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A GENERAL STUDY ON HISTOGRAM EQUALIZATION FOR IMAGE ENHANCEMENT

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ABSTRACT

In statistics, a histogram is a graphical representation of the distribution of data. It is an estimate of the probability distribution of a continuous variable. The histogram of an image represents the relative frequency of occurrence of the various gray levels in the image. Image enhancement algorithms based on Histogram equalization (HE) often fall short to maintain the image quality after enhancement due to quantum jump in the cumulative distribution function (CDF) in the histogram. Moreover, some detail parts appear to be washed out after enhancement. To solve this problem, various histogram equalization methods were introduced which enhanced the image details parts separately and combine it with the enhanced image using a weighted function. This gives a way to control the enhancement of the details improving the quality of the image. Experiments show that the proposed method performs well as compared to the existing enhancement algorithms. Histogram equalization methods preserve the image brightness, local contrast of the image and reduce the noise in speech.

Index terms: Histogram, Histogram equalization, Cumulative distribution function.

I INTRODUCTION

Image enhancement is the process of the increasing the quality and the local contrast of the image. This image enhancement can be done by various methods. One of the powerful method is enhancing the image using Histogram Equalization. Histogram Equalization is the process in image processing which deals with contrast adjustment using the histogram of the image. Histogram Equalization methods can be collaborated with various methods such using Neighborhood Metrics, Dynamic Histogram and Brightness Preserving Histogram. These methods escalate the quality of the image and retain the local contrast or the information of the image. Also the brightness of the image is maintained without increasing or decreasing the contrast of the image. The method is useful in images with backgrounds and foregrounds that are both bright or both dark. 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. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive.

II LITERATURE REVIEW

NyamlkhagvaSengee, AltansukhSengee, Heung-Kook Choi et al proposed the paper on **Image Contrast Enhancement using Bi-Histogram Equalization with Neighborhood Metrics**.This concept was a new extension of Bi-Histogram Equalization and hence named as Bi-Histogram Equalization with Neighborhood Metric (BHENM). Earlier methods used Global Histogram Equalization (GHE) and Local Histogram Equalization (LHE). But these methods did not adapt local information of the image and preserve the brightness of the original image which in turn scaled down the brightness of the image. This deprecation in brightness was escalated by

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collaboration of Bi-Histogram Equalization with Neighborhood Metrics which also retained the local contrast of the original image, the concept. This method primarily involved the division of an histogram. Hence initially the large histogram bins that cause washout artifacts were divided into sub-bins using Neighborhood Metrics and the same intensities of the original image were arranged by neighboring information. The histogram of the original image was separated into two sub histograms based on the mean of the histogram of the original image and the sub-histograms are equalized independently using refined histogram equalization, which in turn produced flatter histograms. Global Histogram Equalization does not provide any means to preserve the brightness of the image. And one of the limitations of the Global Histogram Equalization was that the local information and the brightness of the image cannot be adapted. Bi-Histogram Equalization with Neighborhood Metrics method overcame the above mentioned limitations and preserved the image with constant brightness. Moreover the propose method produced a resultant image histogram that was more flat than in any other prevailing brightness-preserving methods. The Bi-Histogram Equalization preserved the image brightness which was considered to be better than other Histogram Equalization methods. To an added feature, this method used the distinction Neighborhood Metric to sort pixels of equal intensity into different sub-bins to improve image local contrast, and separated the histogram into two sub-histograms and then equalized them independently to preserve the image brightness.

Luz Garcia, Carmen Benitez Ortuzar, Angel De La Torre, Jose C.Segura et al proposed the method of **Class-Based Parametric Approximation to Histogram Equalization for ASR.** It was an improved transformation method for boisterous speech recognition in noisy habitat. The overture was an enlargement of the parametric approximation to Histogram Equalization named PEQ which was divided into a two-step algorithm which negotiated separately with environmental and acoustic discrepancy. In order to exclude the environmental mismatch parametric equalization was consummated. These equalized data were prorated into classes and parametrically re-equalized using class specific references to scale down the acoustic mismatch. For some ASR scenarios, the length of the sentences to be equalized was not adequate to provide the empirical representative acoustic statistics. Such inadequacy of accuracy deteriorated the acoustic information of the equalized voice factor which further became dependent on the particular content of the sentence. Parametric approximations like Double Gaussian Normalization or Parametric Equalization overcame the above limitations. Class-Based Parametric Equalization overcame the limitations of Histogram Equalization which was proposed to a higher number of classes. This method extended the strategy of two-class Parametric Equalization and brought out the fact that the expulsion of environmental discrepancies results in exceptional acoustic classes. Two facts differentiated this method from other Histogram Equalization methods. First, it dealt with the class specific equalization of features that has already cleaned through different normalization techniques. Secondly, the concept of parametric equalization was introduced. Thus this paper proposed the class-based parametric approximation to the well-known technique of Histogram Equalization for potent speech recognition.

OvidiuGhita, Dana E.Ilea, Paul F.Whelan et al proposed the paper on **Texture Enhanced Histogram Equalization Using TV-L^1 Image Decompostion.** This method defined a class image processing operations that was widely applied in the data normalization algorithms. This paper presented the new variational approach for image enhancement which was constructed to alleviate the intensity saturation effects by standard contrast enhancement (CE) methods. The method initially applied the total variation (TV) minimization with a L^1 fidelity term to decompose the input image with respect to cartoon and texture components. This paper was presented on contrary to other papers that solely relied on information encompassed in the distribution of intensity. A wide range of image data and study addresses were evaluated to illustrate the method which in turn produced better results than conventional CE strategies. The main focus of this paper was on Automatic Contrast Enhancement (ACE). As ACE techniques are often used as precursors to higher level image analysis such as image segmentation, feature extraction and pattern recognition and their applications, this substantially enhanced the performance of the computer systems, the presenters were keen on the Automatic Contrast Enhancement. To circumvent the complications associated with implementation of subjective spatially constrained strategies and the occurrence of the stair case effect, the contrast enhancement has been approached as a global histogram wrapping process. The major aim of this paper was to bring in the notion of the variational approach for histogram equalization which involves the application of TV-L^1 model to achieve the cartoon-texture decomposition. This method completely avoided the occurrence of the undesirable artifacts such as intensity saturation and over-enhancement that are characteristics of the conventional histogram equalization methods. This approach formulated the histogram transformation as a non-linear histogram wraping which has been designed to emphasize the texture features during the image contrast enhancement process. This paper offered a flexible formulation that enabled to outperform other histrogram equalization-based methods when applied to image data corrupted by noise.

Se-Hwan Yun, Jin Heon Kim, Suki Kim et al proposed the paper on **Image Enhancement using a Fusion Framework of Histogram Equalization and Laplacian Pyramid**. This paper gave the methods to overcome the local information which sometimes bring fatal flaw of over-enhancement when a quantum jump occurs in the cumulative distribution function of the histogram. The concept of image enhancement based on the Laplacian pyramid framework was introduced that decomposed an image into band-pass images which improved the local contrast and the global information. The paper brought out two major facts on local and global contrast. Global contrast pointed on a well-balanced mapping function which effectively suppressed the quantum jump. Local contrast highlighted on the noise reduction and adaptively gained high-pass images that are applied to the resultant image. The paper incorporated Contrast-limited adaptive histogram equalization (CLAHE) which separated an image into titles, equalized each of them, and interpolated their boundaries. CLAHE showed dramatic contrast enhancement but exaggerated the image details which made the output look unnatural. This framework effectively reduced the quantum jump and two main strategies of boosting noticeable minor areas and slantwise clipping bins in the histogram. Another contrast enhancement approach indulged in this paper was the decomposition of the image in terms of spatial frequency bands. The paper was also based on the previous Retinex theory-based methods. This paper proposed the image enhancement algorithm with a fusion framework which combined a novel of HE algorithm and a modified Laplacian pyramid. The ultimate motive of this method was to overcome the quantum jump and to supplement the improved local details of the image. The paper also focused on the enhancement of video sequences such that one can know whether the video will be suitable for successive frame processing.

Debdoot Sheet, HrushikeshGarud, Amit Suveer, ManjunathaMahadevappa, Jyotirmay Chatterjee et al proposed the idea of **Brightness Preserving Dynamic Fuzzy Histogram Equalization (BPDFHE).** This method improved the brightness preservation and contrast enhancement abilities. Improvisation in brightness eventually reduced the complexity and complications involved in the image. Brightness Preserving Dynamic Fuzzy Histogram used fuzzy statistics of digital images which defined the representation and the processing. The method Representation and Processing enabled the technique to handle the inexactness of gray level values in a better way, which resulted in improved performance. The execution time was dependent on the size of the image and the nature of the image, and the experimental results showed that the it was faster to the techniques used in this method. The Global Histogram Equalization introduced the major changes in the gray level and it speeded the histogram significantly and could not preserve the mean-brightness which was critical to consumer electronics applications. To overcome this limitation, several brightness preserving algorithms were approached. Out of all the brightness preserving algorithms, Dynamic Fuzzy Histogram Equalization algorithm brought out the image with high brightness and quality. This method resulted in meaningful partitions which became the essential requirement for increasing the brightness of the image. Although the brightness of the image is retained, the size or the other properties of the image are was neither increased nor decreased. The method of Dynamic Fuzzy Histogram worked better on the R, G and B planes which became an added feature to Histogram Equalization. Thus this method improved the ability to preserve the brightness and the contrast of the image thus enhancing the quality of the image. Histogram Equalization (HE) is a popular method used for digital image enhancement. This method produces result that has a more enhanced image with improved contrast. The reason for this method not being used in consumer electronics such as television is that it produces a saturation effect in the output that changes the characteristics of the image other than the contrast.

Nicolas SiaPikKonget al proposed a method of color image enhancement using **Brightness Preserving Dynamic Histogram Equalization**. This method overcomes the HE method by maintaining the mean intensity of the input image in the output image. Previously, we proposed a method known as brightness preserving dynamic histogram equalization (BPDHE) which can fulfill the requirement for gray scale images. In this paper we propose several possibilities to extend this method for color images. There are several steps involved in BPDHE for getting a resultant image with average intensity as the input. They include smoothing the histogram with a Gaussian filter to produce a smoother histogram using linear interpolation to fill up the empty bins, detecting and finding the locations of local maximums to split the input histogram into partitions. The local maximums are selected for maintaining the mean brightness. The third step is mapping each partition into a new dynamic range in order to use all the dynamic range in the image, the next step is equalizing each partition independently and combining them together to form a complete image which is enhanced. The last step is normalizing the image brightness. This step includes taking the mean brightness of the image before equalization and the mean brightness of the image after equalization. This is calculated as the normalization is important to maintain the mean brightness of the output image. The color image processing is done using the RGB color representation. The input is assumed to be in the RGB format as most of the appliances uses the RGB format. The pixels in the output are represented using R’,G’,B’ format. After this, seven steps are carried out in order to process the image. The proposed method is completely different from the previous methods. The previous methods had proposed various algorithms that will work only on the gray scale images. But the current generation had been evolved with color images. The need to enhance the quality of color images is produced as many electronic appliances such as the television, digital camera etc., processes images that are colored. The histogram equalization technique does produce an enhanced contrast but the output has an altered brightness than the original. The main aim is to present the possibilities of BPDHE implementations for color images. The important objective of this work is not just to give an overview of processing color images. It also consists of information to find the suitable processing scheme for BPDHE method.

Haidi Ibrahim, Nicholas SiaPik Kong et al presented the paper on **Image Sharpening using Sub-Regions Histogram Equalization (SRHE).** This paper conveys how an image is partitioned based on the smoothed intensity values.These intensity values are obtained by windingthe given input image by using a Gaussian filter.This process when done, gives a transformation function for histogram equalization (HE) that is not dependent completely on the intensity of the pixel but the intensity of the neighboring pixels are also taken into consideration for more superior results. The method of robust histogram equalization function is also proposed in this paper. The results produced are enhanced in contrast and the output image is sharpened successfully. The new methodology of image enhancement using histogram equalization is proposed in this paper. The partition of the input image, spatial domain, into several sub-images, based on the smoothed intensity values is done in this technique. The spatial relationship among the pixels is also considered for the transformation due to the process. This paper consists of the sequence of the algorithm used to obtain the resultant image by processing it with sub-regions Histogram Equalization and the robust histogram equalization technique followed by the proven experimental results for thorough understanding of the concept. The robust HE transformation function maps the input image into a dynamic range using the transformation functions. The output image is already equalized ass per theory. But if not, then the image is inverted, equalized and re-inverted to get the equalized result. The image is not sectioned based on the intensity as in the previous methods. It is done by considering the spatial domain which takes the weight average of the pixel and its surroundings. Then the convolution is done using the Gaussian filter. In addition, a presentation on the transformation function HE for more enhanced imaging is also done for greater results. The sharpness of the image can be controlled by using suitable Gaussian filter size. Since the enhancement is done using the SRHE histogram, the time taken is very terse when compared with the other histogram equalization methods used locally. This method can be used for various consumer electronics.

III CONCLUSION

The methods discussed above thus has various approach that are distinct for improving the image contrast and sharpness for using in electrical appliances.

The histogram method generates a faster result that enhances the image and gives an image which also has preserved brightness. The above proposed techniques are used in various areas and are producing better results.

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