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A Review of Image Fusion Methods

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Abstract:- Image fusion is the method in which two or more than two images are fused into one image with keeping the all important characteristics from each part of the original images. The fusion of images is frequently needed for images got from another method for the same scene of image or objects (as multi-sensor, multi-focus and multimodal images). In this paper , A novel image fusion technique based on multi-resolution singular value decomposition (MSVD), PCA (Principal Component Analysis) , DCT(Discreet Cosine Transform) based method have been presented and evaluated. For Improve the performance of the Image Fusion , we have to improve the PSNR (Peak Signal to Noise Ration) and Reduce MSE(Mean Square Error).

Keywords:- *Image Fusion, Wavelet Transform, Fused Images, Wavelet Based Fusion, Multi-Resolution.*

I. INTRODUCTION

Image fusion is the operation in which two or more than two images are fused into one image with the major features from every part of the original images. The fusion of images is much mandatory for images adopted from different instrument modalities or appropriate methods of the same scene or targets (like multi-sensor, multi-focus and multimodal images).

For example, in multi-focus imaging one or many objects could be focused in a unique image, although another object in the scene can be in concenter in different images. For remotely detected images, some have good resolution data while another part of the image get high resolution. In the field of biomedical imaging, two widely utilized modes, that is to say, the magnetic resonance imaging (MRI) and the computed tomography (CT) scan don't display identically every point of the brain-body structure. While CT scan is particularly eligible for image of the bone structure and hard tissues, the MR image is more good in drawing the soft tissues of the brain. It shows really significant function in finding diseases impacting the skull base. These type of images are complementally in different ways and only one single image is not enough in terms of their individual information content. The benefit of these type of images could be possible by integration the mutual features seen in different images by the process of the image fusion which gives an image of characteristics better observed or presented in the various images. Big practical application of the image fusion includes medical field imaging, microscopic imaging, remote sensing, computer vision, and robotics.

The first step for image fusion is a preprocessing step in which it gets down the high resolution based image part from the different images and fused it into a single image so that all the high resolution based an important part of all the images can be combined into one single image. Image fusion performance can be measured by check the PSNR and MSE of the Image Fusion process. Some Fusion methods provide the easiest way for pixel averaging as principal component analysis and wavelet transform fusion. Several approaches to the image fusion can be described on the fusion of transform based. In these approches, some images are get fused in the spatial domain and some images are get fused in the transformed domain. Li et al. [1] give a multisensory-based image fusion by use the wavelet transform. In this a cascaded sequence of forwarding and reverse wavelet transform for multi-modal images makes a fused image. Another basic wavelet transforms based image fusion systems include maximum selection (MS). It collects the wavelet transform coefficient for every sub-band with the biggest magnitude. Burt and Kolczynski applied a normalized correlation in between the two images. Sub-bands across a little local-area and the outcome coefficient for reconstruction which can estimate the value of a weighted average of the two images coefficients. Zu Shu-long [7] suggested wavelet based fusion approach by use "gradient" standards, while Hill et al. [6] attained fusion by the practical application for the shift invariant and directionally exclusive Dual Tree Complex Wavelet Transform (DT-CWT).

In the paper, an image fusion method is planted on wavelet transform. In the planned scheme, the processed images are broke down into sub-images. The Sub Image are broken down in the equal resolution at equal levels while varied resolution at varied levels. After this process the fusion data will executed applying high-frequency sub-images under the aggregated "gradient" and relative smoothness and criterion. Finally this type of sub-images are rebuilt into a consequent image with good data. The designed method is implement to fuse multi-focus, multi-modal and remotely sensed, multi-sensor images. Different type of image fusion method involves for clear the image.

II. WAVELET TRANSFORM AND WAVELET BASED FUSION

The wavelet transform is an effective mathematical method which applied in the areas of signal processing. It is used to divide the provided function or signal into different scale elements like each scale element can be analyzed on a resolution that matches. Mallat applied the wavelets to the signal processing, so it is known as the Multi-resolution Theory. It is the base of Modern, effective methods. The identical process has been reached to multi-dimensional signal decomposition. In a multi-focus and multi-sensor image attainment system, the sized, preference and position of a target congenator to its own background. It could not be same in all the images of different modes. Integration or fusion for the multi-focus or multi-sensor data is feasible only when the images are

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recorded or set according to a basic coordinate arrangement. In the area of two image fusion, Image registration is the technique of checking mapping in between all points in two different images by the equal scene or object. The more usual form of transform image fusion is wavelet transform fusion. More common technique in entirely transform domain fusion methods is Wavelet Transform. In this, the translated images are fused in the transform region by applying a specified fusion rule and then transformed back to the spatial domain to provide the resulting fused image. Wavelet transform fusion is officially specified by taking the wavelet transforms "w" of the "n" recorded input images I(x,y), j=1,2…n together with the fusion rule "f". Then, the inverse wavelet transform w-1 is computed, and the fused resulting image I(x,y) is reconstructed as depicted in figure 1.

A. Discrete Cosine Transform (DCT)

In the case of discrete Fourier transform(DFT), discrete cosine transform(DCT) convert the image edge to fix the image transformed into the form of even function. It is single usual linear transformations in digital signal process methodology. Two-dimensional discrete cosine transform(2D-DCT) can specify as In the smallest low-frequency coefficient based 2D-DCT not simply focus on the important data of original image , but also focus at the smallest part of the image. It can make the effective compromise between the information centralizing and the computing complication. So it gets the broad application in the compression coding [8].

B. Discrete Wavelet Transform (DWT)

Wavelet transform is a time domain localized based analysis process with the fixed window's sized and form adaptable. There is an effective time specialized rate in high-frequency section of signals DWT transformed. As well there has an effective frequency differentiated rate in its low frequency part. It can distilled the data from signal effectively.---

The basic idea of discrete wavelet transform(DWT) in image process is to multi-differentiated decompose the image into sub-image of different spatial domain and independent frequency district . Then transform the coefficient of sub-image. After the original image has been DWT transformed, it is decomposed into 4 frequency districts which is one low-frequency district (LL) and three high-frequency districts(LH,HL,HH). If the information of low-frequency district is DWT transformed, the sub-level frequency district information will be obtained. A two-dimensional image after three-times DWT decomposed can be shown as Fig.1. Where, L represents low-pass filter, H represents high-pass filter. An original image can be decomposed of frequency districts of HL1, LH1, HH1. The low-frequency district information also can be decomposed into sub-level frequency district information of LL2, HL2, LH2 and HH2. By doing this the original image can be decomposed for *n* level wavelet transformation [18].

The information of low frequency district is a image close to the original image. Most signal information of original image is in this frequency district. The frequency districts of LH, HL and HH respectively represents the level detail, the upright detail and the diagonal detail of the original image. According to the character of HVS, human eyes is sensitive to the change of smooth district of image, but not sensitive to the tiny change of edge, profile and streak. Therefore, it's hard to conscious that putting the watermarking signal into the big amplitude coefficient of high-frequency band of the image DWT transformed. Then it can carry more watermarking signal and has good concealing effect.

C. Principal Component Analysis (PCA)

PCA, also known as the Karhunen-Lowe transform, is a linear dimension-reduction technique. It aims to find the project directions along which the reconstructing error to the original data is minimum, and projects the original data into a lower dimensional space spanned by those directions corresponding to the top eigen values. In face recognition, those directions which are the eigenvectors of the covariance matrix of face images are orthogonal basis vectors.

Consider the training sample set of face image F = $\{x_1,x_2,...,x_M\}$,where $x_i,(x_i \in R^n,i,.....,M)$ corresponds to the lexicographically ordered pixels of the ith face image, and where there are *M* face images. PCA tries to mapping the original n-dimensional image space into an m dimensional feature space, where m<<n. The new feature vectors $y_i \in R^m$ are defined by the following linear transform:

It is widely applied into many fields such as computer vision, medical imaging, and remote sensing. For example, in the computer vision field, the technique can be used for overcoming the limited depth-of-focus of optical lenses in charge-coupled devices. Many methods exist to perform image fusion. The very basic one is the high pass filtering technique. Later techniques are based on Discrete Wavelet Transform, uniform rational filter bank, and Laplacian pyramid. Image fusion methods can be broadly classified into two categories, namely, spatial domain and transform domain. The former, including averaging and principal component analysis (PCA) [2], can directly fuse the source images into the intensity values, whereas the latter, which include the Laplacian pyramid (LAP)-based method [1], discrete wavelet transform (DWT)-based approach [3], and discrete cosine transform (DCT)-based algorithm [4], merge the transform coefficients using the classical weighted average strategy or the choose-max strategy and then obtain the fused result through the inverse transformation of the combined coefficients.

Tensors (multi way arrays) are generalizations of scalars, vectors, and matrices to an arbitrary number of indices. Tensor-based information processing methods are more suitable for representing high-dimensional data and extracting relevant information than vector- and matrix based methods and thus receive lots of attention [5]–[7].

As one of most efficient tensor decomposition techniques [7], higher order singular value decomposition (HOSVD) has been widely applied into many areas such as multidimensional harmonic retrieval [8], face recognition [9], telecommunications, magnetic resonance imaging, electrocardiograph, World Wide Web search, handwritten digit classification [10], color image restoration [11], and texture synthesis [12].

D. MSVD(Multi Resolution Singular Value Decomposition)

A novel image fusion technique based on multi-resolution singular value decomposition (MSVD) will use for improve the performance from the base paper results . The performance of this algorithm is compared with that of well known image fusion technique using wavelets. It is observed that image fusion by MSVD perform almost similar to that of wavelets. It is computationally very simple and it could be well suited for real time applications. Moreover, MSVD does not have a fixed set of basis vectors like FFT, DCT and wavelet etc. and its basis vectors depend on the data set. The results of the CR will be further improve by use MSVD technique.

III. CONCLUSION

A novel image fusion algorithm by MSVD has been presented and evaluated. The performance of this algorithm is compared with well known image fusion technique by wavelets. It is concluded that image fusion by MSVD perform almost similar to wavelets. It is computationally very simple and it could be well suited for real time applications. Moreover, MSVD does not have a fixed set of basis vectors like FFT, DCT and wavelet etc. and its basis vectors depend on the data set.

REFERENCES

[1]. Stephane G. Mallat, "*A Theory for Multi-resolution Signal Decomposition:* The Wavelet Representation", IEEE Transaction on Pattern Analysis andd Machine Intelligence. Vol. II No. 7, pages 671-693, July 1989

[2]. A. Colligon, D. Vandermeulen, P. Seutens, G. Marchal, "*Registration of 3D multimodality medical imaging using surfaces and point landmarks*", *Pattern Recognition* Lett. 15, pp.461-467, (1994).

[3]. S. Banerjee, D.P. Mukherjee, D. Dutta Majumdar, "*Point landmarks for the registration of CT and MR images*", Pattern Recognition Lett. 16, 1033- 1042, (1995)

[4]. H. Li, B.S. Manjunath, S.K. Mitra, "*Multisensor image fusion using the wavelet transform", GMIP: Graphical Models Image Process.* 57(3) pp.235-245 (1995)

[5]. A.A. Goshtasby, J.L. Moigne, "*Image registration Guest Editor's introduction*", Pattern Recognition 32, 1-2, (1999).

[6]. PAUL Hill, Nishan Canagarajah and Dave Bull, "*Image Fusion using Complex Wavelets*", BVMC 2002

[7]. Zhu Shu-long, "*Image Fusion Using Wavelet Transform*", *Symposium on Geospatial Theory, Process and Applications*, Ottawa 2002.

[8]. Paul Hill, Nishan Canagarajah and Dave Bull, "*Image Fusion using Complex Wavelets", BVMC 2002*.

[9]. Pavithra C, Dr. S. Bhargavi ," Fusion Of Two Images Based On Wavelet Transform ", International Journal Of Innovative Research In Science, Engineering And Technology Vol. 2, Issue 5, May 2013.

[10]. Hari Om Shanker Mishra and Smriti Bhatnagar," MRI and CT Image Fusion Based on Wavelet Transform ", International Journal of Information and Computation Technology. ISSN 0974-2239 Volume 4, Number 1 (2014).