A REVIEW ON IMAGE FUSION TECHNIQUES

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ABSTRACT

Image processing is a highly emerging field now-a-days. Image Fusion gains more concentration in this field .This paper explains the concept of image fusion. It explains how image fusion is advantageous. Basically there are two methods of image fusion spatial domain image fusion and frequency domain image fusion. Various image fusion algorithms are studied and compared using various quality measures like Peak Signal to Noise Ratio, Mean Square Error, and Image Entropy. 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.

Keyword: *-IMAGE FUSION, DWT, SWT, PCA, FREQUENCY DOMAIN, SPETIAL DOMAIN .*

1. 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[1]. 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.[2] 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[3].

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[6]. 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 miss-registration but at the cost of complexity.[6]

2. 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[2][4][5].

TABLE-1 : Classification of image fusion techniques

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

The fusion methods, such as averaging, the Bovey 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.[2]

3. Literature Survey

In this section a brief description on the methods like, Averaging, Maximum Selection, Even Degree, Entropy, Discrete Wavelet Transform (DWT), Principle Component Analysis (PCA).

3.1 Simple Average Method

Simple Averaging is the linear based method. This method is used for smoothing the image i.e. provides the better region in fused image than the input images. The value of fused image is defined as[5]

$$F(i,j) = (PA(i,j)+PB(i,j))/2$$

where F(i,j) is the fused image; PA(i,j)and PB(i,j)) are different medical input images

3.2 Maximum Selection Method

This method used to find out the maximum pixel values from the input images. It is defined as[5]

$$F(i,j) = Max((PA(i,j),PB(i,j))$$

where F(i,j) is the fused image; PA(i,j) and PB(i,j) are different medical input images.

TABLE-2 : Classification of image fusion techniques

				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.

3.3 Discrete Wavelet Transform

The registered input images are decomposed into two sub-bands like low sub-bands and high sub-bands using wavelet transform. The low sub-bands and high sub-bands are fused using various fusion methods. Finally, the output of the fused image is obtained by applying inverse wavelet transform on the fused coefficients of low sub bands and high sub-bands.[4]

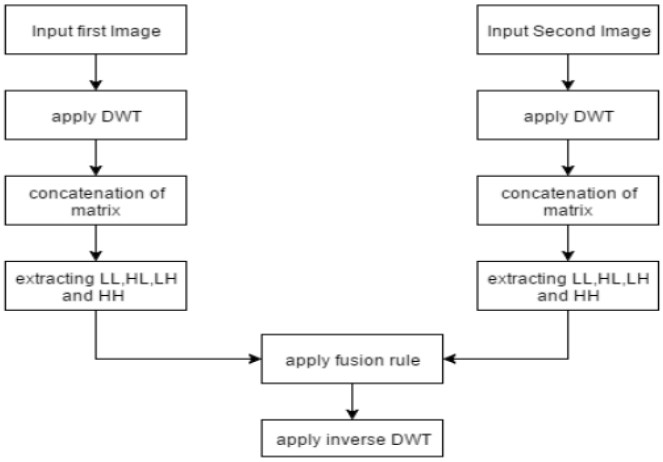

Fig-1 : DWT algorithm[5]

3.4 Principle Component Analysis

Principle Component Analysis is a statistical transformation method. This method is used to convert the multimodality medical input images correlated data variables into a new fused image uncorrelated data variables. The PCA method images are combined with weighted averaging and it's defined as [3]

$$f = (P1*A) + (P2*B)$$

whereP1and P2 are weights corresponds to the Eigen vector with greatest Eigen value from PCA.

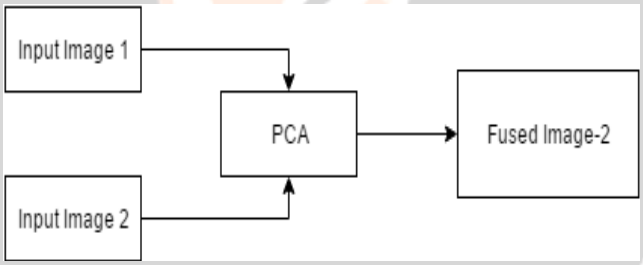

Fig-2 : PCA algorithm[4]

3.5 NUMERICAL RESULTS OBTAINED BY DIFFERENT IMAGE FUSION METHODS

Table-2 Comparison of various image fusion technique[5]

Sr No.	Methods	MSE	PSNR	ENTROPY
1	PCA	610.3	46.686	3.2901
2	DWT	670.2	45.348	3.8179
3	DCT	788.8	44.506	4.7875
4	DWT-PCA	391.7	53.15	4.8639
5	DWT-DCT-PCA	265.5	55.008	4.9914

4. CONCLUSIONS

This paper presents comparative study of different image fusion methods. In this we s how the different approaches to avoid the occurrence of undesired artifacts such over-fusion, lower PSNR, higher MSE, and lack of information in the fused image (Image Entropy). And also On the basis of the Entropy, PSNR and MSE we also see that by hybrid image fusion algorithm we can get better fused image.

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