



IMAGE FUSION USING LP AND MR METHODS

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ABSTRACT

One of the important factors in digital image processing is visualization. In visualization information is transformed into compact form. Laplacian Pyramid methods combine information of images from different sources. The objective of multiresolution study is to compare different techniques. Multiresolution produces most accurate efficient information of image. The present paper concentrates on combining the Laplacian pyramid and multiresolution. The final fused image consist efficient visualization information and technically giving the better results with performance metrics such as Mean, RMSE, PSNR, and PFE.

Keywords: Fusion, Laplacian pyramid, Multi-Resolution, Visualization, Image Efficiency

I INTRODUCTION

The main aim of image fusion is that to collect relevant information from two or more sources and represent it in single form. The final form of image always consist relevant information regarding with all sources. To analyze the information in image fusion is a technique which acquires the data from different sources. In fusion different sensors are used with different physical features to extract more accurate information. Further seen of the image analyzed by machine or human visualization perception.

There are so many approaches are available in image fusion but they are basically classified into four categories. They are

1. Pixel Level
2. Feature Level
3. Decision Level
4. Symbol Level

With respect to studies synthesis approaches also classified into spatial and transform domain methods. In spatial domain features extracted from the image itself whereas in transform domain coefficients are calculated for the source on some basis further features are extracted. Multi-Scale techniques are used in most of the fusion approaches with weighted, scale, average scale methods.

It is essential to consider two factors. Such as reduction of error and improving the clarity in image fusion algorithms. Optimization algorithms are used to improve the clarity in glow resolution reasons. The main measures used to apply in image fusion are PSNR and RMSE at pixel level, entropy and PFE at feature level.



METHODOLOGY

To define image with multiresolution in 1983 Adelson and Burt proposed decomposition method which peaces the image into multiple sub images with different resolution by executing mathematical functionalities. Gaussian pyramid is base for Laplacian pyramid, where Multiscale is obtained from iterative low pass filtering and decimation. Laplacian pyramid is separated into two steps [4]. They are

1. Gaussian pyramid decomposition
2. Laplacian pyramid decomposition

In order to detect huge amount of surplus information generated as of Gaussian pyramid decomposition, Laplacian pyramid decomposition is applied. Band pass filtering is applied in Laplacian pyramid to get difference between two adjacent images.

Let G^*l is image obtained by G_{l-1} , where G^*l is having same size has G_{l-1} . The expanding function is calculated as

$$G^*l = \text{Expand}(G_l) \quad \text{Eq - 1}$$

Further the expand operator has been

$$G_l^*(i, j) = 4 \sum_{m=-2}^2 \sum_{n=-2}^2 \omega(m, n) G_l\left(\frac{i+m}{2}, \frac{j+n}{2}\right) \quad 1 \leq l \leq N, 0 \leq i < R_p, 0 \leq j < C_l \quad \text{Eq - 2}$$

$$G_l^*\left(\frac{i+m}{2}, \frac{j+n}{2}\right) = \begin{cases} G_l\left(\frac{i+m}{2}, \frac{j+n}{2}\right), & \frac{i+m}{2}, \frac{j+n}{2} \in \mathbb{Z} \\ 0, & \text{otherwise} \end{cases} \quad \text{Eq - 3}$$

Set

$$\begin{cases} LP_l = G_l - G_{l+1}^*, & 0 \leq l < N \\ LP_N = G_N, & l = N \end{cases} \quad \text{Eq - 4}$$

2.1. Fusion Approach

Laplacian pyramid determines edge of the image at each levels, it is to possible to generate a fused image with different Laplacian levels by merging outstanding details of each level. Further all the levels information is integrated has single image which retains information as rich as possible.

Choosing of integration factor by applying fusion rule always reflects on final image of fused image. Generally to say, there are two methods available in image fusion.

1. Pixel based
2. Region based

In pixel based, there is less computation and visually poor, because local characteristics of image are not each other, it is essential to design new fusion operator with a neighboring technology is possible in only region based method. This fusion strategy is as shown in Fig.1.

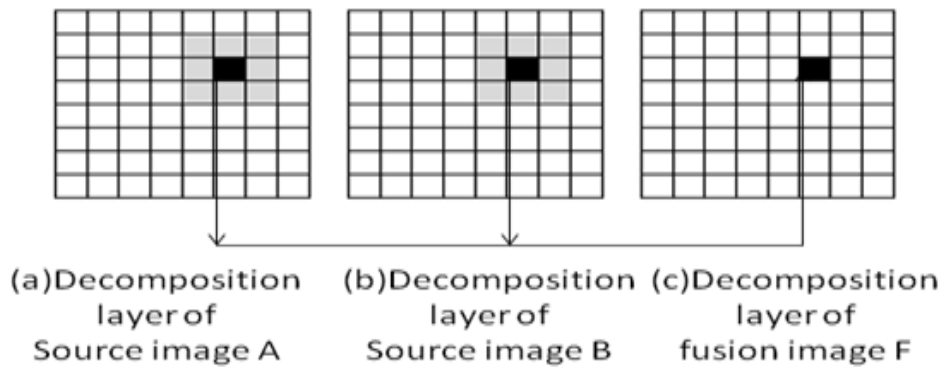


Figure.1. Fusion Strategy based on region

2.2. Basic steps in image fusion

1. Generally Laplacian pyramid for each image.
2. Different decomposed pyramid layers are considered separately to fuse the image.
3. To reconstruct the image inverse pyramid transform method is applied for fused image.

2.3. Psedocode

A necessary steps for the algorithm as follows.

For i=1 to n do // every source images

 LP decomposition & establish LP for each image.

Endfor

For the Nth level Laplacian pyramid do

 If ($D^A(m, n) \geq D^B(m, n)$ and $(E^A(m, n) \geq E^B(m, n))$) then

$LP_N^F(m, n) = LP_N^A(m, n)$

 Else if ($D^A(m, n) < D^B(m, n)$) and $(E^A(m, n) < E^B(m, n))$ then

$LP_N^F(m, n) = LP_N^B(m, n)$

 Else

$LP_N^F(m, n) = (LP_N^A(m, n) + LP_N^B(m, n))/2$

 Endif

Endfor

For the further levels Laplacian pyramid do

 If ($|RE^A_l(i, j)| \geq |RE^B_l(i, j)|$) then

$LP_l^F(m, n) = LP_l^A(m, n)$

 Else

$LP_l^F(m, n) = LP_l^B(m, n)$

 Endif

Endfor

Perform opposite Laplacian pyramid transform, and get the synthesized image.

To enhance the feature extraction of the fused image multi-resolution method [3] [1] is applied for Laplacian pyramid fused image. The below Fig. 2 depict a flow graph of proposed algorithm.

2.4. Steps

1. Read the image of Laplacian pyramid output
2. Find rows and columns
3. Compute the total size
4. Apply DCT for step 3
5. Apply multi-resolution method for step 4
6. Repeat the process until desired ratio is reached.

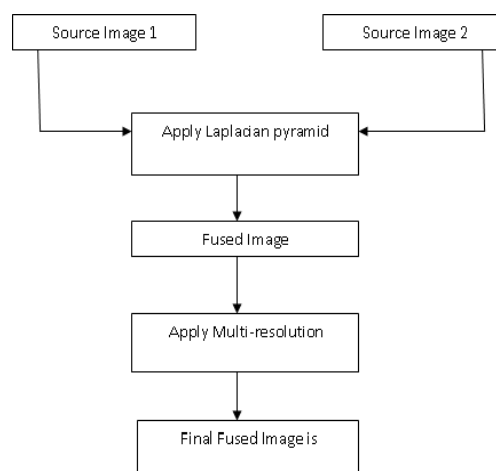


Figure . 2 Flow Graph Of Proposed Algorithm

III IMAGE SYNTHESIS QUALITY METRICS

It measures the quality of the fused image by taking the set of pre-defined quality indicators for evaluating the spectral and spatial similarities between the fused image and raw input images. The following quality metrics such as RMSE, PFE, PSNR, and Mean are used to evaluate the quality of the fused image [2].

3.1. Root Mean Square Error (RMSE)

$$RMSE = \sqrt{\frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (I_r(i,j) - I_f(i,j))^2} \quad \text{Eq - 5}$$

It is normally used to comparison the difference between the reference and fused image by directly computing the variation in pixel values. The combined image is close to the reference image when RMSE value is zero. RMSE is a good indicator of the spectral quality of fused image. A lower value indicator is superior fusion.

3.2. Peak to Signal Noise Ratio (PSNR)

$$PSNR = 20 \log_{10} \left(\frac{L^2}{\frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (I_r(i,j) - I_f(i,j))^2} \right) \quad \text{Eq - 6}$$

It is widely used metric; it is computed by the number of gray levels in the image divided by the corresponding pixels in the reference and the fused images. When the value is high, the fused and reference images are similar. A higher value indicator is superior fusion.

3.3. Percentage Fit Error (PFE):

$$PFE = \frac{\text{norm}(I_r - I_f)}{\text{norm}(I_r)} * 100$$

Eq – 7

It computes the norm of the difference between the corresponding pixels of the reference and fused image to the norm of the reference image. When the calculated value is zero, it points that both the reference and fused images are similar and value will be increased when the merged image is not similar to the reference image. A lower value indicator is superior fusion.

TABLE 1: PERFORMANCE EVALUATION METRICS TO EVALUATE IMAGE SYNTHESIS ALGORITHMS

Images	Algorithm	Mean	RMSE	PSNR	PFE
PEPPERS	LP	209.6137	117.4278	27.4671	99.0002
	LP+MR	182.7055	83.5655	28.9445	70.4518
CAMERA	LP	237.4798	131.2371	26.9842	98.4693
	LP+MR	198.8912	86.571	28.7911	64.9556
INPUT2	LP	195.1676	107.3454	27.857	99.7564
	LP+MR	179.417	86.668	28.7862	80.5408
DISK	LP	196.6256	108.7954	27.7987	99.8612
	LP+MR	179.8142	86.771	28.7811	79.6454
LAB	LP	245.9762	131.1504	26.9871	99.1502
	LP+MR	210.6372	90.7556	28.5861	68.6116

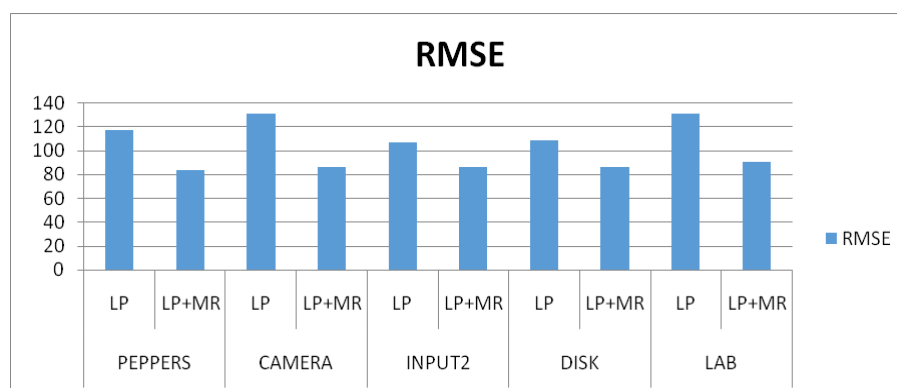


Figure. 3. Synthesis Methods Vs RMSE

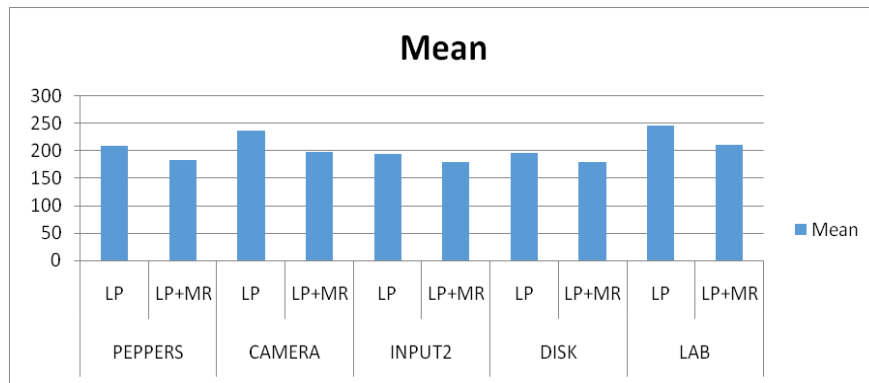


Figure. 4. Synthesis Methods Vs Mean

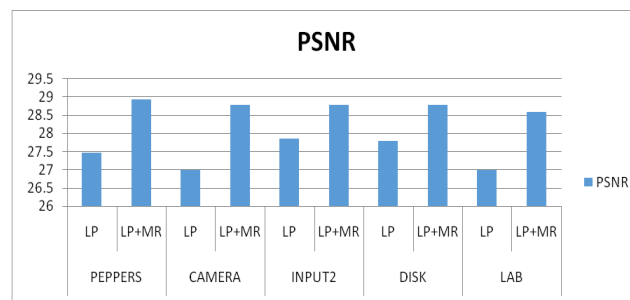


Figure. 5. Synthesis Methods Vs PSNR

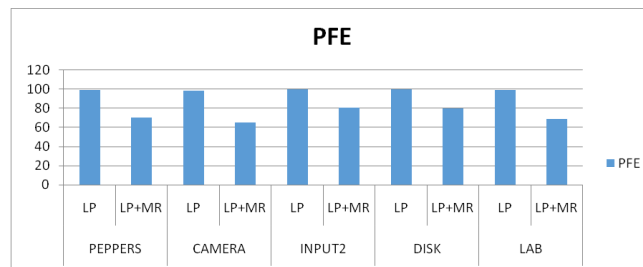


Figure. 6. Synthesis Methods Vs PFE



Figure .7. Peppers: (a) Ground Truth Image (b) Input Source Image 1 (c) Input Source Image 2
(d) Fused Image by LP (e) Fused Image by LP +MR

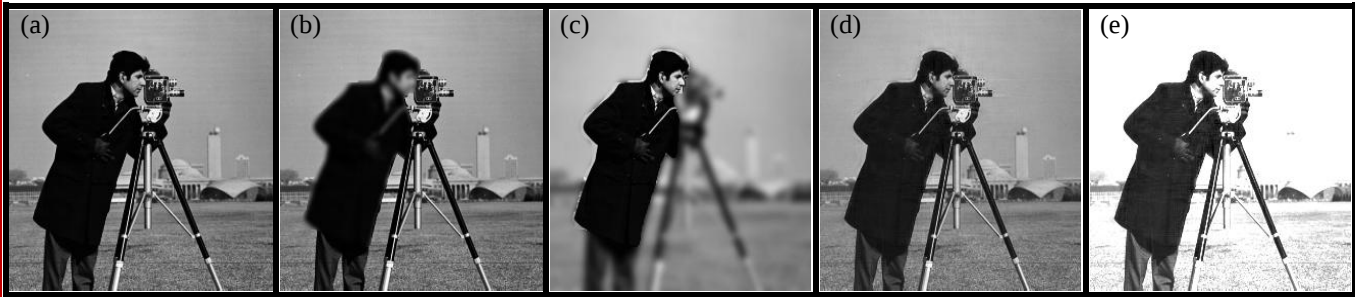


Figure 8. Camera: (a) Ground Truth Image (b) Input Source Image 1 (c) Input Source Image 2
(d) Fused Image by LP (e) Fused Image by LP +MR

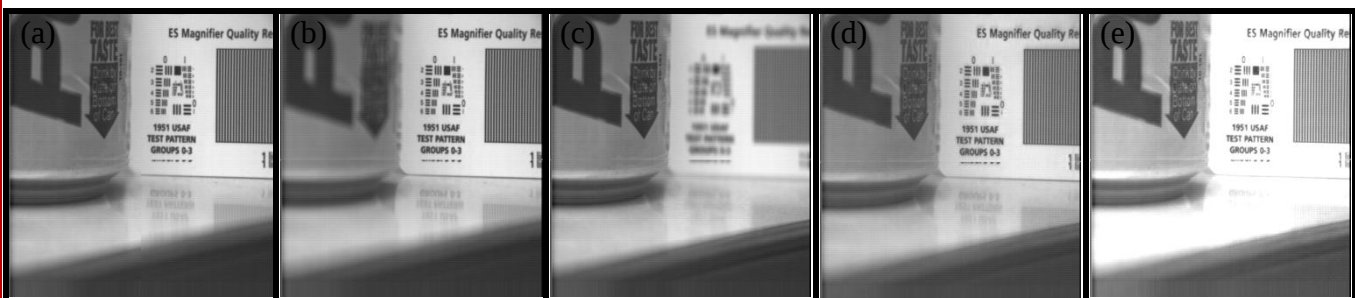


Figure .9. Input2: (a) Ground Truth Image (b) Input Source Image 1 (c) Input Source Image 2
(d) Fused Image by LP (e) Fused Image by LP +MR



Figure .10. Disk: (a) Ground Truth Image (b) Input Source Image 1 (c) Input Source Image 2
(d) Fused Image by LP (e) Fused Image by LP +MR



Figure .11. Lab: (a) Ground Truth Image (b) Input Source Image 1 (c) Input Source Image 2
(d) Fused Image by LP (e) Fused Image by LP +MR



IV CONCLUSION

The advantage of Laplacian pyramid is that it extracts more information related with edges at each level. The proposed fusion method assures the better quality with the help of multi-resolution method. Analysis part has been done to validate quality with metrics such as Mean, RMSE, PSNR, PFE, etc. further work may be extended with DWT or Hybrid DWT methods to achieve better quality.

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