International Journal of Engineering Innovation & Research
Volume 3, Issue 1, ISSN: 2277 – 5668

A New Methodology in Contrast Enhancement Approach using Fusion Techniques

Sanju Kumari
M.Tech. Student,
RKDF Institute of Technology,
Rajiv Gandhi Technical University
Bhopal, M.P., India
Phone: +919975867733;
Email: sanjunew_year@yahoo.in

Mahesh Malviya
Assistant Professor
RKDF Institute of Technology
Rajiv Gandhi Technical University,
Bhopal, M.P., India
Phone: +918109756945;
Email: malviyamahesh12@gmail.com

Srikant Lade
Associate Professor, H.O.D of IT
RKDF Institute of Technology
Rajiv Gandhi Technical University,
Bhopal, M.P., India,
Phone: +919584952704;
Email: shrikantlade@yahoo.com

***Abstract* – The aim of image fusion is to combine relevant information from two or more source images into one single image such that the single image contains better information than all the source images. Fusion algorithms are categorized as the basic function algorithm and pyramid (Laplacian and Gaussian pyramid) based algorithm. Now a day's pyramid based algorithm is used mostly, the need of image fusion is to improve the quality of image for an object taken by different sensors. The fused image contains high spectral information as compared to simple one. The fusion process for different images acquired from different sensors is important for many applications such as medical imaging, microscopic imaging, remote sensing, computer vision and robotics etc. In this paper, we apply this technique to enhance the contrast of the image that improves the quality of visible image without introducing unrealistic visual appearances and is useful for improving quality of image with the modification of brightness differences in the dark (grayish) or bright regions at the expense of the brightness differences in the other regions. The proposed method improves the optimization problem that maximizes average local contrast and global contrast of an image. The quality of image is justified with the help of calculated entropy levels.**

***Keywords* – Contrast Enhancement, Image Fusion, Laplacian and Gaussian Pyramid Decomposition, Image Blending, Brightness.**

I. Introduction

Contrast enhancement improves the perceptibility of objects in the scene by enhancing the brightness difference between objects and their background [1]. This technique is used to optimize process noise and blur. Many digital contrast enhancement techniques have been used in order to optimize the visual quality of the image for human or machine vision through grayscale or histogram modification [2]. The Contrast of an image can be improved by different methods like basic function algorithm, pyramid based algorithm and fuzzy logic based algorithm but here we have considered pyramid based algorithm and the quality of an image is justified with the help of entropy levels. Higher entropy level image is better than the lower entropy level image. The entropy level of second order should more than the first order. The basic function algorithm describes spatial domain analysis while pyramid based algorithm describes the spatial and spectral analysis of an image. Pyramid based algorithm is complex than the basic one but response is better than this, these two methods are commonly known as direct and indirect methods respectively. Contrast measures the relative variation of the luminance/brightness in image and it is highly correlated to intensity gradient [3]. The problem of enhancing contrast of images enjoys much attention and spans a wide gamut of applications, ranging from improving visual quality of photographs acquired with poor illumination to medical imaging.

The direct method enhances the details by defining a function for contrast and indirect method improves the contrast without defining a specific contrast term [4]. Weber contrast is used to measure the local contrast of a small target of uniform brightness against a uniform background. These measurements are not effective for actual image with different lightning or shadows [5]. In this paper the fusion method is used to design a new contrast enhancement technique for images. The primitive fusion scheme performs the fusion right on the source images. This would include operations like averaging, addition, subtraction of the pixel intensities of the input images to be fused. These methods often have serious side effects such as reducing the contrast of the image as a whole. Here image fusion technique automatically blends different images of the same scene into a seamless rendering to find optimal contrast. Image fusion approach is based on a gradient domain technique that preserves important local perceptual cues while avoiding traditional problems such as aliasing. Technically this scheme contributes for asymmetrical fusion of multiple images to preserve useful features for improving the information density in an image. In addition, it has modified the method of image reconstruction from gradient fields to handle the boundary conditions to overcome integration artifacts. A fused image should be visible clearly and it should maintain smooth transition from background to foreground.

II. Fusion Techniques

Fusion technique is a process of combining the relevant information from a set of images, into a single image, wherein the output image will be more informative and complete than any of the input images. A simple fusion technique is the trivial image fusion techniques mainly perform very basic operations like pixel addition, subtraction or averaging. These methods are not always effective but sometimes critical based on the kind of image under consideration. Pyramid fusion technique is famous since decade of 1980's, an image pyramid consists of a set of low pass or band pass copies of an image, each copy representing patterning information of a different scale. This technique can be used to improve the quality of information from a set of images [6]. The basic idea is to construct the pyramid transform of the fused image from the pyramid transform of the source images and then fused image is obtained by taking inverse pyramid transform. Decomposition is the process where a pyramid is generated successively at each level of the fusion. The number of levels of fusion is pre decided. Decomposition phase basically consists of a number of steps. These steps are performed 1 number of times, 1 being the number of levels to which the fusion will be performed. Laplacian pyramid is decomposed into the set of components of band pass filtering images [8], while Gaussian pyramid decomposed in low pass component images. Laplacian pyramid decomposition integrates multisource information at the basic level and can provide more abundant, accurate and reliable detail information. This pyramid does not take into account regarding important details like edges, boundaries and salient features larger than a single pixel, while Gaussian pyramid decomposition involves creation of a series of images which are weight down using Gaussian averaging and scaled down. Pyramids are used in many applications like as image alignment, blending images, and data composition etc.

III. Grayscale Image Enhancement

Grayscale image enhancement is the task to transform of input image in such a way that visual clearity or less noisy output images are generated. This technique is basically improving the interpretability or perceptibility or perception of information in images for human viewers. Contrast enhancement techniques are used widely in image processing, producing digital images with good brightness/contrast and detail is a strong requirement in several areas like vision, remote sensing and biomedical image analysis. Here many automatic procedures are used as: histogram equalization (HE), contrast limited adaptive histogram equalization (CLAHE), Imadjust function. Histogram equalization is less effective when the contrast characteristics vary over the image. HE is a common technique for enhancing the appearance of images. HE spreads out intensity over brightness in higher contrast of output image. This technique is useful in image with background and foregrounds that are of low contrast, bright and dark [7]. CLAHE is used to improve contrast in images and differs from histogram equalization in the respect that the adaptive method. CLAHE improves with transforming each pixel with a transformation function derived from a neighborhood region. It was originally developed for medical imaging. Imadjust function maps the intensity values in gray scale image to new values. Laplacian operator uses multi derivatives: first order and second order derivatives. First order derivatives has a stronger response to gray level steps in an image and are less sensitive to noise while second orders have a stronger response to enhance sharp changes for an isolated noise point. Suppose I(x, y) be an Input image where x and y are the row and column by coordinates, any pixel location is calculated by applying two dimension derivatives.

First order derivative:

$$\nabla I(x,y)=\begin{bmatrix}G_x\\G_y\end{bmatrix}=\begin{bmatrix}\partial I(x,y)/\partial x\\\partial I(x,y)/\partial y\end{bmatrix} \quad ...(1)$$

Where G_x and G_y are approximated by

$$G_x = I(x,y)-I(x+1,y)$$
$$G_y = I(x,y)-I(x,y+1) \quad ...(2)$$

$$|\nabla I|=\sqrt{G_x^{\,2}+G_y^{\,2}} \quad ...(3)$$

Second order derivative:

$$\nabla^2 I(x,y)=\left[\frac{\partial^2 I}{\partial x^2}+\frac{\partial^2 I}{\partial y^2}\right] \quad ...(4)$$

$$\frac{\partial^2 I}{\partial x^2}=I(x+1,y)+I(x-1,y)-2I(x,y)$$

and

$$\frac{\partial^2 I}{\partial y^2}=I(x,y+1)+I(x,y-1)-2I(x,y)$$

So

$$\nabla^2 I(x,y)=[I(x+1,y)+I(x-1,y)+I(x,y+1)+I(x,y-1)-4I(x,y)] \quad ...(5)$$

The Laplacian operator highlights the gray level discontinuities, de-emphasizes slowly varying gray level changes and superimpose on a dark featureless background. The featureless background can be recovered by adding the original and Laplacian images if center is of positive coefficient and also recovered by subtracting if center is negative coefficient. Laplacian operator is isotropic in nature, easy to implement than gradient (on mask only) and more sensitive to noise.

So new image-

$$G(x,y)=\begin{Bmatrix}I(x,y)-\nabla^2 I(x,y)\\I(x,y)+\nabla^2 I(x,y)\end{Bmatrix} \quad ..(6)$$

The absolute value of the image gradient $|\nabla I|$ is taken as a simple indicator of the image contrast C and used as a metric to calculate the scalar weight map. The feature selection method selects the most salient pattern from the source and copies it to the composite pyramid, while discarding the least significant salient pattern [9].

$$F_i(x,y)=\begin{Bmatrix}A_i(x,y); if\ |A_i(x,y)|>|B_i(x,y)|\\B_i(x,y); Otherwise\end{Bmatrix} \quad ...(7)$$

Where A and B are the input images and F is the fused image and are $0 \le l \le N-1$.

Average is calculated as-

$$I_N(x,y)=\frac{A_N(x,y)+B_N(x,y)}{2} \quad ...(8)$$

International Journal of Engineering Innovation & Research
Volume 3, Issue 1, ISSN: 2277 – 5668

III. PROPOSED METHOD

The design of a general framework is to combine different fusion approaches and develop new approaches that combine aspects of pixel level image fusion. Although the fusion can be performed with more than two input images but this study has considered only two input images. The algorithm decomposes the input image using Laplacian pyramid algorithm and Gaussian pyramid algorithm. The new sets of detailed and approximate coefficients from each image are then added to get the new fused coefficients. The final step performs Laplacian pyramid reconstruction to construct the fused image. The algorithm is shown in fig 1. Here we describe the step by step procedure of the proposed image fusion technique. At first, the image to be segmented is taken as input in JPG format. The image is read by MATLAB with the help of *'imread'* command and returns the image data in the array RGB (M×N×3). Next, the image is converted from RGB to grayscale image with the help of 'rgb2gray' command. The fusion of various gray scale images is maintained by local contrast enhancement method. There are three techniques in image enhancement. These techniques are used for performing of fusion method. After that grayscale, contrast limited adaptive histogram equalization method is obtained with the help of the function *'adapthisteq'*. This technique can be limited in order to avoid noise. Next step is to call the histogram equalization to obtain with the help of function *'histeq'*. It is used for the value of intensity over brightness in order to achieve high contrast.

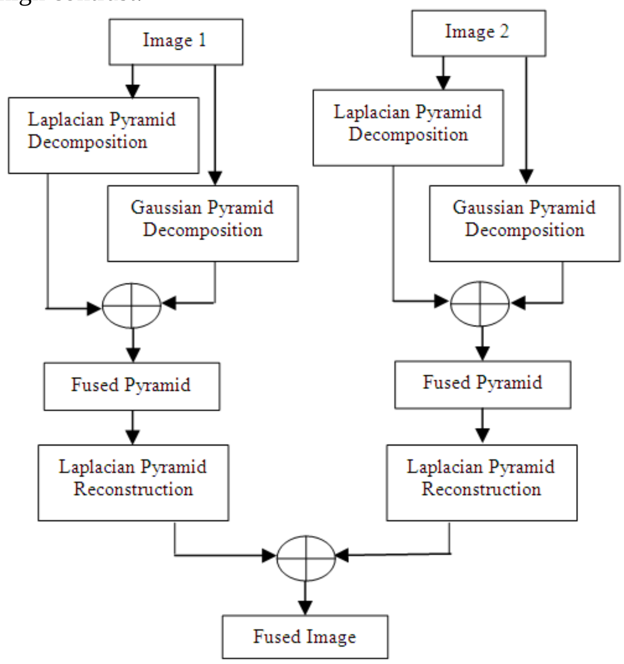


Fig.1. Block diagram of complete fusion process

Histogram equalization image information is then adjusted next by calling the *'imadjust' function*. The imadjust function improves the contrast of the images with narrow histograms. The proposed fusion technique for the contrast enhancement is implemented to get better response and finally reconstructing the fused image we get the better image of high contrast. The finally proposed algorithm of fusion techniques is shown in fig. 2. Final image is the reconstruction of fused pyramid image and we get which has good quality.

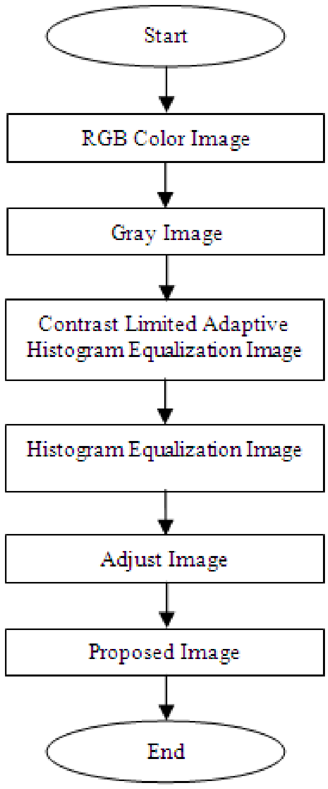


Fig.2. Main flow diagram

IV. EXPERIMENTAL RESULT

The proposed algorithm is coded with the MATLAB programming language. The algorithm steps behind the MATLAB fusion process are shown in fig. 2. So the proposed program can be interpreted as a function to carry out image enhancement process using fusion technique in MATLAB. Entropy has been used to measure the content of an image, with higher values indicating images which are richer in details. The first-order entropy corresponds to the global entropy as used for gray level image thresholding. The higher value of entropy indicates that image is of good quality, so it is necessary to evaluate the entropy value. Here Entropy for first order and second order is used to justify the quality of an image which is obtained preceded by different enhancement techniques. The Given image I of size m × n with L gray levels, the co-occurrence matrix T of the image is an L × L matrix which contains information about the transition of intensities between adjacent pixels. Let $t_{i,j}$ be the element corresponding to row i and column j of the matrix T defined as

$$t_{i,j} = \sum_{l=0}^{n-1}\sum_{k=0}^{m-1}\delta(l,k) \quad \ldots (9)$$

Where

International Journal of Engineering Innovation & Research
Volume 3, Issue 1, ISSN: 2277 – 5668

$$\delta(l,k)=1 \text{ if } \begin{pmatrix} I(l,k)=i, I(l,k+1)=j \\ or \\ I(l,k)=i, I(l+1,k)=j \end{pmatrix} \quad \text{...(10)}$$

$$\delta(l,k)=0 \qquad \text{Otherwise}$$

The probability of co-occurrence $p_{i,j}$ of gray levels *(i, j)* is estimated by

$$p_{i,j}=\frac{t_{i,j}}{\sum_{k=0}^{L-1}\sum_{l=0}^{L-1} t_{l,k}} \quad \text{… (11)}$$

and the second-order entropy H is estimated by

$$H=-\sum_j \sum_i p_{i,j}\log_2(p_{i,j}) \quad \text{… (12)}$$

The gray level values of images in tabular form are given below.

Table I: First order gray level Entropy of an image

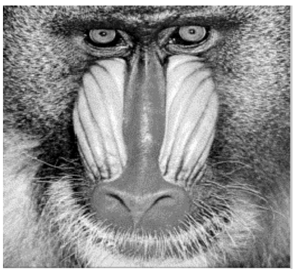
Image	Fig. No. 3	Fig. No. 4
Gray Image	6.4843	7.8081
HE Image	5.6354	5.9846
CLAHE Image	7.3321	7.8536
Imadjust Image	6.4007	7.7472
Proposed Image	7.5215	7.6839

The above table shows the entropy level for each image of fig. 3 and fig. 4. In proposed image entropy level is better than some images but the quality is also directly related with the perception of image so proposed image is good.

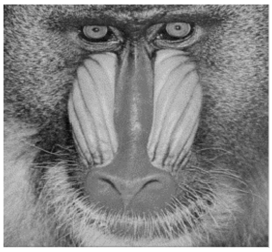
Table II: Second order gray level Entropy of an image

Image	Fig. No. 3	Fig. No. 4
Gray Image	11.7111	12.3749
HE Image	11.4941	12.2106
CLAHE Image	14.3840	12.3749
Adjust Image	11.7111	13.6222
Proposed Image	12.2547	12.2414

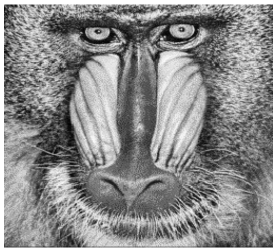
The entropy of second order gray level is higher than the first order that means it gives better response than the first order. Here the experimentation of the proposed technique over a number of sample images is done and some of the results are displayed in fig. 3 and 4. We can see that the images obtained by fusion technique are different to other ways. The images in fig. 3 and 4 show the results on monochrome images Mandrill and Lena, respectively.



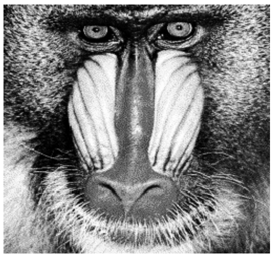
(a) Original Mandrill Image



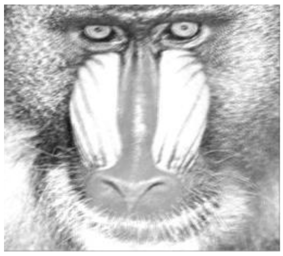
(b) CLAHE Image



(c) HE Image



(d) Imadjust Image



(e) Proposed Image

Fig.3. Experimental results for Mandrill Image

(a) Original Lena Image

(b) CLAHE Image

(c) HE Image

(d) Imadjust Image

(e) Proposed Image

Fig.4. Experimental results for Lena Image

The CLAHE, HE, IMADJUST and Fused operators are applied to the images. Entropy has been used to measure the content fan image, with higher values indicating images which are richer in details as shown in above in table.

V. CONCLUSION

This paper presents a new method of fusion based contrast enhancement for grayscale and color images. All the methods using MATLAB programming are implemented to get the optimal response. It has good noise optimization capability as the technique used for enhancing the contrast of image. This methodology is well suited for many applications in medical imaging. The results are promising and image fusion techniques open a new perspective for contrast and quality enhancement in different imaging applications. Image fusion method is tested and comparison is shown to justify the image quality of different images with its entropy levels.

REFERENCES

[1] Gonzalez RC, Woods RE, "Digital Image Processing". Upper Saddle River, NJ: Prentice-Hall, 2002.

[2] Beghdadi A, Negrate AL, "Contrast enhancement technique based on local detection of edges", *Comp. Visual Graph Image Process* 1989, Vol. 46, pp. 162-274.

[3] Amina Saleem, Azeddine Beghdadi and Boualem Boashash, "Image fusion-based contrast enhancement", *Paris: Springer-Verlag*, 2012.

[4] Tang J, Peli E and Acton S, "Image enhancement using a contrast measure in the compressed domain". *IEEE Signal Process Lett 2003*, Vol.10, pp. 289-292.

[5] Tang J, Kim J, and Peli E, "Image enhancement in the JPEG domain for people with vision impairment*". IEEE Trans Biomed Eng*, Vol.51, pp. 2013-2023, 2004.

[6] Shivsubramani Krishnamoorthy, K P Soman, "Implementation and Comparative Study of Image Fusion Algorithms", *Int. Jour. of Computer Application*, Vol. 9, Nov 2010, pp. 25-35.

[7] Stark JA: Adaptive image contrast enhancement using generalizations of Histogram equalization. *IEEE Trans Image Process*, Vol. 9, pp. 889-896, 2000.

[8] Burt P, Adelson T, "The Laplacian pyramid as a compact image code", *IEEE Trans Comm.*, Vol.31, pp. 532-540, 1983.

[9] N.Indhumadhi, G.Padmavathi, "Enhance Image Fusion Algorithm using Laplacian and Spatial Frequency based Wavelet Algorithm", *in proc. Int. Journal of Soft Computing & Engineering* , Vol. 1, Nov 2011, pp. 2231-2307.