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Feature Level Medical Image Fusion Using Multi Wavelet Transforms

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Abstract: **The use of image fusion has gained significant popularity in the image processing area over the past decade. Fusion mean creating an image in which all the objects are in focus, this would help in doing many application in image processing like segmentation ,image enhancement and many. In this paper we present a block feature based image fusion for the medical images using Multi wavelet transforms. Medical Image Fusion has become an active research topic due to advances in sensor technology, microelectronics, processing techniques that combine information from different sensors into a single composite image for analysis, interrelation and better clinical diagnosis in much rapid and accurate way. A qualitative analysis is done for test images and found best when integrated with the feed forward probabilistic neural networks.**

Keywords: Fusion, Multi wavelets, Neural Networks

I. INTRODUCTION

Fusion is integrating more than one image to create an image in which all the objects are in focus. This has got a significant importance in the image processing field and used in many applications like medical sciences, forensic and defense departments. A simple image fusion method is to take the average of the source images pixel by pixel. Medical Image Fusion has become an active research topic due to advances in sensor technology, microelectronics, processing techniques that combine information from

different sensors into a single composite image for analysis, interrelation and better clinical diagnosis in much rapid and accurate way. However, along with simplicity come several undesired side effects including reduced contrast [11] [12]. In recent years, many researchers recognized that multi scale transforms are very useful for analyzing the information content of images for the purpose of fusion. More recently, wavelet theory has emerged as a well developed yet rapidly expanding mathematical foundation for a class of multi scale representations. At the same time, some sophisticated image fusion approaches based on multi scale representations began to emerge and receive increased attention. Most of these approaches were based on combining the multi scale decompositions (MSDs) of the source images. Fig. 1 illustrates the block diagram of a generic image fusion scheme based on multi scale analysis. The basic idea is to perform a multi scale transform (MST) on each source image, then construct a composite multi scale representation from these. The fused image is obtained by taking an inverse multi scale transform (IMST) [8].

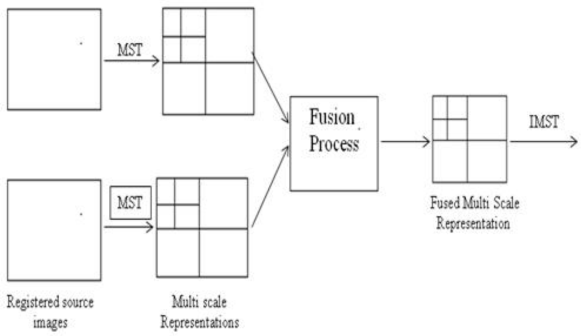

Fig 1: Generalized Block diagram for Multi scale Image fusion

In this paper two images which are in blurred at different regions are considered, mean that in one image the concentration is made on one object in the image and in the other, the other part of object. For example figure2 shows these two images in the figure 2(b) the concentration is done on the right side of the image and in the figure 2(c) the concentration is done on the left but not on the right side. So similar images are prevalent in our day to day life [8], such images are considered as the input for the algorithm proposed in this paper

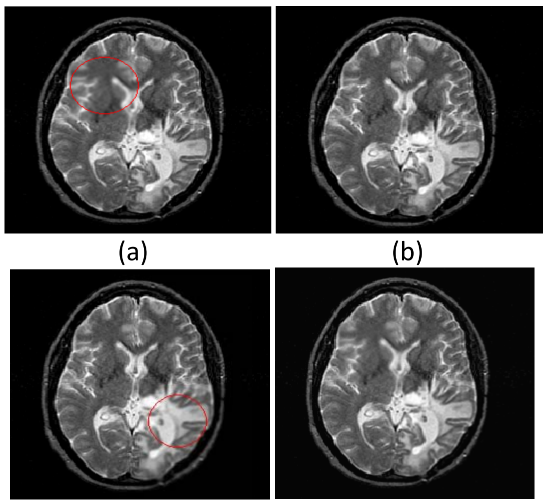

Fig 2: a) Original Image b) Top left blurred image
c) bottom right blurred image d) Fused image with proposed method

II. MULTI WAVELET TRANFORMS

Wavelets are interesting and useful tool in many of the image processing applications like compression, representation and denoising [2]. The idea of MRA (multi resolution analysis) and wavelets have been generalized in many ways like wavelet packets, M-band filter banks. If several wavelet functions and scaling functions are used to expand a signal/image, the Multi wavelets analysis comes into focus [5]. These transforms have more superior properties than any single wavelet function such as support, symmetry and smoothness, due to these properties it can be used for image denoising. Let a scaling function Φ(t) generates a multi resolution analysis then

$$\varphi(t) = \sum_k Ck\varphi(2t-k) \qquad (1)$$

Where C_k are the coefficients, associated with these scaling functions there are 'r' wavelets $W_0(t)$,...........$W_{r-1}(t)$ satisfying the matrix wavelet equation

$$W(t) = \sum_k Dk\varphi(2t-k) \qquad (2)$$

In this paper GHM multi wavelet transform is considered for the multi scale transformation. To implement Multi wavelet transforms a new filter bank structure where the low pass and high pass filter banks are matrices rather than the scalars. That is, the two scaling and wavelet functions satisfy the following two-scale dilation equations [6][8][10]

$$\begin{bmatrix}\emptyset_1(t)\\ \emptyset_2(t)\end{bmatrix} = \sqrt{2}\sum_k H_k \begin{bmatrix}\emptyset_1(2t-k)\\ \emptyset_2(2t-k)\end{bmatrix} \qquad (3)$$

$$\begin{bmatrix}\varphi_1(t)\\ \varphi_2(t)\end{bmatrix} = \sqrt{2}\sum_k G_k \begin{bmatrix}\varphi_1(2t-k)\\ \varphi_2(2t-k)\end{bmatrix} \qquad (4)$$

Table 1: Properties of Multi wavelet Transforms

Property	Multi wavelet	DB-8	9-7	Haar
Orthogonality	Yes	Yes	No	Yes
Symmetry	Yes	No	Yes	Yes
Compact support	Yes	Yes	Yes	Yes

$$H_0 = \sqrt{2}\begin{bmatrix}\frac{3}{10} & \frac{2\sqrt{2}}{5}\\ -\frac{\sqrt{2}}{40} & -\frac{3}{20}\end{bmatrix} H_1 = \sqrt{2}\begin{bmatrix}\frac{3}{10} & 0\\ 9\sqrt{2}\frac{}{40} & \frac{1}{2}\end{bmatrix}$$

$$H_2 = \sqrt{2}\begin{bmatrix}0 & 0\\ 9\sqrt{2}/40 & -3/20\end{bmatrix}$$

$$H_3 = \sqrt{2}\begin{bmatrix}0 & 0\\ -\sqrt{2}/40 & 0\end{bmatrix} \qquad (5)$$

$$G_0 = \sqrt{2}\begin{bmatrix}-\sqrt{2}\frac{}{40} & -\frac{3}{20}\\ -\frac{1}{20} & -3\sqrt{2}\frac{}{20}\end{bmatrix}$$

$$G_1 = \sqrt{2}\begin{bmatrix}9\sqrt{2}\frac{}{40} & -\frac{1}{2}\\ \frac{9}{20} & 0\end{bmatrix}$$

$$G_2 = \sqrt{2}\begin{bmatrix}9\sqrt{2}\frac{}{40} & -\frac{3}{20}\\ -\frac{9}{20} & 3\sqrt{2}\frac{}{20}\end{bmatrix}$$

$$G_3 = \sqrt{2}\begin{bmatrix}-\sqrt{2}/40 & 0\\ 1/20 & 0\end{bmatrix} \qquad (6)$$

III. BLOCK BASED FEATURE EXTRACTION

In this paper block feature based image fusion is considered, the selection of different features is an important task. In multi-focus images, some of the objects are clear (in focus) and some objects are blurred (out of focus). The blurred objects in an image reduce its clearness. Fusing them will produce a clear image; to achieve this, five different features to characterize the information level contained in a specific portion of the image is used in this paper. This features set includes Variance, Energy of Gradient, Contrast Visibility, Spatial Frequency and Canny Edge information.[1]

a) Contrast Visibility: The deviation of a block of pixels from the block's mean value. Therefore it relates to the clearness level of the block. The visibility of the image block is obtained using equation.

$$VI = \frac{1}{m\times n}\sum_{(i,j)\epsilon B_k}\frac{|I(i,j)-\mu_k|}{\mu_k} \qquad (7)$$

Where μ_k is the mean of the block and m, n are the size of the block

b) Spatial Frequency: Spatial frequency measures the activity level in an image. It is used to calculate the frequency changes along rows and columns of the image. Spatial frequency is measured using equation

$$SF = \sqrt{(RF)^2 + (CF)^2} \qquad (8)$$

Where RF and CF are defined as below

$$\boldsymbol{RF} = \sqrt{\frac{1}{m\times n}\sum_{i=1}^{m}\sum_{j=2}^{n}[I(i,j) - I(i,j-1)]^2} \qquad (9)$$

$$\boldsymbol{CF} = \sqrt{\frac{1}{m\times n}\sum_{j=1}^{m}\sum_{i=2}^{n}[I(i,j) - I(i-1,j)]^2} \qquad (10)$$

c) Variance: Variance is used to measure the extent of focus in an image block. It is calculated using equation

$$\boldsymbol{Variance} = \frac{1}{m\times n}\sum_{i=1}^{m}\sum_{j=1}^{n}(I(i,j)-\mu)^2 \qquad (11)$$

d) Energy of Gradient: It is also used to measure the amount of focus in an. It is calculated using equation

$$\boldsymbol{EOG} = \sum_{i=1}^{m-1} \sum_{j=1}^{n-1} \left(f_i^2 + f_j^2\right) \qquad (12)$$

Where fi and fj are given as below

$$f_i = f(i+1,j) - f(i,j)$$
$$f_j = f(i,j+1) - f(i,j)$$

IV NEURAL NETWORKS

Neural network models are used for tackling a diverse range of problems, including pattern classification, function approximation and regression. The fusion problem examined here can be considered as a classification problem. In this paper, consider neural network models, namely, the probabilistic neural network (PNN). The typical architecture consists of one hidden layer and one output layer. Each hidden unit corresponds to a basis or kernel function of the input vector x, and is usually of the Gaussian form [7]

$$\mathbf{H(x)}=\exp(-\|x-c\|^2/\sigma^2) \qquad (13)$$

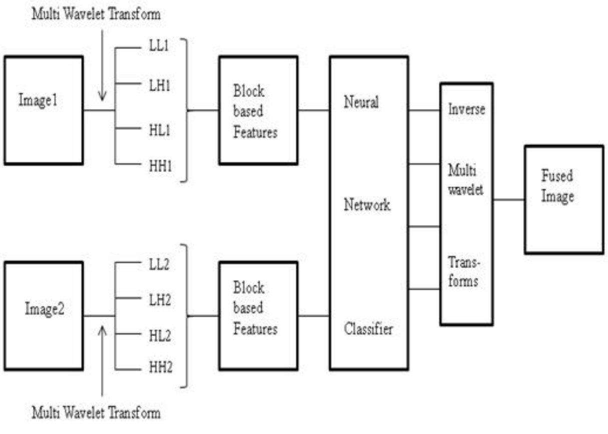

Fig 3: Proposed method for Block feature based image fusion

In the proposed method, we trained the neural network using the block features of different pair of multi-focus images. Once the classifier is obtained then it can be used to fuse any pair of Multi focus images.

V. EXPERIMENT ANALYSIS

Figure 3 shows the proposed method for the image fusion, both the images as the input. Approximations and detailed coefficients are obtained on applying the multi wavelet transform; in this case GHM multi wavelet transform is used. These coefficients are divided into MxN blocks, feature vector for these blocks are obtained which are labeled and trained for neural network. A decision is made based on the value of the classifier like if the out of the classifier is greater than zero than the block from image1coeffcients is selected or else from image2 coefficients. Thus obtained fused coefficients are transformed with inverse multi wavelet transform to get fused image.

VI EVALUATION CRITERIA

The Proposed method is evaluated for different images with the metrics given in [3][4][9]

Table 2: Performance analysis for the proposed Method

Image	**MI**	**Qf**	**Q0**	**Qw**	**Qe**	**PSNR**
Image1	0.2554	0.8630	0.2005	0.2344	0.0469	44.6044
Image2	0.2692	0.8430	0.1899	0.1668	0.0317	43.9719
Image3	0.3242	0.8713	0.1967	0.2550	0.0502	44.6043
Average	0.2829	0.8591	0.1957	0.2187	0.0429	44.3935

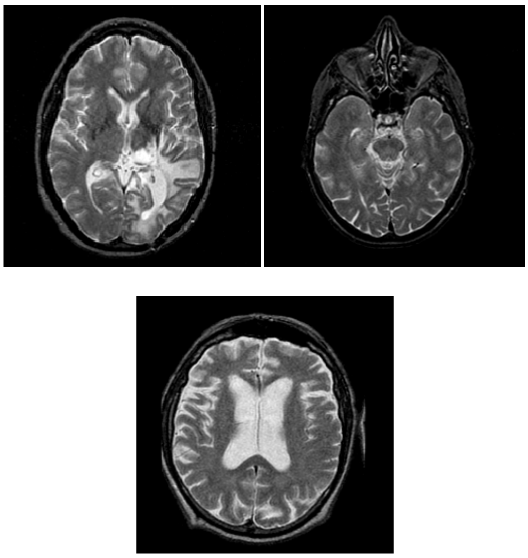

Fig 4: Test images used for the experimental analysis

VII CONCLUSION

In this paper a new approach for block feature based image fusion is implemented using multi wavelet transform and neural networks and a qualitative analysis has been done for the several test image and found better results. The experimental results indicate that the appropriate setting for the number of decomposition levels is two. It is a trade-off between the capability of catching spatial details and the sensitivity to noise and transform artifacts. When the number of decomposition levels is too large, one coefficient in coarse resolutions responds to a large group of pixels of fused image. An optimum block size of 3x3 or 4x4 is used for block feature extraction.

REFERENCES

[1] Abdul siddiqui,M.Arfan Jaffar, "Block based feature level multi focus image fusion ",2010 5th international conference on future information technology pg.no:1-7

[2] Fernando Perez Nava Antonio Falcon Martel,"Planar representation based on multi Wavelets".

[3] G.Piella ,"New quality measures for image fusion"

[4] H.Zheng,D.Zheng,Yanxiang Hu,Sheng Li, "Study on the optimal parameters of image fusion based on wavelet transform", journal of computational information systems vol:1,2010 pg.no: 131-137

[5] Megan Howell jones ,"Wavelets for medical image fusion"; A review of image fusion techniques

[6] Kai chieh Liang,Jin Li and C-c Jay Juo, "Image compression with embedded multi wavelet Coding

[7] Shitao Li,James.TKwok,Yaonan Wang ,"Multi focus image using artificial neural networks", pattern recognition letters, Elsevier, Vol:23,2002 ,pg 985-997.

[8] Shih Gu Huang ,"A tutorial on wavelets for image fusion "

[9] Shutao Li ,Bun yang, Jianwen,Hu, "Performance comparison of different multi resolution transforms for image fusion ", Elsevier, vol:12, 2011, pg 74-84.

[10] Sudhakar R,Jayaram S ,"Fingerprint compression using multi wavelets",International journal of signal processing, WASET, vol:2 2006

[11] V.P.S Naidu and J.R.Rao,"Pixel level image fusion using wavelets and pca", Defence science journal,vol:58,May-2008,pg.no:338-352

[12] Yong Yang , Shuying Huang,Nini rao, "Medical image fusion and effective wavelet approach", Hindawi publishing corporation,vol:2010,Article id 579341