Volume 5, Issue 5, May 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Analytical Comparison of Various Image Fusion Techniques

[1]Harmandeep Kaur, [2]Er. Jyoti Rani
[1]M.tech Student, [2]Assistant Professor
[1, 2] Department of Computer Science & Engineering
GZS PTU Campus, Bathinda, Punjab, India

Abstract - Image Fusion is a process of merging of two images or more than two images or it is a process of blending the complementary as well as the common features of set of similar distorted or incomplete images, to produce a resultant image. The need of image fusion for high resolution on panchromatic and multispectral images or real world images for better vision. There are various methods of image fusion and some techniques of image fusion such as IHS, PCA, DWT, Laplacian pyramids, Gradient Pyramids, DCT, SF. In this paper all the techniques evaluated with their desired inputs and final outputs. Image fusion basically works or uses in all digital areas whether its is medical ,military areas, remote sensing as well as for general purposes where input images or similar images are not clear to vision; fused images help for high resolution of vision.

Keywords- Image Fusion, PCA, DWT, IHS, DCT, SF.

I. INTRODUCTION

Image processing makes use of digital computers to process an image. In digital image processing we require either the full image or the part of image which is to be processed from the user's point of view like the radius of object etc. As digital system is in widely applied in various areas, producing digital images of good contrast and detail is strong in demand especially in areas like computer vision, remote sensing, identification of models at huge level and fault detection. There are various advantages of using digital image processing like preservation of original data accuracy, flexibility and repeatability. Fusion is process in which two input images with incomplete information after fusion one output image with the high resolution and complete information. With the rise of consumer-based digital photography, most of photographers expect to have a more control over their digital images in this field. Astronomical images from rovers and probes are received at an extremely low transmission rate (about 40 bytes per sec.), making the level of transmission of High Resolution (*HR*) data infeasible. In medical imaging, neurologists would like to have the ability to fuse in on specific parts of brain tomography images which tumour images., Finally, the most useful or common application of image fusion is to simply allow one to a larger version of a favourite image obtained from any commercially available digital imaging algorithms.

Different Formats of Digital Images

The format use to save the image file will be determined by its intended use. Some formats are common for the web, others for presentation or print. Some of the formats are listed below:

PICT: Stands for 'Picture' and is used for storing 8-bit, 16-bit or 24-bit color or gray scale level images. *PICT* files work in well mannered for the onscreen presentations of graphics.

TIFF: Stands for 'Tagged Image File Format' and is used to exchange files between applications and computer platforms. It is supported virtually all paint applications, image editing, and page-layout or page format applications.

GIF: Stands for 'Graphic Interchange Format' and is used for simple web images. Because *GIF* files are limited to 256 colours, it is suggested that you should not use this format for photographs or other images with high colour ranges.

JPEG: Stands for 'Joint Photographic Experts Group' *JPEG* is actually a standard method for compressing graphics by removing non-essential information. A *JPEG* file can be created from most file formats and is frequently used for web-based images because of its small file size.

BMP: Stand for 'Bitmap' and this format is used for Images that are simple black and white. Note that 'black and white' refers to those images that have only two tones of colors in bit format, either black or white.

PNG: Stands for 'Portable Network Graphics, format, an open source substitute for *Graphic interchange formats*. *PNG*s provide a very high lossless compression rate than *GIF*s, and help to reduce cross-platform differences in image display quality, among other technical advantages. For the purposes of sharing data files, adding images to PowerPoint for better presentations and posting them to websites, the formats you will use are *JPEG* and *GIF*. Th files of PNG are universally readable by image editors, check on websites, and it offers small size files with reasonable quality levels.

Image Fusion: In this process take the two inputs images like both images are same but both haven't relevant information about the image so the process is to fuse the both images make it relevant in the output image in both multispectral as well as panchromatic images. Output image has good resolution than both input images. Image fusion uses in medical areas very effectively like in diagnosis. Image fusion is related to the enhancement of images through

various outcome algorithms. It is general approach for extraction the information from various images then transform it in informatics image. The goal of image fusion (IF) is to combine complementary multisensor, multitemporal into one new image containing information about the quality of that image.

A. Levels of Image fusion

1. Pixel Level
2. Feature Level
3. Block or Region Based

1. *Pixel Level:* This is most his simple technique in image fusion done at lowest level. In this combine the values and intensities of two input images based on its average, gives the single resultant image.
2. *Feature Level:* It justifies with the features of image like if one image has its distorted eye other have distorted any feature like head, nose. In this level of technique easily extract the features of both similar images individually, then fusion algorithm gives the enhanced image after feature extraction.
3. *Block or Region Based*: In region based fusion occurs according to the pixel blocks of the image. Blocks level technique is highest level technique. It is multistage representation and measurements are calculated according to the regions.

B. Types of Image Fusion

Single Sensor : Single sensor captures the real world as a sequence of images. The set of images are fused together to generate a new image with optimum information content. For example in illumination variant and noise full environment, a human operators like detector operator may not be able to detect objects of his interest which can be highlighted in the resultant fused image.

The shortcoming of this type of systems lies behind the limitations of the imaging sensor that are being used in other sensing area. Under the conditions in which the system can operate, its dynamic range, resolution, etc. are all restricted by the competency of the sensor. For example, a visible-band sensor such as the digital camera is appropriate for a brightly illuminated environment such as daylight scenes but is not suitable for poorly illuminated situations found during night time, or under not good conditions such as in fog or rain.

.*Multi Sensor* **:** A multi-sensor image fusion scheme overcomes the limitations of a single sensor image fusion by merging the images from several sensors to form a composite image an infrared camera is accompanying the digital camera and their individual images are merged to obtain a fused image. This approach overcomes the issues referred to before. The digital camera is suitable for daylight scenes; the infrared camera is appropriate in poorly illuminated environments. It is used in military area, machine vision like in object detection, robotics, medical imaging. It is used to solve the merge information of the several images.

Multiview Fusion: In this images have multiple or different views at the same time.

Multimodal Fusion: Images from different models like panchromatic, multispectral, visible, infrared, remote sensing. Common methods of image fusion

- Weighted averaging pixel wise
- Fusion in transform domain
- Object level fusion

Multifocus Fusion: images from 3d views with its focal length. The original image can be divided into regions such that every region is in focus in at least one channel of the image.

C. Applications and Uses OF Image fusion:

1) Fusion is basically used remote or satellite area for the proper view of satellite vision
2) It must used in medical imaging where disease should analyse through imaging vision through spatial resolution and frequency perspectives.
3) Image fusion used in military areas where all the perspectives used to detect the threats and other resolution work based performance.
4) For machine vision it is effectively used to visualize the two states after the image conclude its perfect for the human vision.
5) In robotics field fused images mostly used to analyse the frequency variations in the view of images.
6) Image fusion is used in artificial neural networks in 3d where focal length varies according to wavelength transformation.

D. Advantages and Disadvantages of image fusion

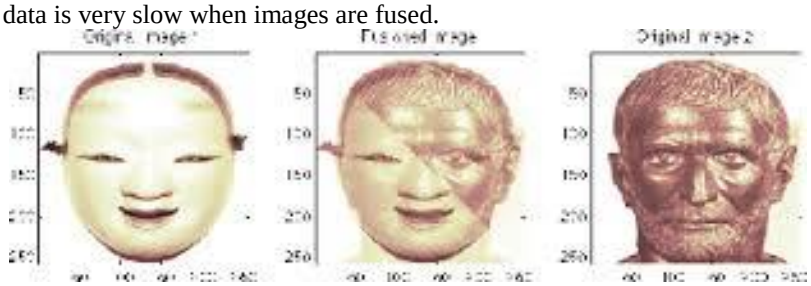
1) Advantages:

a) It is easiest to interpret.
b) Fused image is true in colour.
c) It is best for identification and recognition
d) It is low in cost
e) It has a high resolution used at multiscale images.

f) Through image fusion there is improved fused images in fog
g) Image fusion maintains ability to read out signs in all fields.
h) Image fusion has so many contrast advantages basically it should enhance the image with all the perspectives of image.
i) It increases the situational or conditional awareness.
j) Image fusion reduced the data storage and data transmission.

2) Disadvantages:

a) Images have less capability in adverse weather conditions it is commonly occurred when image fusion is done by single sensor fusion technique.
b) Not easily visible at night it is mainly due to camera aspects whether it is in day or night.
c) More source energy is necessary for the good visualization of mages based on spatial frequency.
d) Due to rain or fog visualization is not cleared if one click the two source images in this type of weather conditions it will give the worst output.
e) In this process there is huge chances of data loss
f) It needs the proper maintenance.
g) Processing of data is very slow when images are fused.



(a) (b) (c)

Fig. 1 (a) Original Image (b) Blurred Original Image (c) Fused Image

II. LITERATUE REVIEW

In 2003, F. Laliberte *et al*. [1] presents proposed method of registration and pixel level fusion techniques. All the images are of different features and different intensities, different resolution at different time and used global point mapping and search for control point matches of retinal images. In this fourteen pixel level fusion used to classified according qualitative and quantitative performance. In 2006, M.Choi *et al*. [2] presents IHS fusion technique useful in applications of remote sensing in panchromatic and multispectral images. By this technique it distorts the colour in the same way as it is applied in this image fusion. The author uses the tradeoffs parameters with its new approach with fast and easy implementation. In 2007, K. Amolins *et al.* [3] presents a panchromatic image is fused with gives the desired output with improved quality or efficient resolution. In this wavelet based image fusion techniques are compared on the base of their spatial frequencies. All the wavelet transforms always gives better result than simple wavelet transform methods alone. When the wavelet based schemes, particularly in terms of minimizing color distortions in images. In 2008, V.P.S Naidu *et al.* [4] works on pixel level image fusion algorithms used wavelet and PCA techniques fused image can be avoided using wavelets with shift invariant property. It has been concluded that image fusion using wavelets with higher level of decomposition shows better performance in some metrics. In 2009, S. Vekkot *et al*. [5] presents the combination of pixel level and region based with enhancement of edges and structure fusion. These techniques are applicable for pixel and energy based algorithms done by analysing the data of images. In 2010, A.Umamahesvari *et al.* [6] gives review of techniques of fusion in RGB images ,Gray Scale images by user interactive with DCT approach which is Discrete cosine transformation usually for the better efficiency in fused images. In 2011, N.Indhumani *et al*. presents work on different modals or techniques of image fusion and applying 2D-DWT algorithm on input images. Both SF and Wavelet- DWT is used for efficient output in fused image. Coefficients at lower approximations are used in laplacian algorithm. Where SF and Wavelet combined together they are working for high approximation. Finally DWT algorithm gives the desired results with desired new fused coefficients. In this paper performance parameters are MSE, PSNR. Where hybrid modal gives better results than this techniques. In 2011, F. Abdulla [8] presents image fusion using IHS transformation this transformation is basically for sharpening and transformations work for transfer colour space to IHS space in the pear various IHS transformations are used and the performance should be evaluated on the basis of its degree of improvement in fused images. In 2011, M.A Mohamed1 *et al*. [9] give their research on implementation of techniques for multifocus images based on FPGA. This paper analyse the issues of image fusion in various methods like in averaging, PCA, Pyramids, DWT, DCT. Author represents the comparison of various methods it gives better assessment by using Field Programmable Gate Arrays. In 2012, H. R. Shahdser *et al*. [10] presented PCA image fusion method i.e. pan sharpening method for the higher and efficient resolution adds spatial information to it with no spatial PCAs visual and statistical analyzes show that this algorithm improves the fused and merging quality and resolution in terms of RASE, ERGAS, SAM as compared to fusion methods IHS, Brovey, PCA, HPF, HPM. In 2012, Deepak Kumar Sahu *et al.* [11] gives review on different techniques of image fusion like primitive fusion (Averaging method, Select Maximum, Select Minimum) gives better output in comparison. In 2013, Xiao Xiang Zhu *et al.* [14] presents high spatial resolution algorithm on panchromatic and multispectral. Sparse is based on sensing theory. When The HR panchromatic

and Low Resolution spectral are combined it gives better results or accuracy in image fusion. Due to distortion in LR so the sparse used the HR algorithm. Author says if the spectral combination does not gives relevant output then reconstruction sparse algorithm applied for robustness of images. In 2013, Kusum Rani *et al.* [12] presents image fusion techniques review which are PCA and DWT and comparison shows better performance in results. In 2013, Simrandeep Singh *et al.* [13] Works on multifocus image fusion it means it is based focal length of the images by using Gaussian and Laplace pyramids. It gives much improved resolution of fused images generally Laplace works on low level band and high level band so it gives good results according to multi focus. In 2014, Nisha Gadara *et al*. [16] presents the comparative study of three techniques which are PCA, DCT, DWT where according to results of comparison there is some drawbacks in PCA, DCT as compared to these two techniques DWT is the best technique for fused the images. In 2014, Deepali Sale *et.al* [19] presents wavelet family with haar orthogonal in this paper Laplace technique used using high level and low level bands where filters do their work for removing distortion at the edges with spatial frequency where Shift variant gives not good results instead of this using shift invariant algorithm for the better results of fused images.

III. EXISTING TECHNIQUES

IHS: Intensity Hue Saturation where Intensity is the measurement of brightness in which zero representing black no brightness, one representing white , full brightness. Luminance means intensity per unit area of light. Hue is colour which is measured at any angle like colour hexagon, where saturation is the amount or quantity of colour in RGB images where intensity of image changes according to the colors.In saturation zero representing grey or no colour and one representing black or full colour.

$$I=(R+G+B)/3$$

By this formula RGB changes in to IHS values or intensity values easily measured by this formula. IHS is easily used for image sharpening in which resolution increases it improves images intensity or enhance the images easily through this Hue Saturation technique.

Algorithm:

(1) Perform image registration (IR) to PAN and MS, and resample MS.
(2) Conversion of MS image from RGB space into IHS space.
(3) Check for the matching of the histogram of PAN images to the histogram of the I component.
(4) Replace the I component with PAN.
(5) Convert the fused MS image to RGB color space.

PCA: Principal Component Analysis is based variables of data set whether the variables are correlated and uncorrelated. It would around axis in linear transformation from measure space to feature space. This is basically pixel level fusion it is defined from multidimensional sets to lower level dimensions measures the weight using Eigen vector rather than picking the largest Eigen value or pixel value of the image.

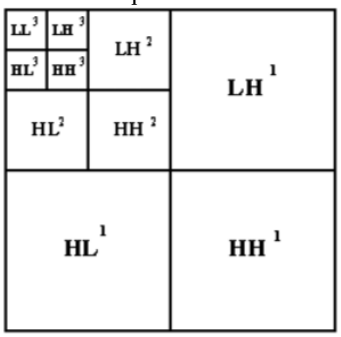
$$Y=A^T X$$

Where A is the matrix of normalized Eigen vector of covariance matrix of X. Where Y has a diagonal covariance matrix

PCA Algorithm:

I. First split the panchromatic image in to further sub images.
II. Produce the column vectors from the input images.
III. Compute the covariance matrix of two columns which are of source images.
IV. Compute the Eigen vector and Eigen values of the input images
V. Normalized the column vectors of source images.
VI. Normalized the Eigen vector having weight values multiply the pixel values.
VII. Fuse the two scaled matrix will be the fused matrix or resultant matrix.

DWT: Discrete Wavelet Transform it works on different conditions. Whether signal is continuous in itself where in discrete wavelet discrete functions varies where it refers to the discrete translations and discrete dilations. In this there is high pass and low pass filters successively computed. In this we generally merge the maximum and minimum approximations with its coefficients and equation is below :



1, 2, 3 --- Decomposition Levels

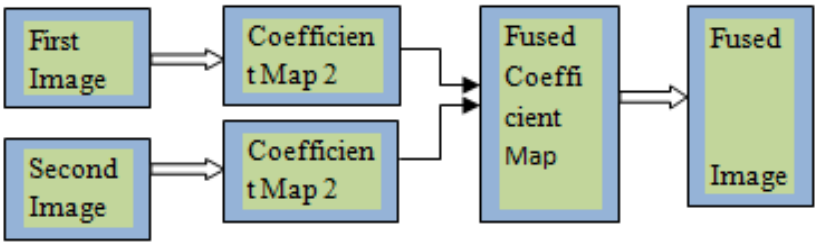
H ------ High Frequency Bands

L ------ Low Frequency Bands

$$f(x) = \sum_k c_{jk}\,\phi_{jk}(x) + \sum_{j=1}^{j} \sum_k d_{jk}\,\psi_{jk}(x)$$

DWT Algorithm:

a. Take two input images. After this take coefficient maps.
b. Then fuse the both images by loading high pass and low pass filters at different decomposition level with coefficient maps.
c. Take at result at both approximations at maxima and minima
d. Output come out in a better way.



DCT: Discrete Cosine Transform in this technique the original images divided in to block then calculate the representations and average values of all DCT representations for its all corresponding blocks then taken the inverse cosine transforms to reconstruct the original images into fused images. it based on average values so it is called DCT+ average it is improved DCT technique.

Laplacian Pyramids: Laplacian is a pattern approach for the image fusion process. In this method feature level used where image pyramids are image features at different levels of resolution requires different filters at different scales. Laplace works on difference between low pass filters and high pass filters. Its information is not only for edges, boundaries and it uses the LL bands rather wavelet does not use LL bands for fusion in wavelet values taken according to assumptions or approximation values whether it is maximum value or minimum value according to average weight the results should be count. Without using LL sub bands contrast of images is not clear for laplacian its necessary to use the LL bands integrate SF with Wavelet Transformation. Then laplacian technique implements "a pattern selective". Laplacian gives better and efficient results than other techniques.

$$F(x,y) = \begin{cases} A_i\,(x,y), & if\left|A_{i(x,y))}\right| > \left|B_{i(x,y)}\right| \\ B_i(x,y), & Otherwise \end{cases}$$

Where A and B are the input images and F is the fused image and $0 \leq i \leq N-1$

SF: Spatial frequency is basically used with other techniques to check the overall intensity or Eigen level of an image. In wavelet transform it break or decompose the images at different scale of bands like low- high, high- low, high-high, low-low. In DWT it ignores the LL sub band but it gives average information about the images. For M*N image F, with its gray scale level at its pixel level where (m,n) denoted F(m,n) and equation for Spatial frequency is :

$$\text{SF}=\sqrt{RF^2 + CF^2}$$

Where RF is row frequency and CF is column frequency.

$$\text{RF} = \sqrt{\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=2}^{N}(F(m,n) - F(m,n-1))^2}$$

$$\text{CF} = \sqrt{\frac{1}{M,N}\sum_{m=1}^{M}\sum_{n=2}^{N}(F(m,n) - F(m-1,n))^2}$$

SF usually used to reflect the clarity of images through this frequency filtered the images from noise or output images are sharp and better in look and intensity.

Gradient Pyramids: In gradient pyramids it is necessarily similar to laplacian pyramids but in this down sampling version used on the images which are decomposed according to the filter bands. Low pass band used on down sampled version of images. Gradient Filters take the decomposition at all directions to evaluate entropy, deviation, average, mean of the images .

(a) (b) (c)

Fig. 2 (a) original image (b) Original Blurred Image (c) Composite Image

IV. COMPARISON RESULTS

TABLE 1 RESULTS of MSE and PSNR of DIFFERENT TECHNIQUES

AUTHOR's NAME	TECHNIQUES	RESULTS	
		MSE	***PSNR***
Susmitha Vekkot	Wavelet based transformation using Hybrid architecture	109.5	27.75
N. Indhumadhi	Laplacian Pyramid and spatial frequency based wavelet algorithm	7.774	37.08
M.A Mohamed1	Based on all techniques of image Fusion PCA DCT DWT SF	 12.041 11.846 15.09 12.040	 25.8824 26.024 24.707 25.882
Deepali Sale	Hybrid Multi Resolution LP SIDWT LP+SIDWT	 5.2100 3.7737 3.4935	 33.7434 36.1620 37.2657

V. CONCLUSION

In this paper the study on the various types of image fusion techniques compare the results of all the DCT, DWT, PCA, IHS, Laplacian Pyramids, and Gradient Pyramids. Overall this survey paper suggests that Laplace with Shift invariant DWT algorithm gives better and efficient results on fused Images. Using this algorithm we have work for better results in proposed work.

REFERENCES

[1] France Lalibert, Langis Gagnon ," *Registration And Fusion of Retinal images- An evaluation study*,"IEEE Transaction on Medical Imaging, Vol. 22, No. 5, May 2003.

[2] Myungjin Choi," *A New Intensity-Hue-Saturation Fusion Approach Image Fusion With a Tradeoff Parameter*," IEEE Transaction on Geoscience and Remote Sensing, Vol. 44, No. 6, June 2006.

[3] Krista Amolins, Yun Zhang, Peter Dare," Wavelet *based Image fusion techniques –An introduction review and comparison*," ISPRS Journal of Photogrammetry & Remote Sensing 62, 2007, pp. 249-263.

[4] V.P.S Naidu and J.R Raol" *Pixel Leevel Image Fusion using wavelet nad Prinicipal Component Analysis*," Defence Science Journal, Vol. 58, No. 3 ,pp. 338-352, May 2008.

[5] Susmitha Vekkot, and Pancham Shukla," *A Novel Architecture of Wavelet Based Image Fusion*, World Academy of Science, Engineering and Technology 57, 2009.

[6] A.Umamaheshvari,K.Thanushkodi," *Image Fusion Techniques*," IJRRAS 4(1), July 2010.

[7] N.Indhumani,G.Padmavathi," Enhanced *Image Fusion Algorithm Using Laplace Pyramids and Spatial Frequency Based Wavelet Algorithm*," International Journal of Soft Computing and Engineering, Vol. 1, Issue 5, Nov. 2011.

[8] Firouz Abdullah Al-Wassai, N.V. Kalyankar, Ali A. Ali-Zuky;" The *IHS Transformation Based Image fusion*," Computer Vision and Pattern Recognition, July 2011.

[9] M.A. Mohamed and B.M. El Den 2,"*Implementation of image fusion Techniques for Multifocus Images Using FPGA*," National Radio Science Conference, April 2011.

[10] Deepak Kumar Sahu, M.P.Parsai*," Different Image Fusion Techniques-A Critical Review*," International Journal of Modern Engineering Research, Vol.2, Issue 5, pp. 4298-4301 Sept.- Oct. 2012.

[11] Hamid Reza Shahdoosti, Hassan Ghassemian," *Spatial PCA as A New Method for Image Fusion*," The 16th CSI International Symposium on Artificial Intelligence and Signal Processing (AISP), 2012.

[12] Kusum Rani, Reecha Sharma," *Study of Different Image Fusion Algorithm*," International Journal of Emerging Technology and Advanced Engineering (IJETAE), Vol. 3, Issue 5, May 2013.

[13] Simrandeep Singh, Narwant Singh Grewal, Harbinder Singh," *Multiresolution Representation of Multifocus Image fusion Using Gaussian and Laplacian Pyramids*," International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE), Vol. 3, Issue 11, Nov. 2013.

[14] Xiao Xiang Zhu,"*A Sparse Image Fusion Algorithm with Application Of Pan sharpening*," IEEE Transactions on Geoscience And Remote Sensing, Vol. 51, No. 5, May 2013.

[15] Roshna J.Sapkal, Sunita M. Kulkarni,"Innovative *Image Fusion algorithm based on Fast Discrete Curvelet Transform with Different Fusion Rules*", Proceedings of 2 IEEE Conference on Information and Communication Technologies (ICT), 2013.

[16] Nisha Gawari, Dr. Lalitha. Y.S.," *Comparitive Analysis of PCA, DCT& DWT based Image Fusion Techniques*," Interanational Journal of Emerging Research in Mangement And Technology, Vol. 3, Issue 5, May 2014.

[17] Er. Simranpreet Singh, Er. Palak Sharma," *Image Fusion,"* International Journal of advanced Research in Computer Science and Software Engineering (IJARCSSE), Vol. 4, Issue 3,Mar. 2014.

[18] Jianbing Shen, Ying Zhao,Shuicheng Yen and Xuelong Li," *Exposure Fusion Using Boosting Laplacian Pyramid*," IEEE Transaction on Cybernetics, Vol. 44, No. 9, Sep. 2014.

[19] Deepali Sale, Varsha Patil, Dr. Madhuri A.Joshi," *Effective Image Enhancement using Hybrid Multi- resolution Image Fusion*, IEEE global Conference on Wireless Computing and Networking (GCWCN), 2014.

