*International Journal of Advanced Scientific Technologies ,Engineering and Management Sciences (IJASTEMS-ISSN: 2454-356X)* *Volume.3,Special Issue.1,March.2017*

# WAVELET TRANSFORMATIONS IN DIFFERENT BANDS BY APPLYING VARIOUS NOISES

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***Abstract— Digital watermarking is a technology being developed to ensure authentication, security and copyright protection of digital media. Watermarking is a technique to hide the watermark in the original image at the sender and remove the watermark at the receiver to get the original image. During transmission, the watermarked image may undergo noise. In this paper by applying different noises to wavelet transformed watermarked image performance measures like PSNR, MSE, NCC are measured in all four bands.***
***Index terms: Discrete Wavelet Transform(DWT), Singular Value Decomposition(SVD), High Frequency(HH), LowFrequency(LL), Peak Signal to Noise Ratio(PSNR), Normalized Correlation Coefficient(NCC), Mean Square Error(MSE).***

## I.INTRODUCTION

A new hybrid watermarking technique is used to hide the watermark in the image . Digital watermarking is the embedding of signal watermark into digital media such as image, audio and video. Later the embedded information is extracted and deleted. Embedded watermarks should be invisible, robust and have high capacity. Invisibility refers [2] degree of distortion introduced by the watermark. Because of growing popularity DWT is used in the proposed watermarking scheme. The transforms are based on small waves called wavelets, of varying frequency and limited duration [3]. The properties of wavelet could decompose original signal into wavelet transform coefficients which contain the positional information. Original signal can be reconstructed by performing inverse wavelet transform on these coefficients. There are four sub bands created when DWT is applied. They are LL, HL sub band (horizontal), LH sub band (vertical), HH sub-band (diagonal). Figures 1 illustrate the sub band decomposition of an image using 2D wavelet transform after single level decomposition [4].

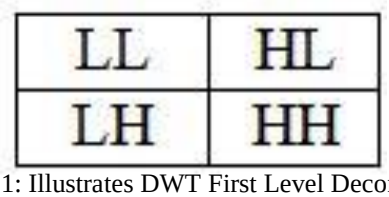


Figure 1: Illustrates DWT First Level Decomposition

## II. LITERATURE REVIEW

Digital watermarking involves the ideas and theories of of different subject coverage, such as signal processing, cryptography, probability theory, networking technology, algorithm design and other techniques.

Digital watermarking hides the copyright information into an image using an algorithm. The watermark can be hidden in digital data either visibly or invisibly. Watermark can be embedded either in spatial or frequency domain. Both domains have their own pros and cons and are applied in different scenarios.

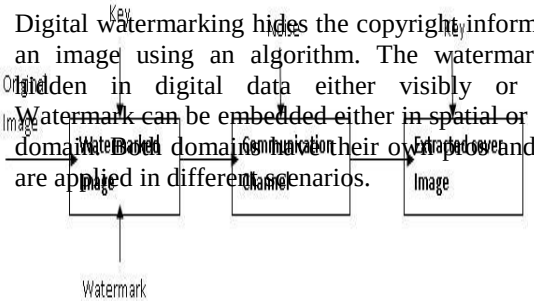


Figure 2: Digital Watermarking System

DWT is more advantageous than DCT and DFT. In DWT prominent information appears in high amplitudes and less prominent information appears in very low amplitudes. Embedding of Watermark in high level sub bands increases the robustness of watermark with loss of image fidelity and reduces robustness. Extracted image quality is measured using MSE, PSNR and NCC. The wavelet transform enables high compression ratios with good quality of reconstruction. Wavelet transform is capable of providing the time and frequency information simultaneously, hence giving time-frequency representation of the signal.

## II. PROPOSED METHOD

Watermark Embedding Algorithm

1. Transform original image and the watermark using DWT.
2. Apply SVD to LL sub band of original image and find the mean M.
3. Check each pixel in LL sub band of the original image with M*50. If it is found to be greater, then add the corresponding pixel of the watermark with the corresponding pixel of the original image .
4. Apply inverse DWT to get the watermarked image.
5. Apply noise to watermarked image to get watermarked noise image.
6. Repeat steps 2 to 5 for LH, HL, HH bands.

Watermark Extraction Algorithm

1. Apply DWT to watermarked noise image.
2. Watermark is decomposed using DWT.
3. Check each pixel value of watermarked noise image in LL band with M*50. If it is greater, then subtract the corresponding pixel of the watermark from the corresponding pixel of the watermarked image.
4. Apply wiener filter on the resultant image.
5. Apply inverse DWT on resultant to get the original image.

6. Repeat steps 2 to 5 for LH, HL, HH bands.

## IV.RESULTS OF THE PROPOSED SCHEME

In the proposed scheme original image and the watermark are considered. In order to test the quality of extracted watermark and original image the following parameters are used.

The quality of the watermarked image is measured using PSNR . The degree of similarity between original image and extracted image is measured using normalized correlation coefficient.

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\left(f(x,y) - f^{1}(x,y)\right)^{2}$$

$$PSNR = 10\log_{10}\left(\frac{255^{2}}{MSE}\right)dB$$

$$NCC = \frac{W.W^{*}}{\sqrt{W^{2}.W^{*2}}} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}W_{ij}W_{ij}^{*}}{\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}W_{ij}^{2}\sum_{i=1}^{it}\sum_{j=1}^{n}W_{ij}^{*2}}}$$

Original Image

Fig 3.1

Watermark

Fig3.2

Table 1 . Results of Gaussian noise in different bands

| Performance Measurement | LL | LH | HL | HH |
|---|---|---|---|---|
| MSE | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 |
| PSNR | 323.9216 | 323.9216 | 323.9216 | 323.9216 |
| NCC | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

Watermarked image after Gaussian noise is applied in different bands are shown in figures 4 and extracted are shown in figures 5.

LL LH HL HH

Fig 4.1 Fig 4.2 Fig 4.3 Fig 4.4

Extracted watermark in different bands after Gaussian noise is applied

LL LH HL HH

Fig 5.1 Fig 5.2 Fig 5.3 Fig 5.4

Table 2. Results of Salt and pepper noise In different bands

| Performance Measurement | LL | LH | HL | HH |
|---|---|---|---|---|
| MSE | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 |
| PSNR | 323.9216 | 323.9216 | 323.9216 | 323.9216 |
| NCC | 1.0000 | 1.0000 | 1.0000 | 0.0417 |

Watermarked images after Salt and pepper noise is applied in different bands are shown in figure 6 and extracted are shown in figure7

LL LH HL HH

Fig 6.1 Fig 6.2 Fig 6.3 Fig 6.4

Extracted watermark in different bands after salt and pepper noise is applied

LL LH HL HH

Fig 7.1 Fig 7.2 Fig 7.3 Fig 7.4

Table 3. Results of Rotation In different bands

| Performance Measurement | LL | LH | HL | HH |
|---|---|---|---|---|
| MSE | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 | 2.6358e-032 |
| PSNR | 323.9216 | 323.9216 | 323.9216 | 323.9216 |
| NCC | 0.9955 | 1.0000 | 1.0000 | 1.0000 |

Watermarked images after rotation is applied in different bands are shown below in figure 8 and extracted watermarks are shown in figure 9

LL LH HL HH

Fig 8.1 Fig 8.2 Fig 8.3 Fig 8.4

Extracted watermark in different bands after salt and pepper noise is applied are shown below

LL LH HL HH

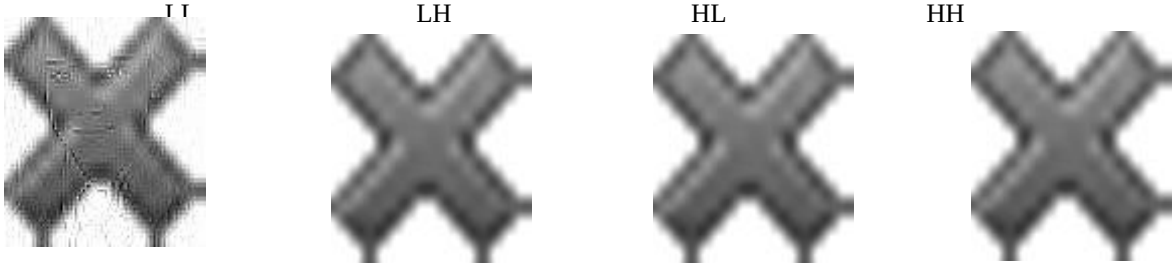

Fig 9.1 Fig 9.2 Fig 9.3 Fig 9.4

CONCLUSIONS

New hybrid watermarking technique presented in this paper is showing good results in LL band due to it's highPSNR and NCC values. Extracted image found better in LL band. The results demonstrated that, proposed method gives high PSNR and NCC even after applying noise.

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