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2D IMAGE CONTRAST ENHANCEMENT BASED ON LAYERED DIFFERENCE REPRESENTATION

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ABSTRACT

This algorithm has two process namely intra-layer optimization and inter-layer aggregation. To enhance image by calculating gray level difference between adjacent pixels,the intra layer optimization is used to obtain the histogram vector and find the gray level differences. The inter layer aggregation is used to combine the difference vectors into the unified difference vectors. Thus, HE yields an extremely noisy image, since it transforms the darkest gray level to 63. Although CVC exploits the 2D histogram information, it still experiences the over-enhancement problem due to the high histogram peak. The algorithm is robust against noise components. Whereas HE and CVC increase the noise variances and make each bell shape more widely distributed in the output histograms, the algorithm preserves the bell shape with smaller magnification factors. Therefore, the proposed algorithm preserves homogeneous regions in an image more reliably than the conventional algorithms.

Keywords: Histogram equalization,Contrast enhancement.

1. INTRODUCTION

In some CT radiographs, the features of interest occupy only a relatively narrow range of the gray scale. Contrast enhancement is a method to expand the contrast of features of interest so that they occupy a larger portion of the displayed gray level range without distortion to other features and the overall image quality. The goal of contrast enhancement techniques is to determine an optimal transformation function relating original gray level and the displayed intensity such that contrast between adjacent structures in an image is maximally portrayed.

The histogram of an image represents the relative frequency of occurrence of gray levels within an image. Histogram-modeling techniques modify an image so that its histogram has a desired shape. This is useful in stretching the low-contrast levels of an image with a narrow histogram, thereby achieving contrast enhancement. In histogram equalization (HE), the goal is to obtain a uniform histogram for the output image, so that an “optimal” overall contrast is perceived.

However, the feature of interest in an image might need enhancement locally. And although there was no decrease in delectability of simulated low contrast live metastases for an experienced reader, radiologists always find the appearance of the HE-enhanced images to be objectionable in that they often introduce undesirable artifacts and noise.

Adaptive Histogram Equalization (AHE) computes the histogram of a local window centered at a given pixel to determine the mapping for that pixel, which provides a local contrast enhancement. However, the enhancement is so strong that two major problems can arise: noise amplification in "flat" regions of the image and "ring" artifacts at strong edges. A generalization of AHE, contrast limiting AHE (CLAHE) has more flexibility in choosing the local histogram mapping function. By selecting the clipping level of the histogram, undesired noise amplification can be reduced.

In addition, by method of background subtraction, the boundary artifacts can also be reduced.Yu Wang, Qian Chen, Baomin Zhang [9] has proposed the equalizing procedure, the neighboring gray levels with light probabilistic density are combined into one gray level, while the gap between neighbor two gray levels with heavy probabilistic density is enlarged. Thus the processed image can have a uniform gray distribution property. J. Alex Stark [5] has proposed to set out a concise mathematical description of AHE. The second aim is to show that the resulting framework can be used to generate a variety of contrast enhancement effects, of which HE is a special case.

Joung Youn Kim, Lee-Sup Kim, and Seung-Ho Hwang [6] has proposed the histogram equalization method is simple and powerful, but it cannot adapt to local brightness features of the input image because it uses only global histogram information over the whole image. This fact limits the contrast-stretching ratio in some parts of the image, and causes significant contrast losses in the background and other small regions.

Sarif Kumar Naik and C. A. Murthy [13] has proposed the algorithms reported above are interesting and effective for enhancement, most of them do not effectively take care of the gamut problem – the case where the pixel values go out of bounds after processing. Soong-Der Chen, Abd. Rahman Ramli, Member, IEEE [10] has proposed Mean preserving Bi-histogram equalization (BBHE) has been proposed then, to overcome the aforementioned problems. BBHE firstly separate the input image's histogram into two based on its mean; one having range from minimum gray level to mean and the other ranges from mean to the maximum gray level.

In this paper, we propose a novel global CE algorithm based on the layered difference representation (LDR). The proposed algorithm also uses a 2D histogram, but adopts a different theoretical approach. We first obtain the 2D histogram of gray-level differences between neighboring pixels. We attempt to amplify gray-level differences, occurring frequently in the input image, to enhance the contrast. To this end, we represent output gray-level differences and the transformation function in a tree-like layered structure. This representation is called the LDR.

2. PROPOSED METHODOLOGY

The AHE process can be understood in different ways. In one perspective the histogram of grey levels (GL's) in a window around each pixel is generated first. The cumulative distribution of GL's, that is the cumulative sum over the histogram, is used to map the input pixel GL's to output GL's. If a pixel has a GL lower than all others in the surrounding window the output is maximally black.

This section proceeds with a concise mathematical description of AHE which can be readily generalized, and then considers the two main types of modification. The relationship between the equations and different (conceptual) perspectives on AHE, such as GL comparison, might not be immediately clear, but generalizations can be expressed far more easily in this framework.

3. PROPOSED ALGORITHM

The proposed algorithm has two main components :intralayer optimization and interlayer aggregation. We first extract a 2D histogram *h(k,k+l)* from an input image, by counting the pair so adjacent pixels with graylevels *k* and *k+l*. we obtain the difference vector **d***l* at layer *l*. Next, in the interlayer aggregation, is combined the difference vectors at all layers into the unified difference vector **d** using the weighting vector **w**. The

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transformation function **x** is reconstructed from **d** and transform the input image to the output image.

3.1 Layered Difference Representation

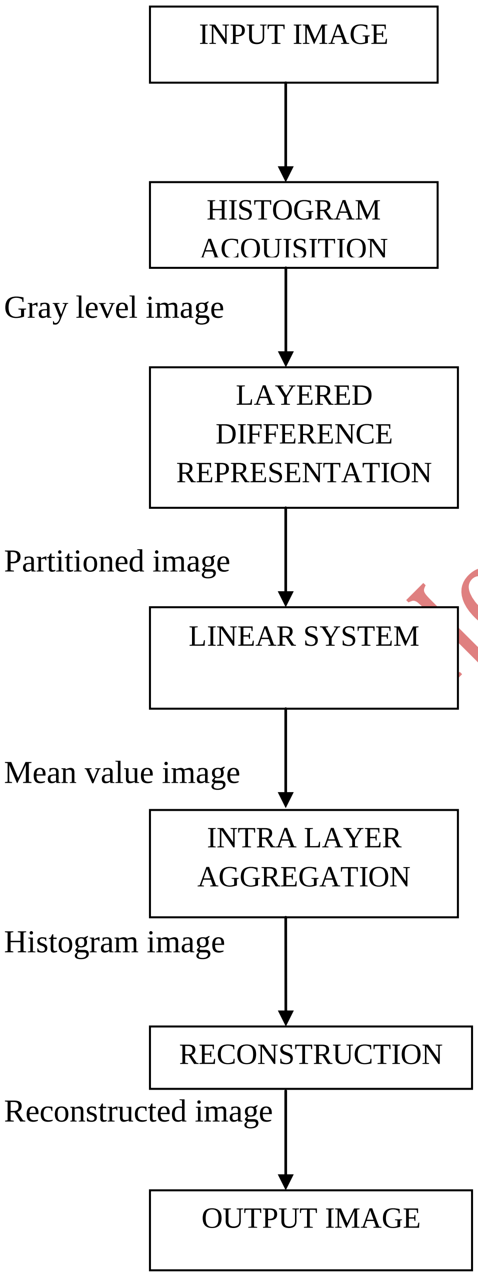

Fig1: Block diagram of the algorithm

For the sake of notational simplicity, let us consider a typical 8-bit imaging system, in which the maximum gray-level is 255. Let **x** = $[x0, x1, \ldots, x255]T$ denote the transformation function, which maps gray-level k in the input image to gray-level xk in the output image. To derive a desirable transformation function, we introduce the LDR.

3.2 Intra-Layer Optimization

More specifically, by considering the relationships at all layers and Also, each $d1$ k should be nonnegative to ensure a monotonically increasing transformation function **x**. We can solve this over-determined system with the nonnegative constraint based on the nonnegative least squares (NNLS) technique.

3.3 Inter-Layer Aggregation

Here k , which is the total number of pixel pairs with the gray-level difference l. sl 's for various test images, which are normalized by the maximum values. We see that, as l increases, the occurrence frequency sl gets lower. We adjust the relative contribution of **d**l based on its reliability sl . Therefore, **d**l at a higher layer l has a less impact on the unified difference vector **d**.

4. RESULT AND DISCUSSIONS

This method is compare with the conventional HE, WAHE and CVC algorithms. First, the proposed algorithm is robust against noise components. Whereas HE and CVC increase the noisevariances and make each bell shape more widely distributed in the output histograms, the proposed algorithm preserves the bell shape with smaller magnification factors.

Therefore, the algorithm preserves homogeneous regions in an image more reliably than the conventional algorithms. Second, the proposed algorithm exploits the entire dynamic range. Given the equality constraint, the algorithm attempts to maximize the gray-level differences of output pixels.

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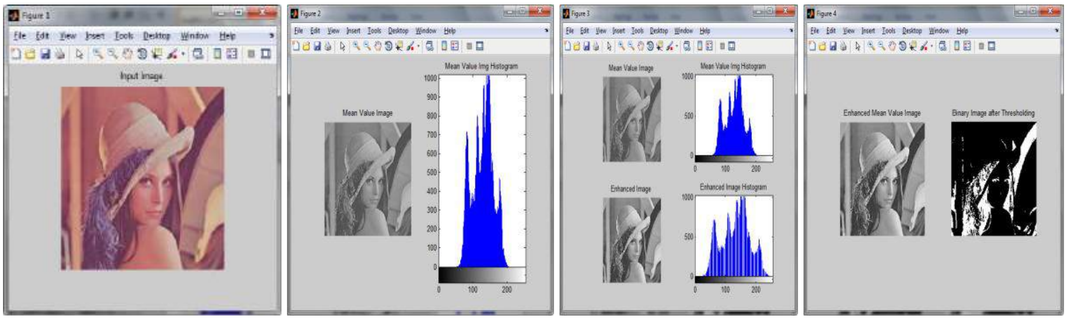
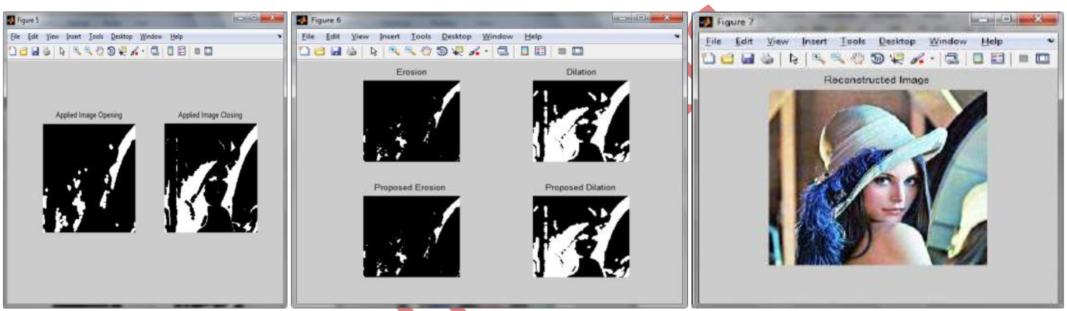
As a result, the proposed algorithm always transforms the darkest and the brightest pixels to the minimum and the maximum gray-levels, respectively. On the contrary, the conventional algorithms may not use the entire dynamic range, depending on the histograms of absolute gray-levels. Therefore, this algorithm generally achieves higher contrast ratios than the conventional algorithms, which is confirmed by the middle and the bottom images



(a) (b) (c) (d)



(e) (f) (g)

Fig 2.(a) illustrates the input image for the contrast enhancement technique,Fig.(b) illustrates the mean value of the input image,Fig.(c) illustrates the enhanced image and histogram,Fig.(d) illustrates the binary image thresholding for the given input image,Fig.(e) illustrates applied image opening and closing,Fig.(f) illustrates the proposed erosion and dilation image,Fig.(g) illustrates the reconstructed image.

5. CONCLUSION AND FUTURE WORK

We proposed a novel contrast enhancement algorithm using the LDR, in which the statistical information of gray-level differences between neighboring pixels in an input image is exploited to control output gray-level differences. We observed that frequently occurring gray-level differences should be amplified to enhance the contrast of the output image, and then formulated the CE as a constrained optimization problem. The proposed algorithm consists of two main steps. First, the intra layer optimization obtains the difference vector at each layer by solving the constrained optimization problem. Second, the inter-layer aggregation combines the difference vectors at all layers into the unified difference vector, which is equivalent. To the transformation function. Extensive experimental results demonstrated that the proposed algorithm provides better image qualities than the conventional algorithms.The dependence of the multi resolution histogram as well as the Fisher information measures on image shape and image texture can be investigated further. The multi resolution histogram can also be computed over higher dimensional domains such as 3D data. The range of the multi resolution histograms can be of multiple dimensions such as color. The performance of multi resolution histograms formed with eccentric Gaussians could be examined. Such multi resolution histograms would be rotationally sensitive.

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