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Image Enhancement Using Novel Spatial & Frequency Techniques

Er. Ashutosh Kumar Singh
(Assistant Professor- Dept of Computer Science & Engineering)
(Aryabhatta College of Engineering & Research Center, Ajmer)
Email- aksingh.cse08@gmail.com

Abstract:
Image enhancement is a necessary step in image processing. The primary goal of image processing is to achieve better visualization so that they could more efficient for human beings and machines. This paper provides description of image using spatial domain and frequency domain.

Keywords: image enhancement, spatial domain, frequency domain, color enhancement.

1. Introduction

Image enhancement is widely used in recent years for image processing and computer vision implementation. Image enhancement are usually used to improve the quality of images, it helps to get better visibility of any given image to the user.

There are mainly two parts of image enhancement spatial domain and frequency domain. In this section the focus is on edge & color enhancement, especially on the sharpening techniques.

One picture is worth more than ten thousand words. The ability to see is one of the truly remarkable characteristics of living beings. It enables them to perceive and digest in a short extent of time an implausible amount of knowledge about the world around them. The scope and array of that which can pass through the eye and be interpreted by the intelligence is nothing undersized of astounding.

The main definition of ornamental is to make a little superior in value, desirability or attractiveness. The term of enhancement implies a process to develop the illustration excellence of the image. Image Enhancement transforms images to provide better representation of the delicate details. The major aim of augmentation is to process an image so that the result is more suitable than the novel image for a precise application. Image enhancement processes consist of a collection of techniques that request to improve the visual manifestation of an image or to convert the image to a form better suited for analysis by a human or a machine. In an image development system, there is no conscious effort to improve the fidelity of a reproduced image in context to some ideal form of the image, as is done in image restoration.

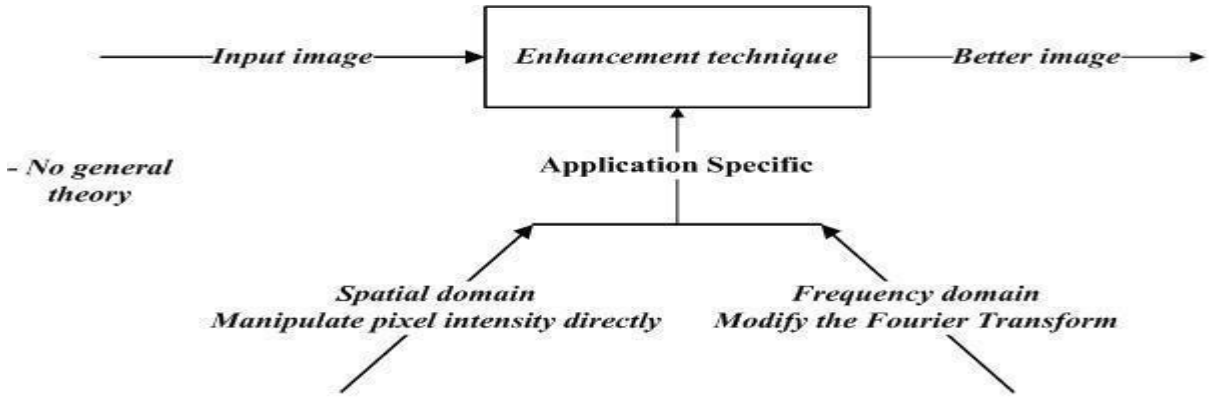

Figure 1: Image enhancement techniques

2- Spatial Domain Techniques

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The spatial domain techniques are based on gray level mappings, where used mapping depends on the criterion. For example, let's consider the problem of enhancing as the contrast of an image. Let *r* and *s* indicate any gray level in the original and enhanced image respectively. Suppose that for every pixel with level *r* in inventive image we create a pixel in the enhanced image with level $S = T(r)$. If $T(r)$ has the form as shown in figure below:

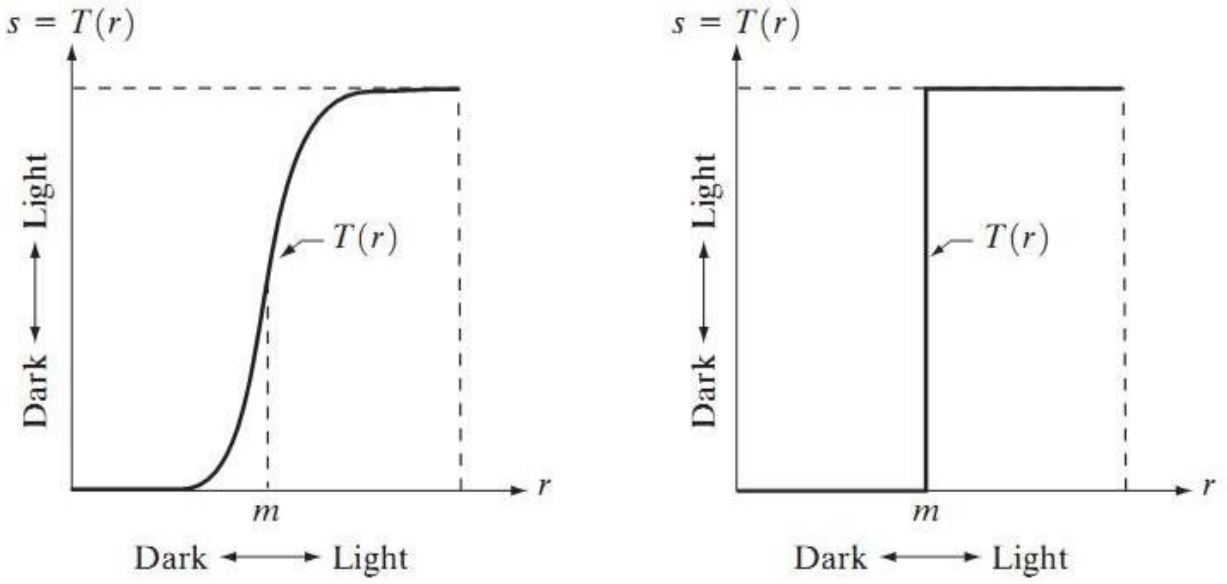

Figure 2: Example of contrast enhancement in spatial domain

The effect of this transformation will be to create an image of superior contrast than the original by darkening the levels below a value *m* and brightening the levels above *m* in the novel pixel spectrum. The technique is referred to as contrast stretching. The values of *r* below *m* are squashed by the transformation function into a narrow range of *S* 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 2-level (binary) image. This is also referred to as image thresholding. Many powerful enhancement processing techniques can be formulated in the spatial area of an image, and there is no general definition of an image enhancement. When an image is processed for visual interpolation, the observer is the ultimate judge of how well a particular method works. Visual evaluation of image quality is a subjective process consequently making the definition of a
'good image' an elusive standard by which to compare algorithm performance. When the problem is one of processing images for machine perception, the evaluation task is easier. For example, if we take the problem of character recognition by a machine the best image processing technique would be the one that yields the best machine detection result. In general, if there is somewhere a clear cut criterion of presentation imposed on a problem there is usually a certain amount of test and inaccuracy before one selects a particular image processing approach.

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3- Frequency Domain Techniques

Frequency domain methods are based on modification of Fourier transform of an image. Let $g(x, y)$ be an image formed by the convolution of an image $f(x, y)$ and a position invariant operator $h(x, y)$,

$$g(x, y) = h(x, y) * f(x, y)$$

From convolution theorem, we have

$$G(u, v) = H(u, v) * F(u, v)$$

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Where G, H F are F T of g, h and f respectively. The transform $H(u, v)$ is referred to as the transfer function of the process.

In the frequency domain relation, the discrete convolution is often more efficiently than using fast Fourier transform algorithm

In a typical image enhancement problem $f(x, y)$ is given and the goal after computation of $F(u, v)$ is to select $H(u, v)$ so that the desired image given by:

$$g(x, y) = F^{-1}\{H(u, v)F(u, v)\}$$

It also exhibits some highlighted features of $f(x, y)$ for example edges in $f(x, y)$ can be accentuated by using a function $H(u, v)$ which emphasizes the high frequency components of $F(u, v)$.

4- Color Image Enhancement

The human eye can distinguish thousands of different colors, visible colors usually occur in the range between 400nm (violet) and 700nm (red) as it's shown on the electromagnetic spectrum in figure below –

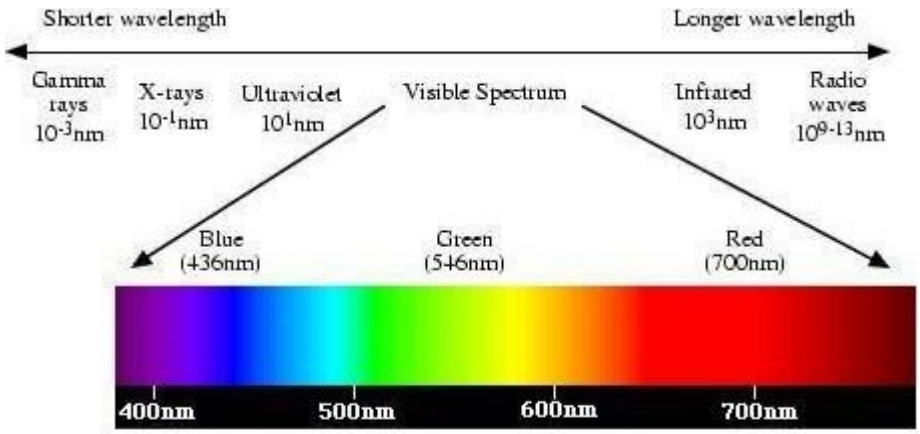

Figure 3: The visible spectrum

Figure 3: The figure on the left shows the additive mixing of primary RGB colors. The Figure on the right is RGB color cube.

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5- Natural Color Image Enhancement

The monochrome image enhancement methods could be applied to natural color images by processing each color component individually. This comprises the class of intra component processing algorithms. There is also a class of inter component processing algorithms in which color pixels are combined on a pixel-by-pixel basis. Finally, there is a class of vector processing algorithms.

6- Conclusion

In this paper mainly two novel techniques are used to enhance the quality of images including color and natural images. Spatial and Frequency domain techniques are quite useful in image enhancement work. These techniques are mainly responsible to enhance the color and edge of any particular image.

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