



COMPARATIVE ANALYSIS OF WATERMARKING TECHNIQUES BASED ON FREQUENCY DOMAIN

¹K.Antony Sudha, ²S.Ramsankar

¹Associate Professor, ² Assistant Professor

¹Computer Science and Engineering,

¹Adhi College of Engineering and Technology, Kanchipuram , India.

Abstract :Digital watermarking is one of the effective tools for securing the unsecured digital data transformation over the network. The watermark is also used to indicate the ownership of a specific product. This chapter performs a comprehension evaluation of different watermarking techniques such as DCT, DWT, and Hyper analytic Wavelet Transform based on frequency domain.

IndexTerms – DCT , DWT, Hyper analytic wavelet Transform.

I. INTRODUCTION

Fast development of Internet and multimedia technologies and availability of data such as text, image, and sound in digital form are increased. Here security and protection of data has become an important issue. Digital watermarking is one of solution for security issue problem. It is used to protect the copyright of digital images. Based on embedding the cover image watermarking can be classified into two categories [12], they are blind and non-blind. The method which needs the cover image in extraction process are called Non-blind method. The method which does not need the cover image in extraction process are called blind method [5]. Watermarking techniques classified in two types based on domain, namely spatial domain and the frequency domain [7]. A pseudorandom sequence is added to the cover image in some critically sampled domain and the watermarked image is obtained by inverse transforming the modified image co-efficient, classic transform domains are the Discrete Cosine Transform (DCT), the Discrete Fourier Transform (DFT) and the Discrete Wavelet Transform (DWT). Wavelet is a function that waves above and below the X-axis with varying frequencies limited duration and zero average value. The main disadvantage of the wavelet transform is its low ability to capture the directional information. To overcome this limitations, multi-scale and directional representations are used in some of the multi-scale transforms are contourlet [10][6], curvelet [4], and shearlet [2], The existing techniques have various disadvantages such as attacks on the watermarked image can desolate the watermark image. Sensitive to filters and hostile attacks [3][9]. The other wavelet transforms as the Double Tree Complex Wavelet Transform (DTCWT) [11] or the Hyper analytic Wavelet Transform (HWT) [8] could also be considered. The advantages of such transforms compared to DWT are Quasi-shift invariance and Enhanced directional selectivity. The data hiding capacity increases with the increase of redundancy.

II. MOTIVATION

The increased adoption of digital data in a wide range of real-world applications has motivated the development of new and more effective methods for ensuring its security. Digital watermarking is a type of cryptography that involves hiding data in a digital image so that it cannot be recovered by unauthorized individuals. Digital watermarking developed as a method for overcoming the limitations of modern copyright rules for digital data. This chapter performs a comprehension evaluation of three watermarking techniques based on frequency domain.

III. WATERMARKING TECHNIQUES BASED ON FREQUENCY DOMAIN

3.1 Discrete Cosine Transform (DCT)

Discrete Cosine Transform is one of the transforms in frequency domain. In frequency domain, the signal is analyzed with respect of frequency. Watermarking Techniques based on Discrete Cosine Transformation are working in various steps [1]. Here the image is divided into 8x8 blocks. Blocks are reduced by dynamic range value by subtracting value 127 from each pixel value. So pixel value range lies between [-127, 127]. These spatial value ranges are transformed into Discrete Cosine co-efficient using Discrete Cosine Transformation. In this transformation, the whole image is divided into different frequency band as shown in Fig.3.1.

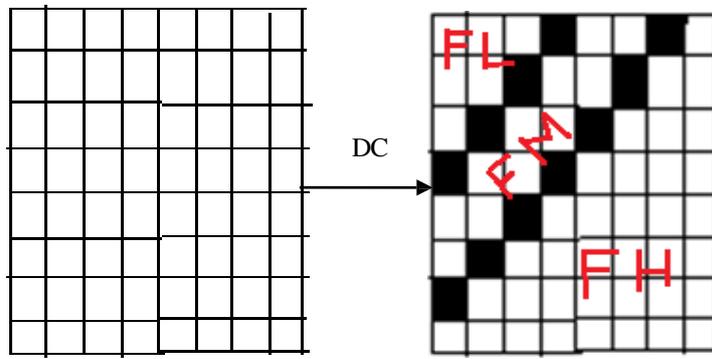


fig.3.1 Different frequency band

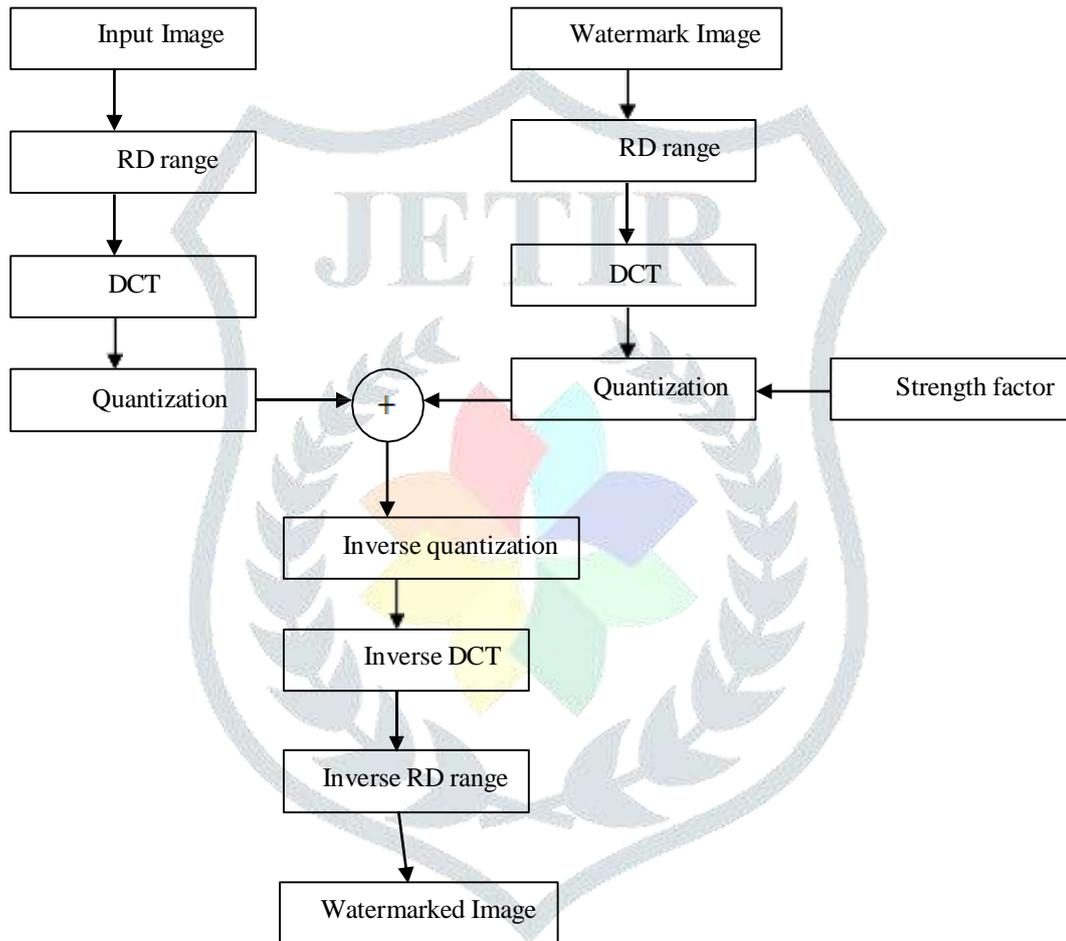


Fig 3.2 Embedding Process of DCT

Fig.3.1 shows the Low Frequency band (FL), Middle Frequency band (FM) High Frequency band (FH) , these are the different frequency bands in DC co- efficient. Here the watermark is embedded in the middle frequency. Low frequency band contains the visual part of the image and high frequency band is removed by the quantization process. In the middle frequency visibility of image remains unaffected.

Fig 3.2 shows the embedding process of DCT. Here the input image is split into 8x8 blocks and then it is reduced by dynamic range. The reduced values are given as input to DCT. After Discrete Cosine Transformation DC co-efficient are produced. These co-efficient are given to the input of quantization process. The watermark image also has same process as far as quantization. Multiply the watermark image by the Strength factor α , and then add to the cover Quantized image. This output is given to an input of Inverse Quantization and then applying Inverse DCT then Inverse Reduced dynamic range and finally get the watermarked image.

3.2 Discrete Wavelet Transform (DWT)

Discrete wavelet transform is a frequency domain analysis technique. It is based on wavelets and sampled discretely. It performs wavelet decomposition using wavelet filters such as Daubechies, Haar, Coiflets. The advantage of DWT is that wavelets are localized

in time and frequency around a certain point. In this frequency domain, watermarking technique is proved to be more effective with respect to achieve the imperceptibility and robustness requirements of digital watermarking technique. In DWT an image is decomposed into four sub-bands LL, LH, HL, and HH by the first level as shown in Fig 3.3.

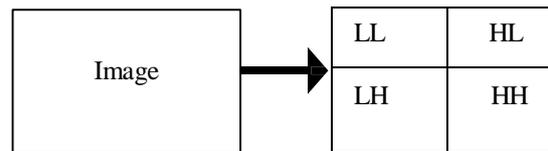


Fig.3.3 First level DWT decomposition of an image

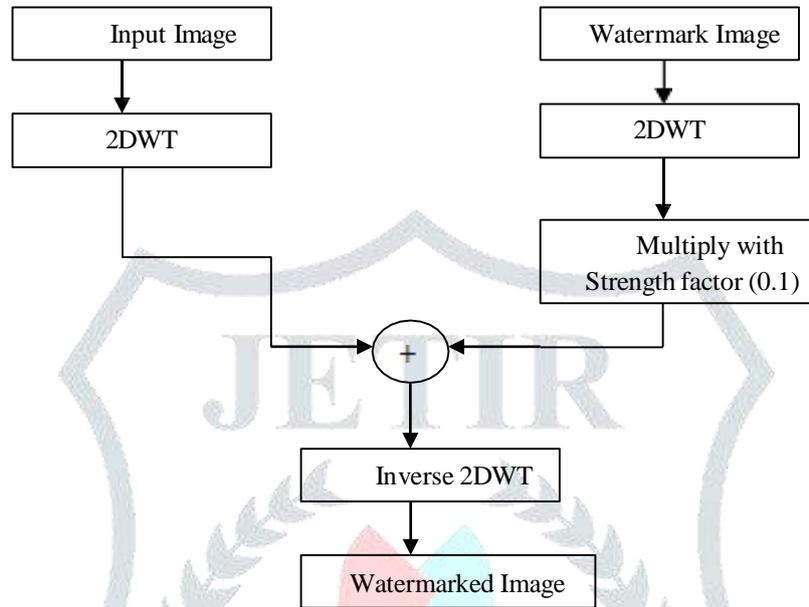


Fig.3.4 Embedding Process of DWT

Fig.3.3 shows the DWT after the first level decomposition, the DWT applied to LL band which decomposes this band into four sub bands, LL1, LH1, HL1, and HH1.

Fig.3.4 shows embedding process of the input image. The watermark image is given an input to 2D DWT. DWT coefficients for input image added to DWT co-efficient for watermark image multiply with strength factor α (0.1). After inverse 2DWT is applied, the watermarked image is obtained.

3.3 Hyper analytic Wavelet Transform (HWT)

Hyper analytic wavelet transform is an extension of analytic wavelet decompositions. It is Quasi shift-invariant and it has a good directional selectivity. In this transform, construction of any special wavelet filter is not required. An ideal Hilbert transformer was considered.

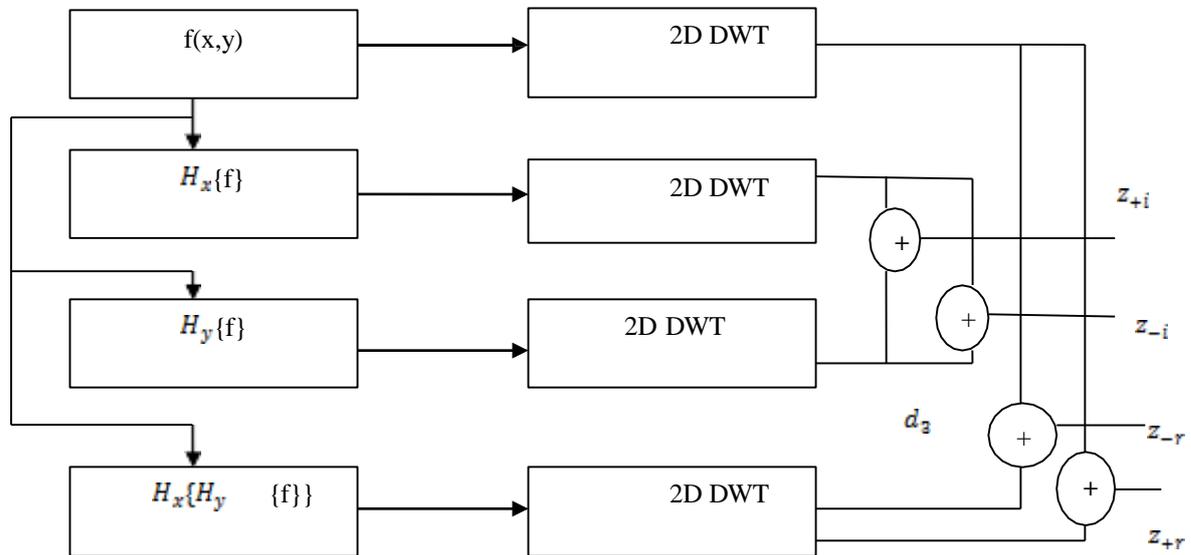


Fig 3.5 Implementation of 2D HWT

HWT implementation shown in the Fig 3.5. Hyper analytic wavelet transform of the image can be computed with the help of 2D-DWT. Discrete wavelet transform applied on hyper complex image. HWT has four trees. In first tree the 2D DWT is applied to the input image. In the second tree 2D DWT is applied to the one dimensional Hilbert transforms computed across the rows(H_x). In the third tree, 2D DWT is applied to the one dimensional HT computed across the columns (H_y). In the fourth tree, 2D DWT is applied to the result obtained after computation of the two 1D HT of the image. Hyper analytic wavelet transformed image obtained with the help of reverse process of construction of HWT. In embedding process the input image and watermark image is given an input to 2D HWT. HWT co-efficients for input image added to HWT co-efficients for watermark image multiply with strength factor α (1.5). After inverse 2D HWT is applied, the watermarked image is obtained. The Fig 3.6 shows embedding process the input image and watermark image.

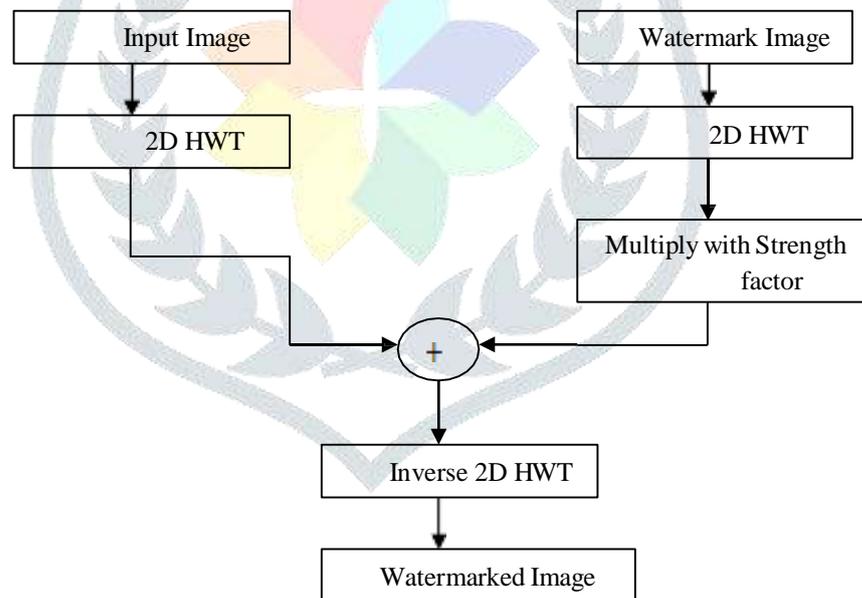


Fig.6 Embedding Process of 2D HWT

IV. RESULTS AND ANALYSIS

In this work, three natural test cover images of size of 512×512 have been taken for analysis. The Peak Signal-to-Noise Ratio (PSNR) was used to assess the quality of a watermarked image. To evaluate the robustness of the proposed technique, the watermarked image was tested against seven kinds of attacks: 1) Salt and pepper 2) Gaussian 3) Rotation 4) Cropping 5) Denoising Attack 6) JPEG compression and 7) Histogram Equalization.



a) Airplane



b) Lotus



c) Flower



d) Fruit



e) Dog



f) Car

Fig.4.7 Sample test natural cover images



Fig 4.8 Watermark image

The watermarked images possess superior Peak Signal to Noise Ratio (PSNR) and Normalized Correlation.

Table 4.1 Comparative analysis of watermarking techniques based on PSNR values

Images	DCT	DWT	HWT
Airplane	27.05	48.91	52.67
Lotus	29.71	50.63	56.36
Flower	23.45	45.05	53.52
Fruit	30.14	51.20	58.58
Dog	29.30	50.14	55.89
Car	25.69	48.39	51.63

Table 4.2 Comparative analysis of watermarking techniques based on NC values

Images	DCT	DWT	HWT
Airplane	0.69	0.72	0.97
Lotus	0.75	0.89	0.97
Flower	0.61	0.81	0.98
Fruit	0.72	0.86	0.99
Dog	0.68	0.71	0.98
Car	0.64	0.69	0.97

Comparative examination of watermarking techniques based on PSNR values is shown in table 4.1. The watermarked image's PSNR in DCT ranges from 23.45 to 30.14. PSNR with the DWT technique ranges from 45.05 to 51.20. The PSNR of the HWT watermarked image fluctuates between 51.63 and 58.58. A higher PSNR implies that the original and watermarked images are more similar. The PSNR value of the HWT approach is higher than the other two techniques. Table 4.2 shows a comparison of watermarking strategies based on NC values for resizing factor. The watermark image has been scaled to 0.5 times its original size. The watermarked image's NC in DCT ranges from 0.61 to 0.75. NC varies from 0.71 to 0.89 in the DWT approach. HWT watermarked image's NC value ranges from 0.86 to 0.97.

Table 4.3 PSNR, NC and BER performance of the HWT technique against different attacks

Attacks	PSNR (dB)	NC	BER
Salt & Pepper	54.10	0.9724	0.06
Gaussian	53.56	0.9367	0.02
Rotation	53.82	0.9612	0.02
Cropping	52.99	0.9615	0.14
Denoising Attack	54.26	0.9729	0.04
JPEG Compression	54.08	0.9763	0.01
Histogram Equalization	53.67	0.9558	0.18

Table 4.3 shows the PSNR, NC and BER performance of the HWT technique against attacks. Referring this table, it is observed that the PSNR values vary in the range from 52.99 to 54.26 db. The highest NC value is 0.9763. The Maximum BER value is 0.18.

V. CONCLUSION

Frequency domain techniques play an important role in digital watermarking. In this chapter, three watermarking techniques based on frequency domain have been compared. It is observed that the HWT based watermarking technique has a superior capacity than the DCT and DWT based Techniques. HWT is suitable for embedding process and it has a flexible structure also. The performance of the HWT technique can be improved by using soft computing techniques.

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