

(1) T(r) is a monotonically increasing function in the interval $0 \leqslant r \leqslant 1$ (preserves order from black to white).

(2) T(r) maps [0,1] into [0,1] (preserves the range of allowed Gray values)

The histogram equalized input and output grey levels with which x-axis represent normalized input grey levels and y-axis represent output grey value.

Step 4: Let us signify the inverse transformation by

$$R = T^{-1}(S).$$

We assume that the inverse transformation also satisfies the above two conditions. We consider the gray values in the input image and output image as random variables in the interval [0, 1].

Step 5: Let pin(r) and pout(s) denote the probability density of the Gray values in the input and output images. If pin(r) and T(r) are known and $r = T^{-1}(s)$ satisfies condition 1, we can write (result from probability theory):

Step 6: One way to enhance the image is to design a transformation T(.) such that the gray values in the output is uniformly distributed in [0, 1], i.e. pout (s) = 1, $0 \leq s \leq 1$ In terms of histograms, the output image will have all gray values in equal proportion; this technique is known as histogram equalization.

Step 7: Next we derive the gray values in the output is uniformly distributed in [0, 1]

Step 8: The output of probability density function equal to CDF of input grey level values r, we can obtain an image with uniform grey values, which result in an enhanced image

III. CONTRAST ENHANCEMENT OF IMAGES AND VIDEOS USING HE

Detailed algorithmic steps of histogram equalization on images and videos are mentioned below. Step 1: Calculate histogram H for source image Step 2: Normalized the histogram so that the sum of histogram bins is 255 Step3: Estimate fundamental of histogram Step 4: Transformation the image using H' as a look up table Destination image (x,y) = H' (src (x,y)) From the above algorithm it is proved that brightness is normalized and contrast of the frame is increase.

Abbreviations and Acronyms

HE-histogram Equalization
CDF-Cumulative Density Function
GHE-Global Histogram Equalization
PSNR-Peak Signal To Noise Ratio

IV. EXPERIMENTAL RESULTS

Contrast enhancement of poor quality video file or image using histogram equalization methods which was conversed prior desired to test. This system feasibility is tested using emgucv-windows-universal 3.0.0.2157 with c# as a software tool. Emgucv is a .Net wrapper to the openCV image processing library. This system is tested with 10 different types of images and 10 varied types of videos; out of them some are display below. The resultant images formed by these method are statistically shows with PSNR (Peak Signal to Noise Ratio) .The PSNR values for output images and videos are stored in tabular form and Shown in Table and the graphical illustration of PSNR are shown by Figure respectively. Figure1 and figure 2 shows original image with equalized image of cameraman and Hurricane Andrew

Figures and Tables

Figure 1 Original and equalized image of cameraman

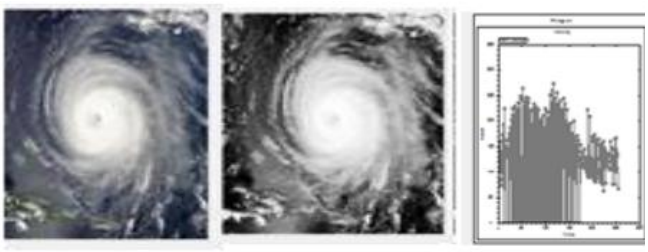

Figure 1 Original image and equalized image of hurricane Andrew

Figure 3 and figure 4 shows original video file and equalized frame of video sequences and its corresponding histogram equalization of last frame of video file

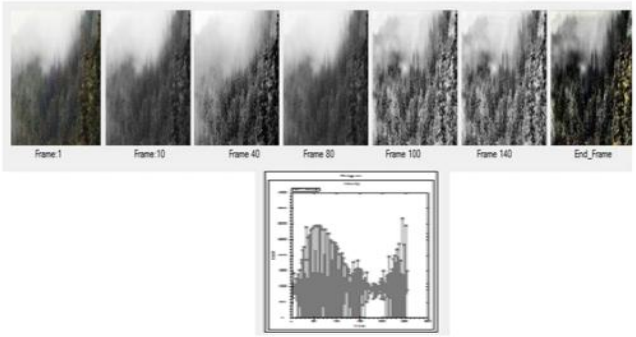

Figure 2 Video file of mist with different frames and equalized image

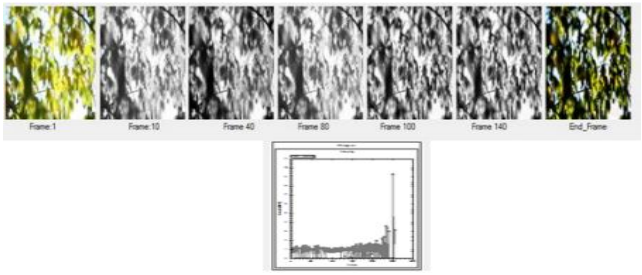

Figure 3 Video File of tree with different frames and equalized

TABLE FOR PSNR VALUES OF IMAGES AND VIDEO FILES

Table 1 PSNR Value for images and video files

Table 1 Images and its PSNR for HE

Image	HE
Tire	18.035897
Cameraman	19.072920
Face	12.647498
Lena	12.974201
Hurricane Andrew	19.521672
Random matches	6.0011012
Cygnus loop	6.8734821
Crab pulsar radio	8.1118209
Bottom_Left (beans)	7.533428
Rice	12.481749

Table 2 Videos and its PSNR for HE

Video	HE
Simple	9.371095
Lake_1	11.98895
Lake_2	13.33258
Mist	19.95238
Ocean	13.38362
Rush_hour	19.85590
Snow	24.981487
Snowfall	10.19004
Street	18.534571
Tree	14.47888

V. IMAGE/VIDEO QUALITY METRICS

The metrics used to quantify image or video quality can be divided into two categories.

Subjective Fidelity Criteria: Subjective fidelity criteria are not based on any metrics, name itself suggest that it is subjective and it depends on perception of human observer and his/her visual system. These techniques require rating on scale from excellent to poor and also required so many observers.

Objective Fidelity Criteria: Objective fidelity criteria provide equations that help us to quantify an error, which help to characterize image quality. If the original image and enhanced image are closer to each other then the results of PSNR is high, similarly if there is major difference in these two images then the PSNR is low.

$$PSNR = 10 \times log10\ 255{\times}255\ MSE$$

PSNR is a peak signal to noise ratio which is generally described for 8-bit technique than it indicates that quality of image is preserved. Table 1 and Table 2 above showed image and video with its PSNR value for HE respectively.

VI. CONCLUSION

This paper applied HE based algorithm on various poor quality of images and videos, the method applied on 10 different images and videos. From experimental results and parametric analysis state that contrast enhancement using histogram equalization is work superior for law quality of video file with poor enlightenment conditions compare to deprived quality of images. This method is only efficient for Video file sequences, in future, work is extended to advanced HE based techniques and tried to calculate PSNR value for every techniques and compare it with global HE method to identified which one is better for image as well as video file. Another work is extended to use gamma correction method instead of HE and then compare it with existing technique to find most significant method for further use.

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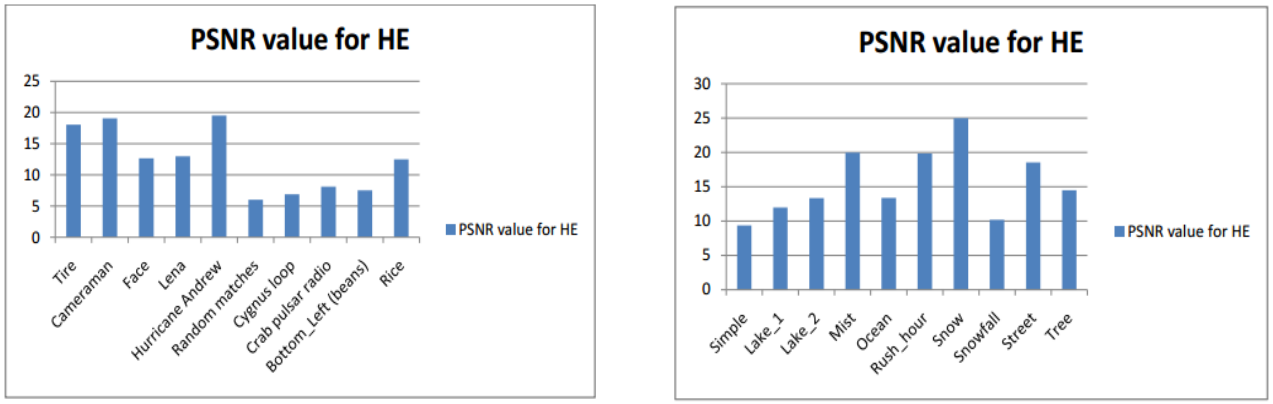

Figure 5 HE value for Images (A) and Video File (B) based on PSNR