ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

A Review on Image Fusion

Suruchi Goyal[#1], Rupinder Wahla[#2]

Student, Department of Computer Science, RIMT-IET, Mandi Gobindgarh, Punjab, India[#1]

Assistant Professor, Department of Computer Science, RIMT-IET, Mandi Gobindgarh, Punjab, India[#2]

ABSTRACT: This paper explains the concept of image fusion. It explains how image fusion is advantageous. It also discusses the related works that has been done in this path and also provide suggestion to improve the results and overcome the limitations of previous methods.

KEYWORDS: Image fusion, Classification, Spatial Domain, Frequency Domain, Related work.

I. INTRODUCTION

Image Fusion is one of the major research fields in image processing. Image Fusion is a process of combining the relevant information from a set of images, into a single image, wherein the resultant fused image will be more informative and complete than any of the input images. Image fusion process can be defined as the integration of information from a number of registered images without the introduction of distortion. It is often not possible to get an image that contains all relevant objects in focus. One way to overcome this problem is image fusion, in which one can acquire a series of pictures with different focus settings and fuse them to produce an image with extended depth of field. Image fusion techniques can improve the quality and increase the application of these data. One of the important pre-processing steps for the fusion process is image registration, i.e., the coordinate transformation of one image with respect to other. Fusion algorithms are input dependent .Image fusion find application in the area of navigation guidance, object detection and recognition, medical diagnosis, satellite imaging for remote sensing, rob vision, military and civilian surveillance, etc.Image fusion systems are widely used in surveillance and navigation applications, for both military and domestic purposes. This is achieved by the use of multiple sensors to obtain the visual information and by utilizing the synergism of different imaging sensors for better situation assessment. Image fusion algorithms can be categorized into different levels: low, middle, and high; or pixel, feature, and decision levels. The pixel-level method works either in the spatial domain or in the transform domain. Pixel level fusion works directly on the pixels obtained at imaging sensor outputs while feature level fusion algorithms operate on features extracted from the source images. The prerequisite for such an operation is that the images have been acquired by homogeneous sensors, such that the images reproduce similar or comparable physical properties of the scene. The feature-level algorithms typically segment the image into contiguous regions and fuse the regions together using their properties. The features used may be calculated separately from each image or they may be obtained by the simultaneous processing of all the images. Decision level fusion uses the outputs of initial object detection and classification as inputs to the fusion algorithm to perform the data integration. Both feature level and decision level image fusion may result in inaccurate and incomplete transfer of information. Several fusion algorithms starting from simple pixel based to sophisticated wavelets and PCA based are available. Image fusion system has several advantages over single image source and resultant fused image should have higher signal to noise ratio, increased robustness and reliability in the event of sensor failure, extended parameter coverage and rendering a more complete picture of the system. The actual fusion process can take place at different levels of information representation. A common categorization is to distinguish between pixel, feature and decision level, although there may be crossings between them. Image fusion at pixel level amounts to integration of low-level information, in most cases physical measurements such as intensity. Generally, the pixel based image fusion methods average pixel intensity values of the source images pixel by pixel which leads to undesired side effects in the resultant image. Recently researchers have recognized that it is more meaningful to combine objects or regions rather than pixels. The region based algorithm has many advantages over pixel based algorithm like it is less sensitive to noise, better contrast, less affected by mis-registration but at the cost of complexity.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

II. CLASSIFICATION

Image fusion techniques can enhance a digital image without spoiling it. The enhancement methods are of two types namely Spatial domain methods and frequency domain methods. In spatial domain techniques, we directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. The fusion methods, such as averaging, the Brovey method, principle component analysis (PCA), and IHS based methods fall under the spatial domain approaches. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image brightness, contrast or the distribution of the grey levels. As a consequence the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values. Pyramid Fusion Algorithm is a fusion method in the transform domain. Image Fusion techniques can be sub divided in three different types of techniques including Simple fusion techniques, Principal Component Analysis (PCA) based Fusion, Pyramid based image fusion methods and Discrete Wavelet Transform (DWT) based fusion as shown in figure 1 as below.

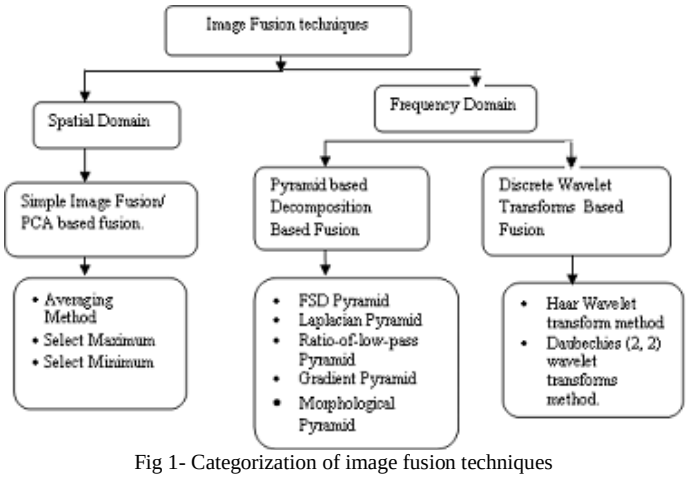

Fig 1- Categorization of image fusion techniques

On the basis of the study only few comparisons between the different existing fusion techniques have been made and are analyzed theoretically which are shown in Table below.

S.NO	Fusion Technique/Algorithm	Domain	Advantages	Disadvantages
1.	Simple Average	Spatial	This is the simplest method of image fusion.	The main disadvantage of Pixel level method is that this method does not give guarantee to have a clear objects from the set of images.
2.	Simple Maximum	Spatial	Resulting in highly focused image output obtained from the input image as compared to average method.	Pixel level method are affected by blurring effect which directly affect on the

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

				contrast of the image
3.	PCA	Spatial	PCA is a tools which transforms number of correlated variable into number of uncorrelated variables, this property can be used in image fusion.	But spatial domain fusion my produce spectral degradation.
4.	DWT	Transform	The DWT fusion method may outperform the slandered fusion method in terms of minimizing the spectral distortion. It also provide better signal to noise ratio than pixel based approach.	In this method final fused image have a less spatial resolution.
5.	Combine DWT, PCA	Transform	Multi-level fusion where the image undergoes fusion twice using efficient fusion technique provide improved result .output image contained both high spatial resolution with high quality spectral content.	This method is complex in fusion algorithm. Required good fusion technique for better result.
6.	Combination of Pixel & Energy Fusion rule	Transform	Preserves boundary information and structural details without Introducing any other inconsistencies to the image.	Complexity of method increases.

Fig 2- Comparison between various fusion techniques

III. RELATED WORK

Firouz Abdullah Al-WassaiThe IHS Transformations Based Image Fusion 2011 http://arxiv.org/abs/1107.3348-The IHS Transformations Based Image Fusion sharpening technique is one of the most commonly used techniques for sharpening. Different transformations have been developed to transfer a color image from the RGB space to the IHS space. Through literature, it appears that, variousscientists proposed alternative HIS transformations and many papers have reported good results whereas others show bad ones aswill as not those obtained which the formula of IHS transformation were used. In addition to that, many papers show differentformulas of transformation matrix such as IHS transformation. This leads to confusion what is the exact formula of the HIS transformation? Therefore, the main purpose of this work is to explore different IHS transformation techniques and experiment itas IHS based image fusion. The image fusion performance was evaluated, in this study, using various methods to estimate the equality and degree of information improvement of a fused image quantitatively.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

SaschaKlonus Performance of evaluation methods in image fusion 12th International Conference on Information Fusion Seattle, WA, USA, July 6-9, 2009 pp 1409-1416- Many algorithms and software tools havebeen developed for fusing panchromatic andmultispectral datasets in remote sensing. Also, a numberof methods has been proposed and developed for thecomparative evaluation of fusion results. To this date,however, no papers have been published that analyzeeffectiveness and quality of the evaluation techniques. In our studies, methods that evaluate fusion quality are testedfor different images and test sites. This analysis showsthat in most cases the tested methods perform well, butare sometimes inconsistent with visual analysis results.

Abhishek SinghImplementation & comparative study of different fusion techniques (WAVELET, IHS, PCA)Volume 1, Issue 4(December 2012), PP.37-41- In the image fusion scheme represented in this paper, we compare three different image fusion techniques, which are: - Wavelet transform, IHS & PCA. Here we apply the input images & corresponding fused image is obtained, with different RGB values for different techniques. In this wavelet transform of different images are appropriately combined by taking inverse wavelet transform of fused wavelet coefficients. Max. area selection rule & consistency verification step are used for feature selection. The Intensity-Hue-Saturation transformation, a method mainly used for merging multi-resolution and multispectral data and for contrast stretching applications, has never been applied. In this study, a method is presented by which transforming the RGB values of a three-channel composite to IHS values. Each wavelet also has a unique image decompression & reconstruction characteristics that lead to different fusion results, However if a wavelet transform& a traditional transform such as PCA transform are integrated for a better fusion results may be achieved. Study of Different Image fusion Algorithm

Kusum Rani Volume 3, Issue 5, May 2013 International Journal of Emerging Technology and Advanced Engineering Pp 288-291- Image fusion is a technique that integrate complimentary details from multiple input images such that the new image give more information and more suitable for the purpose of human visual perception. This paper presents a review on some of the image fusion techniques (simple average, simple minimum, simple maximum, PCA, DWT). Comparison of all the techniques concludes the better approach for its future research.

Ute G. Gangkofner Optimizing the High-Pass Filter Addition Technique for Image Fusion Photogrammetric Engineering & Remote Sensing Vol. 74, No. 9, September 2008, pp. 1107–1118- Pixel-level image fusion combines complementary imagedata, most commonly low spectral-high spatial resolutiondata with high spectral-low spatial resolution optical data.The presented study aims at refining and improving theHigh-Pass Filter Additive (HPFA) fusion method towards atunable and versatile, yet standardized image fusion tool.HPFA is an image fusion method in the spatial domain,which inserts structural and textural details of the higherresolution image into the lower resolution image, whosespectral properties are thereby largely retained. Usingvarious input image pairs, workable sets of HPFA parametershave been derived with regard to high-pass filter propertiesand injection weights. Improvements are the standardizationof the HPFA parameters over a wide range of image resolutionratios and the controlled trade-off between resulting imagesharpness and spectral properties. The results are evaluatedvisually and by spectral and spatial metrics in comparisonwith wavelet-based image fusion results as a benchmark.

Fan Xiujuan The research on graphic outline capturing algorithm based on coloured embroidery pattern of HIS space 2011, Electronic Measurement & Instruments (ICEMI) pp 320 – 323- Computerized embroidery needs outline capturingof color images and stitch filling. Embroidery machines canmake stitch filling according to color blocks in different areas.Considering the character of stitching of embroidery machines and referring to color image morphology, this thesis putsforward multi-scale graphic outline capturing algorithm based on color embroidery pattern of HIS space. And a variety of edge detection algorithms were compared. Experiment resultsshow that this method can effectively control impact of noise onimages. And the effect of image capturing can meetrequirements of embroidery patterns.

Ai DenGAn Image Fusion Algorithm Based on Discrete Wavelet Transform and Canny Operator Advanced Research on Computer Education, Simulation and Modeling Communications in Computer and Information Science Volume 175, 2011, pp 32-38- Choosing one reliable and effective fusion method to determine fusion coefficients is the key of the image fusion.This text puts forwards a new algorithm based on discrete wavelet transform (DWT) and canny operator from the perspective of the edge detection. First make original images multi-scale decomposed using DWT, and then acquire the level, vertical as well as diagonal edge information by detecting low-

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

frequency and high-frequency components' edges. Where after carry out a comparison of the energy of each pixel and consistency verification to more accurately determine the edge points and ensure the clarity of the fusion image. The comparison between the traditional method and this new method is made from the three aspects: independent factors, united factors and comprehensive evaluation. The experiment proved the usefulness of the method, which is able to keep the edges and obtain better visual effect.

IshaMehra 2014 Image fusion using wavelet transform and its application to asymmetric cryptosystem and hiding pp 5474-5483- Image fusion is a popular method which provides better quality fused image for interpreting the image data. In this paper, color image fusion using wavelet transform is applied for securing data through asymmetric encryption scheme and image hiding. The components of a color image corresponding to different wavelengths (red, green, and blue) are fused together using discrete wavelet transform for obtaining a better quality retrieved color image. The fused color components are encrypted using amplitude- and phase-truncation approach in Fresnel transform domain. Also, the individual color components are transformed into different cover images in order to result disguising information of input image to an attacker. Asymmetric keys, Fresnel propagation parameters, weighing factor, and three cover images provide enlarged key space and hence enhanced security. Computer simulation results support the idea of the proposed fused color image encryption scheme.

LigiaChiorean 2009 Medical Image Fusion Based on Discrete Wavelet Transform Using Java-The importance of information offered by the medical images for diagnosis support can be increased by combining images from different compatible medical devices. The fusion process allows combination of salient feature of these images. In this paper we present different techniques of image fusion, our work for medical image fusion based on discrete wavelet transform and how we understand to integrate this process into a distributed application. The dedicated application considers Java technology for using its facilities as a future development, regarding a remote access mechanism.

D**eepak Kumar Sahu (2012) Different Image Fusion Techniques –A Critical Review International Journal of Modern Engineering Research Vol. 2, Issue. 5,Sep.-Oct. 2012 pp-4298-4301-** Image Fusion is a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data. This paper presents a literature review on some of the image fusion techniques for image fusion like, primitive fusion (Averaging Method, Select Maximum, and Select Minimum), Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion etc. Comparison of all the techniques concludes the better approach for its future research.

Jan Flusser 2007 Image Fusion:Principles, Methods, and Applications Institute of Information Theory and Automation pp 2-60-The term fusion means in general an approach to extraction of information acquired in several domains. The goal of image fusion (IF) is to integrate complementary multisensory, multi temporal and/or multitier information into one new image containing information the quality of which cannot be achieved otherwise. The term quality, its meaning and measurement depend on the particular application. Image fusion has been used in many application areas. In remote sensing and in astronomy, multisensory fusion is used to achieve high spatial and spectral resolutions by combining images from two sensors, one of which has high spatial resolution and the other one high spectral resolution. Numerous fusion applications have appeared in medical imaging like simultaneous evaluation of CT, MRI, and/or PET images. Plenty of applications which use multisensory fusion of visible and infrared images have appeared in military, security, and surveillance areas. In the case of multitier fusion, a set of images of the same scene taken by the same sensor but from different viewpoints is fused to obtain an image with higher resolution than the sensor normally provides or to recover the 3D representation of the scene. The multi temporal approach recognizes two different aims. Images of the same scene are acquired at different times either to find and evaluate changes in the scene or to obtain a less degraded image of the scene. The former aim is common in medical imaging, especially in change detection of organs and tumors, and in remote sensing for monitoring land or forest exploitation. The acquisition period is usually months or years. The latter aim requires the different measurements to be much closer to each other, typically in the scale of seconds, and possibly under different conditions.

Dr.S.S.Bedi Image Fusion Techniques and Quality Assessment Parameters for Clinical Diagnosis: A Review International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 2, February 2013 pp 1153-1157- Image fusion is a tool that serves to combine multi sensors images by using advanced

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

image processing techniques. Particularly it serves best in medical diagnosis i.e. computed tomography (CT), magnetic resonance image (MRI), scan provides different types of information, by fusing them we can get accurate information for better clinical diagnosis. Transform domain image fusion methods such as wavelet transform, curve let transform have its specific advantages while going for multi-sensors image fusion. Analysis is done to determine the image fusion algorithm which is more suitable for clinical diagnosis. Analysis is also done on image quality assessment parameters of image fusion. This paper presents a literature review on image fusion techniques and image quality assessment parameters such as Structural similarity index measure, laplacian mean squared error, mean squared error, Peak signal to noise ratio, entropy, structural content, Normalized cross correlation, Maximum difference, normalized absolute error. Comparison and effective use of all the techniques in image quality assessment is also determined.

IV. OBSERVATION

The different pyramid schemes have been used in image fusion method which are mainly applied to fuse visible and IR images for surveillance applications. Discrete wavelet transform for image fusion where two different fusion rules are used for approximation image and detail image respectively. Most of multiresolution (MR) based image fusion approaches deal with the issues

- the selection of specific type of MR decomposition like pyramid, wavelet, linear, morphological etc.
- the appropriate number of decomposition level which facilitates the selection and combination of salient features.

More decomposition levels do not necessarily produce better result because by increasing the analysis depth the neighboringfeatures of lower band may overlap. This gives rise to discontinuities in the composite representation and thus introduces distortions, such as blocking effect or ringing artifacts into the fused image. The considerable work has been done in case of pixel based image fusion; but less work has been explored at feature level and region level image fusion.

V. CONCLUSION

This paper performs the Comparative study of Image fusion techniques and the related work done till now. Here, various techniques of Image Fusion that are useful in image fusion is to create a single enhanced image more suitable for the purpose of human visual perception, object detection and target recognition has been discussed. On the basis of the study we have find out various issues in different techniques and to remove them various techniques are proposed for fusion of different images. This review presents that which approach is better among all the existing Image Fusion techniques. Although selection of fusion algorithm is problem dependent but this review results that spatial domain provide high spatial resolution but spatial domain have image blurring problem. The Wavelet transforms is the very good technique for the image fusion provide a high quality spectral content. But a good fused image have both quality so the combination of DWT & spatial domain fusion method (like PCA) fusion algorithm improves the performance as compared to use of individual DWT and PCA algorithm. Finally this review concludes that hat a image fusion algorithm based on combination of DWT and PCA with morphological processing may be the future trend of research regarding image fusion

REFERENCES

[1] Firouz Abdullah Al-Wassai The IHS Transformations Based Image Fusion 2011 http://arxiv.org/abs/1107.3348
[2] SaschaKlonus Performance of evaluation methods in image fusion 12th International Conference on Information Fusion Seattle, WA, USA, July 6-9, 2009 pp 1409-1416
[3] Abhishek Singh Implementation & comparative study of different fusion techniques (WAVELET, IHS, PCA)Volume 1, Issue 4(December 2012), PP.37-41
[4] Kusum Rani Volume 3, Issue 5, May 2013 International Journal of Emerging Technology and Advanced Engineering Pp 288-291
[5] Ute G. Gangkofner Optimizing the High-Pass Filter Addition Technique for Image Fusion Photogrammetric Engineering & Remote Sensing Vol. 74, No. 9, September 2008, pp. 1107–1118.
[6] Fan Xiujuan The research on graphic outline capturing algorithm based on coloured embroidery pattern of HIS space 2011, Electronic Measurement & Instruments (ICEMI) pp 320 – 323
[7] Ai DenG An Image Fusion Algorithm Based on Discrete Wavelet Transform and Canny Operator Advanced Research on Computer Education, Simulation and Modeling Communications in Computer and Information Science Volume 175, 2011, pp 32-38
[8] IshaMehra 2014 Image fusion using wavelet transform and its application to asymmetric cryptosystem and hiding pp 5474-5483
[9] LigiaChiorean 2009 Medical Image Fusion Based on Discrete Wavelet Transform Using Java
[10] Technology Int. Conf. on Information Technology Interfaces,IEEEpg no 55-60

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

[11] Krista Amolins (2007) Wavelet based image fusion techniques — An introduction, review and comparison Volume 62, Issue 4, September 2007, Pages 249–263
[12] Manu V T A Novel Statistical Fusion Rule For Image Fusion And Its Comparison In Non Subsampled Contourlet Transform Domain And Wavelet Domain The International Journal of Multimedia & Its Applications Vol.4, No.2, April 2012 pno 69-87
[13] Deepak Kumar Sahu (2012) Different Image Fusion Techniques –A Critical Review International Journal of Modern Engineering Research Vol. 2, Issue. 5,Sep.-Oct. 2012 pp-4298-4301
[14] Jan Flusser 2007 Image Fusion:Principles, Methods, and Applications Institute of Information Theory and Automation pp 2-60
[15] Dr.S.S.Bedi Image Fusion Techniques and Quality Assessment Parameters for Clinical Diagnosis: A Review International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 2, February 2013 pp 1153-1157

BIOGRAPHY

Suruchi Goyal is pursuing her M. Tech (Computer Science) from RIMT-IET, MandiGobindgarh, Punjab, India. Her research interests are Computer Graphics, Database etc.

Er. Rupinder Wahla is an active researcher in the field of Image processing. She is currently working as Assistant Professor in the Department of Computer Science, RIMT-IET, MandiGobindgarh, Punjab, India. She has published many papers in International Conferences and Journals.