A REVIEW: ON CURRENT TRENDS IN IMAGE FUSION

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Abstract

Image fusion is a process that can be used to retrieve information about medical images. The Daubechies Complex Wavelet Transform (DCxWT) is an important aspect of image fusion for providing phase information. There are some algorithms that are used in this paper i.e. SIMPLE AVERAGE , SIMPLE MAXIMUM , SIMPLE MINIMUM, DCxWT , PCA. So image fusion finds many applications that involve image processing. It is just a mechanism to improve the grade of information from a group of images. The final image is formed by combining many images into one single image. In this paper we discuss about many applications of image fusion. We discuss the latest trends in image fusion. It increases the performance of image fusion than existing technique.

Keywords: medical images; daubeschies complex wavelet transform; simple maximum; simple minimum; simple average

INTRODUCTION

Image fusion is the process of combining the relevant information from a set of images into a single image,where the resultant fused image will be more informative and complete than any of the input images. Image fusion cab also be described as an artifact that depicts or records visual perception, for example a 2D picture providing a simple depiction of usually a physical object or a person. they may be captured by optical devices like: cameras, mirrors, lenses, telescopes etc. Image fusion techniques can improve the quality of the picture .Several situations in image processing requires both spatial and high spectral information in a single layer. If we talk about computer vision multi sensor image fusion is the process of combining relevant information from two or more images into a single image. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms.

Several image processing require high spatial and high spectral resolution in a single image. Multi sensor data fusion has become a discipline which demands more general formal solutions to a number of application cases. Some well-known image fusion methods are High pass filtering technique , IHS transform based image fusion , PCA based image fusion , Wavelet transform image fusion , Pair-wise spatial frequency matching. Multimodal medical image fusion is a process that can be used to retrieve information about medical images. The Daubechies complex wavelet transform (DCxWT) is an important aspect of image fusion for providing phase information. The fusion method can be compared with wavelet domain (Dual tree complex wavelet transform (DTCWT), Lifting wavelet transform (LWT), Multiwavelet transform (MWT), Stationary wavelet transform (SWT)) and spatial domain (Principal component analysis (PCA), linear and sharp) .

Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. There are some levels of fusion i.e pixel level (Petrovic, 2001), feature level (Lewis et al, 2004) and decision level (Yunfengyixin& Dngmei,2008).

Image fusion process must not introduce any noise or any unexpected feature in the fused image and this image must not miss any relevant information contained in the original images (Nikolov, Hill & Bull, 2001; Rockinger & Fechner, 1998).

The one of the most crucial area of research in image fusion is biomedical image fusion. Biomedical image fusion is the process of

registering and combining multiple images from single or multiple imaging modalities to improve the imaging quality and reduce randomness and redundancy in order to increase the clinical applicability of medical images for diagnosis and assessment of medical problems. It has been very useful now a days for the people. A scientific discipline that has the potential to significantly grow in the coming years.

The biomedical sensors: magnetic resonance imaging (MRI) and computes tomography (CT) are used for withdrawing information used in detecting fractures and abnormalities in a person. Like CT is a tumour and MRI is used to obtain information among tissues. The processs of combining the information into the single image from two or more images which facilate for better treatment is called medical image fusion. These are the modes of medical imaging is CT, X-ray, DSA, MRI,PET, SPECT.

BACKGROUND

The most popular methods for pixel level fusion are pyramid and wavelet transforms ,firstly the source images are decomposed into pyramidal representations and then the application of fusion rules is carried out .Pyramid transform based fusion methods do not provide any directional information and have poor signal to noise ratio. In contrast to pyramid transforms, wavelet transforms have accurate representation of the detailed features of image. Discrete wavelet transform (DWT) is used for image fusion and provides spectral and directional information whether it be vertical, horizontal or diagonal. They are applied to multifocus, multiview, multimodal and infrared. DWT doesn't give any information about the phase.

STEPS FOR INITIATING IMAGE FUSION.

3.1:

The first step is to decompose images using (DCxWT). For this we have to select a mother wavelet. Mother wavelet is the parent wavelet from which we get the other wavelets. Smoothening , distorting and approximating of a signal is required in selection of a mother wavelet

3.2:

The second step is to merge wavelet coefficients. The useful information is preserved which has reduced noise and better visual representation. The fusion rule includes the replacement of smaller magnitude complex wavelet coefficients with higher magnitude complex wavelet coefficients.

IMAGE FUSION ALGORITHMS

Due to the limited focus depth of the optical lens it is often becomes very difficult to get an image that contains all relevant objects in focus. To obtain an image with every object in focus a multi-focus image fusion process is required to fuse or to combine the images giving a better view for human eye. Pixel-based, region-based and wavelet based fusion algorithms are the algorithms used vastly.

4.1 SIMPLE AVERAGE

It is a but obvious that regions of images that are in focus will be of higher pixel intensity. Thus this algorithm is a simple way of obtaining an output image . The value of the pixel P (i, j) of each image is taken and added. This sum is then divided by 2 to obtain the average. The average value is assigned to the corresponding pixel of the output image which is given in the following equation. This is repeated for all pixel values.

Equation:

$K(i, j) = \{X(i, j) + Y(i, j)\}/2$

Where X (i , j) and Y (i, j) are two input images.

4.2 SELECT MINIMUM

This method is similar to select maximum method. But the only difference is, it considers only the pixel with lowest pixel intensity value sand ignores other pixel values. When the input images have low brightness this method can be used.

4.3 SELECT MAXIMUM

The greater the pixel values the more focused the resulting image will be. This algorithm chooses the regions that are more focused from each input image by choosing the greatest value for each pixel, resulting in highly focused output. The value of the pixel P (i, j) of each image is taken and compared to each other. The greatest pixel value is assigned to the corresponding pixel.

For example, if we have two input images A1 and A2 first we need to compare pixels A1(x,y) and A2(x,y).Then pixel with highest pixel intensity is selected and then assigned to the corresponding pixel value of the output image.

If A1(x,y)> A2(x,y)

0(x,y)=A1(x,y)

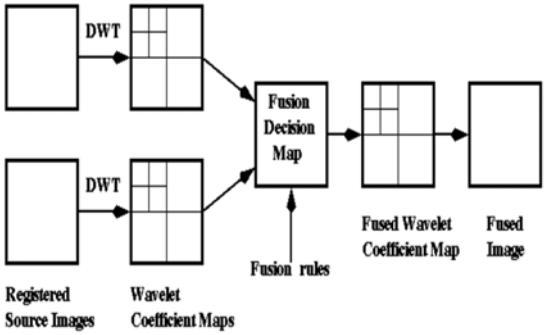
Else
0(x,y)=A2(x,y)
Where A1(x,y) and A2(x,y) are input images and 0(x,y) is the fused image.

This method produces highly focused output image when compared to simple average method. But it considers only the highest pixel intensity, ignoring lower pixel values.

4.4 DISCRETE WAVELET TRANSFORM (DWT)

Wavelets are finite duration oscillatory functions with zero average value. They have finite energy. Wavelets can be described by using two functions ie.the scaling function f (t), also called "father wavelet" and the wavelet function also called "mother wavelet". Mother wavelet (t) undergoes translation and scaling operations to give the equation:
$\psi a, (t)= 1\ a\psi t-ba\ , a, b\epsilon R\ , a> 0$

The wavelet transform decomposes the image into low-high, high-low, high-high spatial frequency bands at different scales and the low-low band at the scale. Higher absolute values of wavelet coefficients in the high bands correspond to simple features such as edges or lines .
Steps in DWTare:
1. First the image is registered to both panchromatic and multispectral image.
2.DWT is applied to both PAN and MS image.
3.The corresponding band coefficients of both images will be fused using the average method.
4.Inverse the given DWT on the coefficients which are fused to get the fused image.



4.5 PRINCIPAL COMPONENT ANALYSIS (PCA)

PCA is a mathematical tool which transforms a number of correlated variables into a number of uncorrelated variables. The PCA is used widely in image compression and image classification. The PCA involves a mathematical procedure that transforms a number of correlated variables into a number of uncorrelated variables called principal components. It consists of an accurate description of the data . The first principal component accounts for as much of the variance in the data as possible and each succeeding component accounts for as much of the remaining variance as possible. First principal component is taken along the direction with the maximum variance. The second principal component lies in the space perpendicular to the first. Within this space, this component points the direction of maximum variance. The third principal component is taken in the maximum variance direction in the space perpendicular to the first two and so on. The PCA is also called as Hotelling transform.

The PCA algorithm for the fusion of images is discussed as Follows.

Step1:Generate the column vectors, from the input image matrices.

Step2:Calculate the covariance matrix of the two column vectors formed.

Step3:Thediagonalelementsofthe2x2covariancematrixwill consist of the variance of each column vector.

Step4:Calculate the Eigen value sand the Eigen vectors of the covariance matrix.

Step5:Normalize the column vector corresponding to the bigger Eigen value by dividing each element with mean of the Eigenvector.

Step6:The values of the normalized Eigen vector act as the Weight values and then they are multiplied with each pixel of the input images.

Step7:Sum of the these two scaled matrices that are calculated in the above step will be the fused image matrix.

5. Related Work Dataset
Techniques used by Ms. Mukta in image fusion helps us to make an image more focused,

intensified and magnified that is apt for human visibility range and aim identification. We call easily increase the resolution of a particular set of images using image fusion techniques. The wavelet modification is a plus point as it results in a top class phantom content.

Dr. S.S Bedi included that Image fusion is a device that helps to mix sensors pictures using modern image procedures specifically in diagnosis ie. computed tomography, magnetic resonance image, scan gives us various types of command or information.
We also focus on computation specifications like normalized absolute error, mean square error, peak signal to noise ratio and normalized cross correlation.

Isha Mehra applied Image fusion using wavelet transform and its application to asymmetric cryptosystem and hiding – Image fusion is a technique that use for a sharp image. The cryptography scheme is used for securing information by wavelet transform. The elements of color image i.e red, green and blue are proceed using discrete wavelet transform for getting a better quality image. The fused color components are using amplitude and phase function. They both approach in Fresnel transform domain. For increase the security the separate color are changed into completely different pictures in order to result an better image of an attacker ,uneven keys, weighing factor , and 3 cover pictures that provided an larger area of key and hence increased security. This is the method for hiding and increase security.
Sejal Beraiya gave Introduction on techniques of image fusion- This presents approaches image fusion i.e. spatial fusion and transform fusion .principle component analysis comes under a spatial fusion. And DWT,DCT are transform technique .parameters like SD,PDNR are don't get high resolution image.
Harmandeep Kaur discussed about the comparisons between the image fusion techniques. Techiniques like PCA,DWT,LAPLACIAN,DCT are discussed.

6. LATEST TRENDS IN IMAGE FUSION

6.1:INTELLIGENT ROBOTS
The image fusion technique is used for controlling the movement of the robots. It is done in light of input from earth from various types of sensors. The robots carry out the survey control in a very intelligent manner. It holds a stereo combination of camera. It helps in making a distinct automatic target for the system. We can use intelligent control of the information that has been surveyed.
6.2: MEDICAL IMAGE
Surgery is carried out by supported computers. The X-beam tomography is fused with attractive images. A 3-D surface is enlisted with a proper spatial effect. A surgery can be carried out by using or taking the help of computers.
6.3:MANUFACTURING
Image fusion helps in making electronic circuit and helps in inspecting and monitoring whether the material used in the manufacturing process is non-destructive or not. We can also make robots using this technique on assembly lines. We can ensure about the product by testing it. Diagnostics of a complex machine can also take place.
6.4:MILITARY AND LAW ENFORCEMENT
It helps in detecting, tracking and identifying the target, during wars at night at the battlefield when the enemies are not visible image fusion techniques can be used by fusing the image at day with the image at night ,which makes the enemies visible. Detecting weapons involve the use of this technique. Directing the direction to the pilots at night even in bad weather is carried out by image fusion.
6.5:REMOTE SENSING
We can transfer a black and white photograph to multi-spectral microwave imaging radar.
Different parts of electro-attractive color range can be used in this technique.

7. FUTURE WORK

The future work is based on optical Rapid Eye and high resolution radar Terra Sar-X imagery.
Research teams have searched and retrieved informative data of new Berlin-Brandenburg airport at different intervals of time. Here we can fuse optical and radar images to get manufactured items with greater statistics. The spatial design of Rapid Eye and TerraSar-X helps to increase the level of fusing an image more properly.
The radar sensor is an active sensor that provides electromagnetic waves with wavelengths of centimeters. The emitted energy passes through the air in the atmosphere, touches the ground and

then gets scattered. It helps in thermal remote sensing.

8. LITERATURE REVIEW

For fusion of MS image with PAN image it is observed that the effective high quality is achieved at the cost of large computational complexity. A scientist concluded an important component substitution, The given framework is compared to the most popular CS based methods based on correlation coefficient, mutual information. Andrea Garzelli et al. [1] while extending this classical component-substitution approach, gave a fast parameter method clustering and overcoming window-based estimation. To solve the problem of color distortion. We divided the pixels of PAN and MS images into various classes by other algorithm followed by multiple methods to calculate weights on each group of pixels. It is also noticed that due to the a varying response of sensors that is attached to satellites.

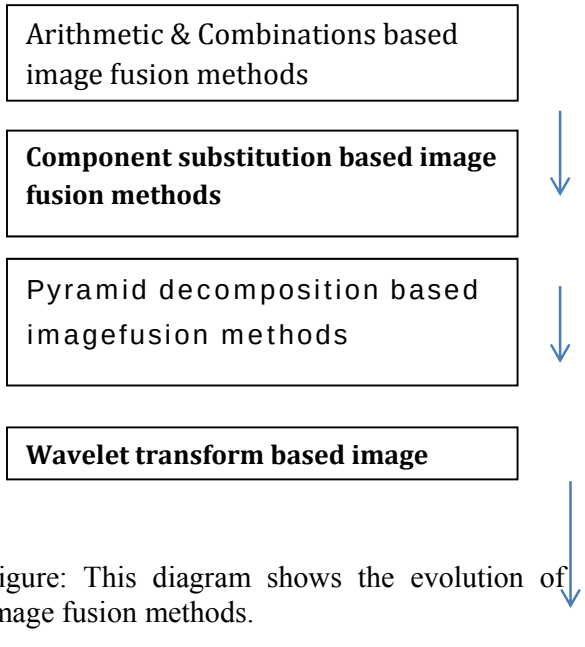


Figure: This diagram shows the evolution of image fusion methods.

9. CONCLUSION

1. Different image fusion methods can work properly with different algorithms.
2. The pixel level fusion has been widely researched for different methods and it gives better quality results after fusion in comparison to unfused image, but the time consumed is more.
3. After evaluating, at times it has been seen that the result after fusion should be evaluated by visual characteristics.

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