Survey on Multimodel Image Fusion using Stationary Wavelet Transform and Fuzzy logic

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Abstract

The information extraction process of image, for example image taken from precise camera, is full of complexities and noises. As a result, cost spend on such processing like time and assets is high, particularly for large and complex amount of information. The fusion of images is the process of merging two or more images into a single image preserving significant features from each. The result of fused image is a single image which is highly appropriate for person and machine observation or further image-processing missions. In this paper, we are going to extract image from two or more images. The proposed fusion techniques are based on two process. one is Stationary Wavelet Transform(SWT) and the other one is Fuzzy logic. Stationary Wavelet Transform provides higher level of decomposition for fused image fusion. And Fuzzy logic allows the problems to be solved in linguistic terms. It can provide number of possible result.

Keywords: Image Fusion, pixel level, Stationary wavelet Transform, fuzzy logic

I. INTRODUCTION

Image fusion combines registered image to make a high quality fused image with spatial and spectral information. It is to combine two or more images of same scene into a single combined (or) fused image, and also to shrink vagueness and minimum idleness so that information can be provided. Image fusion includes

Medical image, Remote Sensing image, Weapon detection, Weather forecasting and biometric images etc[1]. Multimodel images are suitable for Medical images such as Computer tomography (CT) Magnetic Resonance Image (MRI) and Positron Emission Tomography in order to improve diagnosis [2]. Method of image fusion focuses on two types such as Standard Image fusion method and complex method. Standard image fusion method consists of the following techniques:

(1) High pass filtering
(2) Bravery method
(3) IHS transform based image fusion
(4) PCA based fusion
(5) Wavelet Transform image fusion

Spatial image fusion work is to combine the pixel values of the two or more images. The simplest is, averaging the pixel values of the input images. In the transform domain method the multiscale decomposition of the images is done and the composite image is constructed by using the fusion rule used in wavelet transform and laplacian transform domain. Then inverse multiscale transform is applied to achieve the fused image [3].

Pixel level fusion is derived from a set of raw pixels in the various inputs from multiple source images into a single image. Advantages of pixel level are that the original measured quantities are directly involved in image fusion process. Feature level fusion image fusions require the extraction of different features from the source data before features are merger together. Decision level image fusion involves sensor fusion and these fusions combine the clarification of the source images generated after image understanding [4]. Pixel level based image fusion and several algorithms have been already proposed and recently being used in [5,6]

Two problems of image registration:

(1) Register image to other images.
(2) Register image to the real world

Transfer image defined positions onto patient, transfer positions from patient to image model.

Wavelet transform is one of the right tools used for signal processing and image processing. Wavelet transforms find its application in the compression and cleaning of the images. Basically wavelets transforms are of two types, First type is easily reversible, where we are able to easily retrieve the original signal after its transformation. It is used in image compression and image cleaning. Second type is used for the signal analysis and sensor measurement fault detection. The modified form of the original signal is not required and the wavelet transform is not inverted back [7]. Linear, non-linear, global, local transformations are allowed for image fusion.

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Image processing has an uncertainty to define the Stationary Wavelet Transform (SWT). But image fusion at any stage destroys the may arise at any stage of processing of the ambiguity / vagueness in source image or ambiguity in significant edges, boundaries, regions and features. Fuzzy logic is widely applied techniques as it allows the problems to be solved in linguistic terms [9].

II. PIXEL BASED IMAGE FUSION

Let I1 and I2 be the registered source image to be fused. The given images are first transformed to Wavelet transform domain and can find the activity measures are entropy and energy of the low frequency coefficients are computed [9].

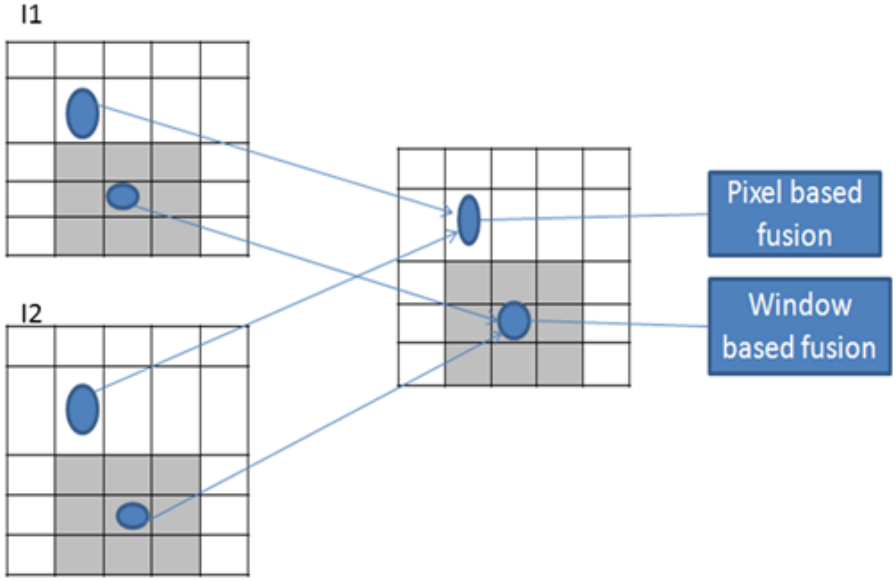

Fig. 1: Pixel Based Fusion

III. STATIONARY WAVELET TRANSFORM (SWT)

Analysis of transient signal Wavelets are contained waves having finite energy. The irregularity and good localization properties compose them better basis for analysis of signals with discontinuities. DWT is a type of signal representation that can give the frequency content of the signal at a particular instant of time and frequency representation is needed. It provides directional information in decomposition levels and contains particular information at different resolutions. The translation invariance is slightly different from DWT called on Undecimated. DWT has down sampling step of the decimated procedure and as a substitute up-sampling the filters by inserting zeros between the filter co-efficient.

The Wavelets are first used to the rows and then to the columns. Modify the filters at each level, by padding them with zeros computationally more complex. As with the decimated algorithm, the wavelets are applied for low and high pass frequencies. The estimated images from the Undecimated algorithms are represented as levels in a parallel piped, with the spatial resolution pleasant grainier at each higher level and the size remaining the same. Stationary Wavelet Transform (SWT) is similar to Discrete Wavelet Transform (DWT) but the only process of down sampling is suppressed that means SWT is a Translation invariant. The 2-D Stationary Wavelet Transform is based on the idea of no decimation. It applies the Discrete Wavelet Transform (DWT) and omits both down sampling in the forward up sampling in the inverse transform. It applies the transform at each point of the image, saves the detailed co-efficient and uses the low frequency information at each level. The fused image is reconstructed by performing Inverse Stationary Wavelet Transform (ISWT) [8].

Wavelet based image fusion process the steps generally involved are registering source images, performing Stationary wavelet transform on each input images, generating a fusion decision map based on a defined fusion rule and constructing fused wavelet coefficient map from the wavelet coefficients of the input images according to the Fusion decision map. Finally, transform back (ISWT) to the spatial domain. Stationary Wavelet Transform performs a multilevel 2-D Stationary Wavelet Transform analysis using either a specific orthogonal wavelet or specific orthogonal wavelet decomposition filters. Stationary wavelet decomposition results in estimate and detail coefficients. They are named as; A (contains the coefficient of approximation), H, V and D (contain the coefficient of Horizontal, Vertical and Diagonal details).

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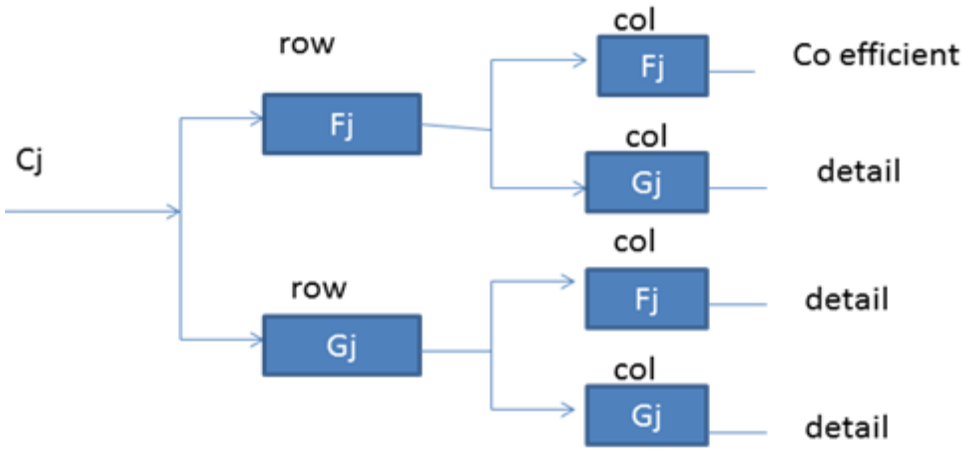

Fig.2: Two Dimensional SWT

IV. FUZZY LOGIC

Fuzzy logic derives from the fact that most modes of human reasoning and especially commonsense reasoning are approximate in nature. It allows computerized devices to reason more like humans. The fuzzy inference process can formulate the mapping from the inputs to the output using the membership functions, fuzzy logic operation and fuzzy control rules.

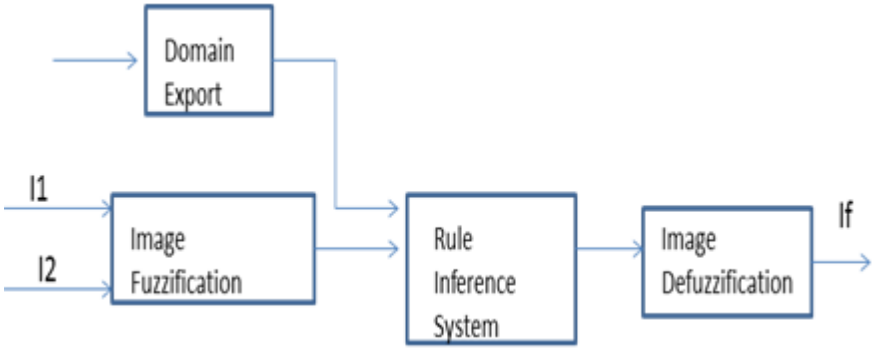

Fig.3: General Structure of Fuzzy Inference System

Fuzzy set is a class of object grade of membership function. Fuzzy set represents spatial information in images along with its imprecision. Membership function that represents a graphical method. Participation of each input in the input space. Input space refer to universe discourse (or) set universal. MF's assign to each object a grade of membership ranging between [0,1]. Fuzzy logic operations are performed in Boolean operation (AND, OR, NOT). Fuzzy control rules are used to IF-then rules. Fuzzy inference process uses two main methods, which are Mamdani and Sugeno. Mamdhani fuzzy inference systems require the output membership functions are fuzzy sets and this requires defuzzification. The Sugeno inference system uses the output Membership function's that is either constant or linear and this avoids the need for Defuzzification.

Fuzzy process involves 3 main steps: Fuzzification, rules based on inference system and Defuzzification.

- Fuzzification: The procedure that converts crisp numerical input values into linguistic variables is referred to as Fuzzification.
- Rules**:** if -then rules
- Defuzzification**:** This process of producing a crisp output from the fuzzy response, the Defuzzifier is the aggregate output fuzzy set that covers a set of output values.
  Rule 1: IF input 1 is low and input 2 is high then output 1 is low.
  Fusion method focus on merging two registered source images which can be applied to more inputs. A Good activity measures are Energy and Entropy, these are used in SWT. Fusion rules and techniques are followed to combine the low and high frequency SWT sub bands.

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Input1	*Input 2*		
	L	*M*	*H*
L	*L*	*L*	*M*
M	*L*	*M*	*H*
H	*M*	*H*	*H*

Fig. 4: Three Membership Function Using Fuzzy Rule table

V. MEMBERSHIP FUNCTION AND FUZZY LOGIC

Fuzzy logic based fusion method depends on choice of membership function. Gaussian Membership Function associates between the input and outputs that can be found more accurately, because they were very smooth, non - zero values not probability and local although not strictly compact. Gaussian MF's is specified by two parameter[10].

$$\text{Gaussian}(x;c,\sigma)=e^{-1/2((x-c)^2/(\sigma)^2)}$$

A Gaussian MF's is determined complete by c and σ;c represents the Membership Function's center and σ determines the width. Fuzzy set in the universe of discourse as low, medium and high[10]. Mamdani type inference system and the fuzzy inference rules are given below:

Rule 1: IF input 1 is low and input 2 is high then output 1 is low.

VI. RELATED WORK

Zhang and Blum established a classification of multiscale decomposition based image fusion to achieve a high quality digit camera image[11].

Panjare's and cruz gave tutorial of the wavelet based image fusion methods. They mainly focused on Decompossion approach which can be used to encrypt the size of images.DWT & Laplacian pyramids are the techniques which can be used for image fusion [12].

Huili, Sandigo, manjunath the wavelet transform of the input image's are suitable, combined and the new image is obtained by taking the inverse wavelet transform of the fused wavelet coefficients. An region based maximum selection rule and a consistency verification step are used for feature selection[13].

Bin yang shetao li pixel level image fusion integrates the information from multiple images of the scene to get an informative image which is more suitable for individual visual opinion (or) image processing[14].

Singh.Raj.J kaur G. established image fusion in which fuzzy logic has, defined rules, inference system, membersip functions. [15].

Mrityunjay Kumar, came out with total variation norm based approach in coincidence with principal factor analysis which is used iteratively to estimate the fused image. The possibility of the proposed algorithm is established on visible-band and infrared sensor images [16].

VII. CONCLUSION

In this paper, a method of image fusion is proposed. It is based on the use Stationary Wavelet Transform(SWT) and fuzzy logic, combined with some simple edge Detection methods, noise removel. From the experiments, the proposed fusion method provides good results. In addition, our proposed method can be applied to other features in the noisy image source.

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