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Image Detail Enhancement Techniques - A Brief Review

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Abstract:- **Image enhancement is required to improve the image quality so that the resultant image is better than the original image for a specific application or set of objectives. Image enhancement is the task of applying certain alterations to an input image like as to obtain a more visually pleasing image. 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. 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 frequency 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.**

I.INTRODUCTION

Image Enhancement is one of the most important and difficult techniques in image research. The aim of image enhancement is to improve the visual appearance of an image, or to provide a "better transform representation for future automated image processing. The detail enhancement technique is really an extensively used image editing tool. Active detail enhancement algorithms provide edge-reserving decomposition algorithms. Any source image is initially decomposed in a base layer which usually is by means of homogeneous areas together with well-defined ends and a depth level which usually is made up of great information or even structure with the edge-preserving decomposition algorithm, after which a new detail-enhanced image is manufactured by amplifying the actual depth layer.

II. ENHANCEMENT TECHNIQUES

Image enhancement is the process of modifying digital photos so that the desired info is far better pertaining to show or maybe for further image analysis. Image enhancement techniques can be divided into two broad categories :-

A. Spatial domain methods

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. Techniques like histogram equalization are effective in many images.

The approaches can be classified into two categories:

1.Point Processing operation (Intensity transformation function).

2.Spatial filter operations.

Point processing operations (Intensity transformation function) is the simplest spatial domain operation as operations are performed on single pixel only. Pixel values of the processed image depend on pixel values of original image. It can be given by the expression $g(x,y) = T[f(x,y)]$, where T is gray level transformation in point processing. They are especially useful for bringing out detail in Fourier transforms.

Direct methods define a contrast measure and try to improve it. Indirect methods on the other hand, improve the contrast through exploiting the underutilized regions or the dynamic range without defining a specific contrast term. Contrast enhancement techniques can be broadly categorized into groups: Histogram Equalization (HE),Tone Mapping.

Histogram Equalization is one of the most commonly used methods for contrast enhancement. It attempts to alter the spatial histogram of an image to closely match a uniform distribution. The main objective of this method is to achieve a uniform distributed histogram by using the cumulative density function of the input image. The advantages of the HE include it suffers from the problem of being poorly suited for retaining local detail due to its global treatment of the image small- scale details that are often associated with the small bins of the histogram are eliminated. The disadvantage is that it is not a suitable property in some applications such as consumer electronic products, where brightness preservation is necessary to avoid annoying artifacts.

Tone Mapping is another approach of contrast enhancement techniques. In this method if we want to output high dynamic range (HDR) image on paper or on a display. We must somehow convert the wide intensity range in the image to the lower range supported by the display. This technique used in image processing and computer graphics to map a set of colours to another, often approximate the appearance of high dynamic range images in media with a more limited dynamic range. Tone mapping is done in the luminance channel only and in logarithmic scale. It is used to convert floating point radiance map into 8-bit representation for rendering applications. The two main aims of tone mapping algorithm: Preserving image details and providing enough absolute brightness information in low dynamic range tone mapped image.

B. Frequency domain methods

Transformation or 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.

III. Related Work

Pietro P., and Malik J. [3] proposed a new scale-space and edge detection algorithm using anisotropic diffusion method. In their technique, the diffusion coefficient is used in such a way to support the intra-region smoothing as comparative to inter-region smoothing, so as to extract the global information after removing the noise from the image. Bilateral filter is introduced by Tomasi, C., and Manduchi, R.[4] for gray and color images. Bilateral filter is non-linear and non-iterative filter that preserve the edges by mean of combining the nearby pixels values in image. They used the technique to combine the gray levels or color based on their geometric closeness and their photometric similarity in both range and domain .F. Durand and J. Dorsey[6] presented a technique for the display of high-dynamic-range images, which reduces the contrast while preserving detail. It is based on a two-scale decomposition of the image into a base layer, encoding large-scale variations, and a detail layer. Only the base layer has its contrast reduced, thereby preserving detail.

Xu, L., Lu, C.et al. [8] have proposed the technique of image smoothing with L_0 gradient minimization method. This method is based on the spatial changes in which a restriction is placed upon the total number of non-zero gradients between pixels so that to globally enhancing the prominent edges, even if the boundaries of objects are much contract. An unsharp masking algorithm is presented by GuandDeng[9] by using exploratory data model as a unified framework. The proposed algorithm is designed to address three issues: 1) simultaneously enhancing contrast and sharpness by means of individual treatment of the model component and the residual, 2) reducing the halo effect by means of an edge-preserving filter, and 3) solving the out-of-range problem by means of log-ratio and tangent operations. M. Son,Y. Lee,et al.[12] presented a novel method for enhancing details in a digital photograph, inspired by the principle of art photography. Their technique provides a flexible tone transform model that consists of two operators: shifting and scaling. This model permits shifting of the tonal range in each image region to enable significant detail boosting regardless of the original tone.

The total variation filter [7] uses an L_1 norm based regularization term to remove noises in images ,which is also considered as an edge-preserving decomposition algorithm. Weighted Least Squares (WLS)[13] based multi-scale decomposition algorithm decomposes an image to two layers by solving a weighted least square optimization problem. In [11] , H. Badri, H. Yahia et al. proposed an accelerated iterative shrinkage algorithm to decompose and enhance image. In [14], the L_0 norm based smoothing algorithm is introduced to a detail enhancement scheme for fusion of differently exposed images by F. Kou, Z. Li, C. Wen. In [15], it is used in a visual enhancement algorithm for low backlight displays.

IV. Proposed Algorithm

The image is composed of based and details layers. The based layer is responsible for structural properties of an image. The human perceptional system can able to recognize the object because of based layer.

To enhance the details part, we need to first extract the base layer from the input image as shown in eq.1

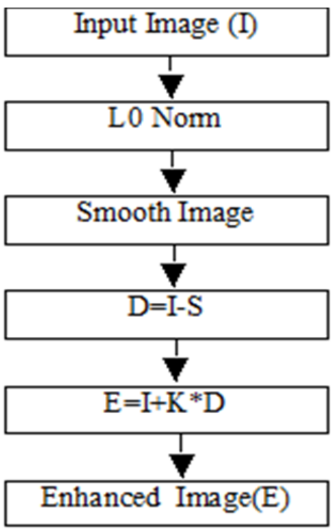
$$D = I - S \quad (1)$$

Then enhanced image can be obtain by eq. 2

$$E = I + K \times D \quad (2)$$

Where K is positive integer used to control the degree of details enhancement. The L_0 norm can be used to obtain based layer S.

The system flow diagram is shown below :-



V. CONCLUSION

Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. 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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