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Image Enhancement at a Glance

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ABSTACT

Contrast enhancement has an important role in image/video processing. Histogram equalization (HE) is one of the most commonly used methods for image contrast enhancement. However, HE and most other contrast enhancement methods may produce unnatural looking images. The images obtained by these methods are not suitable to use in applications such as consumer electronic products where brightness preservation is necessary to avoid annoying artifacts. To solve such problems, we proposed a hybrid and efficient contrast enhancement method based on best features of previous methods. Moreover, expected result of the method shows the images were suitable for consumer electronic products.

Keywords:- Image Enhancement, Spatial Domain Technique, Transform Domain Technique, Alpha Rooting, Power Law Transformation, Logarithmic Transformation

I. INTRODUCTION

Image contrast enhancement is an important step in almost every image processing application. The objective of image enhancement is to increase the visual perception of the image so that they are more suitable for human viewers or machine vision applications. It is well known in the image processing society that there is no unifying or general theory for image enhancement algorithms. Thus an enhancement algorithm that is suitable for some application may not Work in other applications. This justifies the presence of numerous contrast enhancement algorithms in the literature which can be either application-specific or general algorithms that are proposed to provide the developers of image processing applications with different choices to consider in their applications instead of wasting time in developing new enhancement algorithms.

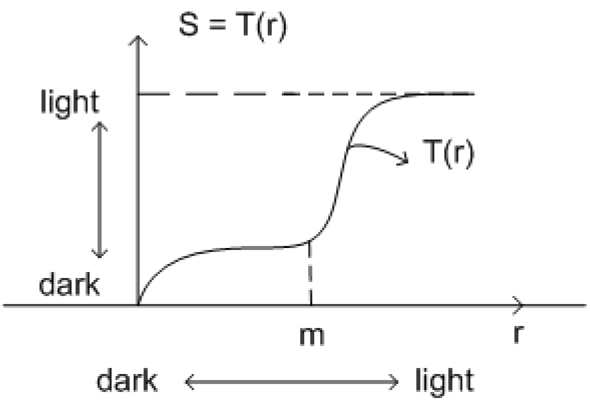
This dissertation, introduce the development and experimentation of four general image contrast enhancement algorithms for grayscale images in the spatial domain. Three of the new algorithms are developed based on the understanding of the mechanism and problems of the popular histogram equalization (HE) algorithm. However, each algorithm approaches these problems from different angle. The MCBHE algorithm utilizes sub image processing, multiple gray level thresholding, and connected components labeling to provide better enhancement of local details. The CVHE algorithm and its local variants build on the variational definition of the HE algorithm to define a new transformation function that reduces the change in the image brightness. Similar to the CVHE algorithm, the BCAHS algorithm enhances the image contrast by preserving its mean brightness, however it achieves that by automatically specifying the output histogram that is the closest to a uniform distribution and has the same mean Value.

Generally, these three algorithms show better performance than the HE algorithm and its variants in terms of the perceived contrast and less production of enhancement artifacts, but at the expense of relative increase in processing time. The last algorithm is the ALGT algorithm that is introduced for contrast Sharpening. It is based on stretching local gray level values adaptively using an optimal transformation function. It showed better results in terms of higher perceivable contrast and less noise amplification.

II. BASIC DOMAINS FOR IMAGE PROCESSING

Spatial domain techniques

These techniques are based on gray level mappings, where the type of mapping used depends on the criterion chosen for enhancement. As an eg. Consider the problem of enhancing the contrast of an image. Let r and s denote any gray level in the original and enhanced image respectively. Suppose that for every pixel with level r in original image we create a pixel in the enhanced image with level $S = T(r)$. If $T(r)$ has the form as shown



Figure(1.1)

The effect of this transformation will be to produce an image of higher contrast than the original by darkening the levels below a value m and brightening the levels above m in the original pixel spectrum. The technique is refered to as contrast stretching. The values of r below m are compressed by the transformation function into a narrow range ofS towards the dark end of the spectrum; the opposite effect takes place for values of r above m .In the limiting case shown in figure, $T(r)$ produces a 2-level (binary) image. This is also referred to as image thresholding. Many powerful enhancement processing techniques can be formulated in the spatial domain of an image.

This example shows several image enhancement approaches. Three functions are particularly suitable for contrast enhancement: imadjust, histeq,and adapthisteq. This example compares their use for enhancing grayscale and truecolor images.

Step 1: Load Images

Step 2: Resize Images

Step 3: Enhance Grayscale Images

Using the default settings, compare the effectiveness of the following three techniques:

- **Imadjust:-** increases the contrast of the image by mapping the values of the input intensity image to new values such that, by default, 1% of the data is saturated at low and high intensities of the input data.

- **Histeq:-** performs histogram equalization. It enhances the contrast of images by transforming the values in an intensity image so that the histogram of the output image approximately matches a specified histogram (uniform distribution by default).

- **Adapthisteq:-** performs contrast-limited adaptive histogram equalization. Unlike histeq, it operates on small data regions (tiles) rather than the entire image. Each tile's contrast is enhanced so that the histogram of each output region approximately matches the specified histogram (uniform distribution by default). The contrast enhancement can be limited in noise which. Might be present in the image contrast. Therefore it is necessary to enhance the contrast. The purpose of image enhancement methods is to increase image visibility and details. Two major classifications of image enhancement techniques are spatial domain enhancement and transform domain enhancement. However, these techniques bring about tonal changes in the images and can also generate unwanted artifacts in many cases, as it is not possible to enhance all parts of the image in balanced manner.

Image 2.1 before Enhancement

Image 2.2 after Enhancement

B. Transformation Domain Techniques

Transformation or frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. Transformation domain techniques are suited for processing the image according to the frequency content [1]. The principle behind the frequency domain methods of image enhancement consists of computing a 2-D discrete unitary transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then performing the inverse transform. The orthogonal transform of the image has two components magnitude and phase. The magnitude consists of the frequency content of the image. The phase is used to restore the image back to the spatial domain [5]. The usual orthogonal transforms are discrete cosine transform, discrete Fourier transform, Hartley Transform etc. The transform domain enables operation on the frequency content of the image, and therefore high frequency content such as edges and other subtle information can easily be enhanced. We see one technique of transformation domain i.e Alpha rooting technique.

Alpha rooting Technique-

Alpha rooting is a simple but effective technique of image enhancement in the transform or frequency domain. The technique is applied on the orthogonal transforms of images. It is used to augment the high frequency content in the image. The method is based upon the fact that after applying an orthogonal transform, high frequency coefficients of an image, will have smaller magnitudes than low frequency coefficients. By raising the magnitude of an image to some value, α, where $0 < \alpha < 1$, the higher valued lower frequency components of an image can be reduced more in proportion to the lower valued high frequency components. The mathematical form of the operation is X =where X(p,s) is the magnitude of the image transform, (p, s) is the phase of the transform and α is the value by which the magnitude is raised ($0 < \alpha < 1$).The effect is observable in most of the images on which alpha rooting is applied and becomes more pronounced in case of darker original images[4]. Thus many a time, the output image, although sharp, is unacceptably dark; it is poor in contrast and brightness expected of a good enhancement.

III. APPLICATIONS

Image enhancement is used for enhancing a quality of images. The applications of image enhancement are Aerial imaging, Satellite imaging, Medical imaging, Digital camera application, Remote sensing.

IV. CONCLUSION

Image enhancement techniques such as spatial and transform domain technique are important techniques. Most of the techniques are useful for altering the gray level values of individual pixels and hence the overall contrast of the entire image. But they usually enhance the whole image in a uniform manner which in many cases produces undesirable results. There are various techniques available which produce highly balanced and visually appealing results for a diversity of images with different qualities of contrast and edge information and it will produce satisfactory result.

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