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A Comparative Study on Histogram Equalization and Cumulative Histogram Equalization

Priyanka Garg , Trisha Jain

***Abstract*— Image enhancement is a way to improve the appearance of image to human viewers or to image processing system performance. Image Enhancement techniques can be classified into two categories as spatial domain and frequency domain. There are five image enhancement algorithms in spatial domain using FPGA technology. These algorithms are: median filter, contrast stretching, histogram equalization, negative image transformation and power-law transformation. This review paper presents different methods of histogram equalization. Histogram equalization is a method to enhance an image very efficiently. Histogram equalization methods are Histogram expansion, Local area histogram equalization (LAHE), Cumulative histogram equalization, Par sectioning, odd sectioning.**

***Index Terms*— Histogram equalization (HE), image enhancement.**

I. INTRODUCTION

In the era of image processing, scientific analysis, digital photography, remote sensing and in visualization, medical image analysis, surveillance system; image enhancement plays a vital role. By enhancement of image noise can be reduced and it can remove artifacts. A special feature of image enhancement is that it can hold all the details of image after enhancement.

As we know contrast enhancement of an image is done by making light colors lighter and dark colors darker at the same time. And this process is done by setting all color components below a specified lower bound to zero, and all color components above a specified upper bound to the maximum intensity.

In this paper various methods of histogram equalization is addressed. Histogram graphically shows the distribution of pixels among grey scale values. Dynamic range of an image can be improved by equalization method. Histogram equalization is an efficient and useful technique.

The intensities will be equally distributed in output image after the process of histogram equalization.

There are some reasons that led to the need of enhancement:

- Bad quality of the used imaging device,
- Lack of expertise of the operator
- The adverse external conditions or environment condition at the time of capture.

Priyanka Garg , Department of Electronics and Communication, RCEW Jaipur

Trisha Jain, Department of Electronics , Banasthali Vidyapeeth Jaipur

II. IMAGE ENHANCEMENT

Processing of images to extract some specific features of an image is called image enhancement. The main motive of image enhancement is to improve the original image for some specific applications. It sharpens or improves image features such as boundaries, or contrast to make a better graphic display, and better analysis

Image enhancement has two categories. 1) Spatial domain method 2) frequency domain method

Spatial domain method is based on direct manipulation of pixels in an image. Frequency domain method is based on modifying FT of an image.

Enhancement of an image proceeds by sharpening, noise removal and brightness increment. Unfortunately there is no general theory for determining what 'good' image enhancement, when it comes to human perception. If it looks good, it is good [2]. Operation of image enhancement is shown by given block diagram [2].

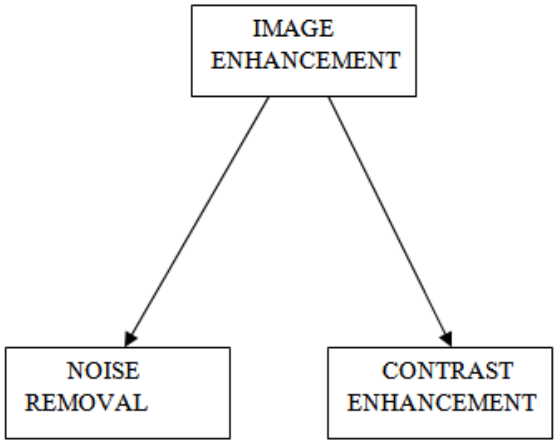

Figure 1: Operation of image enhancement

III. METHODS OF HISTOGRAM EQUALIZATION

Histogram equalization is distribution of particular type of data. By histogram equalization we can improve contrast and appearance of an image. Entire spectrum of pixels (0-255) will be stretches by histogram equalization. A histogram that covers all possible values which is used by gray scale is determined as a good histogram [1]. A good histogram tends to have good contrast and the details of an image that may be easily observed.

METHOD	ADVANTAGE	DISADVANTAGE
HISRTOGRAM EXPANSION	Simple and enhance contrast of an image	If they are grey values that are physically far apart from each other in the image
LAHE	Offers an excellent enhancement of image contrast.	Computationally very slow ,requires a high number of operations per pixel
ODD SECTIONING	Offers good image contrast	Have problems with histogram which covers all grey values
CUMULATIVE HISTOGRAM EQUALIZATION	Has good performance in histogram equalization	Requires a few more operations because it is necessary to create cumulative
PAR SECTIONING	Easy to implement	Better suited to hardware implementation

In particular, the method can lead to better views of bone structure in x-ray images, and to better detail in photographs that are over or under-exposed.

Here some advantage and disadvantage of this method

- **Advantage:** A key advantage of the method is that it is a fairly straight forward technique and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered.
- **Disadvantage:** A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal.

Histogram equalization is a specific case of the more general class of histogram remapping methods. These methods seek to adjust the image to make it easier to analyze or improve visual quality.

As the methods of histogram equalization is histogram expansion, cumulative distributive equalization, par sectioning, odd sectioning and local area histogram equalization. These methods were studied and compared in order to determine which one offers the best equalization and is also best suited to DSP implementation. Table 1 shows the advantages and disadvantages of each method [4].

IV. CUMULATIVE HISTOGRAM EQUALIZATION

In this paper the general approach for cumulative histogram equalization is addressed. Here are the steps for implementing this algorithm [1].

1. Create the histogram for the image.
2. Calculate the cumulative distribution function histogram.
3. Calculate the new values through the general histogram equalization formula.
4. Assign new values for each gray value in the image.

This method is implemented as shown in above Figure, outlining the steps above.

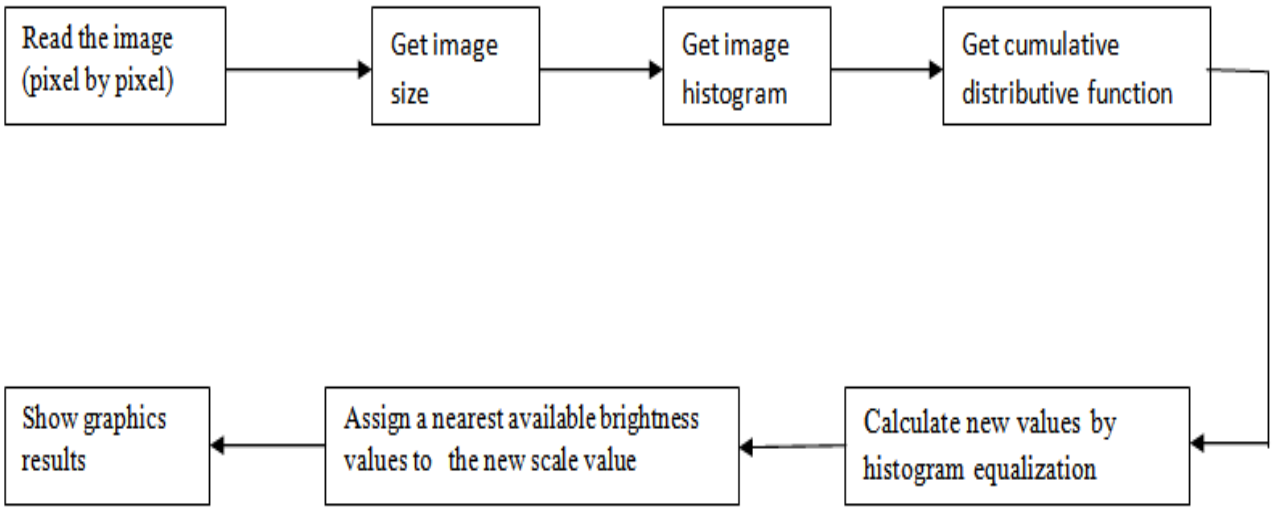

Figure 2: Process of histogram equalization

CONCLUSION

Histogram equalization is best method for image enhancement. It provides better quality of images without loss of any information. However, in some type of images histogram equalization can show some hidden noise after the processing is done. In medical applicatios such as X ray, MRIs and CT scan achieve better results after histogram equalization because of this doctors can easily diagonse the disease. By this review paper have come to know that histogram equalization provides excellent result with cumulative distributive equalization.

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