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IMAGE FUSION: A NOVEL APPROACH

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Abstract: An image fusion is from a combination of two or more source images corresponding to the image information into a single process. The information displayed in the modified image of the combination shows a higher quality. The quality of an image depends on its perception quality, resolution and contrast. In this paper, we have applied Pyramid Decomposition based on image fusion techniques, which means Laplacian and Gaussian pyramid decomposition. Good quality of fused images in many research results are applied to remote sensing, robotics, microscopy, medical field. The results show the quality of image is advanced as well as better brightness in dark, gray or bright regions also.

Keywords: Pyramid Decomposition, Histogram Image, Image Fusion , Perception Quality.

INTRODUCTION

The better quality of an image shows the different parameter for perceptibility of Quality of an image is the important parameter for perceptibility of substances in the scene by enhancing the brightness difference between substances and their background [1]. The enhancing contrast of images much attention and spans a wide range of applications, ranging from improving visual quality of photographs acquired with poor illumination to medical imaging. Basically, two techniques for contrast enhancement, direct methods 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 [2]. Contrast measures the relative variation of the luminance/brightness in image and it is highly correlated to intensity gradient [3]. Many digital contrast enhancement techniques have been used in order to optimize the visual quality of the image for human or machine vision through gray-scale or histogram modification [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, we have used fusion techniques to improve the quality of image with respect to brightness in dark and other regions. The proposed image fusion approach is based on a pyramid decomposition technique that conserves important local perceptual cues while avoiding traditional problems.

GAUSSIAN AND LAPLACIAN PYRAMID DECOMPOSITION

The Fusion techniques are classified as three subsections: simple image fusion, pyramid decomposition and discrete wavelet transform based on fusion. A simple image fusion technique is the composite technique which mainly performs very fundamental operations like pixel addition, subtraction or averaging. These operations are not suitable always effectively for image. Decomposition is the procedure by which a pyramid is generated successively at each level of the fusion. Pyramid decomposition fusion technique is the introduction of pyramid transforms 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]. Decomposition can be classified as Laplacian Pyramid decomposition and Gaussian Pyramid Decomposition.

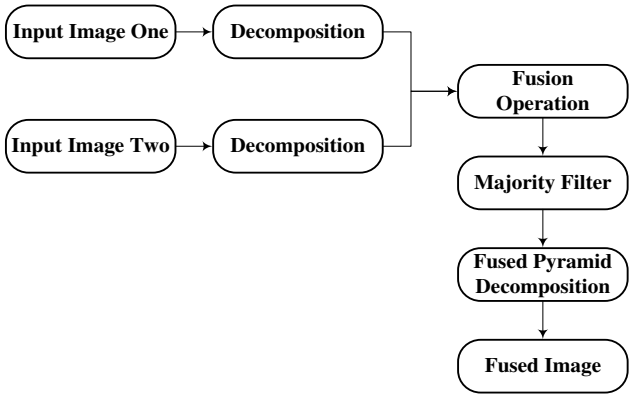

Figure.1. Laplacian Pyramid Decomposition

IMAGE ENHANCEMENT

Image enhancement or contrast enhancement of gray scale is to convert the input image into less noisy output images. This technique is basically improving the interpretability or perceptibility or perception quality for images for human viewers and used widely in image processing. Many usual 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. It is a common technique for enhancing the appearance of images. It 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 Imadjust 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:

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

Where G_x and G_y are approximated by

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

$$G_y = I(x,y)-I(x,y+1) \quad (3)$$

Second order derivative:

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

$$\begin{cases}\dfrac{\partial^2 I}{\partial x^2} = I(x+1,y)+I(x-1,y)-2I(x,y)\\[2ex] \dfrac{\partial^2 I}{\partial y^2} = I(x,y+1)+I(x,y-1)-2I(x,y)\end{cases} \quad (5)$$

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

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:

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

The absolute value of the image gradient | 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].

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

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

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

OUR PROPOSED METHOD

This effort focuses on Pyramid decomposition that integrates the Laplacian pyramid decomposition and Gaussian pyramid decomposition. The fusion can be performed with more than two input images, in this paper, we considers only two input images. 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 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 gray-scale 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 grays-cale, 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 *'histep'*. It is used for the value of intensity over brightness in order to achieve high contrast. Histogram equalization image information"s 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.

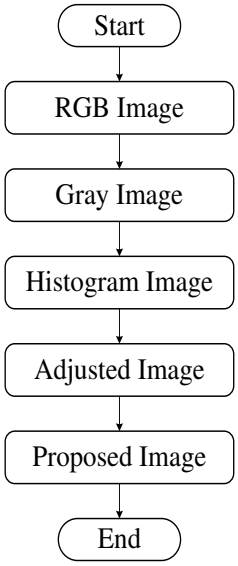

Figure.2. Fused image using Pyramid Decomposition

Final image is the reconstruction of fused pyramid image and we get which has good quality.

EXPERIMENTAL SETUP AND RESULTS

The proposed method is coded with the MATLAB programming. Entropy is 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. Following different GUI windows shows the different analytical results for Lena.jpg image. Images may be used different for different analysis platforms.

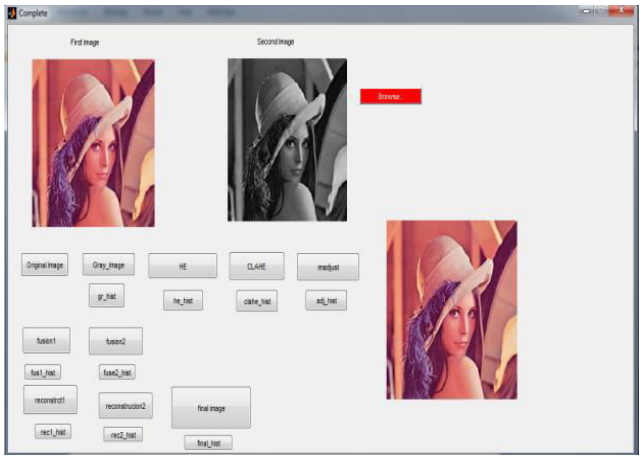

Figure.3. GUI window for color image.

Above figure 3 shows the color image of lena using GUI, Matlab window

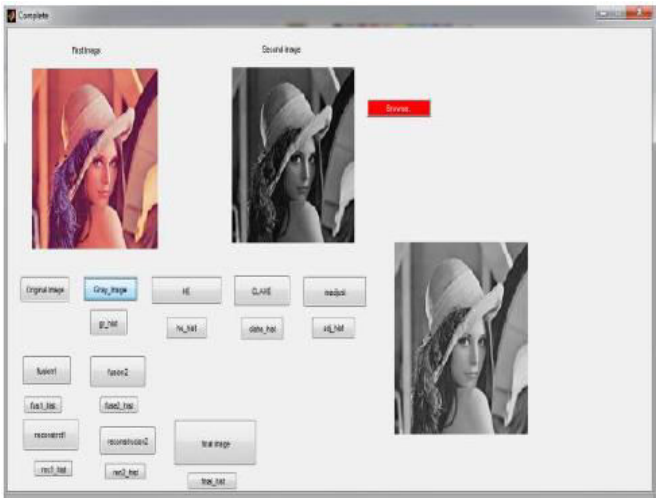

Figure.4. GUI window for Gray scale image.

Figure 4 shows the gray scale image, it is converted image using color image.

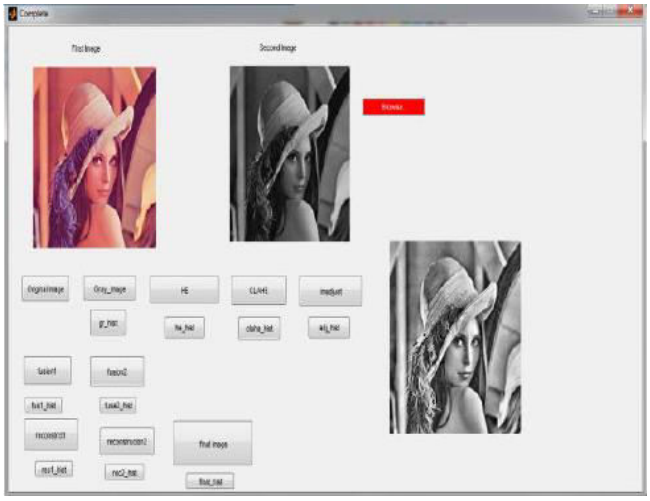

Figure.5. GUI window for CLAHE image.

For Contrast limited adaptive histogram equalization (CLAHE) image GUI window is shown above.

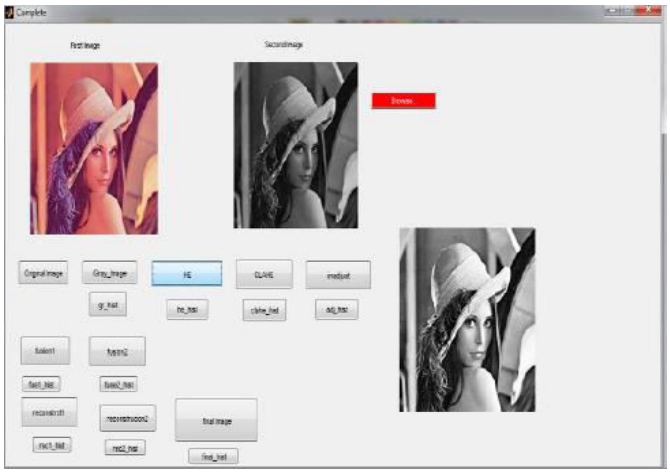

Figure. 6 GUI window for CLAHE image.

As per flow diagram of proposed algorithms image is converted into histogram equalization (HE) image as shown figure 6. Image quality of input image is also not powerful as our requirements. The image is further modified into Imadjust image as shown in figure 7.

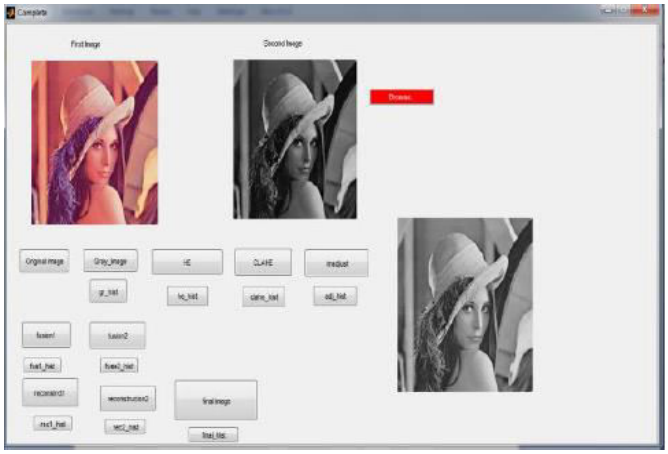

Figure.7. GUI window for Imadjust image.

Figure 7 shows the Imadjust image of input image.

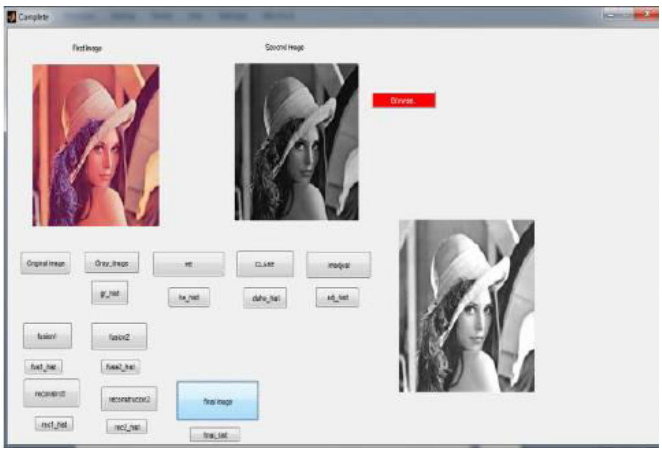

Figure.8. GUI window for Proposed image.

Finally, a figure 8 GUI window shows the proposed image with good quality of perceptibility.

Figure.9. GUI window for Proposed Histogram image.

All GUI windows shows the various figure according to various methods, But proposed method shows the better quality of input image with respect to entropy enhancements. Entropy is used to measure the content of image, with higher values indicating images which are richer in details.

CONCLUSION

This paper presents a new method of fusion based on Pyramid decomposition contrast enhancement for gray-scale and color images. We have implemented this techniques using Matlab, GUI programming windows. We have analyzed different methods, but we have analyzed proposed method is good noise removal capability as the technique using image fusion, removing noise is always hard for image processing[10], the current algorithm ranging from deep learning based to metric learning based[11] approach. This methodology is well suited for application in medical imaging and robotics. The proposed method shows positive potential result, and image fusion technique open a new perspective for enhancement applications.

In the future, we would like to introduce some information theory based method[12] and mathematical model based algorithms[13][14][15] to optimize our method.

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