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RESEARCH ARTICLE

A Study On Asphyxiating the Drawbacks of Wavelet Transform by Using Curvelet Transform

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Abstract: Image Fusion is a 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. Several fusion algorithms have been evolved. All of them lacks in one criteria or other. Fusion of medical images should be taken carefully, because the whole diagnosis process depend on it. This paper presents a detailed analysis of the medical image fusion method which is using wavelet transform. The problem with Wavelet Transform (WT) is that, it can preserve spectral information efficiently but cannot express spatial characteristics well. The advantages of using curvelet and contourlet transform are thoroughly reviewed and we are going to use curvelet or contourlet instead of wavelet.

Keywords: Image Fusion, MRI, CT, wavelet transform, Curvelet Transform, Contourlet Transform

I. INTRODUCTION

One of the challenging problems in computer vision applications, is the combining of relevant information from various images of the same scene without introducing artifacts in the resultant image. Since images are captured by the use of different devices which may have different sensors. Because of the different types of sensors used in image capturing devices and also, due to the limited depth of focus of optical lenses used in camera, it is possible to get several images of the same scene producing different information. Therefore, combining the different information from several images to get a new improved composite image becomes important area of research[1].

There are two basic requirements for image fusion. First, fused image should possess all possible relevant information contained in the source images; second, fusion process should not introduce any artifact, noise or unexpected feature in the fused image. So Image fusion should be carefully performed without any loss of information.

Image fusion can be performed at three levels - pixel level, region level [2] and decision level [3]. **Pixel-based fusion** is performed on a pixel-by-pixel basis. It generates a fused image in which information associated with each pixel is determined from a set of pixels in source images to improve the performance of image processing tasks such as segmentation. **Feature-based fusion** at feature level requires an extraction of objects recognized in the various data sources. It requires the extraction of salient features which are depending on their environment such as pixel intensities, edges or textures. These similar features from input images are fused. **Decision-level fusion** consists of merging information at a higher level of abstraction, combines the results from multiple algorithms to yield a final fused decision. Input images are processed individually for information extraction. The obtained information is then combined applying decision rules to reinforce common interpretation.

The image fusion procedure mainly consists of two steps: decomposition of source images and selection of coefficients from the decomposed images i.e. fusion rule to be used.

II.MEDICAL IMAGE FUSION

Image fusion is important in many image processing fields such as satellite imaging, remote sensing and medical imaging. Medical images should be of high resolution with maximum details. So the best medical image fusion method should be used to diagnose the disease accurate and perfect [9].

III. DIFFERENT MODALITIES

Computed **A**xial **T**omography**(CT)** scan, combines special x-ray equipment with sophisticated computers to produce multiple images or pictures of the inside of the body. The cross-sectional images of the area being scanned can then be examined on a computer monitor or be printed. CT scans of internal organs, bones, soft tissues and blood vessels can provide more details than a regular x-ray exam.

Magnetic **R**esonance **I**maging (**MRI**) uses a magnetic field from super-cooled magnets to distinguish more accurately between healthy and diseased tissues. A MRI provides much greater contrast between the different soft tissues of the body than the CT scan. Using magnetic and radio waves, means no exposure to radiation. An MRI provides clear pictures of the body parts that are surrounded by bone tissue, so the MRI is very useful for examining the brain and spinal cord. A CT scan can only show pictures horizontally, while the MRI can scan from almost every angle with more detail.

Positron **E**mission **T**omography (**PET**) scan provides images on the function of a tissue rather than a static image like any x-ray. PET scan helps physicians locate the presence of any cancers or infections anywhere in the body. During the PET scan, glucose is injected into the body and taken up by cancer cells. The PET scan can detect any spread of cancer in the body. The amount of radiation exposure is minimal and the radioactive glucose is rapidly excreted from the body.

Single **P**hoton **E**mission **C**omputerized Tomography (**SPECT**) scan, analyzes the function of your internal organs. It is a type of nuclear imaging test that uses a radioactive substance and a special camera to show pictures of your organs. A SPECT scan produces 3-D images that show how your organs work. The scan is used primarily to view how blood flows through arteries and veins of organs such the heart and brain [10].

IV. CT AND MRI

MRI provides the best view of soft tissues, while CT is better for its assessment of bone structures. The CT and MRI scanned images of human brain are used as input images.

In MRI image, the soft tissue like the membranes covering the brain can be clearly seen. But the hard tissue like the skull bones cannot be clearly seen.

In the CT image, hard tissue like the skull bone is clearly seen. But the soft tissues like the membranes covering the brain are less visible.

Therefore to get more information, CT and MRI scanned images are combined so that hard tissue like the skull bones and soft tissues like the membranes covering the brain will be clearly visible [9].

V. CATEGORIES OF IMAGE FUSION METHODS

The image fusion techniques can be organized into three main categories. **Primitive fusion schemes**, such as averaging, weighted averaging and global Principal-Component-Analysis (PCA), are performed in the spatial domain. Even though these methods are easy to implement, they pay the expenses of reducing the contrast and distorting the spectral characteristics. To solve these problems, more refined fusions in the **transform domain** are used. They employ properties like multi-resolution decomposition. It decomposes images at different scale to several components, which account for important salient features of images. Therefore, it enables a better performance than those performed in the spatial domain. The methods in the third category utilize statistical ways, such as Bayesian optimization to obtain the fused image; however, it suffers from a significant increase of computational complexity [5]. Fig.1 shows the transform domain fusion methods.

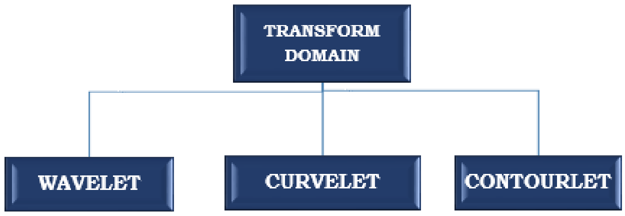


Fig. 1 Transform Domain Fusion Methods

VI. WAVELET TRANSFORM

Wavelet transform is the most promising image fusion method, because it is very simple and accurate in preserving the time and frequency details of medical image to be fused [9].

Wavelet fusion transforms the images from spatial domain to wavelet domain. The wavelet domain represents wavelet coefficient of the images. The wavelet decomposition is performed by passing the image into series of low pass and high pass filters. The various filter bands are produced and each band producing images of different resolution levels and orientations. These sub bands are then combined using inverse wavelet transform.

The Discrete Wavelet transform proves to be better than pyramid transform due to better signal to noise ratio and straight edges are detected well as it operates on point singularity [4].

VII. DRAWBACKS OF WAVELET TRANSFORM

But the discrete Wavelet transform has poor directionality and also fails to represent curvilinear structures [4].

The discrete wavelet transform (DWT), stationary wavelet transform (SWT), and dual-tree complex wavelet transform (DTCWT) cannot capture curves and edges of images well. More reasonable bases should contain geometrical structure information when they are used to represent images [5].

There are some major drawbacks in the wavelet transform. First, it doesn't provide shift invariance, and it does not capture the edges properly. Another major drawback in the wavelet transform is, it provides limited information along the horizontal, vertical and diagonal direction [6].

The above said drawbacks are to be removed using some best transforms such as curvelet and contourlet etc.

VIII. ADVANTAGES OF CURVELET TRANSFORM

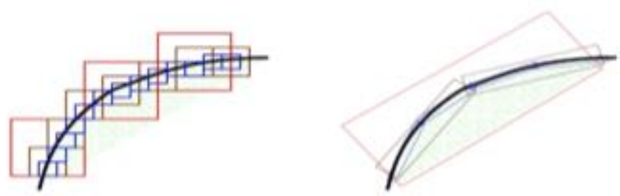
Curvelet transform has advantages over wavelet transform in terms of high directionality, representing curve-like edges efficiently and reduces noise effect [4].

The CVT is more suitable for the analysis of image edges, such as curve and line characteristics, than the wavelet. The CVT is referred to as the true 2-D transform. [5]

The curvelet transform is a very young signal analyzing method with good potential. It is recognized as a milestone on image processing and other applications. Curvelet transform is more accurate to deal with the curve than wavelet transform as shown in the fig. given below. In wavelet approach, many wavelet coefficients are needed to account edges. i.e. singularities along lines or curves needed to account edges. In curvelet approach, less coefficients are needed to account edges [7].

The curvelet transform is used to represent the curved shapes. This transform represents edges better than wavelets. The fused image gives higher details than the original image due to edge representation thereby preventing image denoising. The concept used here is segmenting the image into small overlapping tiles and then transform is applied to each tile [9].

The Curvlet outperforms the wavelet transform.



CURVELET WAVELET

IX. ADVANTAGES OF CONTOURLET TRANSFORM

Different from the curvelet which is first developed in continuous domain and then is discretized for sampled data, contourlet transform (CT), introduced by Do and Vetterli, starts with a discrete- domain construction [5]. This transform is more suitable for constructing multi-resolution and multi-directional expansions using non-separable Pyramid Directional Filter Banks (PDFB) with small redundancy factor.

Contoured transform starts with a discrete domain construction. The contourlet is also deemed as a “true” two dimensional transform that can capture the intrinsic geometrical structure of an image. Two filter banks are employed to implement the contoured transform.

The Laplacian pyramid is first used to capture the point discontinuities, and then a directional filter bank is used to link point discontinuities into linear structures. As the DWT, the contoured transform also has no shift invariant property because of the down-sampling operation [8].

With a rich set of basis oriented at various directions and scales, contourlet can effectively capture the intrinsic contours and edges in natural images that set radiational multiresolution analysis methods are difficult to handle. Contourlet offers a much richer sub band set of different directions and shapes, which helps to capture geometric structures in images much more efficiently [8].

The wavelet transform is good at isolating the discontinuities at object edges, but cannot detect the smoothness along the edges. Moreover, it can capture limited directional information. The contourlet transform can effectively overcome the disadvantages of wavelet. Contourlet transform is a multi-scale and multi-direction framework of discrete image. In this transform, the multi- scale analysis and the multi-direction analysis are separated in a serial way.

X. APPLICATION DOMAINS

Medical image fusion methods can be applied on various application domains such as

(i) Brain:

Brain is one of the important organs that have been subjected to a wide range of medical image analysis and research. The imaging studies reveal several important pieces of information about the brain which are otherwise not visible to human sensory mechanisms.

(ii) Breast:

The breast has been subject of several studies due to the high rates of breast cancer in women. The most commonly used modality for breast studies is mammogram followed by MRI and/or CT. The combinations of PET and X-ray computed tomography has shown significant improvements in diagnostic accuracy, allowing better differentiation between normal and pathological uptake.

(iii) Prostate:

Prostate is another organ that has been studied using multi-modal medical images. There exists a range of techniques and studies on prostrate based image fusion, that often face the challenge deformation of prostrate in multi-modal imaging setups.

(iv) Lungs:

Lung is a vital organ that undergoes direct contact with environment through the air intake and is the main part of respiratory system. Lungs are prone to damage from pollutants and viruses. The imaging of the lungs can often reveal several details that reflect the condition of the internal tissues. The ability to distinguish a damaged tissue, cancerous tissue and a healthy tissue is not an easy task in early diagnosis. Image fusion techniques have been shown to improve the diagnostic performance and screening, and especially improve the clinical monitoring outcomes.

(v) Liver:

The Liver is another vital organ that is being increasingly studied using images, and the complexity of the liver tissue makes the medical imaging studies challenging. The registration and fusion of liver images for medical diagnosis is a task of primary importance.

(vi) Shoulder:

Spinal cord injury is usually the result of an accident (for example, motor vehicle accident, fall, sports injury) or acts of violence such as gunshot wounds. It can also be caused by surgical complications or by disease. The combinations of CT and MRI has been used to improve the diagnostic accuracy.

XI. CONCLUSION

This study tried to give a first perfective and a methodology to determine what fusion methods should be used under which circumstances. In this paper the disadvantages of wavelet transform and the advantages of curvelet and contourlet transforms are thoroughly reviewed. After analyzing these methods, it was realized that a robust and generic method was needed to fuse complementary, multi modal medical images. We have found that the most of the existing literature has neglected the problem of noise which will be presented in fused image due to integration of two images. So in near future we will use suitable transform to remove it.

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