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A Review of image contrast enhancement techniques

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Abstract -*With the continuous development of computer science and technology, the field of Image processing is considered as a very active area of research. Digital Image Processing refers to processing of digital images by means of digital computer. The aim is to produce digital images with better contrast and hidden details. For this purpose, Image Enhancement techniques that process an input image so that output image will be more suitable than the original image are required. This paper reviews several approaches for contrast enhancement. The survey leads to the conclusion that field of DE is growing fast and improving the contrast using DE will help to solve many complex problems in Image Processing.*

Keywords: Image enhancement, histogram equalization, DWT, DE.

1. INTRODUCTION

Image enhancement process consists of a collection of techniques that aim to improve the visual appearance of an image. Image enhancement means as the improvement of an image appearance by increasing dominance of some features or by decreasing ambiguity between different regions of the image. The objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application. Image enhancement is broadly divided into two categories: spatial domain methods and frequency domain methods. Spatial domain method refers to the image plane and approaches in this category are based on direct operation of pixels in an image. Frequency domain methods are based on adapting the Fourier transform of an image. Image enhancement, which is one of the significant techniques in digital image processing, plays important roles in many fields, such as medical image analysis, remote sensing, high definition television (HDTV), hyper spectral image processing, industrial X-ray image processing, microscopic imaging etc. It is mainly utilized to improve the visual effects and the clarity of the image, or to make the original image more conducive for computer to process. The contrast enhancement is one of the commonly used image enhancement methods. Many methods for image contrast enhancement have been proposed which can be broadly categorized into two methods: direct methods and indirect methods. Among the indirect methods, the histogram modification techniques have been widely utilized because of its simplicity and explicitness in which the histogram equalization (HE) is one of the most frequently used techniques. The fundamental principle of HE is to make the histogram of the enhanced image approximate to a uniform distribution so that the dynamic range of the image can be fully exploited. Contrast enhancement changing the pixels intensity of the input image to utilize maximum possible bins. Contrast enhancement is based on five techniques such as local, global, partial, bright and dark contrast.

2. LITERATURE SURVEY

T. Aarthi et al. [1] In this author propose a fuzzy enhancement technique for improving the visual quality of an image. Existing techniques produces an image with background noise and unnatural look. The drawbacks of the existing systems are removed to some extent using the proposed method. It produces high contrast images using fuzzy logic. In this technique, the gray scale image is fuzzified and it is defuzzified after changing its membership values. Experimental results are shown for different gray scale images along with its performance.

B. Vijilin et al. [2] A quality enhancement algorithm is proposed for images compressed using bit plane reduction. Compression is based on the observation that least significant bit (LSB) planes can be removed without affecting the quality of the image. It also use the fact that the bits in a bit plane repeat and hence can be compressed losslessly by encoding. At the receiver end, the quality of decompressed image is improved by random bit replacement. The proposed method can be used for image quality enhancement after lossy compression or near lossless compression. The proposed method has better PSNR and has less computational complexity.

Y. Kim et al. [3] In this author propose a contrast enhancement method for dark images using the value gap expansion force (VGEF) and the sorted histogram equalization. The inter-pixel relationship is analogous to the electrostatic force, author define the pixel field spread around each pixel and the pixel mass at each pixel position. Then compute the VGEF exerted to a pixel by multiplying the pixel field and the pixel mass. Then sort the pixels of the same value into 5 clusters according to their VGEF magnitudes to reduce contour artifacts in the enhanced image.

N. U. Khan et al. [4] A method for image de-noising and edge enhancement has been proposed by applying singular value decomposition on anisotropic diffused images. The two diffused versions of the input noisy image are generated in the first stage by anisotropic diffusion. The first diffused image is a well smoothed image and the second diffused image is sharp edge detected image. Then Singular value decomposition is applied on the two diffused versions to remove noise and to sharpen the detected edges respectively. Finally, the output image with reduced noise and sharp edges are obtained by adding these two singular value decomposition filtered images.

N. Gupta et al. [5] Images clicked in night or dark area need enhancement to visualize the objects clearly. Now-a-days this problem is widely removed in various application. The proposed technique for the dark image enhancement is based on the combination of Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) using Dynamic Stochastic Resonance (DSR). The proposed new technique removes the drawbacks of each transformation and uses the advantages instead. The proposed technique is performing best as compared to various existing techniques.

J. M. Headlee et al. [6] use three factors to score images: lightness, contrast, and noise. An image enhancement techniques lean to push an image towards these. The proposed metric uses statistics to locally score images based on lightness, contrast, and noise content and these pixel scores are averaged to get an overall image quality score. An image fusion technique is also proposed that fuses multiple enhanced images into one based on the local scores obtained from the no-reference metric. It is shown that fused images score higher using the no-reference metric and also have better visual quality

P. B. Zadeh et al. [7] presents a generic wavelet based image enlargement technique using cycle-spinning. Different wavelet transforms such as Daubechies, symlet, Coiflet, Biorthogonal, Reverse Biorthogonal and Discrete Meyer wavelets are used in this investigation. It include the following steps: A high resolution image is first generated from an input low resolution image, using an inverse wavelet transform, where the coefficients in high frequency sub bands are sets to zero. The cycle spinning method is then used to remove the ringing arte facts . These results indicate that the performance of the image enlargement technique is a function of the chosen wavelet and also the frequency components or texture of the image.

R. R. O. Al-Nima et al. [8] In this author propose to extract Finger Texture (FT) features of the four finger images (index, middle, ring and little) from a low resolution contactless hand image. For this apply a new Image Feature Enhancement (IFE) method to enhance the FTs. The resulting feature image is segmented and a Probabilistic Neural Network (PNN) is employed as an intelligent classifier for recognition. Experimental results show that the proposed method has superior performance than recent published work. So, the best IFE results were obtained with the Equal Error Rate (EER) equal to 4.07%.

A. R. S. M. et al. [9] describe, hardware implementation of an improved image enhancement technique using single scale retinex algorithm. Consider, the dynamic range of digital camera is narrower so contrast correction is required to reproduce the information in darker regions. In the proposed method, an input RGB color image is converted to YCbCr color space. Y and Cr component is modified as the variations in blue components are nominal. In enhancing Y and Cr component, the Gaussian surround function is used and then the difference between scaled version of Y and Cr component and the convolved one is added to the original one. This algorithm is implemented in FPGA . FPGA platform is preferred as it's ability to perform parallel algorithm due to it's inherent parallelism.

P. S. Rajpoot et al. [10] Histogram equalization is a simple method for image contrast enhancement. This method uses the histogram of images in its processing. The traditional histogram equalization technique is generally acknowledged but this method has the disadvantage of "meanshift" issue, i.e. mean brightness of processed image will be the center gray level in any case the mean brightness of the input image. So it is not considered as the best technique for stand out upgrade from splendor protection. A few other histogram adjustment based systems have been familiarized with beat the downside of mean-shift issue. In this generally utilized histogram equalization methods is used for difference upgrade and brilliance conservation.

H. Cao et al. [11] The main objective of image enhancement is to improve the quality of an image to make its visibility better. In this author presents a power-constraint histogram equalization (HE) algorithm in YCbCr space for Active-Matrix Organic Light-Emitting Diode (AMOLED) driving. Active-Matrix Organic Light-Emitting Diode (AMOLED)-based displays consume different power when displaying different colors, due to their emissive nature. In the proposed algorithm, the power-constraint local histogram equalization (PCLHE) is applied on the Y component. And the traditional histogram equalization is applied on the Cb and Cr component separately. Finally, the algorithm has been successfully implemented on a FPGA platform (DE2-115). The result shows that by using this algorithm the power consumption is reduced 21%.

S. A. B. Ahmad et al. [12] Subjective evaluation of the abnormalities in dental images faces low contrast problem. The abnormalities are periapical radio lucency (PA), widen periodontal ligament space (widen PDLs) and loss of lamina dura (Loss of LD). In this method firstly collect the raw intra-oral dental images. Then apply the sharpening based contrast image enhancement algorithms on the images. After that, the images were evaluated by dentists towards the image quality and the abnormalities mentioned. Results show that disagreement issue among the evaluators do exists to the extent of above 90%. Comparing to the original images, enhanced images are able to slightly reduced the subjective evaluation disagreement in image quality and abnormalities.

H. Kusetogullari et al. [13] proposed a new approach to enhance the handwriting image by using learning-based windowing combined with contrast enhancement and Gaussian Mixture Model (GMM). To perform it, a fixed size window moves over the handwriting image and two quantitative methods i.e. discrete entropy (DE) and edge-based contrast measure (EBCM) are used to estimate the quality of each window. These results are used in the unsupervised learning algorithm which is k-means clustering to assign the quality of windowing and make a decision whether the handwriting is low contrast or not. After that, if the corresponding patch has low contrast then a contrast enhancement method is applied to the window to enhance the handwriting. GMM is final step to smoothly exchange information between original and enhanced images to discard the artifacts to represent the final image. The proposed work provides a better contrast enhancement of handwriting and information preservation of input document image.

K. L. Hua et al. [14] In this author present an effective method for image contrast enhancement that combines local information and global information. In local enhancement, multiple intensity mapping functions are get from the recursive mean-separate histogram equalization method .Then, According to intensity level, map different transformation functions to the center sub-block and its neighboring sub-blocks. This method is combined with unsharp masking to enhance the local detail of the image.

Q. Yang et al. [15] proposed an adaptive image contrast enhancement algorithm based on differential evolution to tune gray transform automatically. Tubbs proposed a regularized incomplete beta function that represents some nonlinear transform functions used in image contrast enhancement. But defining the coefficients of the beta function was a problem. Applying the differential evolution in image contrast enhancement utilized the global quickly search ability of the differential evolution algorithm, adaptive mutation, search, at last searches the optimal α,β values of beta function and get an adaptive contrast enhanced image. To avoid trapping into local optimum, a chaotic differential evolution algorithm was proposed. Experimental results showed that the proposed algorithm can find the global optimal α, in few iterations and save computational time and complexity.

L.M. Rasdi et al. [16] proposed an adaptive DE based on chaotic sequences and random adjustment for enhancing the contrast of image. Proposed method evaluated two variations of adaptive DE for application of optimal image contrast enhancement. The first method was DE using chaotic sequences and the second was DE based on random adjustment of the parameters. The objective is to increase the fitness criterion. The results are compared with classical DE which shows that the proposed DE gives best objective function.

G.E. Guraksin et al. [17] proposed an underwater enhancement approach by using differential evolution algorithm. Here, the underwater image firstly separated into RGB color components in the sense of the objective of improving underwater images. After that the contrast for each component improved. Then the R, G, B components of the colored image obtained, contrast stretching procedure was performed to these components separately. While improving contrast, differential evolution (DE) algorithm used in order to determine the contrast limits. Differential evolution described limits as a fraction between 0.0 and 1.0. After improving contrast, underwater images sharpened by using unsharp masking and the enhanced version of the underwater image was obtained.

3. CONCLUSION

Many researchers have proposed various research papers with contrast enhancement. In this article, we made an effort to outline the state-of-the-art research contrast enhancement techniques over the years and came to conclusion that the field of DE is growing fastest in every area of research. Thus DE is considered as a very powerful technique which can be utilized efficiently in the field of image enhancement.

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