Review on: image Fusion

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Abstract- Image fusion is a procedure in which unite two or more different images into a new original image, and keep hold of important features from each image with extensive or comprehensive information comfortable. The production of fusion image is a new image that is more efficient for machine and human in sight and more image processing task as object recognition, segmentation and feature extraction. The Fusion of low spectral/high spatial resolution and high-spectral/low spatial resolution multispectral panchromatic satellite image is very useful method in various applications of remote sensing. The image fusion is very useful in the medical field also, in medical field the fusion of the MRI and PET image gives absolute information, higher accuracy and improved or superior visualization. This paper introduce the review on some fusion techniques such as simple maximum, PCA, DWT, DCT, simple average and using parameters for result metrics such as PSNR, CCR,MSE,NCC,EN,SC,SF etc.

Keywords— *image fusion, preprocessing, Discrete Cosine transform, Discrete wavelet transform*

I. INTRODUCTION

The image fusion is mainly the method of combining significant information from two or more images into a single new image. The new image will be additional informative than any other of input and enhanced quality of image. The new image gives better accuracy, and better visualization than input images. The fusion of image is frequently necessary for images acquired from distinct capturing techniques and instrument modalities like multifocus, multisensory and multimodal images. For remotely sensed images, some have good Phantom or spectral information whereas other has evaluated geometric resolution. In The image fusion can be achieve at three levels objects, pixel and decision level.

The different fusion levels use different fusion algorithms and have different applications. The main categories of fusion including multiview fusion, multimodal fusion, multitemporal fusion, multifocus fusion for image resolution. The multitemporal method identifies two dissimilar aims. Images of the similar scene are obtained at different times either to find or evaluate changes in the scene or to attain a fewer degraded image of the scene. The earlier aim is ordinary in medical imaging, especially in change in remote sensing for monitoring land or forest exploitation, recognition of organs and tumors. The acquisition period is usually months or years. The latter aim requires the different dimensions to be much closer,typically in the scale of seconds, and possibly under dissimilar situation. In the case of multiview fusion, several images of the same scene taken by the same sensor but from diverse viewpoints is fused to attain an image with higher resolution than the sensor in general give or to recover the 3D representation of the scene. Multimodal fusion of images approaching from different sensors such as CT and NMR, visible and infrared, multispectral satellite and panchromatic images. Multifocus fusion of images of a 3D scene taken repeatedly with various focal length. The main function strategies are:

- Acquisition of different images
- Image to Image Registration

In the area of biomedical imaging two broad used modalities such as computed tomography and magnetic resonance imaging scan do not expose identically every detail of brain structure.

***Applications of image Fusion*:** In astronomy and remote sensing, multisensory fusion is used to attain high spatial and spectral resolutions by combining images from two sensors, one of which has elevated spatial resolution and the further one high spectral resolution. Many fusion applications have appeared in medical imaging like immediate estimate of CT, MRI, and/or PET images. many applications which use multisensor fusion of visible and infrared images have appeared in security, surveillance areas, military.

II. PREPROCESSING IN IMAGE FUSION

The images are captured by using the multisensor and it is first step in the image Fusion after capturing the images, the next step is preprocessing is very useful. The preprocessing involves brightness, adjustment and contrast stretching. When two images taken in different angles of scene sometimes cause distortion. The most of objects are same but the same is changed little.

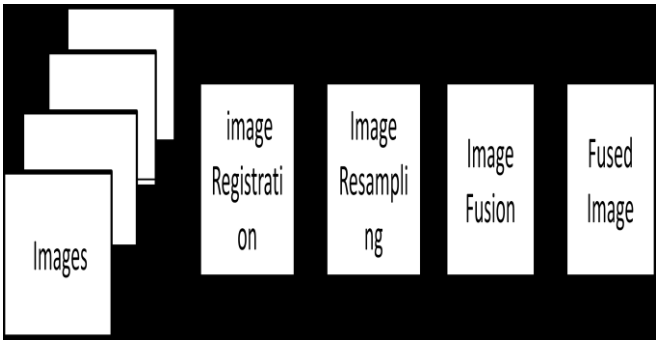

Fig 1: image preprocessing method

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Fig 3: image fusion process using DCT

The registration and image resampling is done to adjust each image that about to fuse to the same dimension. After the image resampling each image will be of same size. After the image resampling image fusion algorithm is applied and sometimes image is transfer into different domains. If image is transmitted then inverse transform is necessary that step is called preprocessing of image fusion.

III. Image Fusion Techniques

***Discrete Wavelet Transform*:** The discrete wavelet transform is the most common technique of transform type image fusion algorithm due to its simplicity and its ability to preserve the time and frequency details of image to be fused. The wavelet transform is decomposes a image into several parts such as low-low, low-high, high-low, high-high frequency spatial bands at different scales. The low-low band contains the average image information and other band contains directional information due to spatial orientations. Higher absolute values of wavelet coefficients in the higher bands correspond to salient features such as edge or lines.

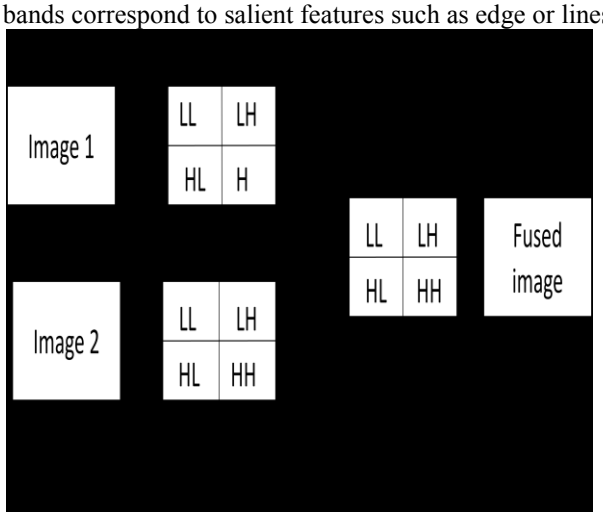
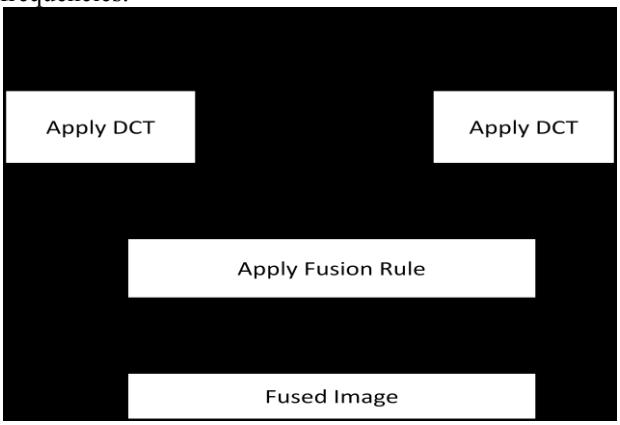


Fig 2: Discrete wavelets transform technique

Discrete Cosine Transform: Discrete cosine transform (DCT) is an imperative transform widely used in digital image processing (DIP). Large DCT coefficients are determined in the low frequency region. Hence, it is identified to have excellent energy compression properties. The DCT is used to convey a series of finite data points in terms of a sum of cosine functions oscillating at diverse frequencies.



Images to be fused are separated into non-overlapping Blocks of size NxN. DCT coefficients are compute for each block and fusion rules are applied to get fused DCT coefficients. IDCT is then applied on the fused coefficients to produce the fused image/block. The curvelet transform has gone throughout two main revisions. The first invention curvelet transform Used a multifarious series of steps involving the ridgelet analysis of radon transform of an image. The performance was exceeding slow. The next innovation curvelet transform Discarded the use of the ridgelet transform, thus reduced the amount of redundancy in the transform and improved the Speed considerably.

***Principal Component Analysis*:** PCA is the straightforward and mainly helpful in the true eigenvector-based multivariate
Analyses, because its operation is to reveal the internal
Formation of data in a neutral way. If a multivariate
Dataset is visualized as a set of coordinates in a elevated dimensional data space, PCA supplies the user with a 2-Dimensional picture, a shadow of this object when prospect from its most instructive viewpoint. This dimensionally-reduced image of the data is the ordination figure of the 1st two principal axes of the data, which when united with metadata can quickly expose the main factors underlying the structure of data. Principal component analysis (PCA) is a vector space Transform often used to ease multidimensional data sets to lower dimensions for analysis.
Image fusion process
Via PCA can be described as follow:

- From the input image matrices create the column Vectors.
- Calculate the covariance matrix of two column vectors twisted before.
- determine the Eigen value and Eigen vector of the Covariance matrix.
- The column vector parallel to the superior Eigen value is normalized by dividing each element with mean of Eigen vector.
- Stabilize Eigen vector value act as the weight Values which are respectively multiplied with each Pixel of the input images.
- The fused image matrix will be computation of the two scaled matrices.

***Neuro- Fuzzy Technique*:** A Neuro- fuzzy system is a Fuzzy scheme which is trained by any of neural network learning algorithms and according to the training data System parameters are modified automatically. Implementation of Neuro-Fuzzy technique is completed via ANFIS. The fused coefficients are obtained by concern ANFIS fusion rule to the SGWT coefficients. It is functionally equal to fuzzy inference system with the difference that, ANFIS also uses neural networks for decrease the error. Neural Network (NN) is a network which provisions the experimental knowledge and uses it for test data. Neuro-Fuzzy is a grouping of Fuzzy logic and Artificial Neural Network (ANN). Using this method we can train the system with input dataset and desired output.

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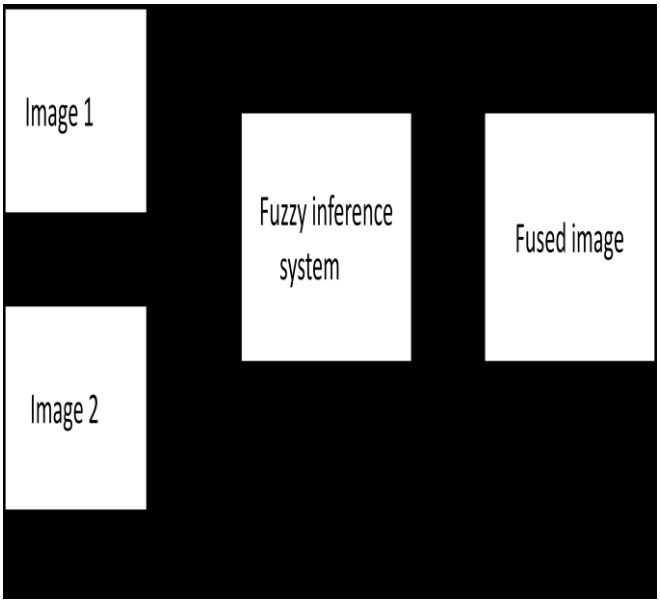

Fig 4: Neuro fuzzy system

Simple Average: The areas of images that are in focus tend to be of elevated pixel intensity. Simple average algorithms a easy way of attain an output image with all regions in focus. The value of the pixel P (i, j) of each image is in use and added. This summation is then divided by 2 to attain the average. The average value is allocate to the corresponding pixel of the output image.

***Maximum Selection Method*:** In maximum selection method ,the maximum intensity is selected of every corresponding pixel.

***Minimum Selection Method*:**In minimum selection method ,the minimum intensity values are selected of corresponding pixel.

***Laplacian Pyramid Method*:**An image pyramid consists of a set of low pass or band pass copies of an image,each copy representing pattern information of adifferent scale[4].
There are three main phases for pyramid transform are:

i. Decomposition
ii. Formation of the initial image for recomposition
iii. Recomposition

Proposed Methodology

In proposed image fusion system we take two images as input , one is CT image and another is MR image. For decompose the image using the curvelet and wavelet transform and then fused the coefficients. To train the system or classied the system two techniques used are ANFIS and SVM.

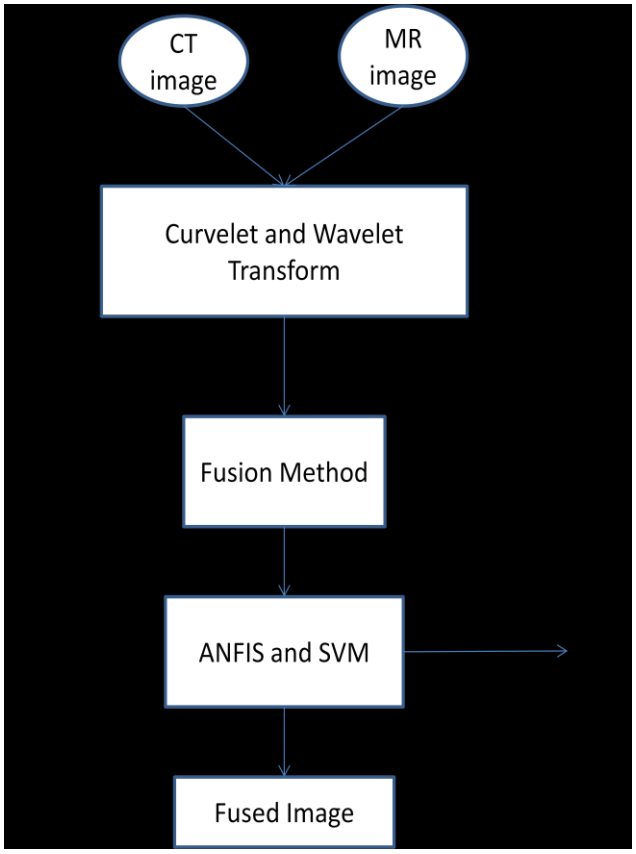

Fig 5: steps of proposed system

IV. Resulting Parameter

The quality of fused images attain from different algorithms (SWT, Fuzzy, Neuro-Fuzzy, Fuzzy let and Neuro-Fuzzy let) is evaluate using Fusion Quality Performance Evaluation Indices. Evaluate the quality by two methods, one is full reference method and another is no reference method.

***(A) Root Mean Square Error (RMSE)* :** RMSE is used reference based metric is. The RMSE between the images considered by the following equation:

$$\mathbf{RMSE} = \frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\big(R(m,n) - F(m,n)\big) \quad \mathbf{(1)}$$

The performance of the fusion algorithm is better, if the RMSE value is smaller.

(B) Peak Signal to Noise Ratio (PSNR): PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise. This is considered by:

$$\mathbf{PSNR = 20\log 10[L^2\ /RMSE]} \qquad \mathbf{(2)}$$

(C) Entropy (EN): Entropy is a guide to evaluate the information quantity contained in an image. If

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the value of entropy becomes elevated after fusing, it indicates that the information enhances and the fusion performances are better.

$$E = \sum_{i=0}^{L-1} p_i \log_2 p_i \qquad (3)$$

(D) Correlation Coefficient(CC): The correlation coefficient is the measure the closeness or similarity in small size structures between the original and the fused images. It can vary between -1 and +l .Values closer to + 1 indicate that the reference and fused images are highly similar while the values closer to -1 indicate that the images are highly dissimilar.

$$\mathbf{CC} = \frac{2Cr_f}{C_{r+C_f}} \qquad (4)$$

Where

$$C_r = \sum_{i=1}^{M} \sum_{j=1}^{N} I_r\ (i,j)$$

$$C_f = \sum_{i=1}^{M} \sum_{j=1}^{N} I_f\ \ (i,j)$$

$$C_{rf} = \sum_{i=1}^{M} \sum_{j=1}^{N} I_f\ \ (i,j) \quad I_f\ \ (i,j)$$

Literature Review: Swathy Nair and Bindu Elias [1] present a paper on" pixel level image fusion". Fuzzy logic method explained In this paper and neuro fuzzy techniques and quality measure parameters. R.J.Sapkal and S.M.kulkarni [2] introduce "Image fusion on Wavelet transform for medical applications" in which discuss about the wavelet transform fusion method. Discuss the wavelet theory, fusion theory and working on medical applications. Gehad Mohamed Taher, Mohamed Elsayed Wahed, Ghada El Taweal, Ahmed Fouad [3] present a paper "Image fusion approach with noise reduction using Genetic Algorithm" in this describes the image de-noising using genetic algorithm and image fusion by curvelet transform. The PSNR for genetic algorithm gave 38.7426 and contour let gave 33.5483. T.S.Anand; K.Narasimhan and P.Saravanan [4] introduce "Performance Evaluation of Image Fusion Using the Multi-Wavelet and Curvelet Transforms".Fusion algorithm explain in this paper for two different modality medical images based on the Multi Wavelet Transform (MWT) and Curvelet transform using distinct fusion techniques was implemented and results are analyzed using different quantitative parameters. Ms. Kulkarni Aparna S. [5] present "Underwater Image Reconstruction Using Image Fusion Technique". the wavelet based image fusion technique and fusion rules mentioned in this paper. D. Egfin Nirmala, A. Bibin Sam Paul and V. Vaidehi [6] "Improving independent component analysis using support vector machines for multimodal image fusion" in this paper the features extracted in ICA transformation and DT-CWT domain. And spatial domain are used in order to improve the performance of the fusion process. For the training the SVM (support vector machine) algorithm is used. Navneet kaur, Madhu Bahl, Harsimran Kaur [7] "introduce Review On: Image Fusion Using Wavelet and Curvelet Transform".Two medical images are fused based on the Wavelet Transform (WT) and Curvelet transform using different fusion techniques in this paper. The input CT and MR images are registered and wavelet and curvelet transforms are applied on it. The results are calculating using fusion techniques. The parameters like PSNR, CCR and MSE are evaluated. Y. Kiran Kumar [8] "Comparison of fusion techniques applied to preclinical images: fast discrete curvelet transform using wrapping techniques and wavelet transform ". In this paper, Fast Discrete Curvelet Transform using Wrapper algorithm based image fusion technique, has been apply, analyzed and compared with Wavelet based Fusion Technique.

CONCLUSION

In this paper, image fusion idea, some of the image fusion techniques are discussed and the image quality assessment parameters have been reviewed and determine the role of individual image quality assessment parameter to determine the quality of the fused image. Selection of proper fusion Technique are depends upon the specific application of image fusion.

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