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STUDY OF IMAGE ENHANCEMENT TECHNIQUES USING HISTOGRAM EQUALIZATION

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HISTOGRAM EQUALIZATION

Histogram Equalization (HE) is a very popular algorithm in the field of image enhancement. Its theory is very simple but effective and easy to implement. However, this algorithm cannot get good result in some special cases. Furthermore, it will change the mean brightness of original image significantly. According to these drawbacks of HE, some novel algorithms have been proposed. The main target of these algorithms is trying to preserve the brightness and entropy of original image better. But they also decrease the enhancement efforts at the same time. In this paper, a novel algorithm, Normal Matching Histogram Equalization (NMHE), is proposed. Experimental results show that this algorithm can not only preserve the mean brightness and entropy of original image but also keep the enhancement efforts simultaneously.

Histogram Equalization (HE) is a simple and effective image enhancement technique. But, it tends to change the mean brightness of the image to the middle level of the permitted range, and hence is not a very suitable for consumer product. While preserving the original brightness is essential to avoid annoying artefacts. To preserve brightness and to enhance contrast of images, numerous methods are introduced, but many of them present unwanted artefacts such as intensity saturation, over-enhancement and noise amplification. In the present paper, available histogram equalization based methods are reviewed and compared with image quality measurement (IQM) tools such as Absolute Mean Brightness Error (AMBE) to assess brightness preserving and Peak Signal-to-Noise Ratio (PSNR) to evaluate contrast enhancement.

LITERATURE REVIEW

Sengee *et al.*, 2010, which divide the large histogram bins that cause washout artefacts into sub-bins using neighborhood metrics, and the histogram of the original image is separated into two sub-histograms based on the mean of the histogram. Then, sub-histograms are equalized independently using refined histogram equalization, which produce flatter histograms. The distinction neighborhood metric is to sort pixels of equal intensity into different sub-bins, to improve image local contrast, and to separate the histogram into two sub-histograms and then equalize them independently to preserve the image brightness.

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Menotti *et al.*, 2007 proposed Minimum Within-Class Variance Multi-Histogram Equalization (MWCVMHE) and Minimum Middle Level Squared Error Multi Histogram Equalization (MMLSEMHE) techniques to yields images with natural appearances, at the cost of contrast enhancement. MWCVMHE partitions the input histogram into multiple sub-histograms by minimizing within-class variance and then applies histogram equalization in each sub-histogram separately. MMLSEMHE uses the Otsu threshold selection technique to select separating points, before equalizing each sub-histogram independently with HE.

Kim and Chung et.al 2008 proposed Recursively Separated and Weighted Histogram Equalization (RSWHE) to enhance the image contrast as well as to preserve the image brightness. This method splits the input histogram into two or more sub-histograms recursively based on the mean or median of the image. Also the resulted sub-image histograms will change through a weighting process based on the power law function. RMSHE and RSIHE are similar to RSWHE in terms of recursive histogram segmentation, but they do not execute the histogram weighting function as in RSWHE.

CONTRAST ENHANCEMENT USING HISTOGRAM

Texture synthesis is the ability to create ensembles of images, that look visually similar in structure yet differ pixel to pixel, from sample textures that have been photographed. An important common application of texture synthesis is real-time computer graphics where the objective is to generate textures "on the fly" to simulate realistic scenes,1-4 without the artifacts created from texture maps Procedural techniques have been developed for real-time texture synthesis." Such approaches, however, are not necessarily optimal for natural textures.

We instead propose to use an approach that employs multiscale decomposition and filtering of both a texture sample and a realization of white noise image for each synthesis. The utilization of multiple realizations of white noise images allows photorealistic generation of ensembles of statistical textures. Textures such as marble, grass, and sand have been synthesized. Y and we have extended the method to include synthesis of medical textures."

Texture synthesis may indeed play an important role in the assessment of image quality in medical imaging, where quality is defined in relation to medical tasks efficacy.'? To assess the ability to detect lesions in various types of medical images (e.g., liver ultrasound, mammogram), a large ensemble of statistically equivalent images is required. These images may serve as background images into which one mayor may not insert objects of interest. For ex- ample, in optimizing or assessing a mammography imaging system to detect cancerous lesions, a large number of statistically equivalent mammography backgrounds, half with inserted lesions, half without, can be generated." The ensemble of images can be created using texture synthesis as an alternative to establishing a large pool of certified "nor- mal" mammograms.

An approach to mammography texture synthesis is shown in Fig, where some underlying small-scale texture is extracted from the larger scale. Two realizations of the synthesized small-scale texture are shown. The larger scale may be synthesized using, for example, lumpy back- grounds.'! By recombining the synthetic structures, synthetic mammograms may be obtained. Naturally, the need for large ensembles of statistically equivalent images for image quality assessment may apply equally well to do- mains of image science other than medical imaging.

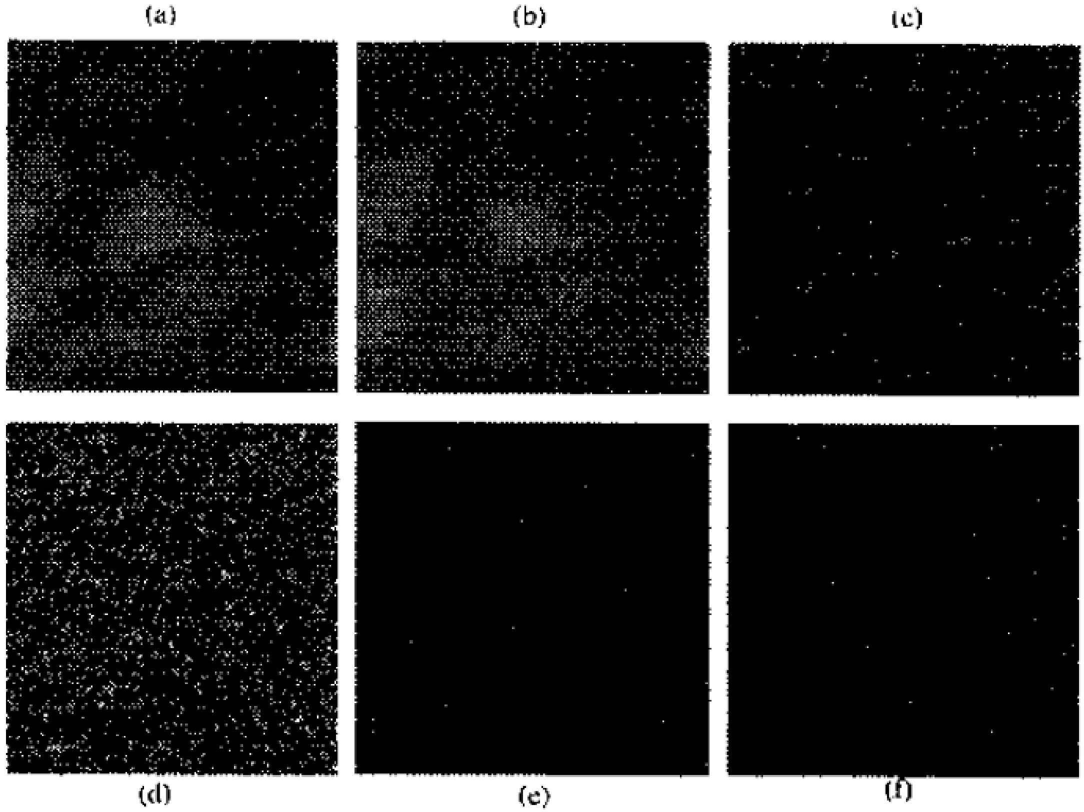

Figure 1: In the top row, (a) shows a *256x256* pixel image 01 a sample mammography tissue; the same image blurred with a Gaussian of *a*- 6 pixels is shown in (b). The underlying mammography texture shown in (c) is obtained by subtracting image (b) lrom image (a). In the bottom row, a realization 01 a white noise image is shown in (d); and two examples of synthesis of the underlying mammography texture shown in (c) are displayed in (e) and (I), respectively.

The method of texture synthesis, that we employ to make, for example, the mammography texture samples shown in figure, comprises a technique known as histogram matching between two images recursively. Histogram matching, sometimes referred to as histogram specification, is an image processing technique, specifically a point operation, which modifies a candidate image so that its histogram matches that of a model image." While histogram matching is not widely employed in image processing, it is a generalization of histogram equalization, an image processing technique commonly employed to enhance low-contrast images.

Based on applications that require either the generation of on-the-fly synthetic textures (i.e., computer graphics) or large ensemble of synthetic textures (i.e., image quality assessment in image science) high- speed computation is necessary for all procedures of the texture synthesis algorithm, including histogram matching. A further important point for the motivation of a faster histogram-matching algorithm is that we shall encounter multiple histogram matching steps in the synthesis of a single realization of a texture as a consequence of the multiple-scale and multiple-orientation decomposition required by the texture synthesis algorithm. The histogram- matching algorithm thus needs to be efficient for small images (e.g., 16X16 pixels), as well as large ones (e.g., 256 X256 pixels).

A basic question that thus motivated this research is how to speed up the texture synthesis algorithm. For equally fast algorithms, we hall also value the simplicity of the algorithm. The investigation of how various components of the texture synthesis algorithm can be optimized for increased computational speed will be reported elsewhere. This paper reports on establishing fast, and, if possible, simple, histogram-matching algorithms. In this thesis, two algorithms are presented. Within the context of texture synthesis, the overall computational-speed performance and simplicity of the algorithms are also assessed.

HISTOGRAM EQUALIZATION METHODS

The most popular technique for contrast enhancement of images is histogram equalization (HE). It is one of the well-known methods for enhancing the contrast of a given image in accordance with the samples distribution. HE is a simple and effective contrast enhancement technique which distributes pixel values uniformly such that enhanced image have linear cumulative histogram. It stretches the contrast of the high histogram regions and compresses the contrast of the low histogram regions. The HE technique is a global operation hence; it does not preserve the image brightness. HE has been widely applied when the image needs enhancement, such as medical image processing, radar image processing, texture synthesis, and speech recognition. HE usually introduces two types of arte facts into the equalized image namely over-enhancement of the image regions with more frequent gray levels, and the loss of contrast for the image regions with less frequent gray levels. To overcome these drawbacks several HE-based techniques are proposed and are more focused on the preservation of image brightness than the improvement of image contrast. Few methods often generate images with annoying visual arte facts and unnatural appearances, though the image brightness is preserved to some extent.

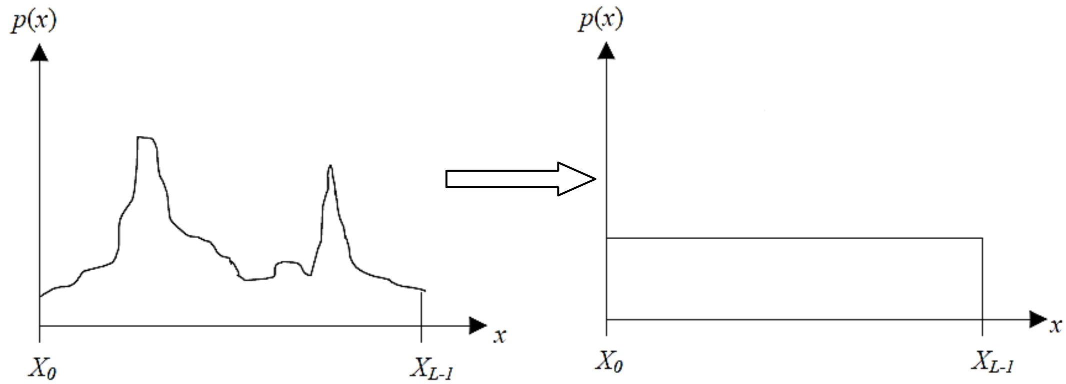

Figure 2. Histogram Equalization
(a) Histogram (b) Equalized Histogram

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