IMPLEMENTATION OF MULTI FOCUS IMAGE FUSION BASED ON NON-SUB SAMPLED CONTOURLET TRANSFORM (NSCT)

[1]C.SATHYA DEPT COMMUNICATION SYSTEMS, [2]P.GEETHA ASSOCIATE PROFESSOR OF ECE PREC-THANJAVUR.
c.sathyadhurai@gmail.com,7708459832.

Abstract—Medical image fusion technique to fuse sourceimages of MRI and CT scanners based on discrete non sub sampled contourlet transform and pixel level fusion rule. NSCT (Non- sub sampled contourlet transform) based fusion involves maximum Gabor energy and maximum gradient coefficient selection are chosen to fuse low-frequency and a high-frequency band to restrain the background information and enhance the information of desired regions in the fused image for diagnosis .It decompose the image into finer and coarser details and finest details will be decomposed into different resolution in different orientation. All sub bands are fused with pixel level fusion rule with better accuracy. The goal of image fusion is to obtain useful complementary information from CT/MRI multimodality images. By this method we can get more complementary information and also satisfactory Entropy, Better correlation coefficient, PSNR (Peak- Signal-to-Noise Ratio) and less MSE (Mean square error).

Keywords: **Medical image fusion, Multimodality images, NSCT,Fusion rules.**

I. INTRODUCTION

Medical image fusion has been also a popular fusion means the matching and fusion between two or more images of the same lesion area from different medical imaging equipment, and aims to obtain complementary information and increase the amount of information. Medical image fusion technique is to combine the information of a variety of images withcomputer-based image processing method.

It is being used for medical image fusion so as to get a better image which is clearer and contains more information. In the clinical diagnosis and treatment, the use of fused images can provide more useful information. It is important for lesion location, diagnosis, making treatment and pathological study.

In the medical imaging field, we can get different images of the same part of the same patient with different imaging devices, and the information provided by a variety of imaging modes is often complementary. In the medical images, CT can clearly reflect the anatomical structure of bone tissues. Oppositely, MRI can clearly reflect the anatomical structure of soft tissues, organs and blood vessels. CT, MRI and other modes of medical images reflect the human information from various angles. In the clinical diagnosis and treatment, the problems about the comparison and synthesis between image CT and MRI were frequently encountered with the development of new imaging sensors arises the need of a meaningful combination of all employed imaging sources. The actual fusion process can take place at different levels of information representation; a generic categorization is to consider the different levels as, sorted in ascending order of abstraction: signal, pixel, feature and symbolic level. This site focuses on the so-called pixel level fusion process, where a composite image has to be built of several input images. To date, the result of pixel level image fusion is considered primarily to be presented to the human observer, especially in image sequence fusion.

where the input data consists of image sequences. A possible application is the fusion of forward looking infrared (FLIR) and low light visible images (LLTV) obtained by an airborne sensor platform to aid a pilot navigates in poor weather conditions or darkness. In pixel-level image fusion, some generic requirements can be imposed on the fusion result. The fusion process should preserve all relevant information of the input imagery in the composite image (pattern conservation) The fusion scheme should not introduce any artifacts or inconsistencies which would distract the human observer or following processing stages .The fusion process should be shift and rotational invariant, i.e. the fusion result should not depend on the location or orientation of an object the input imagery .In case of image sequence fusion arises the additional problem of temporal stability and consistency of the fused image sequence. The human visual system is primarily sensitive to moving light stimuli, so moving artifacts or time depended contrast changes introduced by the fusion process arehighly distracting to the human observer. So, in case of image sequence fusion the two additional requirements apply. Temporal stability: The fused image sequence should be temporal stable, i.e. gray level changes in the fused sequence must only be caused by gray level changes in the input sequences, they must not be introduced by the fusion scheme itself; Temporal consistency: Gray level changes occurring in the input sequences

must be present in the fused sequence without any delay or contrast change.

II. FUSION METHODS

The following pages summarize several approaches to the pixel level fusion of spatially registered input images. Most of these methods are developed for the fusion of stationary input images (such as multispectral satellite imagery). Due to the static nature of the input data, temporal aspects arising in the fusion process of image sequences, e.g. stability and consistency are not addressed.

A generic categorization of image fusion methods is the following:

- Linear superposition
- Nonlinear methods
- Optimization approaches
- Artificial neural networks
- Image pyramids
- Wavelet transform
- Generic multi resolution fusion scheme

With the development of new imaging methods in medical diagnostics arises the need of meaningful (and spatial correct) combination of all available image datasets. Examples for imaging devices include computer tomography (CT), magnetic resonance imaging (MRI) or the newer positron emission tomography (PET). The following images in illustrate the fusion of a CT and a MRI image.

Methodologies

- NSCT based Multiscale decomposition
- Gradient and Gabor filter bank Measurement
- Pixel Level Fusion
- Parameter analysis(RMSE,PSNR

Ct Image

Computed Tomography (CT) refers to the crosssectional imaging of an object from either transmission or reflection data collected by illuminating the object from many different directions. The impact of this technique in diagnostic medicine has been revolutionary, since it has enabled doctors to view internal organs with unprecedented precision and safety to the patient. The first medical application utilized x-rays for forming images of tissues based on their x-ray attenuation coefficient. More recently, however, medical imaging has also been successfully accomplish.

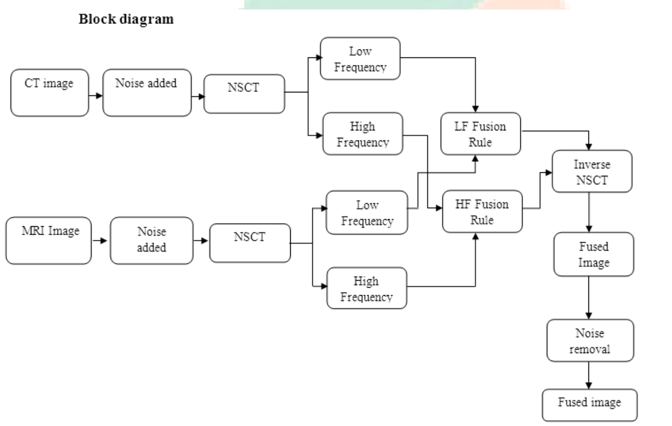


Fig1: fused images in NSCT

Nsct Transform Of Image

Compared with the traditional Contourlet transform, the NSCT also has translational invariance and reduces the infection of registration error on fusion performance. Meanwhile, each sub band image got by the image decomposition had the same size with the original image. It could easily find out the correspondence between the sub band images and make fusion rules.

Similar to the Contourlet transform, the NSCT also do scale decomposition and direction decomposition separately. Firstly, the Non sub sampled Pyramid Filter Bank (NSPFB) was used to get the image multi-scale decomposition. Then the Non sub sampled Directional Filter Bank (NSDFB) was used to do the direction decomposition on each sub-band images.

Nsct Decomposition Process

NSCT decomposition is to compute the multi scale and different direction components of the discrete images. It involves the two stages such as non sub sampled pyramid(NSP) and non sub sampled directional filter bank(NSDFB) to extract the texture, contours and detailed coefficients. NSP decomposes the image into low and high frequency sub bands at each decomposition level .

it produces n+1 sub images if decomposition level is n. NSDFB extracts the detailed coefficients from direction decomposition of high frequency sub bands obtained from NSP.

The sub band images of two source images obtained from NSCT are utilized for morphing process to get the enhanced information to diagnose the brain diseases. Here, the pixel level fusion method is approached for this process. It will be implemented based on Gabor filter bank and gradient detection for coefficient selection. The low frequency sub bands of two source images will be used by Gabor coefficients selection and high frequency sub bands will be used by gradient measurement to select desired coefficients. Finally, fused two different frequency sub bands are inverse transformed to reconstruct the fused image and parameters will be evaluated between input and fused image.

Process Flow

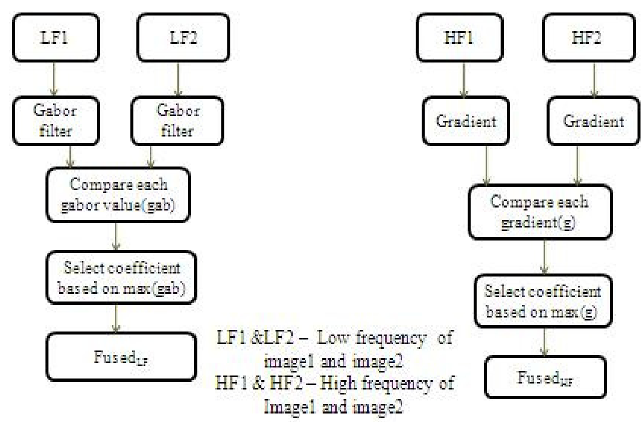


Fig:2: Process Flow

LowFrequency:

The low frequency sub bands of two source images are fused based on selection of appropriate coefficients using Gabor filtering. It is useful to discriminate and characterize the texture of an image through frequency and orientation representation. It uses the Gaussian kernel function modulated by sinusoidal wave to evaluate the filter coefficients for convolving with an image. The 2D Gabor filter is defined by,

Gabor Filter Approach

The low frequency sub bands of two source images are fused based on selection of appropriate coefficients using Gabor filtering. It is useful to discriminate and characterize the texture of an image through frequency and orientation representation. It uses the Gaussian kernel function modulated by sinusoidal wave to evaluate the filter coefficients for convolving with an image. The complex Gabor in space domain, here is the formula of a complex Gabor function in space domain

(x, y) = s(x, y) wr(x, y)

where s(x; y) is a complex sinusoidal, known as the carrier, and wr(x; y) is a 2-D.

Gaussian-shaped function, known as the envelop. The complex sinusoidal is denotes as follows,

s(x, y) = exp (j (2*pi(u0 x + v0 y) + P))

where (u0, v0) and P denotes the spatial frequency and the phase of the sinusoidal

respectively. The real part and the imaginary part of this sinusoidal are

Re (s(x, y)) = cos (2*pi*(u0 x + v0 y) + P) Im (s(x, y)) = sin (2*pi*(u0 x + v0 y) + P)

the parameters u0 and v0 denotes the spatial frequency of the sinusoidal in Cartesian

Co ordinates. This spatial frequency can also be expressed in polar coordinates as

magnitude F0 and direction w0:

$$F_0 = \sqrt{u_0{}^2 + v_0{}^2}$$

$$\omega_0 = \tan^{-1}\left(\frac{v_0}{u_0}\right)$$

$$u_0 = F_0 \cos \omega_0$$

$$v_0 = F_0 \sin \omega_0$$

Using this representation, the complex sinusoidal is

$$s(x, y) = \exp\left(j\left(2\pi F_0 \left(x \cos \omega_0 + y \sin \omega_0\right) + P\right)\right)$$

The Gaussian envelop looks as follows

$$w_r(x, y) = K \exp\left(-\pi\left(a^2 \left(x - x_0\right)_r{}^2 + b^2 \left(y - y_0\right)_r{}^2\right)\right)$$

where (x0; y0) is the peak of the function, a and b are scaling parameters of the

Gaussian, and the r subscript stands for a rotation operation3 such that

The high frequency coefficients are also fused by evaluating the gradient of the \each sub band coefficients. The gradient of an image will be defined as,

G = Sqrt (dzdx. ^2 + dydx. ^2)

Where, the dzdx and dydx are the y derivatives and x derivatives obtained by the sobel edge operators.

Then these coefficients are fused based on the searching maximum gradient of these two using decision rule.

III. PARAMETER EVALUATION

Peak –Signal-To Noise Ratio And Mean Square Error:

How do we determine the quality of a digital image? Human eyes perception is the fastest approach. However, although this criterion is effective in general, the results may differ from person to person. To establish an objective criterion for digital image quality, a parameter named PSNR (Peak Signal to Noise Ratio) is defined in equation 3.8 as follows:

PSNR = 10*log10 (255*255/MSE)

where MSE (Mean Square Error) stands for the mean-squared difference between the cover-image

stego-image. The mathematical definition for MSE is defined in equation 3.9 as follows:

$$MSE=1/(M*N) \sum_{i=1} \sum_{j=1} (a_{ij}-b_{ij})^2$$

In this above equation a_{ij} means the pixel value at position (i,j) in the input image and b_{ij} is the pixel value at the same position in the output image. The calculated PSNR usually adopts dB value for quality judgments. The larger PSNR is, the higher the image quality is (which means there is only little difference between the input-image and the fused-image). On the contrary, a small dB value of PSNR means there is great distortion between the input-image and the fused-image.

Correlation Coefficient

It gives similarity in the small structures between the original and reconstructed images. Higher value of correlationmeans that more information is preserved. Coefficient correlation in the space domain is defined by:

Correlation = sum (sum (B.*A))/Sqrt (sum (sum (B.*A))*sum (sum (A.*A)));

Where, B is difference between fused image and its overall mean value. A is difference between source image and its overall mean value.

INPUT IMAGES

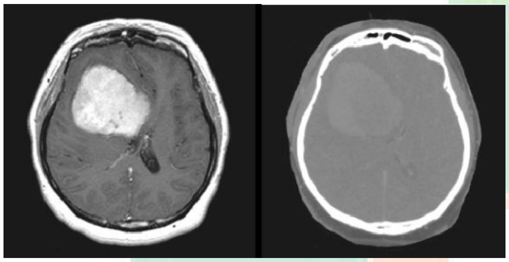


Fig: a) MRI IMAGE   Fig: b) CT IMAGE

NonsubsampledContourlet coefficients level 1

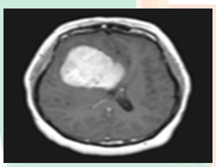


Fig: a) MRI NSCT Level 1 Process

NSSC coefficients: level 2   NSSC coefficients: level 2

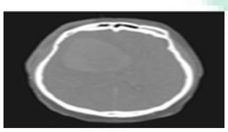


Fig: b) CT NSCT Level 1 Process

NSSC coefficients: level 2   NSSC coefficients: level 2

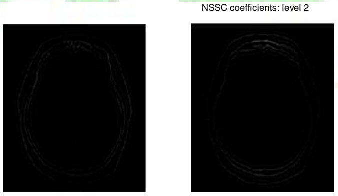


Fig: b) CT NSCT Level 2 Process

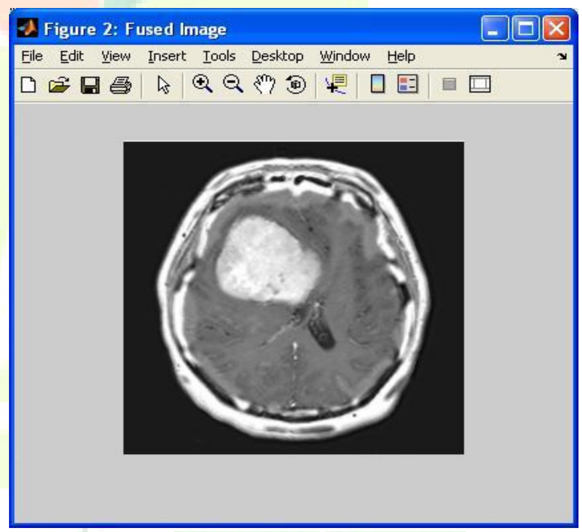
NSSC coefficients: level 3   NSSC coefficients: level 3

NSSC coefficients: level 3   NSSC coefficients: level 3

Fig: b) CT NSCT Level 3 Process

IV.RESULT

1.Fused output image



2.PARAMETER

Root Mean Square Error:	3.5069
Peak Signal to Noise Ratio:	42.6816
Correlation Coefficient:	0.8794

V. CONCLUSION

In this paper the image fusion is done by applying NSCT to the CT and MRI images are fused with MATLAB Software. The information in the soft tissue and bony structure both are important in the medical diagnosis problem.

REFERENCES

1. K. Kannan, S. ArumugaPerumal, K. Arulmozhi, “Area level fusion of Multi-focused Images using Multi-Stationary Wavelet Packet Transform”, International Journal of Computer Applications (0975 – 8887) Volume 2 – No.1, May 2010.

2. PusitBorwonwatanadelok, WiratRattanapitak and SomkaitUdomhunsakul, “Multi-Focus Image Fusion based on Non Subscriber Contourlet Transform”, 2009 International Conference on Electronic Computer Technology. 978-0-7695-3559-3/09 $25.00 © 2009 IEEE.

3. SomkaitUdomhunsakul, PradabYamsang, SuwutTumthong and PusitBorwonwatanadelok,“Multiresolution Edge Fusion using NSCT and SFM”, Proceedings of the World Congress on Engineering 2011 Vol II WCE 2011, July 6 - 8, 2011, London, U.K.

4. K. Kannan, S. ArumugaPerumal, K. Arulmozhi ,“Performance Comparison of various levels of Fusionof Multi-focused Images using Wavelet Transform”,©2010 International Journal of Computer Applications (0975 – 8887) Volume 1 – No. 6

Mirajkar, et al, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974

Int. J. Adv. Eng.

5. S. Udomhunsakul, “Edge Detection in Ultrasonic Image Using Gabor Filters,” IEEE Trans. on TENCON, 2004,pp. 175–178.

6. R.C. Gonzalez, R.E. Woods, S.L. Eddins, “Digital Image Processing,” Pearson Prentice Hall, New Jersey, 2004.

7. Q. Gao, Y. Zhao and Y. Lu, “Despecking SAR image using Non Subscriber Contourlet Transform