International Journal of Engineering Innovation & Research
Volume 2, Issue 3, ISSN: 2277 – 5668

Entropy Enhancement Using Image Fusion Techniques Based on Laplacian and Gaussian Pyramid Decomposition

Amita Jain, Sumit Sharma

***Abstract* – The quality of an image directly related with its visual clarity (perception quality), resolution and contrast, in image fusion process it is combined appropriate information from two or more source images into one single image such that the fused or output modified image contains most of the information from parent images. Here the two categories of image fusion algorithms are implemented, the basic function algorithm and pyramid based algorithm. Pyramid based algorithm means that Laplacian and Gaussian pyramid decomposition. The successful fusion images acquired from different instruments is great important in many applications such as medical imaging, microscopic imaging, remote sensing, computer vision and robotics. In this paper, we apply this fact effectively design a contrast enhancement method for images that improves the quality of visible image without introducing unrealistic visual appearances. Entropy Enhancement is a useful technique for improving image of brightness differences in the dark, gray or bright regions as compare to 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.**

***Keywords* – Entropy Enhancement, Image Fusion Techniques, Laplacian and Gaussian Pyramid Decomposition, Contrast Improvements, Perception Quality.**

I. Introduction

The problem of enhancing Entropy 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. There are two main techniques for contrast enhancement: direct and indirect methods. The direct methods enhance the details by defining a function for contrast and indirect methods; improve the contrast without defining a specific contrast term [4]. Quality of an image is the important parameter for perceptibility of objects in the scene by enhancing the brightness difference between objects and their background [1].

This technique is removing noise and blur, coding artifact reduction and improves contrast of an image. 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]. Contrast measures the relative variation of the luminance/brightness in image and it is highly correlated to intensity gradient [3]. 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]. Here, we use the fusion method to design a new contrast enhancement technique for images. The proposed image fusion approach is based on a gradient domain technique that preserves important local perceptual cues while avoiding traditional problems such as aliasing. Here technical contribution is a scheme for asymmetrical fusing multiple images preserving useful features to improve the information density in an image. In addition, we modify 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. Fusion method is a technique to improve the quality of information for a set of images. Today's fusion are good information from each of the given images is fused together to form a resultant image whose quality is superior to any of the input 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 are mostly not so appropriate such as reducing the contrast of the image as a whole. Here a class of image fusion techniques is used to automatically blend different images of the same scene into a seamless rendering.

II. Image Fusion Techniques Based on Laplacian and Gaussian Pyramid Decomposition

The mixing of appropriate information of all natural images to form a good image, this process is accurately known fusion technique, wherein the output image will be more informative and complete than any of the input images. In this section, the set of image fusion techniques are considered and also categorized under three subsections: simple image fusion, pyramid decomposition and discrete wavelet transform based on fusion. A simple fusion technique is the complex technique which mainly performs very fundamental operations like pixel addition, subtraction or averaging. These methods are not so appropriate always effective but are at times critical based on the kind of image under consideration. Pyramid fusion technique is the decade of 1980's saw the introduction of pyramid transform a fusion method in the transfer domain. An image pyramid contains a set of low pass or band pass forms of an original image; a single module represents pattern wise information of a different scale. This technique can be used to improve the quality of information from a set of images [6]. The fundamental terminology 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 by which a pyramid is generated successively at each level of the fusion. There are number of steps are generated by the decomposition of phase. Fusion is pre decided. Decomposition phase basically consists of the 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 filtered images. Laplacian pyramid decomposition components multisource information at the basic level and can provide more abundant, accurate and reliable information. This pyramid does not take into account important details like edges, boundaries and salient features larger than a single pixel, while Gaussian pyramid decomposition involves creating a series of images which are weighted down using Gaussian averaging and scaling down. Pyramids are used in many applications like as image alignment, blending images, and data composition are maintained by pyramids.

III. Entropy Grayscale Image Enhancement

Image enhancement of gray scale is the task to transform the input image such as visually clear or less noisy output images. This technique is basically improving the interpretability or perceptibility or perception quality for 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 different areas like vision, remote sensing, biomedical image analysis, fault detection. Many automatic techniques are used in this process, i.e., histogram equalization (HE), contrast limited adaptive histogram equalization (CLAHE), Imadjust function. Histogram equalization is less effective when the contrast characteristics vary across 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 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. The adjust function maps the intensity values in gray scale image to new values. Contrast measure is used in Laplacian operator. Laplacian operator is used multi-derivatives: first order and second order derivatives. First order derivatives have a stronger response to gray level steps in an image and are less sensitive to noise. Second orders have a stronger response to a line than to a step and to a point than to a line. It is more powerful than first order derivative in enhancing sharp changes at the boundaries. Input image I(x, y) where x and y are the row and column by coordinates, any pixel location is calculated by applying two dimension derivatives.

First order derivative:

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

Where G_x and G_y are approximated by

$$G_x = I(x,y)-I(x+1,y)$$
$$G_y = I(x,y)-I(x,y+1) \quad \ldots (2)$$
$$|\nabla I|=\sqrt{G_x{}^2+G_y{}^2} \quad \ldots (3)$$

Second order derivative:

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

$$\frac{\partial^2 I}{\partial x^2}=I(x+1,y)+I(x-1,y)-2I(x,y)$$
$$\frac{\partial^2 I}{\partial y^2}=I(x,y+1)+I(x,y-1)-2I(x,y) \quad \ldots (5)$$

$$\nabla^2 I(x,y)=[I(x+1,y)+I(x-1,y)+I(x,y+1)+I(x,y-1)-4I(x,y)] \quad \ldots (6)$$

The Laplacian operator high lights the gray level discontinuities, deemphasizes 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 positive coefficient or subtraction, if center is negative coefficient.

So new image-

$$G(x,y)=\begin{Bmatrix}I(x,y)-\nabla^2 I(x,y)\\ I(x,y)+\nabla^2 I(x,y)\end{Bmatrix} \quad \ldots. (7)$$

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 appropriate pattern from the source and copies it to the composite pyramid, while discarding the least significant salient pattern [9].

$$F_i(x,y)=\begin{Bmatrix}A_i(x,y),\ldots if\ |A_i(x,y)|>|B_i(x,y)|\\ B_i(x,y)\ldots\ldots\ldots\ldots\ldots Otherwise\end{Bmatrix} \quad \ldots. (8)$$

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-

$$I_N(x,y)=\frac{A_N(x,y)+B_N(x,y)}{2} \quad \ldots (9)$$

IV. Proposed Method

The general framework for combination of different image improvement approaches and develops new approaches that combine aspects of pixel level in image fusion. This work focuses on both these requirements and proposes a new method that integrates the Laplacian

International Journal of Engineering Innovation & Research
Volume 2, Issue 3, ISSN: 2277 – 5668

pyramid decomposition and Gaussian pyramid decomposition. Although the fusion can be performed with more than two input images, this study considers 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. At the last performs Laplacian pyramid reconstruction is done to construct the fused image. The algorithm is shown in figure 1.

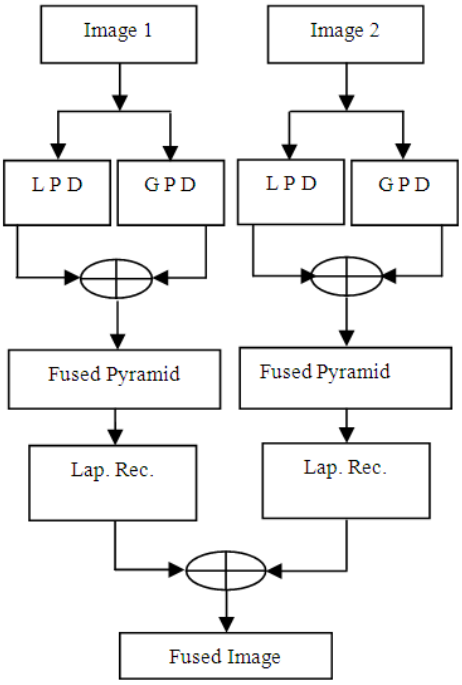


Fig.1. Block diagram of Image Fusion Techniques

Here the step by step procedure of the proposed image fusion technique is followed. 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. Histogram equalization image informations are then adjusted next by calling the *'imadjust' function*. The imadjust function improves the contrast of the images with narrow histograms. Final step performs the proposed fusion technique for the contrast enhancement. Final image is the reconstruction of fused pyramid image and we get which has good quality.

V. Experimental Results

The proposed algorithm is coded with the MATLAB programming language. The steps of algorithm 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 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. The Entropy of the gray level values of images in tabular form is given below.

Table 1: Shows Entropy Enhancement using Image Fusion Techniques based on Laplacian and Gaussian Pyramid Decomposition

Images	Winter Image	Water Lilies Image
Gray Image	6.5431	7.0261
HE Image	6.8209	7.2491
CLAHE Image	7.5622	7.8620
Adjust Image	6.1957	6.5153
Proposed Image	10.4616	10.8685

Above table shows the entropy of different images used in our proposed method.

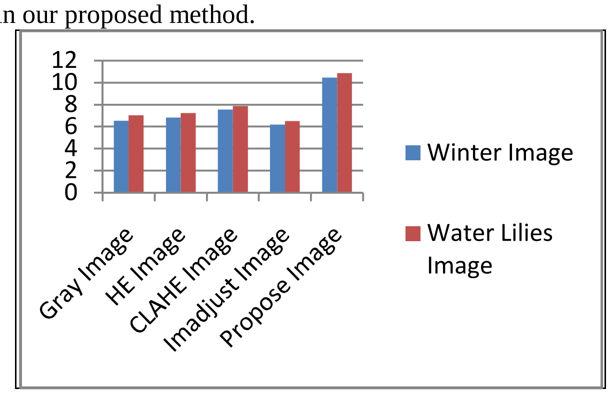
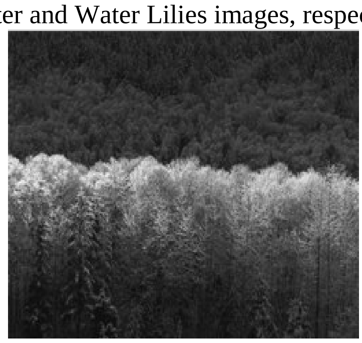


Fig.2 Shows Graph of Entropy Enhancement of Images

The experimentation of the proposed technique over a number of sample images and some of the results are displayed in fig. 3 and 4. We can see that the fused as obtained by MATLAB technique are different to other ways. fig. 3 and 4 shows the results on monochrome images Winter and Water Lilies images, respectively.



(i). Original Winter Image


(ii). CLAHE Image


(iii). HE Image


(iv). Imadjust Image


(v). Proposed Image

Fig.3. Experimental results for Winter Image


(i). Original Water Lilies Image


(ii). CLAHE Image


(iii). HE Image


(iv). Imadjust Image


(v). Proposed Image

Fig.4. Experimental results for Water Lilies Image

The CLAHE, HE, ADJUST 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 below in table.

VI. Conclusion

This paper presents a new method of fusion based Entropy enhancement for grayscale and color images. Here, we have proposed a new fusion based enhancement methods using in MATLAB programming. It has good noise removal capability as the technique using image fusion. This methodology is well suited for application in medical imaging. The results are promising and image fusion methods or techniques open a new perspective for enhancement applications. Image fusion method is test and comparison of the result with different images with contrast metrics.

References

[1] Gonzalez RC, Woods RE: Digital Image Processing Prentice Hall, Upper Saddle River, NJ; 2002.
[2] Beghdadi A, Negrate AL: Contrast enhancement technique based on local detection of edges. Comput Visual Graph Image Process 1989,46:162-274.
[3] Amina Saleem, Azeddine Beghdadi and Boualem Boashash “Image fusion-based contrast enhancement”, EURASIP Journal on Image and Video Processing 2012, 2012:10.
[4] Tang J, Peli E, Acton S: Image enhancement using a contrast measure in the compressed domain. IEEE Signal Process Lett 2003, 10(10):289-292
[5] Tang J, Kim J, Peli E: Image enhancement in the JPEG domain for people with vision impairment. IEEE Trans Biomed Eng 2004, 51(11):2013-2023.
[6] Shivsubramani Krishnamoorthy, K P Soman. “Implementation and Comparative Study of Image Fusion Algorithms”, IJCA (0975 – 8887) Volume 9– No.2, November 2010.
[7] Stark JA: Adaptive image contrast enhancement using generalizations of Histogram equalization. IEEE Trans Image Process 2000, 9(5):889-896.
[8] Burt P, Adelson T: The Laplacian pyramid as a compact image code. IEEE Trans Commun 1983, COM-31:532-540.
[9] N.Indhumadhi, G.Padmavathi “Enhance Image fusion algorithm using Laplacian and Spatial frequency based Wavelet Algorithm”,IJSCE(2231-2307) Volume-1,Issue-5, November 2011.

Author’s Profile

Amita Jain
is the M. E.., Student of Shri Ram Institute of Technology Jabalpur, Rajiv Gandhi Technical University Bhopal, M.P., India.
Phone: + 917489080441; Email: jainamita2004@gmail.com

Sumit Sharma
is the HOD of Shri Ram Institute of Technology Jabalpur, Rajiv Gandhi Technical University, Bhopal, M.P., India,
Phone: +91 9893389365