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A DISCUSSION ON IMAGE ENHANCEMENT USING HISTOGRAM EQUALIZATION BY VARIOUS METHODS

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ABSTRACT

Image enhancing is a needed process for improving the quality of the image so that it can be used in various applications and appliances. Today, many things are based on the visual representation, the image and a good image has a good use. Histogram equalization is a technique used for obtaining an image that has enhanced contrast. This method is used for images which has over contrast and under contrast regions as it increases the total contrast of the image by equalizing the histogram of the image. It does so by spreading out most frequent intensity values. It can be used to increase the X-ray contrast containing the bone structure and for enhancing under or over exposed photographs. The drawback of this method is that it changes the brightness of the resulting image creating problems while used in an electrical appliance such as television. To overcome this problem and several other problems during the contrast enhancing process, many have come up with their idea of approach which gives good results as well as some variations in some situations. In this paper, we have discussed the proposals of various authors for enhancing the image that is not proper without altering the other important characteristics of it. The proposed methods are proven to be successful under most conditions.

Index terms: Histogram, X-ray, Photographs.

I INTRODUCTION

Image enhancement is the process of improving the quality of a digital image by manipulating the image with software. An image can be made darker or brighter or even can be increased and decreased in contrast. Advanced image enhancement softwares are provided with various filters for complicated enhancement. Such softwares are also called image editors. Image enhancement is important in applications that use image inputs or for appliances that is based on image display like cameras, monitors, televisions. It is very mandatory to produce a high quality image for such products so that the users are satisfied with it. To achieve such level of enhanced images, there are some algorithms and techniques that help to produce the required result. The most effective and simple way is to use the histogram equalization method. This equalizes the intensity by spreading it globally over the whole image improving the contrast. But the image rendered does not contain the same brightness as the actual input image. This alteration is a major drawback in this method. It is of no concern now as many authors have proposed various methods of enhancing with far good results by extending the histogram method. These methods overcame all the drawbacks that were seen in the previous techniques with a much faster processing time.

II LITERATURE REVIEW

Haidi Ibrahim, Nicholas Sia Pik 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 winding the given input image by using a Gaussian filter. This process when done, gives a transformation function for histogram equalization

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(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.

Ji-Hee Han, Sejung Yang, and Byung-Uk Lee et al proposed a new modern technique called **the novel 3-D histogram equalization method with uniform 1-D gray scale histogram**. The major and thriving problem in the color histogram equalization method is that the yielded image does not have uniform histogram in the gray scale. It varies in composition of the brightness altering the properties of the original image other than the contrast. Thus the produced after image of the conversion of a color histogram equalized image into a gray scale is worse in contrast of a 1-D gray scale histogram equalized image because of the above problem. We, by the proposed method in this paper, are defining a new cumulative probability density function in 3-D color space. The theoretical analysis on why the prevailing methods are not ideal in performance is also discussed in this paper. The novel 3-D histogram equalization method with uniform 1-D gray scale histogram overcomes the problems in current methods and it also redefines the cdf in RGB color space. Due to this process it gives an image that has uniform luminance distribution past equalization. The importance lies in achieving uniform luminance cdf, it is because the gray scale histogram is a very powerful and effective tool for contrast improvement although it has some drawbacks. The process involved in deriving a 1-D gray scale histogram is extended to 3-D color histogram as there are three dimensions of color involved in a color image. The gray scale histogram is an effective method as it enhances the contrast of over imposed and under imposed regions of an image. It is widely used in digital cameras and mobile phones as it is very simple. The generalization of gray scale image enhancement to color proposes a scheme of producing intensity images and updating color components based on scaling and shifting. But the proposed method, a CDF with an ISO-luminance plane boundary brings an image that has uniform distribution in intensity domain. The function necessary for the rendering of the output using cdf is applied and this results in a histogram similar to the gray scale histogram. With that we find the luminance component. Once we have that, we can render the colors without any gamut problems by using the method of scaling and shifting. The results obtained from this method are compared with natural and synthetic images for performance analysis.

OvidiuGhita, Dana E.Ilea, Paul F. Whelan et al proposed the paper on **Texture Enhanced Histogram Equalization Using TV-L^1 Image Decomposition.** This method defined a class image processing operations that was widely applied in the data normalization algorithms. This paper presented the new varied 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 $TV\text{-}L^1$ 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 wrapping 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 histogram equalization-based methods when applied to image data corrupted by noise.

Taekyung Kim and Joonki Paik et al proposed a technique of **adaptive contrast enhancement using Gain Controllable Clipped Histogram Equalization (GC-CHE).** The contrast enhancement using histogram equalization is a simple but an effective method as it can automatically define the intensity transformation function based on statistical characteristics of the image such as the intensity and saturation. But the fact that it changes the brightness is not suitable for consumer electronic products where original brightness plays an essential role in avoiding annoying artifacts such as a high saturated display in a monitor. The achievement of contrast enhancement using generalization of the existing bi-histogram equalization (BHE) and recursive mean-separate histogram equalization (RMSHE) is presented in this paper. The proposed methodology gives a result with enhanced contrast with the brightness surprisingly equal to the actual brightness of the original image given as the input. A technique of adaptive contrast enhancement using Gain Controllable Clipped Histogram Equalization is the proposed process. The clipped histogram equalization gives an enhanced contrast in the rendered output image. The clipping rate is based on the brightness of the image whereas the clipping threshold depends solely on the clipping rate found. By controlling the clipping rate, the contrast is enhanced with brightness preserved as the actual. The mathematical proof of this thesis which has the values of the image characteristics of both the output and the original is also provided to show that the actual brightness and the result's brightness converge to equality. The Simulation result proves that the proposed GC-CHE method elopes existing histogram-based methods such as HE, BHE and RMSHE in various situations. This method also proves to solve further more problems noise amplification problem and saturation problem. The method proposed in this paper controls maximum value of histogram by clipping histograms higher than the specified threshold for an enhanced output. The CHE can preserve the original intensity distribution but the contrast enhancement is comparatively low when compared with HE method. In this paper a presentation of the gain controllable CHE (GC-CHE) method for solving above mentioned problems in contrast enhancement. The results obtained are proven to be enhanced in contrast with preserved brightness.

Nyamlkhagva Sengee, Altansukh Sengee, Heung-Kook Choi et al proposed the paper on **Image Contrast Enhancement using Bi-Histogram Equalization with Neighborhood Metrics** .This concept was anew 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 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. 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 SiaPik Konget 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.

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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