RESEARCHERID
THOMSON REUTERS

[INIT: January 2017] ISSN 2348 – 8034
Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

MULTISPECTRALIMAGE ENHANCEMENT THROUGH HISTOGRAM EQUALIZATION AND DECORRELATION STRETCHING

Priya M.S[*1] & Dr. G.M. Kadhar Nawaz[2]

[*1]Research Scholar, Bharathiar University, Coimbatore. Asso. Prof, Department of Computer Science St.Anne's F.G.C,Bangalore, India

[2]Director, Department of Computer Application Sona College of Technology, Salem, India

ABSTRACT

Image enhancement is basically improving the actual interpretability or perception of information in images for human viewers and providing greater input for other hard-wired image processing techniques. Multispectral images used in remote sensing are generally prepared for interpretation by selecting three of the image channels for display as red, green and blue components of an additive colour picture. Spectral information contained in the data is portrayed in the colours of the displayed picture. It is advantageous to create colourful pictures to convey as much spectral information as possible to the photo interpreter. Image enhancement algorithms offer a wide selection of approaches for modifying photographs to achieve visually appropriate images. The choice connected with such techniques is a function with the specific task, image content, observer characteristics, along with viewing conditions. The place processing methods are many primitive, yet essential image processing operations and are utilized primarily for contrast enhancement. Decorrelation stretching enhances the color separation of an image with significant band-to-band correlation. The exaggerated colors improve visual interpretation and make feature discrimination easier. The original color values of the image are mapped to a new set of color values with a wide range. The color intensities of each pixel are transformed into the color eigenspace of the NBANDS-by-NBANDS covariance or correlation matrix, stretched to equalize the band variances, and transformed back to the original color bands. Each image enhances differently depending on the distribution of colors, color space chosen, and whether the inverse transform is used to map the decorrelated colors back.

Keywords- *Image Enhancement; Histogram Equalization; Image Processing; Contrast Stretching; Decorrelation Stretching.*

I. INTRODUCTION

Imageenhancement is used to improve the quality of animage for visual perception of human beings. It is also usedfor low level vision applications. It is a task in which the setof pixel values of one image is transformed to a new set ofpixel values so that the new image formed is visually pleasingand is also more suitable for analysis. The main techniquesfor image enhancement are contrast stretching, slicing,and histogram equalization for gray scale images. The types of enhancement methods can broadly often be divided into Spatial Methods for Image Enhancement and Frequency Domain Methods for Image Enhancement. In spatial domain techniques, we directly deal with all the image pixels. Thepixel cost is manipulated to attain wanted enhancement. In frequency domaintechniques, the image is first transferred straight into frequency domain. Itmeans that, the Fourier Transform from the image is computed first. Every oneof the enhancement operations are performed for the Fourier transform of thespecific image and then the Reverse Fourier transform is performed to get theconcomitant image.

The goal of image enhancement is usually to improve interpretability or perception of info available within the images, making it suitable for human vision, as well as to provide improved input to the other automated image processing techniques.Decorrelation Stretch (DCS) is applied to the multi channel image enhancement. Image Adjust (IA) is primarily concentrate on adjusting the contrast and the quality of the entire image. Image noise (IN) is utilized to incorporate the noise within the image.Histogram equalization (HE) is amongst the effective and simple method of improving image quality. However, the standard histogram equalization methods [7] usually lead to excessive contrast enhancement/improvements. Other equally important methods [11] such as Adaptive Histogram Equalization (AHE), Histogram Equalization (HE), Decorrelation Stretch (DRS), Image Adjust (IA) and Image

ISSN 2348 – 8034
Impact Factor- 4.022

Noise (IN) are classified as the important ones. Adaptive Histogram Equalization (AHE) is primarily utilized in image processing techniques and it is helpful to increase the contrast within the images [13].Histogram Equalization (HE) is usually a contrast adjustment when using the image histogram, it enhances the global contrast of each and every pixel of the images.

II. LITERATURE REVIEW

The research on image enhancement techniques are large in number where a few have be studied and documented in this paper. Adaptive histogram equalization differs from ordinary histogram equalization in which the adaptive method computes several histograms, each corresponding to a distinct section. Hence, it is suitable in improving the neighborhood contrast of an effigy and bringing out more details. [2] Histogram equalization is a method in image processing of contrast adjustmentwhile using the image's histogram. This process usually improves the globalcontrast of countless images, especially when the usable data with the image isrepresented by close contrast values. Through this adjustment, the intensities areusually better distributed within the histogram. This gives for elements of lowerlocal contrast to get an increased contrast. Histogram equalization accomplishesthis by effectively spreading out the most frequent intensity values [7]. Brightness Preserving Bi-Histogram Equalization divided the whole picture histogram into two parts; the separation intensity is presented from the input mean brightness value, which can be the standard power of all pixels that construct the input image. Then separation processes, [8] both of these histograms are independently equalized. Using this method, the mean brightness on the resultant imagewill lie between input mean along with the middle gray level. The histogramwith vary from 0 to L-1 is split into two parts, with separating intensity. Dualistic Sub-Image Histogram Equalization (DSIHE) [18] follows identicalbasic idea of BBHE method. Toexpand the collection of brightness values in an incredible image thecontrast enhancement techniques are used, so the image can be efficiently shownin a manner desirable to the analyst [15]. The quantity of contrast in an image may vary due for you to poor illumination or unacceptable setting in the swap sensor device. [5]. A Decorrelation Stretch (DCS) is a method to maximize the difference concerningdifferent bands of data. By using eigen vectors and a covariance matrix, thedetails are "rotated" in to a whole new space where the values are then maximized as well as returned to the master copy space. Another method [17]suggests a practical implementation approach shot of decor relation as wellas linear contrast image enhancement technology in image processing. Themain goal is to extend the medical imaging for optical interpretation such ascerebral. Proposes two pre-processing techniques are implemented. [9] Equallytwo methods are largely used to improve the actual classification accuracy.Main purpose of this method is to enhance the interrupted images as well asimprove the classification effects.

III. IMAGE ENHANCEMENT

Spatial Domain techniques are based on direct manipulation of pixels in an image, whereas frequency domain techniques are based on modifying the Fourier transform of the image. The combination of spatial domain and frequency domain techniques [11] are also used to improve the quality of the image for a specific application. Spatial domain refers to the aggregate of pixels composing an image. Spatial domain methods are procedures that operate directly on these pixels. Spatial domain processes will be denoted by the expression:

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

where f(x,y) is the input image, g(x,y) is the processed image and T is an operator on f, defined over some neighbourhood of (x,y). T can operate on a set of input images.

ISSN 2348 – 8034
Impact Factor- 4.022

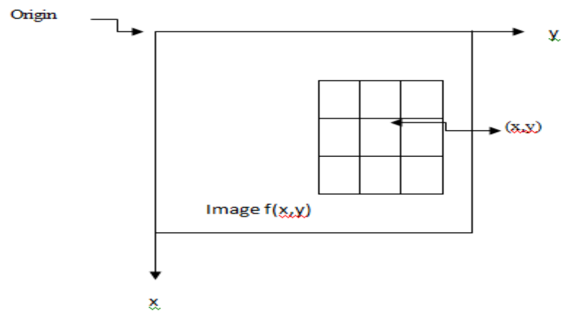

Fig. 1. A 3 x 3 neighbourhood about a point (x,y) in an image.

The simplest form of T, is when the neighbourhood of size 1x1 i.e., a single pixel. In this case, g depends on the value of f at (x, y), and T becomes a grey-level thus intensity of mapping transformation. The grey level transformation functions of the form:

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

where, r and s are variables denoting the grey level of f(x,y) and g(x,y) at any point (x,y).

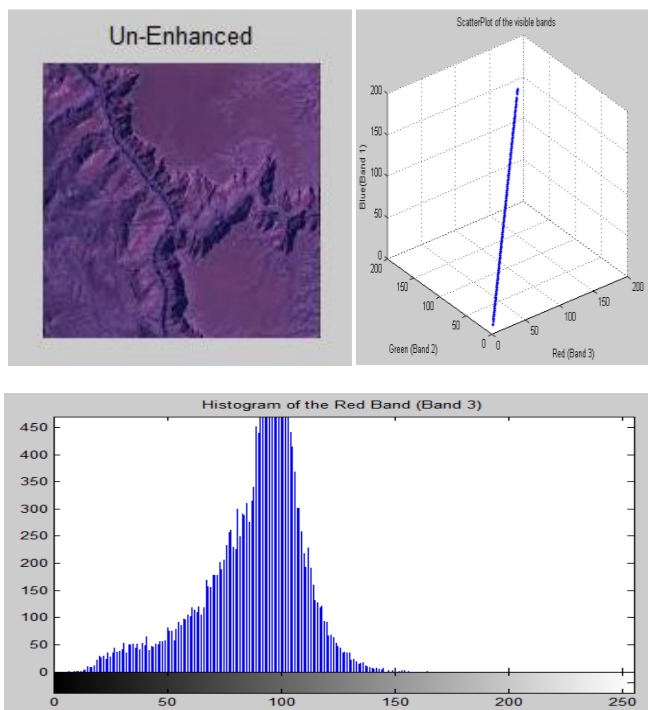

Fig. 2 Unenhanced Image – Scatterplot and Histogram of the Red Band

A. Contrast Stretching

Contrast stretching is a simple image enhancement technique that attempts to improve the contrast in an image by 'stretching' the range of intensity values it contains to span a desired range of values. Before stretching it is necessary to specify the upper and lower pixel value limits [4] over which the image is to be normalized. These limits will be the minimum and maximum pixel values that the image type concerned allows. For example, for 8-bit gray level images the lower and upper limits might be 0 and 255, which is represented as a, b in the function below:

$Pout = (\text{Pin} - \text{c})\left(\frac{\text{b}-\text{a}}{\text{d}-\text{c}}\right)$+a (3)

The image is scanned to find the lowest and highest pixel values present in the image as c and d and each pixel P is scaled using the above equation.

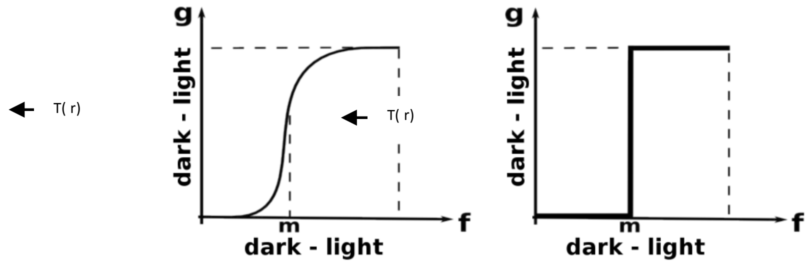

Fig. 3Transformation to every pixel

If s=T(r) has the form as shown in the fig.3 the effect of applying the transformation to every pixel of f to generate the corresponding pixels in g would produce higher contrast than the original image, by:

- Darkening the levels below m in the original image.
- Brightening the level above m in the original image.

Thus, contrast stretching is a simple image enhancement technique that improves the contrast in an image by stretching the range of intensity values it contains to span a desired range of values.

B. Histogram Equalization

Histogram Equalization is an automatic enhancement technique which produces an enhanced image that has a near uniformly distributed histogram. For continuous function, the intensity in an image may be viewed as a random variable with its probability density function. The probability density function at a gray level r represents the expected proportion of occurrence of gray level r in the image [8]. A transformation function has the form

s = T (r) = (L – 1)$\int_0^r p_r(w)dw$ (4)

where w is a variable of integration. The right side of the equation is called the Cumulative Distribution Function (CDF) of random variable r. For discrete gray level values, probabilities and summations are used instead of probability density functions and integrals [1]. Thus, the transform will be:

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) = (L-1)\sum_{j=0}^{k}\frac{n_j}{M \times N}$$

$$= \frac{(L-1)}{M \times N}\sum_{j=0}^{k} n_j \quad k = 0,1,2,\ldots,L-1 \qquad (5)$$

The right side of the equation is known as the cumulative histogram for the input image. This transformation is called histogram equalization or histogram linearization. Since a histogram is an approximation to a continuous probability density function, flat histograms are rare in applications of histogram equalization. Thus, the histogram equalization results in a near uniform histogram. It spreads the histogram of the input image so that the gray levels of the equalized image span a wider range of the gray scale. The net result is contrast enhancement.

C. Decorrelation Stretching

Decorrelation stretch is a linear, pixel-wise operation in which the specific parameters depend on the values of actual and desired image statistics. The purpose of a contrast stretch is to alter the distribution of the image values within the 0 -255 range of the display device and utilize the full range of values in a linear fashion. The Decorrelation stretch performs a stretch on the principal components of an image[10], not on the original image. A

ISSN 2348 – 8034
Impact Factor- 4.022

principal components transform converts a multiband image into a set of mutually orthogonal images portraying inter-band variance[3]. The vector containing the value of a given pixel in each band of the input image A is transformed into the corresponding pixel b in output image as follows:

b=T * (a – m) + m_target (6)

where a,b are nBands – by – 1 vectors, T is an nBands – by – nBands matrix, m and m_target are nBands – by – 1 vectors such that:

- m contains the mean of each band in the image, or in a subset of image pixels that you specify
- m_target contains the desired output mean in each band. The default choice is m_target=m.

The linear transformation matrix T depends on the band to band sample covariance of the image. Thus, the decorrelation stretch removes a mean from each band and normalizes each band by its standard deviation. Rotates the bands into the eigenspace of correlation and covariance and applies a stretch in the eigenspace, leaving the image decorrelated and normalized in the eigenspace. Then rotates back to the original band-space, where the bands remain decorrelated and normalized. Finally rescales and restores the mean in each band.

IV. RESULTS AND DISCUSSION

The quantity of contrast in an image may vary due to poor illumination or unacceptable setting in the swap sensor device. Therefore, there is a need to manipulate the particular contrast of an image in order to catch up on difficulties in image acquisition. For the images of this category can use contrast stretching to increase the dynamic range on the gray levels in the image being processed. The method is to modify the actual dynamic range of the specific grey levels [14] in the current image. The matlab function used for contrast stretching is J = imadjust(I) maps the intensity values in greyscale image I to new values in J such that 1% of data is saturated at low and high intensities of I. This increases the contrast of the output image J.

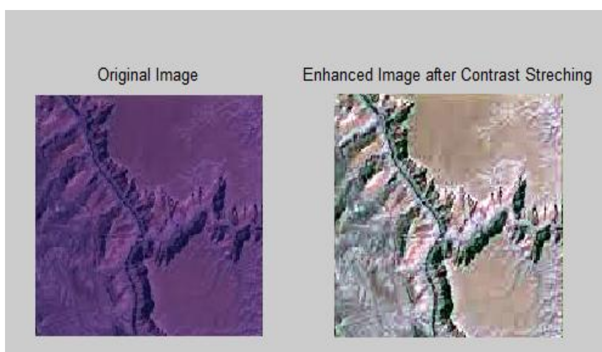

Fig. 4 Enhanced image after Contrast Stretch

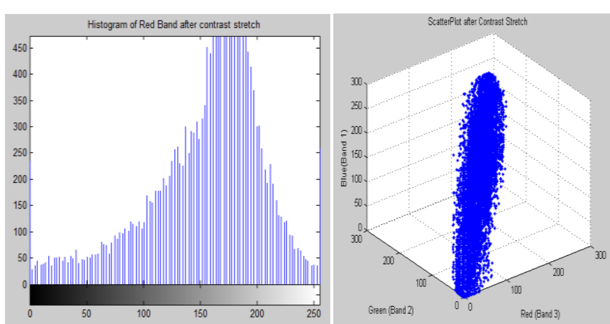

Fig. 5 Histogram and Scatterplot after Contrast Stretch

Histogram modeling is usually introduced using continuous, rather than discrete, process functions. Therefore, we suppose that the images of interest contain continuous intensity levels[6] (in the interval [0,1]) and that the

ISSN 2348 – 8034
Impact Factor- 4.022

transformation function *f* which maps an input image A(x,y) onto an output image B(x,y)is continuous within this interval.

The matlab function used for histogram equalization is histeq() that enhances the contrast [16] of images by transforming the values in an intensity image, or the values in the colormap of an indexed image, so that the histogram of the output image approximately matches a specified histogram.

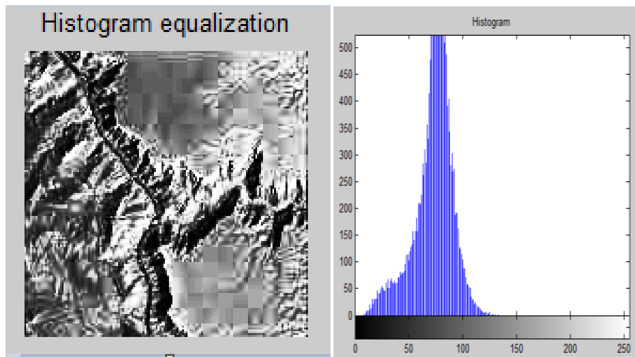

Fig. 6 Enhanced image after Histogram Equalization

Decorrelation stretch is a method to maximize the difference concerning different bands of data. By using Eigen vectors and a covariance matrix [12], the details are rotated into a whole new space where the values are then maximized as well as returned to the master copy space.The primary purpose of decorrelation stretch is visual enhancement. Decorrelation stretching is a way to enhance the color differences in an image [3].The matlab function used for decorrelation stretch is S = decorrstretch(A) applies a decorrelation stretch to an m-by-n-by-nBands image A and returns the result in S. S has the same size and class as A, and the mean and variance in each band are the same as in A. A can be an RGB image (nBands = 3) or can have any number of spectral bands.

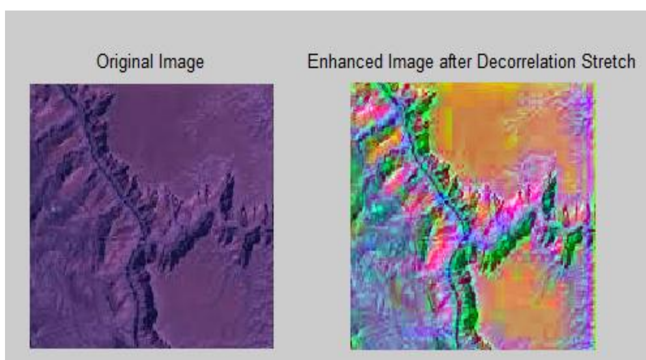

Fig. 7 Enhanced image after Decorrelation Stretch

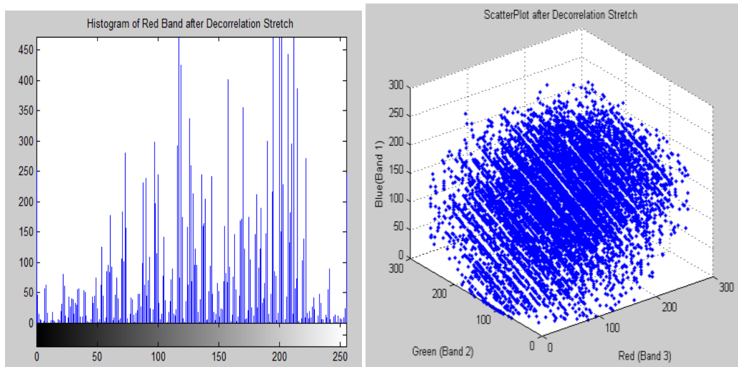

Fig. 8 Histogram and Scatterplot after Decorrelation Stretch

V.CONCLUSION

The histogram represents the frequency of occurrence of the various gray levels in the image. Its objective is to map an input image to anoutput image such that its histogram is uniform after the mapping. The main advantage of this technique is that pictures with very poor dynamic range can be enhanced. The main disadvantage of this method is that visual artefacts get introduced. Local enhancement is often necessary to enhance details over small areas. Influence of the number of pixels in these areas may be negligible on the computation of a global transformation, so the use of global histogram specification does not necessarily guarantee the desired local enhancement. Low-contrast images can occur often due to poor or non uniform lightening conditions, or due to non linearity, or small dynamic range in the image sensor. Contrast stretching enhances the low contrast images. The main goal of contrast stretching is to group the gray levels.A decorrelation stretch is especially useful for IR data where compositional information shows up as slight variations in emissivity or radiance between bands. Thus compositional variation gets maximized and it will show up as a different color in the decorrelation stretch.

REFERENCES

1. *A. Raju, Dwarakish. G.S, D. Venkat Reddy, "A Comparative Analysis of Histogram Equalization based Techniques for Contrast Enhancement and Brightness Preserving", International Journal of Signal Processing, Image Processing and Pattern RecognitionVol.6, No.5, pp.353-366, 2013.*
2. *Al Gyu-Hee Park, Haw- Hyan Cho, "A Contrast Enhancement Method using Dynamic Range Separate Histogram Equalization", IEEE Transactions on Communication, Networking and Broadcasting, pp. 1981-1987, 2008.*
3. *Alan R. Gillespie, "Enhancement of Multispectral Thermal Infrared Image: Decorrelation Contrast Stretching", Remote Sensing of Environment, pp. 147-155, 1992.*
4. *B.Chanda, D. Dutta Majumder, "Digital Image Processing and Analysis",PHI Learning Pvt, New Delhi, Second Edition, June 2011.*
5. *David Menotti, Laurent Najman, Jacques Facon, and Arnaldo de A. Araujo, "Multi-Histogram Equalization Methods for Contrast Enhancement and Brightness Preserving", IEEE Transactions on Consumer Electronics, Vol.53, pp.1186-1194, August 2007.*
6. *H. Zhu, F. H. Y. Chan, and F. K. Lam, "Image contrast enhancement by constrained local histogram equalization", Computer Vision and Image Understanding, vol. 73, no. 2, pp. 281 –290, 1999.*
7. *M. Abdullah-Al-Wadud, Md. Hasanul Kabir, M. Ali Akber Dewan, Oksam Chae,"A dynamic histogram equalization for image contrast enhancement", IEEE Transactions. Consumer Electron. vol. 53, no. 2, pp. 593 - 600, May2007.*
8. *M. Eramian and D. Mould, "Histogram equalization using neighbourhood metrics", Proc. The 2ndCanadian Conference on Computer and Robot Vision, pp. 397–404,2005.*
9. *Micha Kalfon and Moshe Porat, "A New Approach to Texture Recognition using Decorrelation was stretching", Journal of olden doffs Minerva center,2012.*
10. *N.A. Campbell, "The Decorrelation stretch transformation", International Journal of Remote Sensing, pp.1939-1949, 1996.*

11. *R. C. Gonzalez and R. E. Woods, Digital Image Processing. Upper Saddle River, NJ: Prentice-Hall, 2006.*
12. *S. E. Umbaugh, Computer Vision & Image Processing, Prentice Hall PTR,1998.*
13. *S. M. Pizer, E. P. Amburn, J. D. Austin, R. Cromartie, A. Geselowitz,T. Greer, B. T. H. Romeny, and J. B. Zimmerman, "Adaptive histogram equalization and its variations",Computer. Vision Graph. Image Process, vol. 39, no. 3, pp. 355–368, 1987.*
14. *S. Mukhopadhyay, B. Chanda, "A multiscale morphological approach to local contrast enhancement", Signal Processing, pp.685-696, 2000.*
15. *Soong-Der Chen and Abd. Rahman Ramli, "Contrast enhancement usingrecursive mean-separate histogram equalization for scalable brightnesspreservation", IEEE transactions on Consumer Electronics, Vol.49, pp.1301-1309, November 2003.*
16. *Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving", Butterworth-Heinemann, Elsevier, 2009.*
17. *Venkata Rasa.M, V.R.Anitha, B.Abdhul Rahim, VSRD International Journal of Electrical, Electronics and Communication Engineering, VSRD-IJEECE, Page: 402-410, 2001.*
18. *Y. Wang, Q. Chen, and B. Zhang, " Image enhancement based on equal area dualistic sub-image histogram equalization method", IEEE Trans. On Consumer Electronics, vol. 45, no. 1, pp. 68-75, Feb. 1999*