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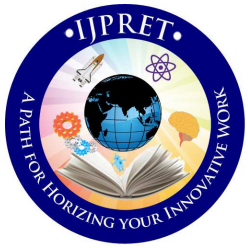

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A PATH FOR HORIZING YOUR INNOVATIVE WORK

COMBINED APPROACH OF SPATIAL AND TRANSFORMATION DOMAIN TECHNIQUES

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Abstract

Image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image enhancement is one of the important parts of image processing. Image enhancement is the task of applying certain alterations to an input image like as to obtain a more visually pleasing image. The alteration usually requires interpretation and feedback from a human evaluator of the output resulting image. Image enhancement is to improve the image quality so that the resultant image is better than the original image for a specific application or set of objectives. There are two techniques of image enhancement spatial and frequency domain. Alpha rooting one of the technique of transform domain. 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. Log transform and power law transform are spatial domain techniques. Spatial domain operates directly on pixel of an image.

1. INTRODUCTION

Image processing is a rapidly growing area of computer science. Its growth has been fueled by technological advances in digital imaging, computer processors and mass storage devices. Digital Image Processing helps to overcome different problems such as noise, degradation, etc. Image processing technology is used by planetary scientists to enhance images of mars, Venus or other planets. One of part of the image processing is the image enhancement. Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. Image Enhancement is the technique to improve the interpretability or perception of information in images for human viewers. It is to improve the image quality so that the resultant image is better than the original image for a specific application. The main purpose of image enhancement is to bring out detail that is hidden in an image or to increase contrast in a low contrast image. Whenever an image is converted from one form to other such as digitizing the image some form of degradation occurs at output. Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured. Enhancement may be used to restore an image that has suffered some kind of deterioration due to the optics, electronics and/or environment or to enhance certain features of an image. The objective of image enhancement is dependent on the application context, and the criteria for enhancement are often subjective or too complex to be easily converted to useful objective measures, image enhancement algorithms tend to be simple, qualitative, and ad hoc. In addition, in any given application, an image enhancement algorithm that performs well for one class of images may not perform as well for other classes.

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or machine. Many images such as medical images, remote sensing images, electron microscopy images and even real life photographic pictures, suffer from poor

contrast. Therefore it is necessary to enhance the contrast.

II. Image Enhancement Techniques

There are two techniques of image enhancement Spatial and frequency domain techniques. Spatial domain techniques directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. Spatial domain techniques like the logarithmic transforms, power law transforms, histogram equalization, are based on the direct manipulation of the pixels in the image Spatial techniques are particularly useful for directly 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. It is not possible to selectively enhance edges or other required information effectively.

1. Spatial domain Techniques

In spatial domain techniques we directly deal with the image pixels. In spatial domain for getting desired output the pixel vales are manipulated. Basically in spatial domain the value of pixel intensity are manipulated directly as

G(x, y) =T [f(x, y)]

Where f (x,y) is input image, G(x, y) is output image and T is an operator on f.

A. **Log transformation**

Log transformation is one of the elementary image enhancement techniques of the spatial domain that can be effectively used for contrast enhancements of dark images. The log transform is essentially a grey level transform which means that the grey levels of image pixels are altered. This transformation maps a narrow range of low grey level values in the input image to a wider range of output levels [6]. The general form of the log transformation can be mathematically represented as

$$\boldsymbol{s = c\ log(1 + r)}$$

Where, s is the output grey level, r is the input grey level and c is a constant. It is assumed that r ≥ 0.

B. Power-law transformation

Power law transformation is another commonly used gray level transformation in

the spatial domain. It is conceptually similar to alpha rooting in the frequency domain as this is done by raising the input grey level by some power [6]. It is similar in operation to the log transforms in that power law transforms with fractional values of γ map a narrow range of dark input values into a wider range of output values thereby increasing the contrast. The transformation can represented as

$$s = br^{\gamma}$$

Where s is the output grey level, r is the input grey level, b is a scaling constant and γ is the power to which the input grey level is raised. One significant advantage of the transformation is that it is possible to control the transformation function by varying the parameter γ.

2. Frequency Domain Techniques

Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. Frequency domain techniques are suited for processing the image according to the frequency content. 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. 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.

Alpha Rooting Technique

Alpha rooting is a simple but effective technique of image enhancement in the 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 < α < 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

$$\hat{X} = |X(p,s)|^{\alpha} \; e^{j\theta(p,s)}$$

where $X(p,s)$ is the magnitude of the image transform, Θ(p, s) is the phase of the transform and α is the value by which the magnitude is raised (0 < α < 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.

III. Combined Approach of Spatial and Frequency Domain Techniques

The method is combining approach of spatial and frequency domain techniques. It is hybrid combination of grey level transform algorithm like log transforms and power law transform with alpha rooting technique. Conventional alpha rooting results in an enhancement of subtle edge information in images. It increases the sharpness and makes the image crisper. This artifact therefore necessitates the development of a new method by which the tonal change can be eliminated or rather reversed thus achieving good contrast and brightness also. I chose those techniques from each domain having a basic nature, simplicity and ease of experimentation and at the same time being efficient also. Log transform and power law transform in the spatial domain account for techniques that are not complex but at the same time provide powerful enhancement. They were chosen especially for their power to map grey values across spectrum with the aid of parameters. This provides with flexibility to mix and match these parameters and mappings to get optimum enhancement.

Alpha Rooting itself was chosen because it is one of the most basic techniques in the frequency domain which contributes to good sharpening and enhancement of images. This technique also holds the flexibility of a parameter aided operation

which is highly appreciated for experimenting with different levels of enhancement. Also by employing such basic and simple techniques we can sidestep major performance overheads which would entail in case of a combination of more complex techniques from the domain. Needless to say, this would enhance both experimental and operational efficiency. These techniques are not exhaustive in such an approach and further research could be carried out by substituting other techniques from the domain. This method will be able to enhance the subtle edge information along with the contrast which together produces excellent visual quality.

Design of Method

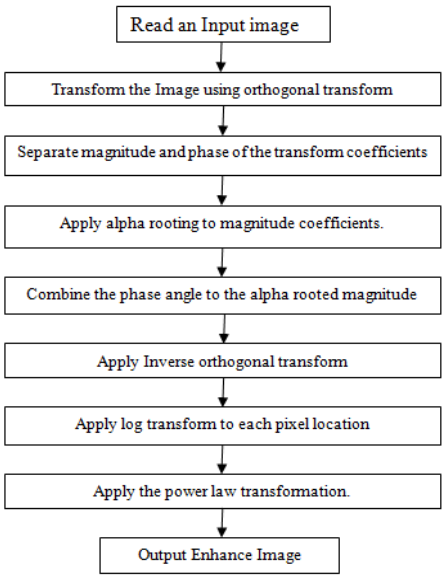

Figure shows flowchart of above method. The procedure initial step is to reads an image. In next step take the orthogonal transform of the input image. The usual transforms are Fourier transform, discrete cosine transform etc. which transform the image into the frequency domain. Then in next step magnitude and the phase of the frequency transform coefficients are separated. In next step apply alpha rooting to the magnitude of the coefficients. After that, the phase is restored and the inverse orthogonal transform is applied to get the output image of alpha rooting. The result of alpha rooting, as earlier mentioned, is many a time poor in contrast and brightness and suffers from the graying effect. To counter this problem, I subject the result to spatial gray level contrast enhancement transforms. The next step the log transforms is applied to the output image of alpha rooting. This process scales the narrow range of dark values to a wider range. This result is then subjected to the power law transformation which results in additional enhancement. This step also allows us to control the level and extent of enhancement by varying the power

parameter. The addition of the log transform and power law transform enhances the quality of the image with good contrast and brightness.

IV. Conclusion

In combined approach method an enhanced image is generated. This enhanced image is comparatively better than other techniques such as alpha rooting, log transform etc. The method will 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. The improvement in image enhancement is particularly effective in the case of very low contrast images.

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