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Design and Analysis of 2-D Wavelet Based Image Fusion System Approach for restoring Image by Performing Wavelet Decomposition using Soft Computing

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Abstract-Today in this digital world image fusion is the most emerging field in the area of image processing. Image fusion is a technique that integrates complementary information from multiple images such that the fused image is more suitable for processing task. Its main objective of image fusion is enhancing the visibility of image and improving the spatial resolution and spectral information of an original image. This paper start with the study of initial concepts of image fusion and different technique of image fusion, then implement the wavelet based image fusion using soft computing. In this paper I have consider four wavelet families that is haar, daubechies, symlets, coiflets at all the level (level1, level2, level3, level4.level5) and analysis that which families provide the maximum information after the fusion. The fused image is assessed using Entropy, Standard deviation and Mean.

Keywords—Image fusion, Magnetic resonance imaging Principle Component Analysis, Computed tomography component; The Discrete Wavelet ,Pyramid Decomposition Fusion Algorithm.

1. INTRODUCTION

Any piece of information makes sense only when it is capable to express the content across. The information clarity is important. By the method of image fusion, the good information from each of the given images is fused simultaneously to form a resultant image whose quality is better to any **of** the input images [1]. **Image fusion,** the general meaning of word fusion is an approach to obtain information that is in several domains [2]. Image Fusion is a method to get better quality of information from a set of images [1]. In the area of biomedical imaging, two modalities are used that is the magnetic resonance imaging (MRI) and the computed tomography (CT).The CT scan is especially appropriate for imaging bone structure and tough tissues. The MR images are much better in depicting the soft tissues in the brain that play vital roles in detecting diseases that affecting the skull base. These images are thus related in many ways and single image is not [3]. The main objective of the paper is to designing and implement the wavelet based images fusion using DWT technique and get the maximum information from fused images. The basic idea of image fusion is shown in figure 1. [4]

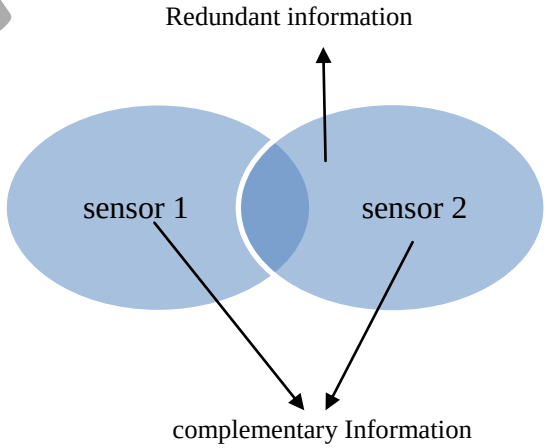

Fig. 1.1 Image fusion

Image fusion algorithms may be classified into different level:-low, middle, and high; or pixel, feature, and decision levels. [5]

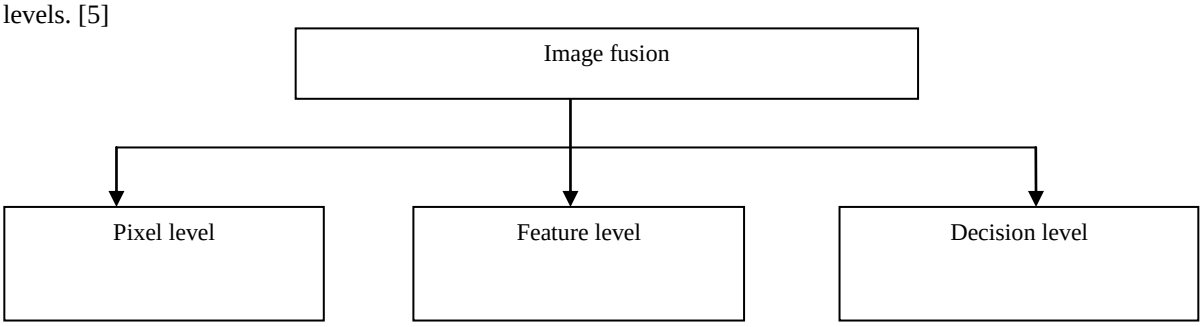

Fig. 1.2 Three level of image Fusion

1.1 Image fusion technique

The improvement methods are of two types namely frequency domain methods and spatial domain methods. [6].

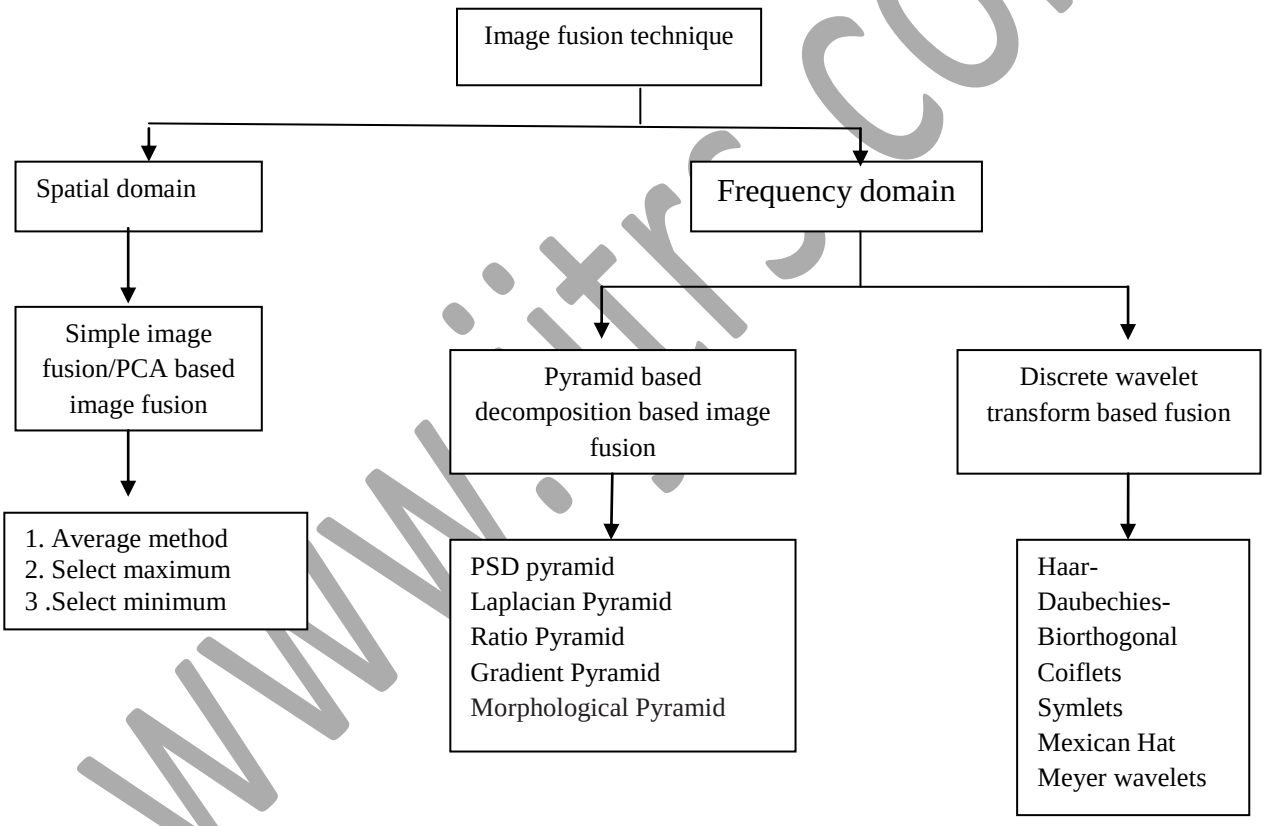

Fig. 1.3 Categorization of image fusion technique [6]

1.2 Spatial Domain Fusion Method

In this techniques, directly deal with the image pixels. The pixel values are manipulated to get desired enhancement.

1.3 Transform Domain Fusion Methods

- **Transform:** Transform of a signal or image is just another form of representing the signal or an image.. It does not change the information content present [87
- **Wavelet transform:** This is the type of frequency domain method
- Wavelet transform provides time -frequency representation at the same time.

- High frequency wavelet transform provide poor frequency resolution and good time resolution.
- Low frequency wavelet transform provide good frequency resolution and poor time resolution in wavelet transform [7].

1.4 The Discrete Wavelet Transform (DWT)

The Discrete Wavelet Transform (DWT) of image presents a non-redundant image representation. DWT provides superior spectral and spatial localization of image information compared with other multi level representation. Recently, Discrete Wavelet Transform has attracted more attention in image processing. The DWT can be explained as signal decomposition in a set of autonomous, spatially oriented frequency channels. The signal is passed through two corresponding filters and develops as two signals that are Details and approximation. This is called decomposition or analysis. Elements can be assembled back into the original signal without overcome of information. This procedure is called reconstruction or synthesis or fusion [8]. The figure 3 shows the main blocks and flow of fusion process using DWT [8].

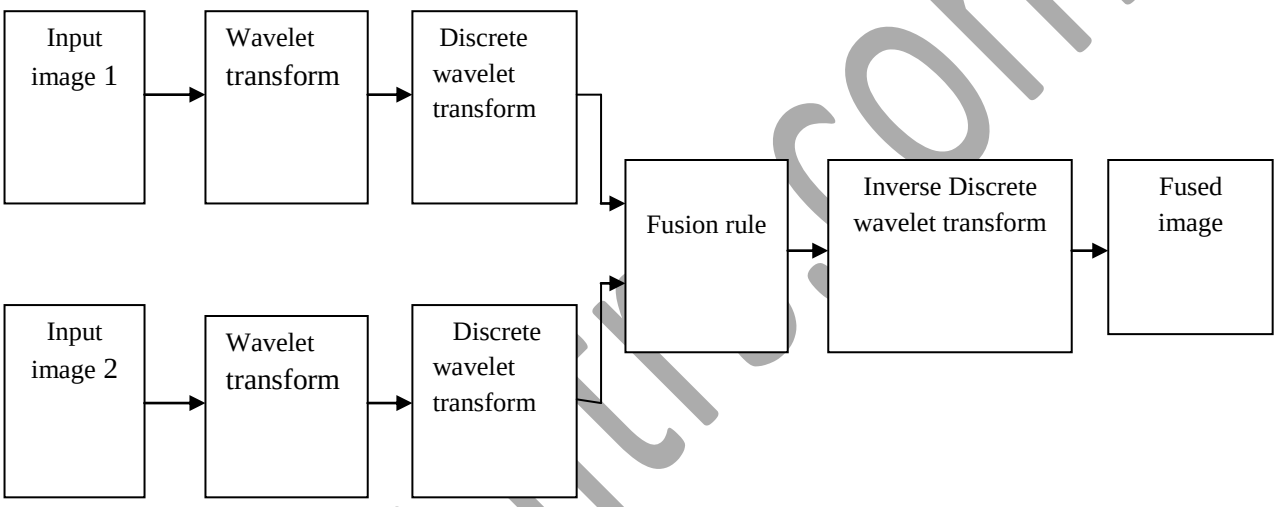

Fig. 1.4 Information flow of DWT [8]

1.5 Wavelet Families

There are 8 types of families .But in the paper four families is used for image fusion are consider that is HAAR wavelet, Db wavelet ,Sym wavelet, Coif wavelet

2. FUSIONS BASED ON WAVELET TRANSFORM TECHNIQUES

The 2-D (two dimensional) wavelet transform becomes one of the ordinary tools for image fusion.. In the wavelet image fusion, merging the two original images using fusion methods applied to details coefficients and approximations coefficients. The wavelet transform split the original image into high frequency and low frequency components. The high frequency coefficients reproduce the detail of the luminance change which corresponds to the edge information of an image. The low frequency coefficients reproduce the approximate feature of the image.

2.1 Proposed Algorithm for multilevel decomposition:

- Take the CT and MRI images from user.
- Check for the size.
- If size is not same, resize the input images.
- Enter the level of decomposition.
- By using discrete wavelet transform. decompose both the images
- Separate out the approximate and details from decomposed image.
- Apply appropriate selection criterion to select the wavelet coefficients from both the images and concatenate them to for a single decomposed image.
- By using inverse discrete wavelet transform reconstruct the image

- Evaluate the different parameters of fused image (Mean, Entropy, Standard deviation

2.2 Flow Chart

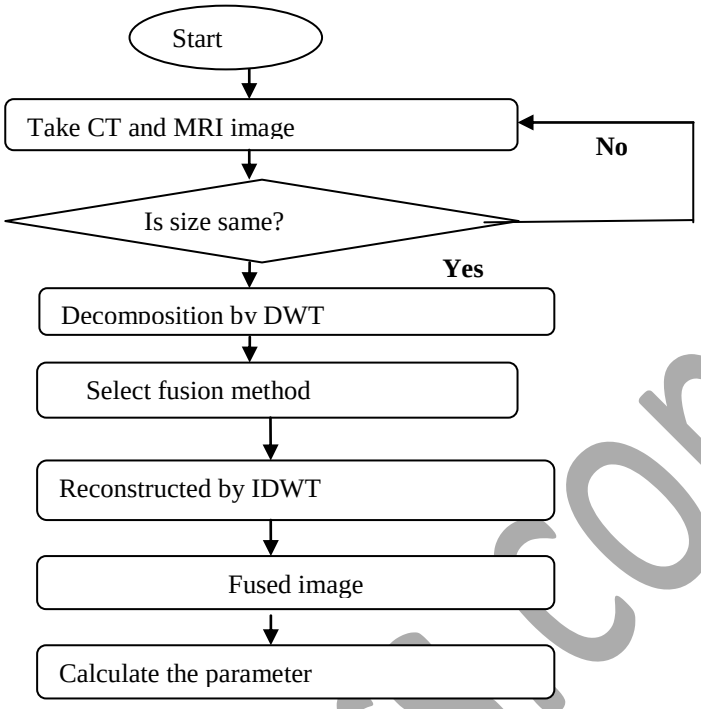

Fig. 2.1 Flow chart of research work

3. RESULTS AND DISCUSSION

In wavelet image fusion scheme, the source images (a) and (b) are decomposed into approximation and detailed coefficients at all level(1,2,3,4,5) using Haar ,Db.Sym.Coif Wavelet.. The fused image is obtained by taking the inverse wavelet transform. The different different fusion rule is used in this research to obtain the maximum information from two source images Here, the input images are a pair of medical images, with one of them being a CT scan and the other being MR scan.

Input Images

CT image MRI image

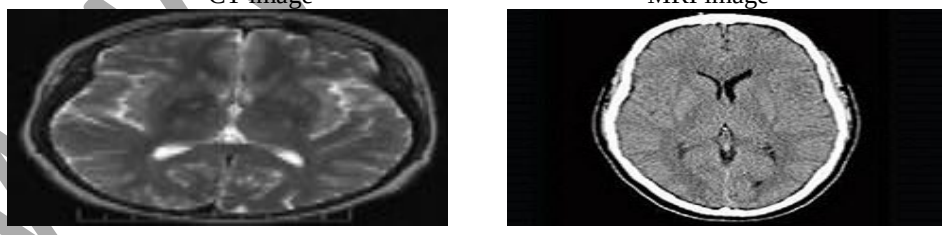

Fig. 3.1 Input Pair of Images (Medical)

In this paper fusion by using get the fused image (synthesized image)by using the different different rule that are:-

- Max-coefficient max-detail
- Min-coefficient min-detail
- Mean coefficient mean-detail
- Max-coefficient min-detail
- Min-coefficient mean-detail
- Mean-coefficient max-detail

And i have calculated the parameter of fused images (synthesized image)

3.1 Data Set Analysis (By Script File Using MATLAB)

- **Simulated output:** The output obtain by max-max-rule provide the maximum information at different different level.

3.1.1 Output at Level 1

By using four wavelet families wavelet ,the maximum entropy is found by max-max rule.the output of wavelet at level 1 of max-max- rule is shown in figure (3.2)

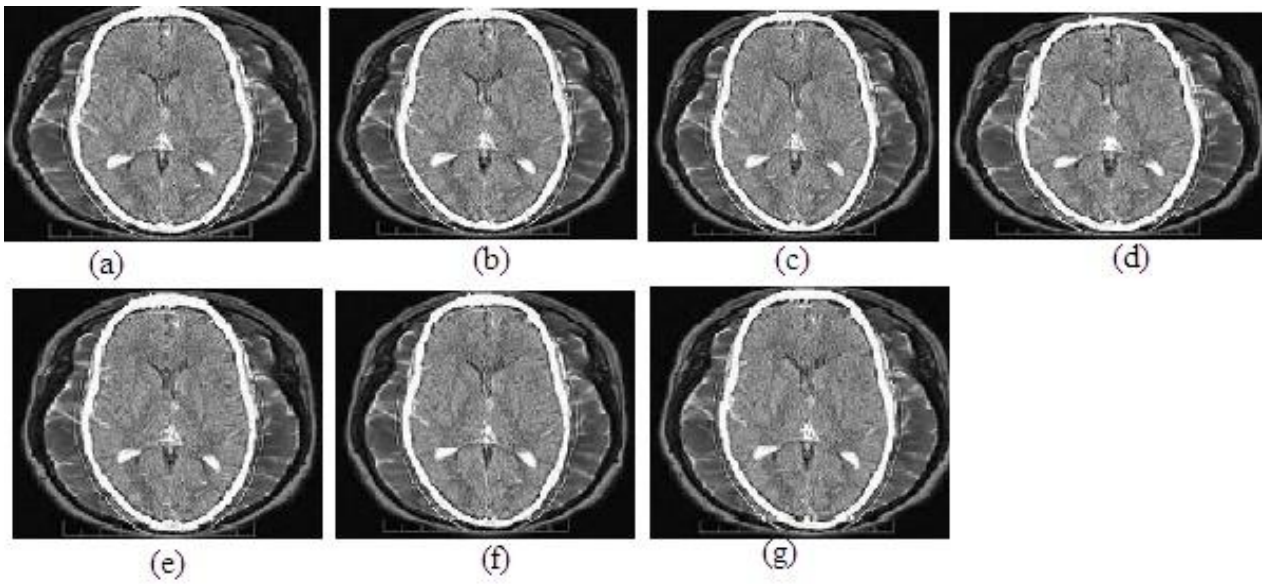

Fig. 3.2 Fused image at level 1 (a) haar (b) db1 (c) db2 (d) sym2 (e) sym3 (f) coif1 (g) coif2

3.1.2 Output at Level 2

The output of HAAR ,db,sym,coif wavelets at level 2 is shown in figure(3.3)-

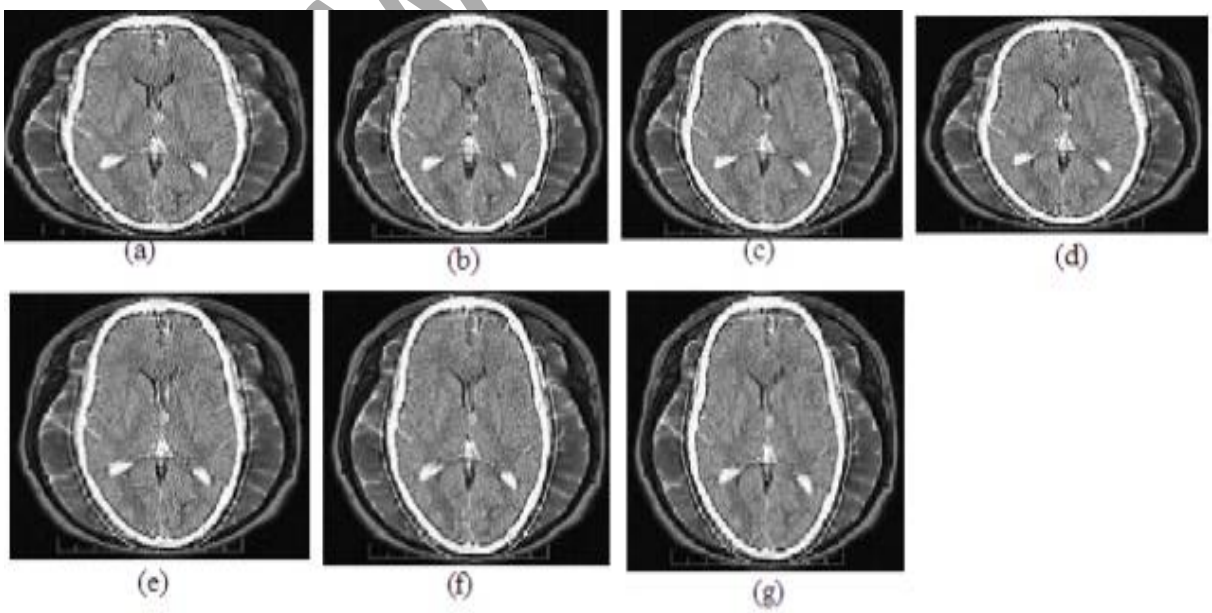

Fig. 3.3 Fused image at level 2 (a) haar (b) db1 (c) db2 (d) sym2 (e) sym3 (f) coif1 (g) coif2

3.1.3 Output at level 3

The output of wavelets at level 3 is shown in fig. 3.4

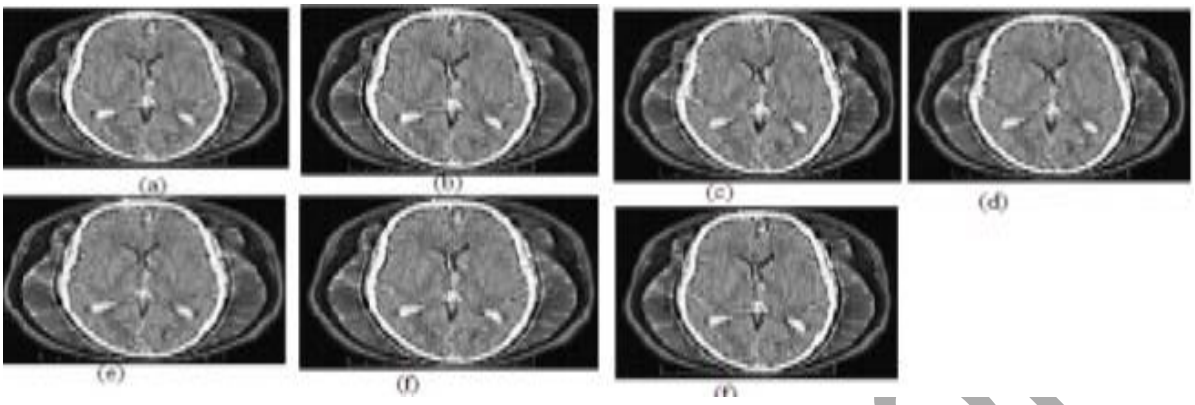

Fig. 3.4 Fused image at level 3 (a) haar (b) db1 (c) db2 (d) sym2 (e) sym3 (f) coif1 (g) coif2

3.1.4 Output at at level 4

The output of wavelets at level 4 is shown in fig. 3.5

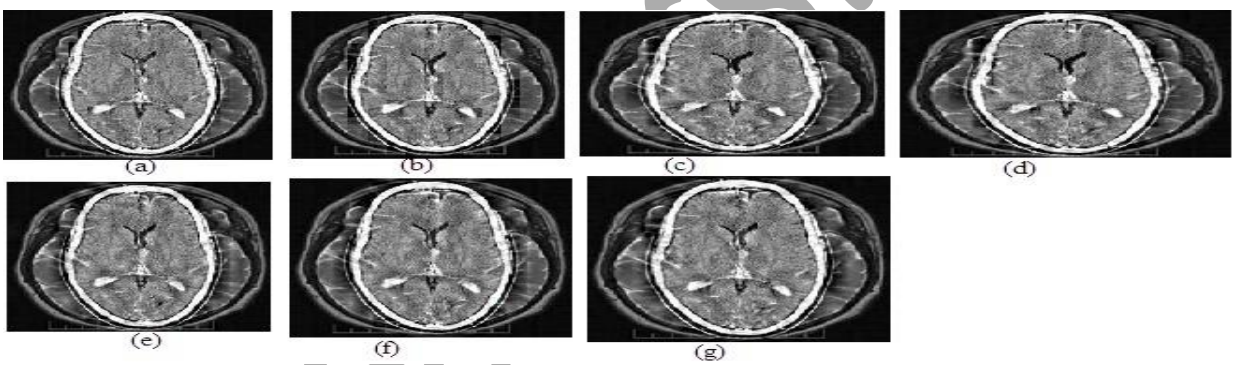

Fig. 3.5 Fused image at level 4 (a) haar (b) db1 (c) db2 (d) sym2 (e) sym3 (f) coif1 (g) coif2

3.1.5 Output at Level 5

The output of wavelets at level 5 is shown in figure(3.6)-

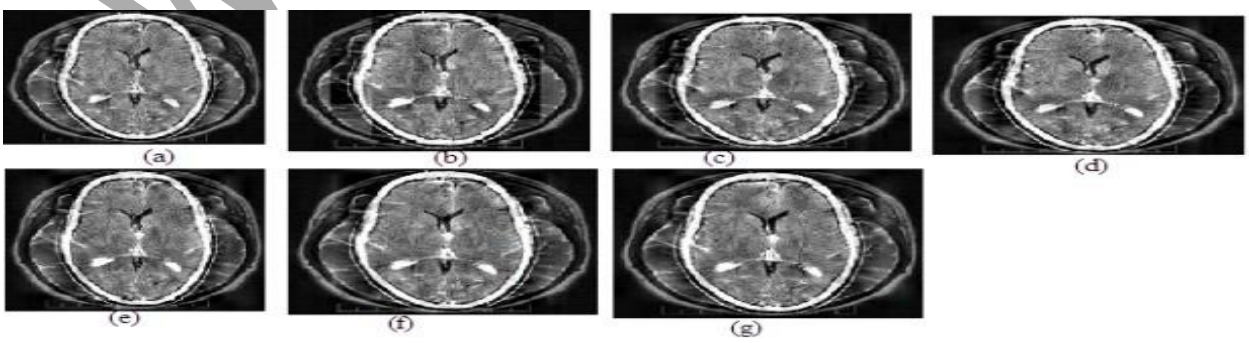

Fig. 3.6 Fused image at level 5 (a) haar (b) db1 (c) db2 (d) sym2 (e) sym3 (f) coif1 (g) coif2

4. PARAMETRE EVOLUTIONS

The performance measures used in this paper present some quantitative comparison among different fusion schemes:-

Table-4.1 Parameters of Input Images

Parameter	Image (1)	Image (2)
Entropy	6.8435	5.9647
Mean	64.6819	64.8105
Standard deviation	43.9787	75.9984

4.1. Quality Assessment of fused image (Entropy)

Table-4.2 Entropy of Fused Image

	Entropy				
Wavelet families	At level 1	At level 2	At level 3	At level 4	At level 5
Haar	7.2764	7.3032	7.3457	7.3473	7.2738
Db1	7.2764	7.3032	7.3457	7.3473	7.2738
Db2	7.2708	7.3130	7.3560	7.3820	7.4434
Sym2	7.2708	7.3130	7.3560	7.3820	7.4434
Sym3	7.2721	7.3280	7.3695	7.4142	7.4843
Coif1	7.2701	7.3149	7.3504	7.3826	7.4054
Coif2	7.2648	7.3132	7.3626	7.3897	7.4733

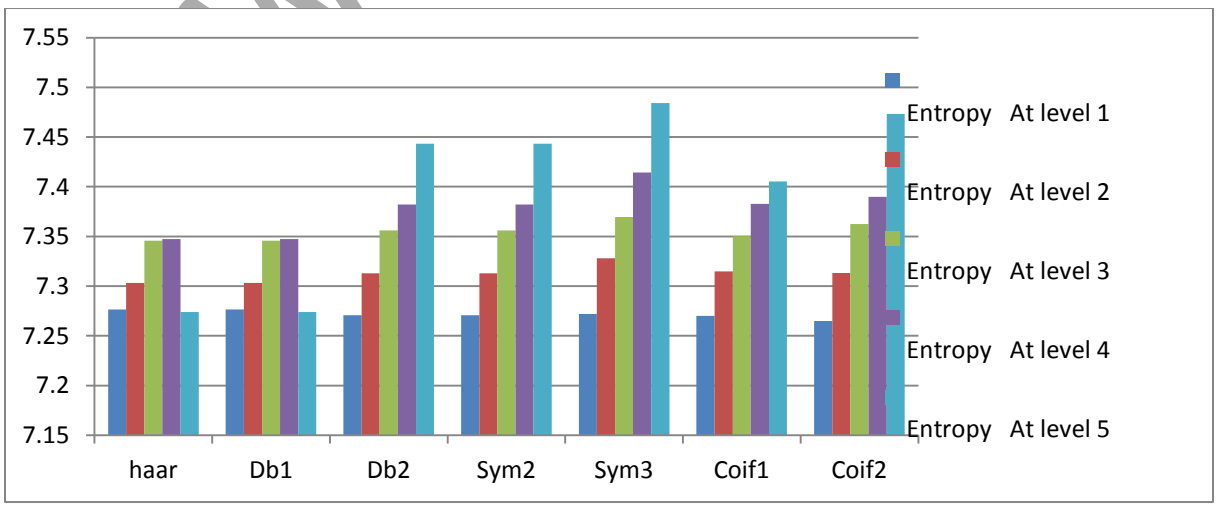

Fig. 4.1 Quality measure of fused image (entropy)

4.2 QUALITY ASSESSMENT OF FUSED IMAGE (MEAN)

Table-4.3 Mean of Fused Image

	mean						
Wavelet families	**At max-max rule**	**At min-min rule**	**At mean-mean rule**	**At max-min rule**	**At min-max rule**	**At min-mean rule**	**At mean-max rule**
haar	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Db1	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Db2	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Sym2	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Sym3	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Coif1	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462
Coif2	96.0769	95.9231	95.7143	98.5600	98.5600	98.2692	98.3462

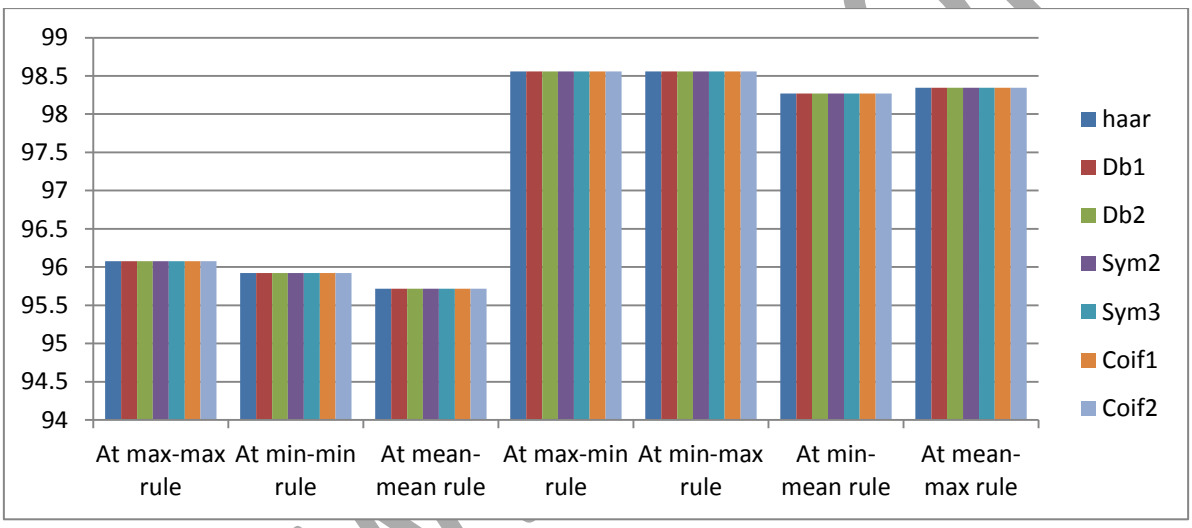

Fig. 4.2 Quality measure of fused image (mean)

4.3 QUALITY ASSESSMENT OF FUSED IMAGE (STANDARD DEVIATION)

Table-4.4 Standard Deviation of Fused Image

	Standard deviation						
Wavelet families	**At max-max rule**	**At min-min rule**	**At mean-mean rule**	**At max-min rule**	**At min-max rule**	**At min-mean rule**	**At mean-max rule**
haar	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Db1	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Db2	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Sym2	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Sym3	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Coif1	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153
Coif2	26.7969	26.3453	25.2687	23.6222	23.6222	22.8623	23.1153

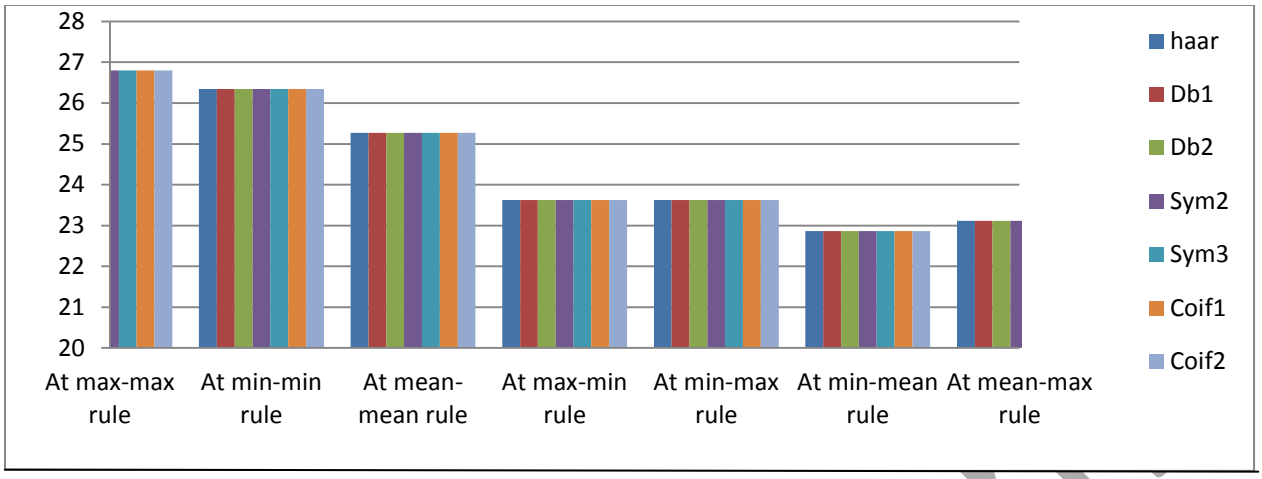

Fig. 4.3 Quality measure of fused image (standard deviation)

4. CONCLUSIONS

In conclusion, using wavelet transform and get a good fusion image of CT/MRI compared to the single CT or MRI .The proposed DWT based image fusion method is implement in MATLAB using four wavelet families at all level (level1 ,level 2,level3, level4, level5).After the implementation ,I have analyzed that symlets3 at level 5 provide the maximum information after the fusion .and that fused image provide the better information of CT and MRI images. The mean and standard deviation is same in all the wavelet families.

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