Implementation of Image Enhancement Techniques

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Abstract*: Image enhancement is a process which modifies the pixels of an image up to certain magnitude. It results in more subjectively pleasing image for human and machine analysis for some specific applications such as- X-Ray, fingerprinting, modelling photographs etc. It improves the visual appearance of pixels of an image. Pixels of an image can be manipulated in frequency as well as spatial domain. There are different image enhancement techniques comes under point processing in spatial domain such as- negative of an image, contrast stretching, thresholding, power law, logarithmic and grey level slicing.*
Keywords: *digital image processing, contrast stretching, grey level slicing, thresholding, image enhancement.*

I. INTRODUCTION

Any changes in visual appearances of an image significantly improve the image. If an image is low contrast and dark then it can be modified by operating pixels of that image before displaying at output. Also, it is possible that some noise components get added into an image which may cause blurredness in an image. Before displaying an image, it should be pre-processed. This pre-processing is known as Image Enhancement. It means to process an image such that it gives more suitable results for output display. It modifies the image attributes that improves interpretability of image information for human viewers. Image enhancement is applicable in every field where images are ought to be analysed, for e.g. X-Ray images, images from satellites etc [1].

Image enhancement can be done by two domains namely Spatial domain- in which pixels of an image are manipulated directly and secondly Frequency domain- It is based upon the modification of Fourier transform of an image [2].

Consider an 8-bit grey level input image $f(x, y)$ having pixel value ranging from 0 - 255. It can transform input image $f(x, y)$ into $g(x, y)$, which indicates processed output. T represents an operation on image 'f' defined over some neighbourhood of (x, y).
It can be expressed as

$$g(x, y) = T [f(x, y)] \qquad (1)$$

Grey level transformation function can be written as

$$s = T(r) \qquad (2)$$

where r and s are intensity of pixels of f(x, y) and $g(x, y)$ [3].

In this paper, basic image enhancement techniques have been discussed with mathematical equations. The work carried out focuses on spatial domain technique with particular reference to point processing methods along with grey level slicing as shown in fig. 1.
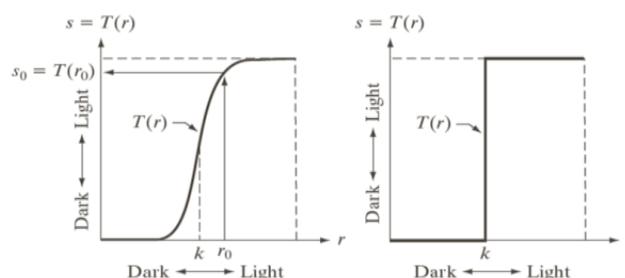

Figure 1. Spatial Domain Techniques.

II. POINT PROCESSING TECHNIQUES

Point Processing Techniques are among the simplest of all image enhancement techniques [4]. These include:

A.   *Negative of an Image*

The simple operation in image processing is to compute the negative of an image. It can be done by reversing the pixel values from black to white and white to black. Intensity of output image decreases as intensity of input image increases.

$$b = (255 - a) \qquad (3)$$

where a is an original image & b is negative image processed.

Each pixel of an image gets subtracted from 255 and the resultant negative image will depend upon the original pixel values. Fig. 2 shows an example of original and negative image.
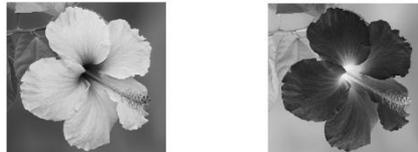

Figure 2.   Original & Negative Image

B. *Thresholding*

It is a process of extracting a part of an image which contains information. In this transformation, one threshold level is set and pixel values below threshold are to be taken as 0 and above values are taken as 255 as shown. Let us consider an image of a lady and transform that image into form of matrix i and j [5].

If $a (i, j) < t;$
then $b (i, j) = 0;$
else $b (i, j) = 255;$

'a' and 'b' are original and processed images respectively. Matrix values i, j are pixel locations in an image, t is thresholding parameter.

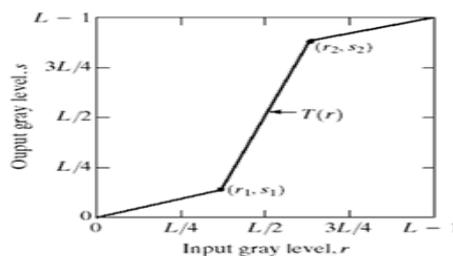Figure 3.   Various degrees of grey levels at output and their affetcs on contrast.

Intermediate values of r_1, r_2, s_1 and s_2 produces various degrees of grey levels at output which affects its contrast as shown in fig. 3.

If $r_1 = s_1$ and $r_2 = s_2$, then there is no change in grey level and transformation is a linear function.

If $r_1 = r_2$, $s_1 = 0$ and $s_2 = L - 1$ then transformation performs a thresholding function as shown in fig. 4.

$$i_1j_1 \quad i_1j_2 \quad i_1j_3 \quad i_1j_4 \ldots\ldots\ldots\ldots i_1j_n$$
$$i_2j_1 \quad i_2j_2 \quad i_2j_3 \quad i_2j_4 \ldots\ldots\ldots\ldots i_2j_n$$
$$i_3j_1 \quad i_3j_2 \quad i_3j_3 \quad i_3j_4 \ldots\ldots\ldots\ldots i_3j_n$$
$$i_nj_1 \quad \cdot \qquad \cdot \qquad \cdot \ldots\ldots\ldots\ldots i_nj_n$$

(a)   (b)

Figure 4.   (a) Original Image (b) Processed Image

C. Contrast Stretching

Contrast Stretching is used increase the dynamic range of grey levels in an image. It is required due to poor contrast. Poor Contrast normally occurs due to poor or non-uniform illumination, non-linear dynamic range in an image sensor, wrong setting of lens aperture. This technique simply increases the contrast of an image by making dark regions darker and bright regions brighter [4][6].

Intermediate values of r_1, r_2, s_1 and s_2 produces various degrees of grey levels at output which affects its contrast as shown in fig. 3. If $r_1 < r_2$ and $s_1 < s_2$, then function will be single valued and monotonically increasing as shown in fig. 5.
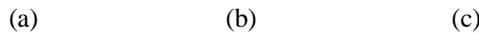

(a)   (b)   (c)

Figure 5.   (a) original image (b) increased brightness (c) decreased brightness

D. Gray Level Slicing

Grey level slicing is equivalent to band pass filtering. It manipulates group of intensity levels in an image up to specific range by diminishing rest or by leaving them alone. This transformation is applicable in medical images and satellite images such as X-ray flaws, CT scan. Two different approaches are adopted for grey level slicing [6][7].

1) Grey level slicing without background: It displays high values in the specific region of an image and low value to other regions by ignoring background. Fig. 6 highlights range [A, B] of grey levels by reducing all others to a constant level.
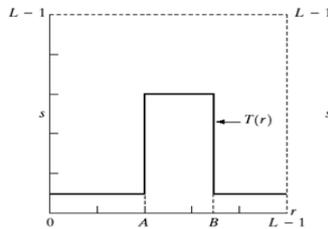

Figure 6.   Range [A, B] of grey levels by reducing all others to a constant level.

2) Grey level slicing with background: Fig. 7 highlights range [A, B] by preserving all other levels. Fig. 8 displays high values in specific region of an image and original grey level to other region by preserving background [8][9][10].
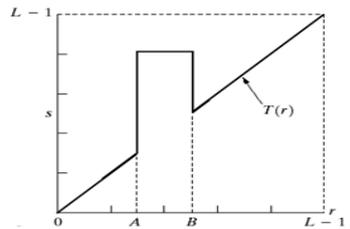
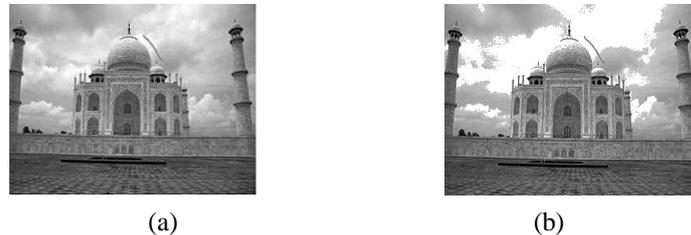Figure 7.   Range [A, B] by preserving all others levels.

(a)   (b)

Figure 8.   (a) Original Image (b) Gray level slicing with background.

III.   APPLICATIONS OF IMAGE ENHACEMENT

- Medical imaging where automatic contrast enhancement and sharpening is needed such as - X-ray, Digital mammography, CT scan.
- Helps to improve the luminance and brightness of LCD panel which tends to brighter and clearer onscreen images.
- It brightens and darkens the dusk and dawn viewing.
- Improves images for fog and sand storm environments.

IV.   CONCLUSION

Image enhancement techniques provide different approaches for improving the visual characteristics of an image. To make choice between these techniques depends upon various factors such as image content, viewing conditions, characteristics by observer and specific task. The point processing methods are most primarily used. Digital negative is used to enhance white details in a dark background for medical imaging applications. Thresholding and Contrast stretching techniques are applied by stretching the grey levels of an image. Grey level slicing technique is applied to some specified region in an image. In this paper, authors have not discussed about computational cost of these algorithms while making choice within these techniques for real time applications.

REFERENCES

[1]   A. K. Jain, *Fundamentals of Digital Image Processing*, Prentice Hall, 1989.
[2]   R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Second Edition, Prentice Hall, 2002.
[3]   S. Jayaraman, T. Veerakumar, and S. Esakkirajan, *Digital Image Processing*, Tata Mc Graw Hill, 2009.
[4]   Gyu-Hee Park, Hwa-Hyun Cho, and Myung-Ryul Choi, "*A Contrast Enhancement Method using Dynamic Range Separate Histogram Equalization,*" IEEE Trans. on Consumer Electronics, vol. 54, no. 4, pp. 1981-1987, Nov. 2008.
[5]   Shan Du, "*Adaptive Region-Based Image Enhancement Method for Robust Face Recognition Under Variable Illumination Conditions,*" IEEE Trans. on Circuits And Systems For Video Technology, vol. 20, no. 9, pp. 1165-1175, Sept. 2010.
[6]   N.R.Mokhtar, Nor Hazlyna Harun, M.Y.Mashor, H.Roseline, Nazahah Mustafa, R.Adollah , H. Adilah, N.F.Mohd Nasir, "*Image Enhancement Techniques Using Local, Global, Bright, Dark and Partial Contrast Stretching For Acute Leukemia Images,*" Proceedings of the World Congress on Engineering, UK, vol. 1, 2009.
[7]   Raman Maini and Himanshu Aggarwal, "*A Comprehensive Review of Image Enhancement Techniques,*" Journal of Computing, vol. 2, no. 3, pp. 8 -13, 2010.
[8]   Rakhi Chanana, Er.Parneet Kaur Randhawa, Er.Navneet Singh Randhawa, "*Spatial Domain based Image Enhancement Techniques for Scanned Electron Microscope (SEM) images,*" International Journal of Computer Science Issues, vol. 8, no. 4, 2011.
[9]   Sitti Rachmawati Yahya, S. N. H. Sheikh Abdullah, K. Omar, M. S. Zakaria and C. -Y. Liong, "*Review on Image Enhancement methods of Old Manuscript with Damaged Background,*" International Journal on Electrical Engineering and Informatics, vol. 2, no. 1, 2010.
[10]   A. N. Netraveli and B. G. Haskell, *Digital Pictures: Representation and Compression*, New York: Plenum, 1988.