Image Enhancement By Spatial Domain Technique: A Study

Ashish Dwivedi[1], Prof.Nirupma Tiwari[2]
[1]Dept of CSE
[2]Assistant rofessor, Dept of CSE
[1, 2] ShriRam College of Engineering and Management Banmore, Indian

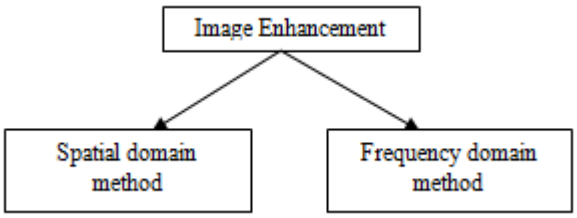
Abstract- *In the research area related to pictures, Image enhancement (IE) is mostly used techniques. IE is done to upgrade the quality and visual appearance of an image. Almost all the pictures suffer from poor and bad contrast. In order to raise the quality of pictures we elevate the contrast and eliminate the noise. IE mechanism is of utmost important in medical sciences. Clear visual pictures are attained by IE method. The enhancement mechanism varies from one range to another depending on its purpose. Mainly two kinds of IE techniques are there: Spatial Domain (SD) and Frequency Domain (FD) Enhancement. This paper represents a scrutiny of IE Processing Mechanism in SD. We classify processing techniques on the basis of prototypical mechanism of IE. This paper gives contribution in the study of enhancement methods.*

Keywords- Filters, Image Enhancement (IE), frequency domain enhancement, Spatial based Domain Enhancement Methods, etc.

I. INTRODUCTION

For ameliorating the value or worth of the picture and to give better input for processing the picture, we use IE technique. The IE mechanism is separated into two categories:

1. Spatial domain methods: When operation takes place directly on the pixels of the picture that enhances contrast is called as SD method.
2. Frequency domain methods: When the operation done on the Fourier transform (FT) of the respective picture is called as FD method. It works on FT, discrete sine and cosine transform of the image.[1]



Real time solutions are carried out in SD as it is simple, easy to interpret and mainly the complexity range is low. The two major standards which is lacking in SD are Robustness and imperceptibility factors. Functional assessments done along frequency in FD Method with objective of increasing the worth of the picture. By applying changes in the transform coefficient functions one can increase the quality of image. The beneficial aspect of FD image enhancement involve low computational complexity, manipulation in the frequency coefficient of a picture [2]. The limitation of this method is that it cannot generate clear picture of background. It cannot enhance all the components of the picture. It focuses only on specific parts. Noise removal is the major aspect of IE mechanism.

II. IMAGE ENHANCEMENT TECHNIQUE

- Filtering is a technique which acts as a tool for eliminating the unwanted sound present in the picture.
- IE is defined as: input picture is given having low quality like low contrast and noise and we require improving it for better output for many useful applications.
- IE techniques are classified in two types which is described as follows.

A. Spatial domain techniques

When operation takes place directly on the pixels of the picture that enhances the contrast is called as SD method. These techniques are done on pixels. The values of pixels are changed to achieve the desired improvement. These are mainly cast-off for the direct alteration of the gray values of the pixels one by one and also for the sharpness of the picture. The problem in it is that sometimes it also produces the unacceptable results because it works in the uniform way in the whole pictures. So this method is not beneficial for the picture that wants to update the selected region or the intended information. This mechanism includes log transformations, power-law (gamma) transformations, histogram equalization (HE) and Matching specification that depend on the direct operation on the pixels in the picture. Spatial filtering is cast-

off for this purpose. Spatial masks are cast-off for IP in spatial filtering. The masks are called as spatial filters.[3]

Following are the operations related to SD technique.

1. Mask Operation- Every pixel is modified as per their values in a close or small neighborhood in this operation.
2. Global Operation All the values of pixel are taken into consideration of the picture to do the global operation.
3. Point Operation- The individual pixels are operated by image processing (IP) operation or the point operations that is
   g(m, n)= T[f(m, n)]

Where, f(m ,n) is the input or original picture, g(m, n) is the processed or resultant picture, and T is used for modification procedure that is operated on a one pixel.

B. Frequency domain techniques

It is beneficial for the pictures that depend on frequency components. This mechanism works on the orthogonal transformation of the picture other than the picture itself. The central concept of these methods is composition of 2D discrete cosine transformation, for representation of the 2-D DCT. It consists of two constituents one is magnitude and other is phase. Magnitude is built of frequency component and phase component is for reinstate the picture back to the SD. These are straightforward techniques. Firstly, the FT of the picture is evaluated which is to be computed and result is multiplied by a filter and inverse transform is taken to generate the outcome of image. In low pass filtering (LPF), high frequency components of image are removed because of this reason; picture would be blurred related with noise. An ideal filter also has two hindrances: ringing of image and blurring of image.
Following are FD methods:

1) Low Pass Filtering (LPF): The edges of the picture are smoothened by LPF. Sharp transitions as the gray levels that accord to the HF content of its FT also done by LPF. Elimination of low frequency components takes place.
2) High Pass Filtering (HPF): The HPF components represent edges. It uses different convolution kernel Sharpening of edges is done by downgrading the low frequency components without disturbing the high frequency information. It causes small and faint details to be highly distorted.
3) Band-pass filtering: The frequencies within an appropriate limit are passed on, and reject frequencies outside that limit. Reflectance constituents and illumination constituents can be separately filtered. It relates the frequencies having low value of the FT of the natural log of an image with illumination and high frequencies with reflectance and it is separately filtered.

III. APPLICATIONS

Image enhancement has wide range of applications in many areas such as digital camera pictures, remote sensing , aerial imaging, satellite images, forensic labs, astrophotography, fingerprint or face recognition etc. It is a necessary tool for highlighting areas to upgrade the visual presentation of the picture. It has a significant application in pictures related to medical sciences like in MRI, Ultrasound and X- Rays.

IV. LITERATURE REVIEW

Mundhada [4] many alterations are done on the authentic picture in order to built it visibly effective in IH of an picture. The evaluator provides the data that are required for modification of picture. IE is performed to build good quality image as compared to the input picture for specific applications. Alpha rooting usually works on the transform domain (TD). It depends on the frequency content of the picture.

Bedi [5] IE is the essential and demanding mechanism in picture research work. Any picture can suffer from bad sharpness and noise while capturing or transmitting it and pictures can be medical pictures or real life pictures. So there is requirement to improve the contrast and removal of noise is also important to achieve better results. As IE upgrades the clarity of pictures for human vision, increases the contrast and highlight the details, so it is necessary stage in medical picture identification and interpretation. The techniques that exist at present are frequency and SD enhancement. Categorization and survey has been done on IE mechanisms through this paper, shortcomings were evaluated and general needs in the field of active research like the noise was not totally eliminated from the medical pictures and pointed out those promising directions for IE in future.

Madhu[6] The whole picture in a dark tone are given by alpha rooting. The outline of the clouds that visualize in aspect of histogram equalization (HE) is lost. Adaptive histogram equalization (AHE) generates better result but the picture is not free from washed out impression. Poor sharpness in the picture occurred in this method. The background information along with the plane is still fogged with bad contrast.

Agaian [7] Histogram equalization has the problem that it is poorly suited for preserving local description because

of its global treatment of the image. An undesired loss of visual data quality occurs due to HE.

Tang [8] It decribes the global HE that adjusts the intensity of histogram to proportionate uniform distribution. The global image properties may not be properly applied in a local context. Global HE treats all parts of the image equally. Hence derive poor local performance regarding detail preservation. In this way, different types of local IE algorithms have been introduced to improve enhancement.

Arulmozhi [9] presented that the DI enhancement has number of choices for upgrading the radiographic picture to make it more pleasing in human vision. There are many algorithms that have been proposed till now in the past years. In the enhancement of contrast sharpening algorithm are being used. Loss of small details, addition of noise, undesired and unnatural look of the pictures that were processed are there in the pictures. A new algorithm for contrast enhancement for radiographic images in SD is developed. These algorithms provide a flexible and better path for enhancing contrast but they did not get natural looking processing result which can be enhanced in future which will demonstrate the superiority rather the traditional HPF.

Francis Fons et.al [10] There is implementation of an automatic fingerprint recognition system by using efficient hardware-software architecture. The outcome reveals that a middle range reconfigurable FPGA faces both real time and parallel compute intensive demands of the fingerprint image enhancement process.

V. SPATIAL DOMAIN FILTERING TECHNIQUES

Inadequate amount of processing tools are required for SD technique and mainly it requires very less computation time. This process is done by using the mathematical formula, and it is denoted by the the equation

$$g(x,y)= T[f(x,y)]$$

Where f(x,y) corresponds to the image which is taken as input, g(x,y) corresponds to image which we obtain as output, T denotes operator which is defined on f applied over a neighbouring point(x, y). We can reduce the noise by applying this operator to the single pixel of an image or to different set of images. Basic intensity transformation functions are used in spatial IP. The respected value which is obtained from the function is given in the expression of the form in

$$S = T(r)$$

Where,
The pixel value(r) is mapped with pixel value(s) by using the transformation T. Intensity transformation involves three types of transformations which are used for IE process. They are:

- Linear- negative transformation.
- Logarithmic- log transformation.
- Power law- Intensity transformations.

These transformation functions are very effective and considered to be the simplest and easiest methods to implement.

5.1 Image Negatives

Negative of the image or inverting the pixel of the image is one of the methods in IEprocess. Image negatives are calculated by negative transformation with the intensity level is present in the range of [0, L-1]. It is represented by the formula as below

$$S = L-1-r$$

Photographic negative of an image is obtained by reversing or inverting the intensity level of the image. In an image, if the darker areas are predominant and larger means we can apply this technique for improving the grey or white information combined with darker parts of the image. Inverting input low lighting video as well as dehaze algorithm techniques are used in image negative. These algorithms are used in the improvement of LCD displays and low quality videos.

5.2 Log Transformation

Log transformations are mathematically expressed using the Equation

$$S = c \log (1+r)$$

Where C is taken as constant. It is taken that r>=0. Darker pixel values of the image are enlarged on compressing the values in the higher levels. For inverse log transformation function the process is done at the reverse order. Dynamic range values compression in an image on giving large variation in the pixel value is refered to as the main properties of log transformation. These techniques are mainly used in security surveillance applications.

5.3 Power Law Transformation

Power law transformation is one of the mechanisms cast-off for IE process. The basic form of power law transformation is given in the

$$S = c\, r^{\gamma}$$

Where,
c and ɣ are positive constants6 used this technique. The input value which is thin and of darker range is mapped with output value which is having broader range by using the power law curves with the fractional values of ɣ. If higher level values are given to input, the process is done in the reverse order. Capturing image, respond to display of the image and printing the image are considered as the applications done by using power law technique. In general we state the exponent of power law equation as gamma. Gamma correction is the process or procedure which will rectify or correct the power law response.

5.4 Piecewise Linear Transformation

In this transformation each pixel value of the image is manipulated. This transformation technique is used for enhancing the quality of the image by altering the range of values. Content classification and adaptive processing techniques are used. Arbitrary complex functions can also be solved by using piecewise linear method. This is considered as the major advantage of this technique. There are three different types for this kind of transformations. These are as follows-

- Intensity level slicing method
- Contrast stretching method
- Bit plane slicing method.

VI. CONCLUSION

In the arena of development and research, Image enhancement is extensively used subject for researchers. Image Enhancement technique is all about enhancing the visual appearance of images or we can say that image enhancement is upgrading the quality of an image. There are several techniques for image enhancement but in this paper we describe about the spatial domain filtering techniques like intensity transformation, piecewise linear transformation techniques, histogram equalization were surveyed in brief. There is analysis of various processing techniques regarding spatial domain enhancements.

REFERENCES

[1] P. Janani, J. Premaladha and K. S. Ravichandran," Image Enhancement Techniques: A Study", Indian Journal of Science and Technology, vol 8(22), ISSN (Online) : 0974-5645 .

[2] Nirmala S. O ,K.S., India T. D, R. K. Kamat," Review on Image Enhancement Techniques: FPGA Implementation perspective", International Journal of Electronics Communication and Computer Technology (IJECCT) Volume 2 Issue 6 (November 2012), ISSN:2249-7838 .

[3] Gurpreet kaur, Rajdavinder Singh," Image Enhancement and Its Techniques- A Review", International Journal of Computer Trends and Technology (IJCTT) – volume 12 number 3 – Jun 2014, ISSN: 2231-2803

[4] Snehal O.Mundhada, Prof. V. K. Shandilya" Image Enhancement and Its Various Techniques "International Journal of Advanced Research in Computer Science and Software Engineering" Volume 2, Issue 4, April 2012 ISSN: 2277 128X

[5] S.S. Bedi , Rati Khandelwal, "Various Image Enhancement Techniques- A Critical Review" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 3, March 2013.

[6] Arun R, Madhu S. Nair, R. Vrinthavani and Rao Tatavarti. "An Alpha Rooting Based Hybrid Technique for Image Enhancement". Online publication in IAENG, 24th August 2011.

[7] Agaian, SOS S., Blair Silver, Karen A. Panetta, "Transform Coefficient Histogram-Based Image Enhancement Algorithms Using Contrast Entropy", IEEE Transaction on Image Processing, Vol. 16, No. 3, March 2007.

[8] Jinshan Tang Eli Peli, and Scott Acton, "Image Enhancement Using a Contrast Measure in the Compressed Domain", IEEE Signal processing Letters , Vol. 10, NO. 10, October 2003

[9] K. Arulmozhi1, S. Arumuga Perumal2, K. Kannan3, S. Bharathi4"Contrast Improvement of Radiographic Images in Spatial Domain by Edge Preserving Filters" IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.2, February 2010,233

[10] Francisco Fons, Mariano Fons, and Enrique Canto, "Approaching Fingerprint Image Enhancement through Reconfigurable Hardware Accelerators," IEEE International Symposium on. 2007, pp.1-6.