Finger Print Fusion Using Daubechies (Db1) Wavelet Transformation and Quality Measures

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Abstract –Image Fusion is mechanism that is used to associate admissible information from a set of images of same scene into a single image. A Fused image is more informative, clear, noise free. In this paper Finger prints are used as input to image fusion mechanism. Daubechies Wavelet transformation is applied on them. Various fusion rules are applied on wavelet coefficients like mean, add, maximum, minimum. Quality of fingerprints are being tested using parameters are PSNR, Average Difference, Entropy, Chi-Square.

Keywords – Daubechies, Fusion, Ridges, PCA.

I. INTRODUCTION

Image fusion is booming area of image based application field on which vast research is being carried out .Fingerprint is a pattern of interleaved ridges and valley. Ridges are the flow of lines, valleys are the gaps between two parallel ridges. Pores are the pits in the ridges. The features of fingerprints are divided into three levels are level 1, level 2, level3. Ridges are comes under level1 features. In level 2 features like bifurcation, trifurcation, crossovers, tells about the various ways the ridges flows.Level3 concerned with fine details of fingerprints like width, shape, curvature, edge contours dots. Sometimes fingerprints sensed by sensors do not contain complete, clear information. To obtain complete image, fusion with more than one fingerprint of same sample is performed. In this paper we use Daubechies (Db1) Wavelet Transform to decompose the image into four different coefficients are correct approximation (CA), horizontal, and diagonal, vertical. These coefficients of input images of sample are fused by using different fusion rules like mean, minimum, maximum, addition.

II. IMAGE FUSION TECHNIQUES

1. *Simple Maximum Method:* In this method maximum operation is performed on corresponding pixel values of input images .The resultant fused image is defined as

$$F(i,j) = [A(i,j) + B(i,j)]/2$$
$$\textit{where A and B are image matrices}$$

2. *Simple Minimum Method:* In this method minimum operation is performed on corresponding pixel values of input images .The resultant fused image is defined as

$$F(i,j) = \sum_{i=0}^{m}\sum_{j=0}^{m} min(A[i,j], B[i,j])$$
$$\textit{where A and B are image matrices}$$

3. *Simple Average Method:* In this method average operation is performed on corresponding pixels of input images .The resultant fused image is defined as

$$F(i,j) = [A(i,j) + B(i,j)]/2$$

Where F is fused image and A and B are input image matrices.

4. *PCA*: Principal Component Analysis is a mathematical tool, which cuts the multidimensional data sets into lower dimensions for analysis. This method regulates the weights for each source image using the eigenvector corresponding to the largest eigen value of the covariance matrix of each source image.

Steps for PCA algorithm are as below

1. Produce column vectors from input images
2. Compute the covariance matrix of the two column vectors formed in 1
3. Compute eigen vector and eigen values of the covariance.
4. Normalize column vector
5. Normalized eigen vector act as the weight values which, multiply with each pixel of the input image.
6. Fuse the two scaled matrices will be the fused image matrix.

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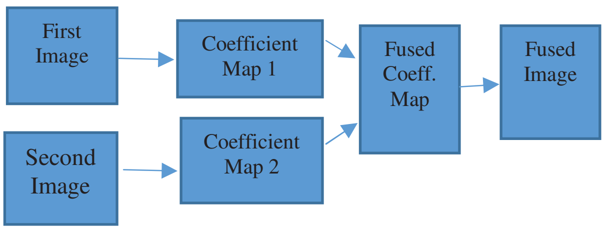
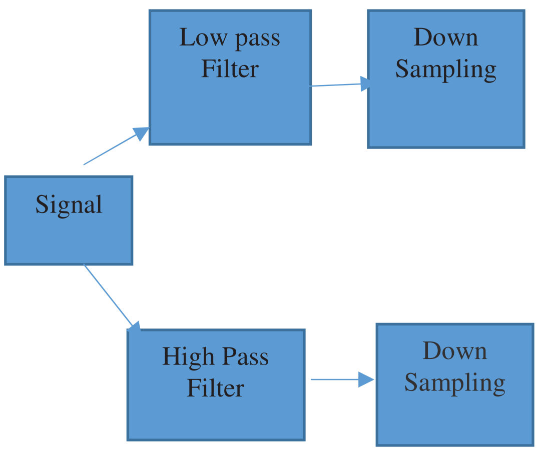
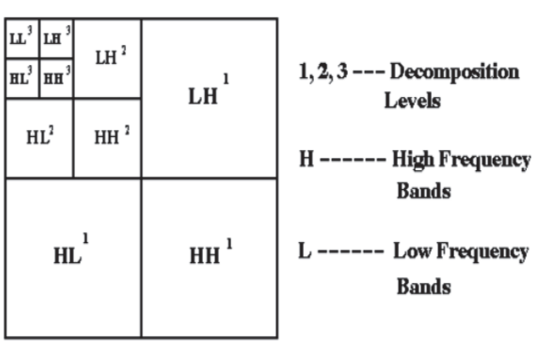
5. *Discrete Wavelet Technique:* The fused coefficient map is formed from the source image. The fusion decision map is formed on the basis of fusion rules. Lastly, IDWT applied to form fused image.



DWT Decomposition: A signal is passed through number of filters for decomposition. First it is passed through low pass filter to give approximation coefficients and this signal is also decomposed by high pass filter that gives detail coefficients. After that 2nd down sampling is performed on the filters outputs

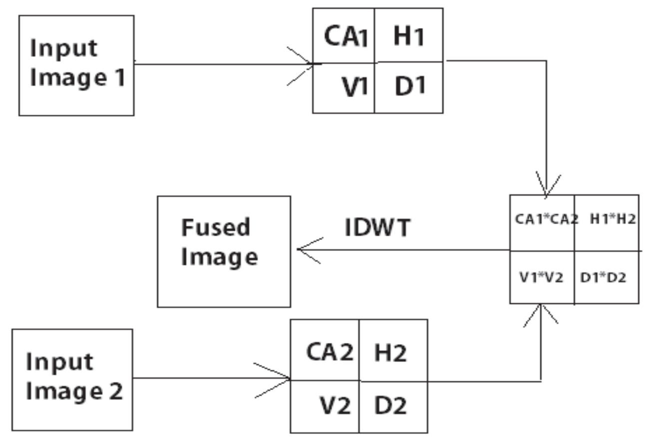


Wavelet transforms are multi-resolution image decomposition tool that offer a diversity of channels expressive the image feature by dissimilar frequency sub bands at multi-scale. It is a well-known technique in analyzing signals. When putrefaction is executed, the approximation and detail component can be separated 2-D Discrete Wavelet Transformation (DWT) translates the image from the spatial domain to frequency domain. The image is divided by vertical and horizontal lines and represents the first-order of DWT, and the image can be separated with four parts those are LL1, LH1, HL1 and HH1.



III. PROPOSED ALGORITHM

In this proposed algorithm, fingerprints are used as input images. Input fingerprints having noise like blur, salt pepper, Gaussian etc. Our motive is to merge both images to form solo image containing relevant, noise free, complete information. The block diagram of proposed algorithm of image fusion is shown below



where * denotes fusion rules

Block diagram of Proposed Method for Image Fusion

The steps involved in proposed algorithm are

1. The two input images must be registered to be fused are applied as input.
2. Then DWT is applied to decompose image into wavelet coefficients CA (correct approximation), D (diagonal), H (horizontal), V (vertical).
3. Then various fusion rules are applied on wavelet coefficients of image 1 and image 2.
4. In minimum fusion rule, minimum value of corresponding pixels of sub images is selected.

$$\sum_{i=0}^{m}\sum_{j=0}^{m} min(A[i,j], B[i,j])$$

where A and B are image matrices

5. In maximum fusion rule, maximum value of corresponding pixels of sub images is selected.

$$F(i,j) = \sum_{i=0}^{m}\sum_{j=0}^{m} max(A[i,j], B[i,j])$$

where A and B are image matrices

6. In mean fusion rule, maximum value of corresponding pixels of sub images is selected.

$$F(i,j) = [A(i,j) + B(i,j)]/2$$

Where F is fused image and A and B are input image matrices

7. In the last inverse DWT is applied on fused coefficients map to form fused image.

IV. EXPERIMENT AND RESULT

The result of fingerprint fusion is represented by using graphical user interface. The parameters used to evaluate quality are Average-Difference, Entropy, and Chi Square. The quality metrics parameters are shown in Table 1. The evaluation of images using ADD fusion rule is represented in Table 2(a, b, c) , MINIMUM fusion rule is represented in Table 3(a, b, c), MAXIMUM fusion rule is represented in Table 4(a, b, c) and MEAN fusion rule is represented in Table 5(a, b, c).

STATISTICAL PARAMETERS VALUE FOR BETTER FUSION PERFORMANCE

TABLE I. PARAMETERS

Quality Metrics	**Value**
Entropy, Average Difference	High
Peak Signal To Noise Ratio	High
Root Mean Square	LOW
Chi-Square	Low

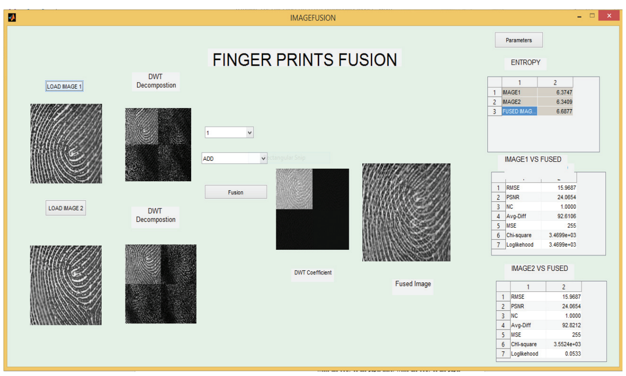


Fig. 1(a). Result of Image 1 and Image 2 fused with ADD fusion Rule

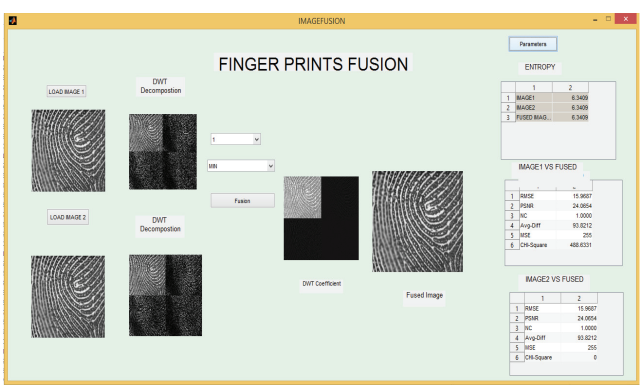


Fig. 1(b). Result of Image 1 and Image 2 fused with MINIMUM fusion Rule.

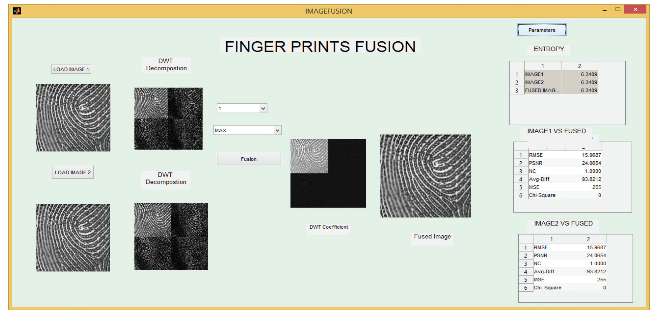


Fig. 1(c). Result of Image 1 and Image 2 fused with MAXIMUM fusion Rule.

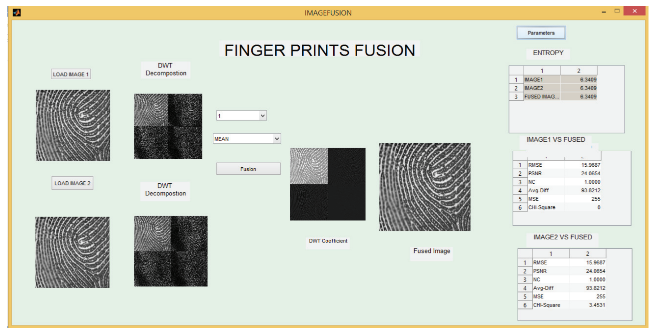


Fig. 1(d). Result of Image 1 and Image 2 fused with MEAN fusion Rule.

EVALUATION OF IMAGE1 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (a) USING **ADD** FUSION RULE.

TABLE II(A)-USING ADD FUSION RULE

PARAMETERS	**VALUE**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	6.974e+0.3

EVALUATION OF IMAGE2 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (a) USING **ADD** FUSION RULE.

TABLE II(B)-USING ADD FUSION RULE

PARAMETERS	**VALUE**
RMSE	15.9687
PSNR	24.0654

NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	7.0391e+0.3

EVALUATION OF IMAGE1, IMAGE2 AND FUSED IMAGE OBTAINED FROM Fig.1 (a) USING **ADD** FUSION RULE FOR ENTROPY PARAMETER.

TABLE II(C)-USING ADD FUSION RULE

IMAGE	**ENTROPY VALUE**
Image 1	6.3747
Image 2	6.3257
Fused Image	6.1963

EVALUATION OF IMAGE1 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (b) USING **MINIMUM** FUSION RULE.

TABLE III(A)-USING MINIMUM FUSION RULE

PARAMETERS	**VALUE**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	35.1894

EVALUATION OF IMAGE2 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (b) USING **MINIMUM** FUSION RULE.

TABLE 3(B)-USING MINIMUM FUSION RULE

PARAMETERS	**VALUE**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255

AVG-DIFFERENCE	93.6106
CHI-SQUARE	65.4570

EVALUATION OF IMAGE1, IMAGE2 AND FUSED IMAGE OBTAINED FROM Fig.1 (b) USING **MINIMUM** FUSION RULE FOR ENTROPY PARAMETER.

TABLE III(C)-USING MINIMUM FUSION RULE

IMAGE	**ENTROPY VALUE**
Image 1	6.3747
Image 2	6.3257
Fused Image	6.3177

EVALUATION OF IMAGE1 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (c) USING **MAXIMUM** FUSION RULE.

TABLE IV(A)-USING MAXIMUM FUSION RULE

PARAMETERS	**VALUES**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	35.1894

EVALUATION OF IMAGE2 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (c) USING **MAXIMUM** FUSION RULE.

TABLE IV(B)-USING MAXIMUM FUSION RULE

PARAMETERS	**VALUES**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106

CHI-SQUARE	65.4570

EVALUATION OF IMAGE1, IMAGE2 AND FUSED IMAGE OBTAINED FROM Fig.1 (c) USING **MAXIMUM** FUSION RULES FOR ENTROPY PARAMETER.

TABLE IV(C)-USING MAXIMUM FUSION RULE

IMAGE	**ENTROPY VALUE**
Image 1	6.3747
Image 2	6.3257
Fused Image	6.3443

EVALUATION OF IMAGE1 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (d) USING **MEAN** FUSION RULE.

TABLE V(A)-USING MEAN FUSION RULE

PARAMETERS	**VALUES**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	35.1894

EVALUATION OF IMAGE2 AGAINST FUSED IMAGE OBTAINED FROM Fig.1 (d) USING **MEAN** FUSION RULE.

TABLE V(B)-USING MEAN FUSION RULE

PARAMETERS	**VALUES**
RMSE	15.9687
PSNR	24.0654
NC	1.0000
MSE	255
AVG-DIFFERENCE	93.6106
CHI-SQUARE	7.1207

EVALUATION OF IMAGE1, IMAGE2 AND FUSED IMAGE OBTAINED FROM Fig.1 (c) USING **MEAN** FUSION RULE FOR ENTROPY PARAMETER.

TABLE V(C)-USING MEAN FUSION RULE

IMAGE	**ENTROPY VALUE**
Image 1	6.3747
Image 2	6.3257
Fused Image	6.3177

After displaying result, it is clear that only entropy and Chi-square shows variation but rest of parameters like RMSE, PSNR, NC, and Average difference does not show any variation.

V. CONCLUSION AND FUTURE SCOPE

In this paper, fusion of blurred fingerprints is performed .Different fusion like min, max, mean, add are applied. As we consider parameter Entropy, tells the information stored in image with max fusion rule, we get maximum value than other fusion rules. Similarly Chi-Square parameter tells the similarities between input image and fused image .Result shows that with ADD fusion rule get very closed images. In the end we can conclude that ADD and MAX fusion rules gives better fused image than other rules. The future work includes enhancements in the proposed algorithm by interchanging pixel level rules with region level fusion rules. The quality of fused images will be assessed by using additional parameters like log-likelihood, standard deviation etc.

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