



Enhancement of DWT based Watermarking Technique for Images

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Abstract: The ease of reproduction, distribution, and manipulation of digital documents creates problems for authorized parties that wish to prevent illegal use of such document. To this end, digital watermarking has been proposed as a last line of defense. Digital Watermarking is a data hiding technique where an information or message is hidden inside a signal. This method is used for copyright protection of digital media. Digital representation of the signal has made the job of Watermarking easier and cost effective, and thus this technology is already developing very fast among the media industry. In this paper we introduced Digital watermarking with its classification. Also we have developed DWT based digital watermarking technique for Images.

Keywords: Data Hiding, Digital Watermarking, Copyright Protection, DWT

I. INTRODUCTION TO DIGITAL WATERMARKING

In the past several years there has been an explosive growth in multimedia technology and its applications. This growth has escalated the necessity to build secure methods for legal distribution of the digital content. As digital multimedia like video, audio and images become available for retransmission, reproduction and publishing over the Internet. So a real need for protection against unauthorized copy and distribution is increased. Thus, there is a rise in apprehensions over copyright protection of digital contents [1][2]. So the solution of this problem is Digital Watermarking, which is the most common and possibly strongest technique for protecting digital data.

Digital watermarking is a method to assert an intellectual copyright in the electronic world. Digital watermarking is the process of embedding information into a digital signal. The signal may be audio, pictures or video. The embedded information is known as a watermark that can be extracted or detected [1]. A watermark may be a digital signal or pattern which is inserted into a digital data. Since this signal or pattern is present in each unaltered copy of the original data, the digital watermark may also serve as a digital signature for the copies.

II. CLASSIFICATION OF DIGITAL WATERMARKING TECHNIQUES

Watermarking techniques can be classified based on several criteria as shown in below figure 1:[1]

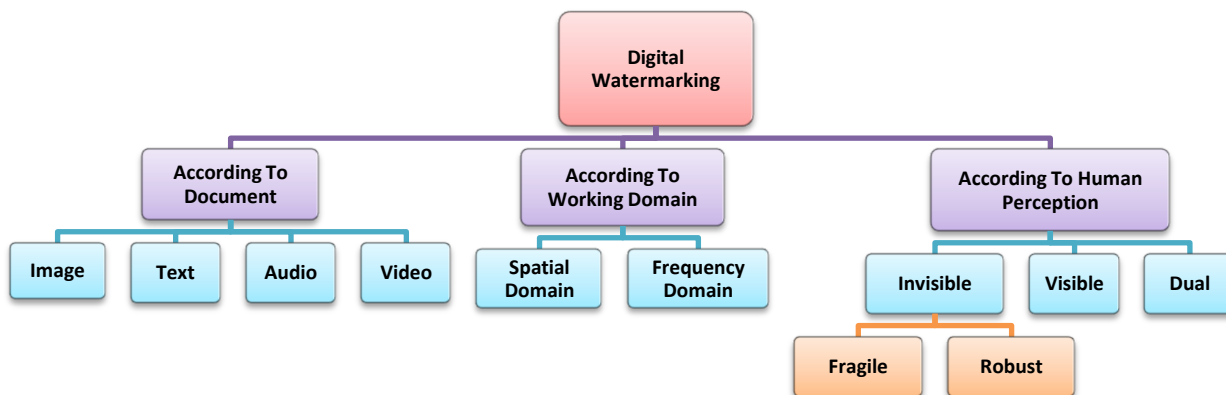


Fig 1 Classification of Digital Watermarking Techniques



III. INTRODUCTION TO DISCRETE WAVELET TRANSFORM

Wavelet Transform is a modern technique frequently used in digital image processing, compression, watermarking etc. The wavelet transform provides the time-frequency representation of a given signal. The transforms are based on small waves, called wavelet, of varying frequency and limited duration. The wavelet transform decomposes the image into three spatial directions, horizontal, vertical and diagonal. Hence wavelets reflect the anisotropic properties of HVS more precisely. Magnitude of DWT coefficients is larger in the lowest bands (LL) at each level of decomposition and is smaller for other bands (HH, LH, and

HL). A two dimensional transform can be accomplished by performing two separate one-dimensional transforms. First, the image is filtered along the x-dimension using low pass and high pass analysis filters and decimated by two. Low pass filtered coefficients are stored on the left part of the matrix and high pass filtered on the right. Because of decimation the total size of the transformed image is same as the original image. Then, it is followed by filtering the sub-image along the y-dimension and decimated by two. Finally, we have split the image into four bands denoted by LL, HL, LH and HH and one level decomposition and figure shows one level and second level decomposition [3].

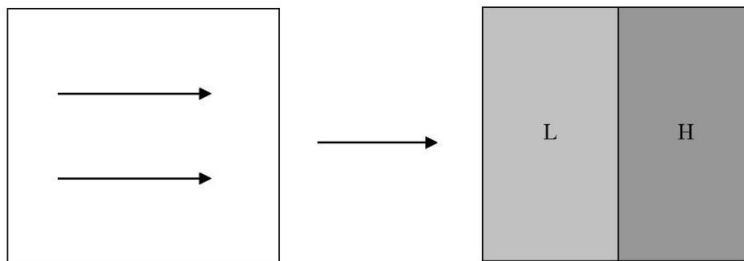


Fig 2 Horizontal Transform-2 subbands

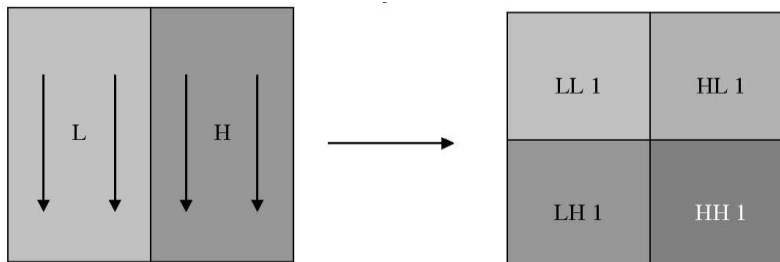


Figure 3 Vertical Transform-4 subbands

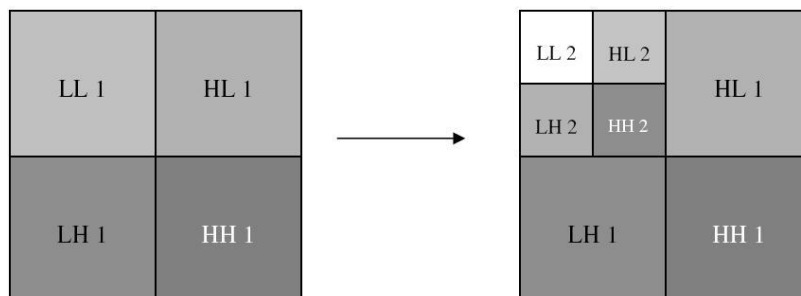


Fig 4 second level filtering

After decomposing the cover image and the watermark at the desired level, the watermark coefficients are hidden to the appropriate coefficients of the cover image [4].



Characteristics of DWT

1. The wavelet transform decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal. Hence wavelets reflect the anisotropic properties of HVS more precisely.
2. Wavelet transform is computationally efficient and can be implemented by using simple filter convolution.
3. Magnitude of DWT coefficients is larger in the lowest bands (LL) at each level of decomposition and is smaller for other bands (HH, LH, HL).
4. The larger the magnitude of the wavelet coefficient the more significant it is.
5. Watermark detection at lower resolution is

computationally effective because at every successive resolution level there are few frequency bands involved.

6. High resolution sub bands helps to easily locate edge and texture patterns in an image.

IV. WATERMARK EMBEDDING PROCESS

The proposed model for DWT based image watermark embedding is shown in figure 5.

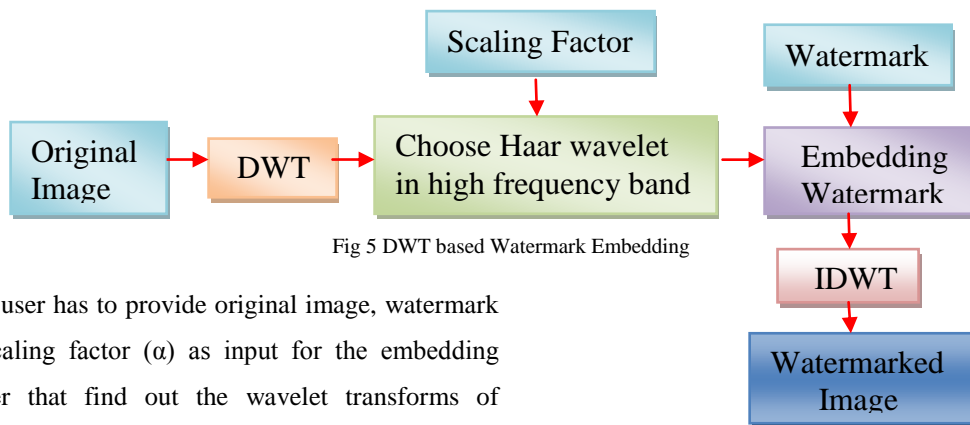


Fig 5 DWT based Watermark Embedding

In this model user has to provide original image, watermark image and scaling factor (α) as input for the embedding process. After that find out the wavelet transforms of original image and choose 'haar' wavelet in the high frequency band. During embedding process, embed the watermark coefficient with the highest value wavelet coefficient of original image. Apply inverse DWT to the image and get watermarked image.

A. Steps

- 1) Read the original image, the watermark and scaling factor.
- 2) Find the wavelet transforms at level 2 for original image and at level 1 for watermark image.
- 3) Find out the value of original image coefficient I_r .
- 4) Find out the value of watermark image coefficient W_w .
- 5) To the highest value wavelet approximation coefficients of original image, embed the watermark approximation

coefficients using following equation:

$$I_w = I_r (1 + \alpha W_w) \text{ Where,}$$

- I_w represents watermarked coefficients.
 - I_r represents actual original image coefficients.
 - W_w represents the watermark image coefficients
 - α represents the scaling factor to maintain the invisibility of the watermark in the smooth part of the cover image. ($\alpha = 0.2$ to 0.9)
- 6) Apply inverse DWT to the image whose coefficients are changed using above equations.
 - 7) Convert to uint8 data type and save the watermarked image to a file.
 - 8) Display the dual watermarked image.



9) Calculate PSNR for original cover image and the watermarked image.

V. WATERMARK EXTRACTING PROCESS

The proposed model for DWT based image watermarking extracting is shown in figure 6.

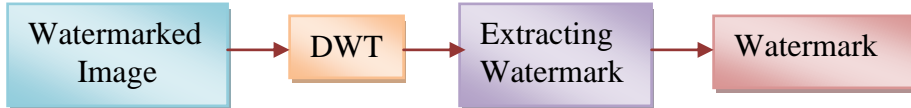


Fig 6 DWT based Watermark Extracting

In this model user has to provide watermarked image as input for the extracting watermark. After that find out the wavelet transforms of watermark image as well as watermarked image. After that retrieve the coefficients of the watermark image. Then after apply DWT to retrieve watermark from the watermarked image which is the result of the given model.

A. Steps

- 1) Read the watermarked image.
- 2) Find out the wavelet transform of both images at level 2.
- 3) From the highest value wavelet coefficients of the low resolution representation of the image, find out the approximation coefficients of the watermark using

following equation:

$$W_w = \frac{1}{\alpha} \left[\frac{|w|}{|r|} - 1 \right] \quad (2)$$

- 4) Apply DWT to the retrieved watermark from the watermarked image.
- 5) Display the reconstructed watermark and save it to a file.

VI. RESULTS

A. Image Watermark Embedding using DWT



Fig 7 Original Image (DWT Embedding)

Best

Fig 8 Watermark (DWT Embedding)

When the factor value $b = 0.3$ then following result will be displayed.

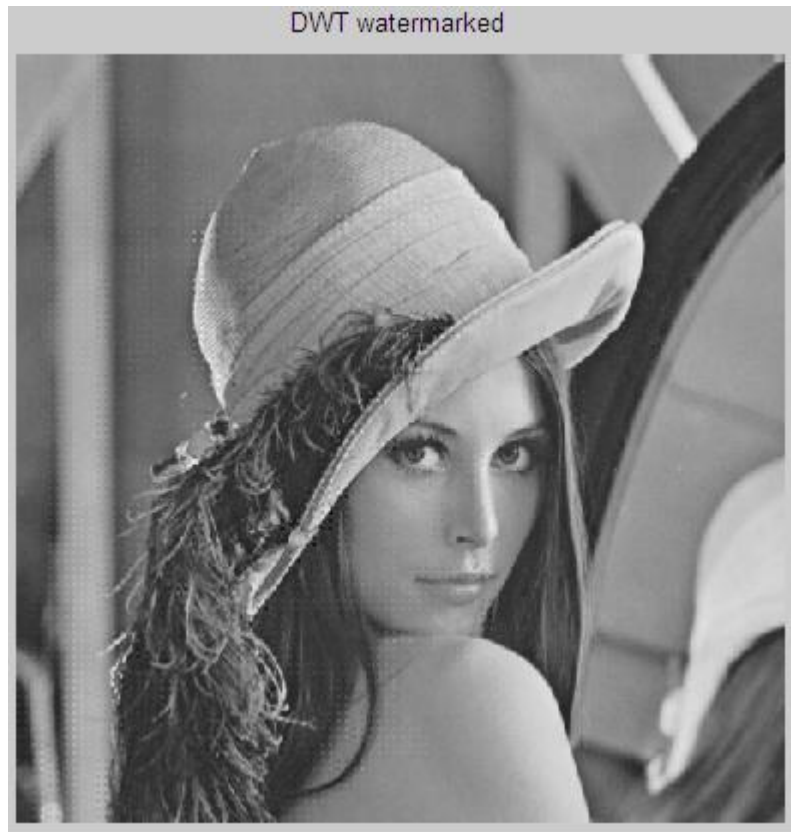


Fig 9 Watermarked Image (DWT Embedding) for $b=0.3$

When the factor value $b= 0.6$ then following result will be displayed.

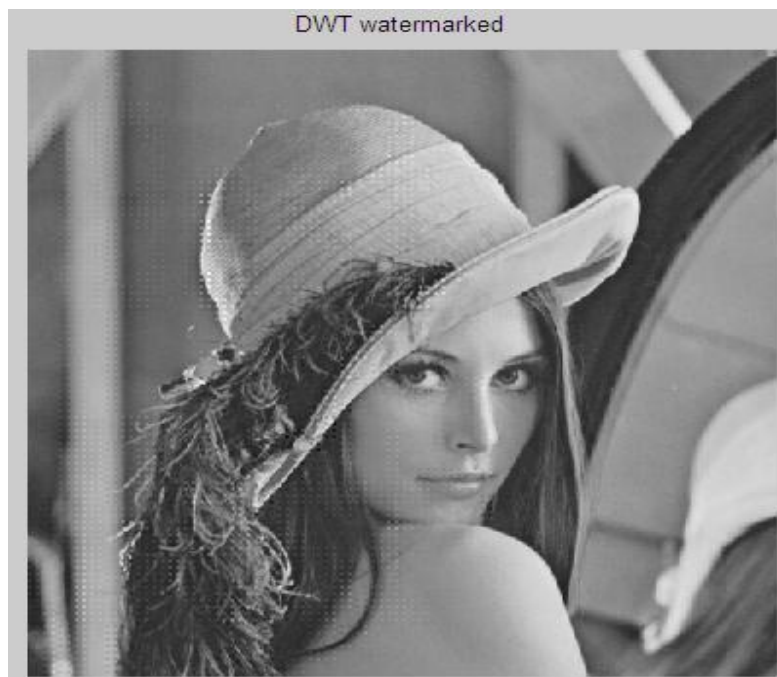


Fig 10 Watermarked Image (DWT Embedding) for $b=0.6$



When the factor value $b=0.9$ then following result will be displayed.



Fig 11 Watermarked Image (DWT Embedding) for $b=0.9$

B. Image Watermark Extracting using DWT

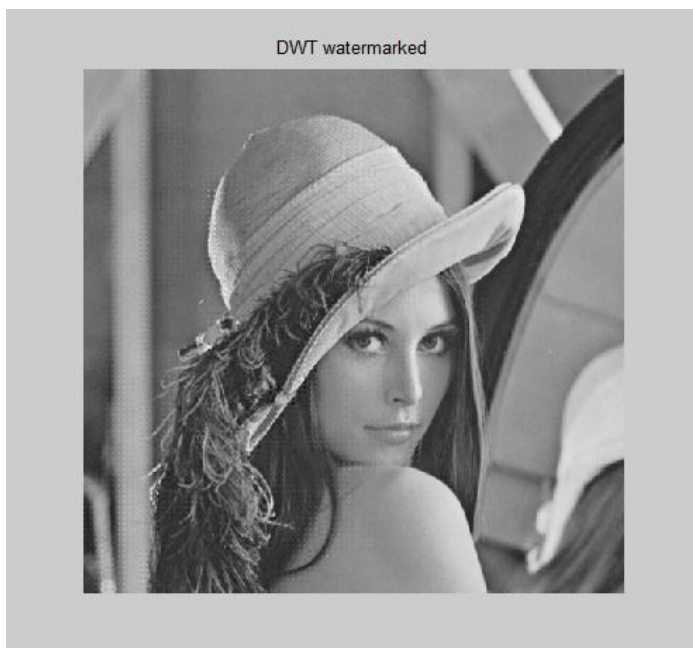


Fig 12 Watermarked Image (DWT Extracting)



Fig 13 Watermark (DWT Extracting)

VII. CONCLUSION

In this paper we have presented introduction and classification of digital watermarking techniques. These techniques are classified into several categories depending upon the domain in which the hidden data is inserted and the requirement of which the hidden data is to be extracted. We have also presented frequency domain method named as DWT based watermarking technique with embedding and extraction process. The experiment shows that frequency domains are typically better candidates for watermarking than spatial domain, for both reasons of robustness as well as visual impact. The result indicates Wavelet coded image is a multi-resolution description of image. In DWT an image can be shown at different levels of resolution and can be sequentially processed from low resolution to high resolution by changing the scaling factor. In future this digital watermarking technique will be implemented for the digital data such as text, 3-Dmeshes, face animation parameters, video and audio.

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