FUSION OF MULTIPLE IMAGES USING SUPPORT VECTOR MACHINE AND DISCRETE WAVELET TRANSFORM

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Abstract—: **Fusion method is the method in which multiple images acquired from many sensors are integrated which produces a single image having appropriate important information from the images. Image fusion method provides a fantastic way to reduce all unwanted information and extract the important or suitable information. In this image fusion method DWT and SVM has an significant role for appropriate results. Extraction of relevant features is done by DWT and SVM mainly provides classification of the coefficients obtained after applying DWT. By using DWT computation time, resolution and storage space gets reduce. The fusion method includes feature extraction of the DWT sub bands such as energy, entropy, PSNR, mutual information, MSE. And the classification of such various features can be done by using SVM which is a best classifier. Results on analysis shows that quality of image which is fused is improved for multimodal image.**

Index Terms—**Discrete Wavelet Transform (DWT), Support Vector Machine (SVM), Fusion of images, Wavelet coefficients.**

I. INTRODUCTION

Data acquired from multi sensor has an important role in many applications such as observation, medical-imaging, remote sensing, weapon detection or tracking system. Due to increased availability of low cost and low power visual sensors there has been rising interest in surveillance applications. As image is captured from various sensors many images of the same scene provide different information. Improved image is obtained by merging various information acquired from multi sensor. This is called as fusion. In upcoming years there has been tremendous development in use of multi sensors to increase the efficiency of systems in various fields such as surveillance, medical imaging, remote sensing, etc. By using image fusion process we can obtain single image by extracting multiple images which contains all relevant information from the main images. By using multiple sensors we get large amount of data and image fusion technique results in reducing large amount of data by giving new images with proper and required information. By using above mentioned technique we can improve the accuracy of the system by reducing redundancy. Images acquired for fusion process can be taken either from same type sensors or different type of sensors at same time or different time. The image fusion process can be executed at three levels such as pixel level, decision level, and feature level [2]. Pixel level fusion operates on raw pixels directly and then forms a fused image in which every pixel is obtained from another set of pixels from source image. Feature level fusion performs extraction of features and works on those features. Decision level fusion operates at higher level and after understanding the image interpretations are obtained from different images [1]. Some of the information is lost while extracting the images which leads to less accuracy in decision and fusion level [4].The image which is obtained after fusion should contain maximum required information of the input image and may not include any distortions or loss of information in fused image.

II. LITERATURE SURVEY

There are various methods used for fusing images such as Brovery's method, Principal Component Analysis (PCA), IHS based method. The most simple method is pixel level image fusion which takes pixel-by-pixel intensity weighted average of the given source image. The adverse effects of this are reduced contrast. In current years ,it has been analyzed my many researchers that multi-scale transforms (MST) are useful for analyzing the content of images for purpose of fusion [2].The most commonly used multi-resolution methods are the Discrete Wavelet Transform and Pyramid Transform. The pyramid structure is an simple structure for representation of an image at multiple resolution. Human system is sensitive to sharp change contrast and pyramid transform provides information on that sharp contrast changes. The variations of pyramid contrast include Gradient Pyramid [5], Laplacian Pyramid[4],Contrast Pyramid[6],Morphological Pyramid[3].The simplest way of fusion is averaging in which the average value of the neighboring pixels is taken. The averaging method is enough for some applications but there are also images with low contrast or poor lighting due to which the quality of average image decreases. Another analysis is the Principal Component Analysis which is a statistical technique which converts the multivariate data with the variables which are correlated with uncorrelated variables from which new variables are obtained. The variables obtained are linear combination of the original variables. The implementation includes steps like checking the resolution of image such that the input images should have same resolution. This images are then arranged in two column vector . The eigenvector and eigenvalues for the resulting vectors are then computed. After analyzing the larger eigenvalue is obtained. The normalized component are computed from the obtained eigenvector and is fused for getting fused image. In Pyramid Transform techniques the pyramid structure can be described as a collection of images at various scales which collectively gives the original image. Pyramid Transform is used to represent the pyramid structure. Another type of Pyramid that is Laplacian

Pyramid implements a “pattern-selective” method for fusing images. In this approach the image is constructed at feature level and not at pixel level. For this the basic concept is to perform pyramid decomposition on each image. After that all these decompositions are integrated and a composite representation is formed. The represented image is reconstructed finally by performing inverse pyramid transform to get fused image.

III. BLOCK DIAGRAM DESCRIPTION

1. The source image which is to be fused is decomposed by using Discrete Wavelet Transform.
2. The sub-bands are sorted in non-overlapping blocks.
3. The features extracted such as energy, entropy, PSNR is used to train SVM.
4. SVM is trained by using these features.
5. By loading the extracted features of blocks of sub bands we can determine that if the block is taken from visual image or infrared image.
6. The classification of coefficients blocks is done in two classes: Class 1 having value 1 and Class 2 having value 2.If the class value is 1 the block is selected from Visual image and if class value is 2 the block is selected from Infrared image.
7. Now by applying IDWT from the selected coefficients the fused image is obtained.

- **Discrete Wavelet Transform**

In various application we have to analyze a function in both time and frequency. Basis function are decomposed by wavelet transform and also provides time time-frequency representation. Wavelets are used as basis function in wavelet transform as sine and cosine in Fourier transform. Wavelets are produced from a single basic wavelet by scaling and translation which is called as the mother wavelet.

$$\Psi s,\tau(t) = \frac{1}{\sqrt{s}}\Psi\left(\frac{t-\tau}{s}\right)$$

Where s is the scale factor, τ is the translation factor. Scaling a wavelet is nothing but stretching in which low scale means high frequency and high scale means low frequency. Wavelets are used for various range of application, namely signal processing, data compression, speech recognition. Fourier transform is a classical method for a periodic function. But the main drawback of FT is that we lose are time information which is very crucial [8]. The main advantages of wavelets is that they offer same localization in time and frequency domain and also it is computationally very fast wavelet transform wavelet has the grate ability to separate fine details or information present in the signal. A signal can be decomposed into component wavelet which is done by wavelet transform. ON image matrix 1-D filter bank is applied on the rows and then applied on the columns of each channel of result. Due to which we obtain three high pass channel correspond to vertical, horizontal, diagonal and one approximation image. The approximation may be low scale, high frequency components of the signal.

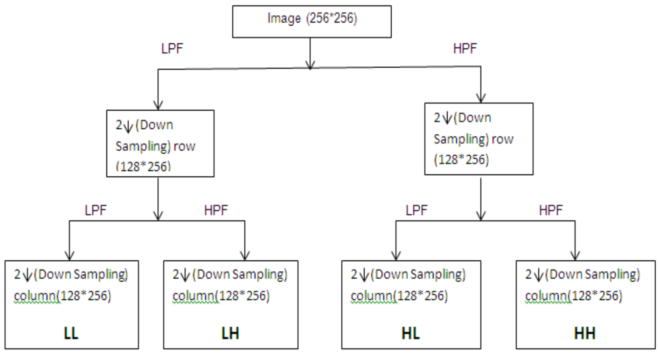

Fig 1: 2-level DWT transform

- **Support Vector Machine**

SVM is used to bifurcate data point or different samples in space. SVM is having two set of vector as an input data n-dimensional space that construct a different hyper plane which increases the margin between two data sets in that space[7]. In SVM object is seen as a n-dimensional vector in which we want to differentiate such object with a n-1 dimensional hyper plane, which is called as linear classifier. SVM algorithm makes a model which assign new examples into single category or other. This Model is represented as points in space, they are plotted so that the example of different category are separated by a gap that is much wider as possible. SVM can perform non-linear classification by plotting their input into large dimension feature spaces. SVM is used for classifier regression or different task in a high or finite dimension spaces. Effectively better bifurcation is obtained by the hyper plane having farthest distance to the nearest training data point of any class which is also called as functional margin. Vapnik in 1963 introduced a linear classifier. This classifier was obtained from optimal hyper plane. The algorithm which is obtained is heavily similar, except that each and every dot product is replaced by non -linear kernel function. The transformation can be non-linear and the transform space high dimensional, it can be non-linear in the main input space through the classifier is a hyper plane in the high dimension feature space.

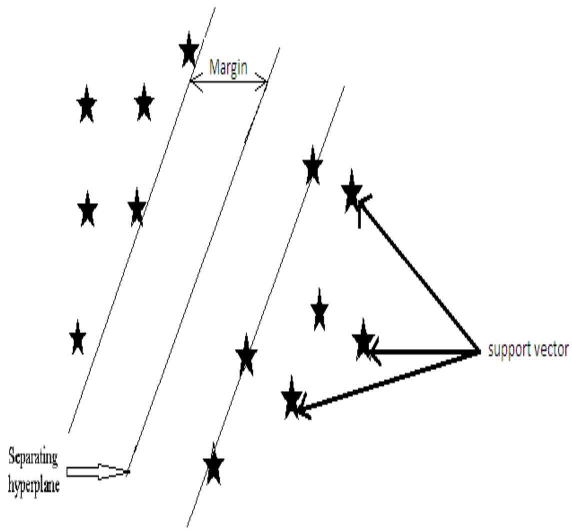

Fig 2: Points classification using SVM

- **Extraction of Features**

In many cases source data is extremely large, which creates need to be represented and reduced in set of features. So this

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procedure is called as feature extraction. The image which we get after feature extracted should contain proper required information from the input data to perform the required task. The image obtained after features extracted should contain more accuracy. By performing operation of complex data major problem occurs with more number of variables present in it. For performing an operation of large number of variables, more amount of memory and power is required and also classified algorithm is required which contain training and testing phase. In this method combination of variable are form and described the data with proper accuracy. All details, sub band coefficients are separated into non overlapped blocks of fixed size of extracted image which consists of energy, entropy, mutual information, PSNR, MSE by using following equations:

Energy

$$E= \sum_{i,j=1}^{N} C^2 (i,j)$$

Entropy

$$H = -\sum_{i,j=1}^{N} C(i,j) \log_2 C(i,j)$$

Standard Deviation

$$SD = \sqrt{\frac{1}{N^2} \sum_{i,j=1}^{N} [C(i,j) - C]^2}$$

Where,
C(i,j) = DWT Coefficient
C= Mean of each coefficient-block

IV. RESULTS

There are two main stages for image fusion such as training the SVM and then classification for testing for the model trained. In the fig. GUI panel shows following images that is visual image with its wavelet transform and infrared image with its wavelet transform values for R & C for the block selection which is the main motto for fusion. By applying image fusing algorithm the output is obtained. By changing the values of R and C the fusion gives different results. Which also gives different results for the parameter such as Energy, Entropy, MI, PSNR, MSE. The recorded matrices shows in tabular form with different block sizes like 2*2, 4*4, 8*8, 16*16.

Fig 3: Fusion Results For Visual and Infrared Images of 2*2

Block size	Energy	Entropy	MI	PSNR	MSE	Time(sec)
2*2	23982.7052	-1048.5686	3.4524	21.3666	474.6973	128.0047
4*4	23304.3808	-1023.6061	3.1771	17.3007	1210.6314	32.9979
8*8	22079.5199	-980.4257	2.6774	14.4115	2354.6691	8.3549
16*16	19731.9958	-896.2486	2.2156	12.1579	3956.3518	2.243

Table: Fusion matrices for Visual and Infrared Images of 2*2

V. CONCLUSION

Human/machine requires fused image of suitable form which is provided by fusing images. Image fusion has scope in medical imaging, remote sensing and surveillance. As SVM is used time required for computation is more but as it is trained only once there's no such issue of time complexity. We get best results by using small block size that is as block size reduces results acquired are more better. By experimental result it is clear that the method gives more information in image which is fused.

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