WAVELET BASED WATERMARKING ON DIGITAL IMAGE

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Abstract

Safeguarding creative content and intellectual property in a digital form has become increasingly difficult as technologies, such as the internet, broadband availability and mobile access advance. It has grown to be progressively easier to copy, modify and redistribute digital media, resulting in great declines in business profits. Digital watermarking is a technique which has been proposed as a possible solution to this problem. Digital Watermarking is a technology which is used to identify the creator, owner, distributor of a given video or image by embedding copyright marks into the digital content, hence digital watermarking is a powerful tool used to check the copy right violation. In this paper a robust watermarking technique based on DWT (Discrete Wavelet Transform) is presented. In this technique the insertion and extraction of the watermark in the grayscale image is found to be simpler than other transform techniques. This paper successfully explains the digital watermarking technique on digital images based on discrete wavelet transform by analyzing various values of PSNR's and MSE's..

Keywords: Digital watermarking, Discrete Wavelet transform, Insertion, Extraction, Watermark, Alpha Blending, PSNR, MSE.

1. Introduction

Watermarking technology plays an important role in preventing copyright violation as it allows to place an imperceptible or perceptible Watermark depending on the requirement in the multimedia data to identify the legitimate owner or detect malicious tampering of the document. The significant portions of the host image,e.g. the low frequency components have to be modified in order to encode the information in reliable and robust way[2]. This led to the development of watermarking schemes embedding in the frequency domain. Many image transforms have been considered like DCT (Discrete Cosine Transform)[2],DHT(Discrete Hartley Transform).With the standardization process of JPEG2000 and the shift from DCT to wavelet based image compression methods, Watermarking schemes operating in wavelet transform domain[1] have become more interesting. A transparent and robust watermark should be such that the watermark is detectable in the host image. The proper selection of the frequency transform is dependent on the fact, the better the image transform approximates the properties of the HVS(Human Visual System) the easier is to put more energy in the embedded signal without causing perceptible distortion. According to the HVS the high frequencies are less visible then the low frequencies. In this paper We have used wavelet transform because it is more close to the Human Visual System than DCT.DWT is the multiresolution description of an image the decoding can be processed sequentially from a low resolution to the higher resolution. In this the low frequency signals are located in the frequency domain while high frequency signals are located in the pixel domain. Wavelets have their energy concentrated in time and are well suited for the analysis of the transient, time varying signals. The 2D wavelet transform decomposes an image into lower resolution approximation image(LL) as well as horizontal(HL),vertical(LH) and diagonal(HH) detail components. The perceptible watermark should be embedded in the low frequency region while the imperceptible watermark should be embedded in the high frequency region.Fig-1 shows the architecture of the watermarking model based on digital watermarking. In this the Discrete wavelet transform is applied to the original image and the watermark separately. After this the watermark is embedded in the image using the alpha blending technique. For the recovery of the watermark and the original image the IDWT(Inverse Discrete Wavelet Transform) is applied to the watermarked image and the both images are recovered. The recovered images are compared with the original images to calculate the values of the PSNR(Peak Signal to Noise Ratio).

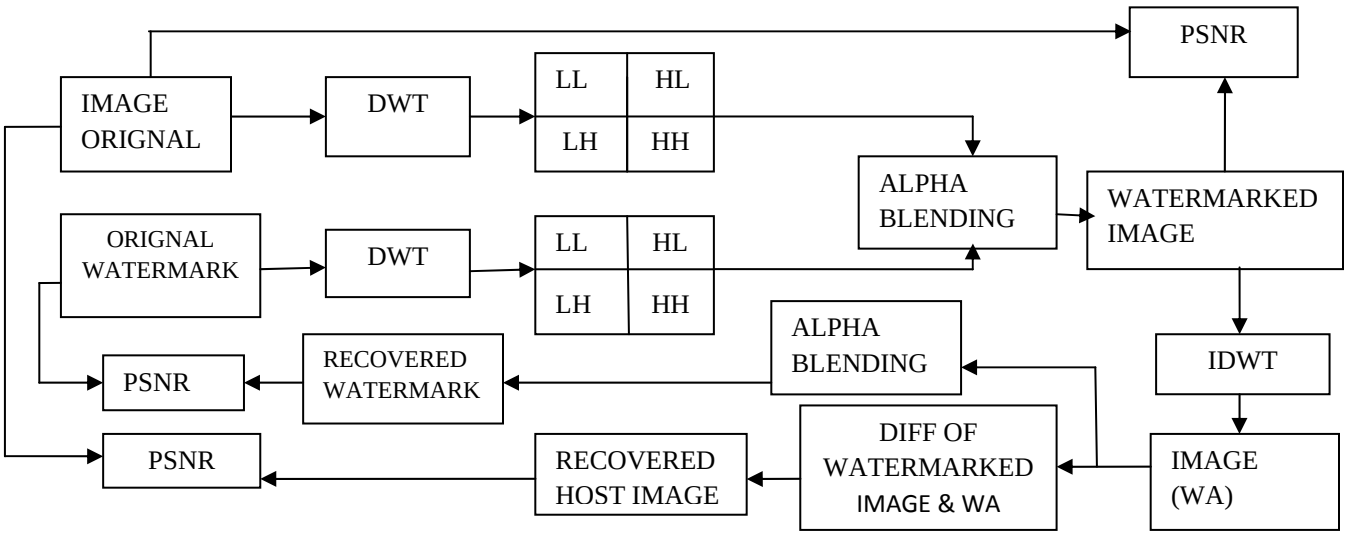

Fig. 1 : Architecture of wavelet based Watermarking Model

2. Watermark Embedding

In this process firstly the gray scale host image is taken and 2D DWT (Discrete Wavelet Transform)is applied to the image which decomposes image into four components low frequency approximation, high frequency diagonal, low frequency horizontal ,low frequency vertical components. In the same manner DWT is also applied to the watermark image which is to be embedded in the host image. The wavelet used here is the wavelets of daubecheis. The technique used here for inserting the watermark is alpha blending[3]. In this technique the decomposed components of the host image and the watermark which are obtained by applying DWT to both the images are multiplied by a scaling factor and are added. During the embedding process the size of the watermark should be smaller than the host image but the frame size of both the images should be made equal. Since the watermark embedded in this paper is perceptible in nature or visible, it is embedded in the low frequency approximation component of the host image.

2.1 *Alpha blending*

According to the formula of the alpha blending the watermarked image is given by

$$WMI=k*(LL1) +q*(WM1) \quad (1)$$

WMI=Watermarked image
LL1=low frequency approximation of the original image
WM1=Watermark.
k, q-Scaling factors for the original image and watermark respectively.

3. Watermark Extraction

In this process the steps applied in the embedding process are applied in the reverse manner. The Inverse discrete wavelet transform is applied is applied to the watermarked image .Now the result obtained is subtracted from the watermarked image and in this way the host image is recovered. The watermark is recovered from the watermarked image by using the formula of the alpha blending.

3.1 Alpha blending

$$RW=(WMI - k*LL1) \quad (2)$$

RW=Recovered watermark, LL1=Low frequency approximation of the original image,
WMI=Watermarked image

4. Experimental Results

In this process we have used grayscale images Lena as original image and the logo of the JEC Jabalpur as the watermark .Both the images are of equal size of 572X561. Since the alpha blending technique is used here which adds the low frequency contents of the two images hence both images of equal size are taken. For embedding of watermark in the original image the value of scaling factor k is varied from 0.002 to 0.0002 by keeping q constant and best result is obtained for k=0.001 as shown in the table 3. As the value of k is decreased further to 0.0002 the watermarked image becomes darker and finally becomes invisible. For the process of recovering the original image from the watermarked image the value of the scaling factor k is varied from 0.0035 to 0.0012 by keeping q constant at 0.0009.The best result for the recovered image from the watermarked image is obtained for k=0.002 and q=0.0009 which has a PSNR of 6.2302 as shown in the table2.Here the quality of the recovered image is affected by only by varying the scaling factor k. When the value of q is kept constant at 0.0009 and k is varied as shown in the table2 the recovered image after the best result becomes darker and PSNR also decreases. For the process of recovering the watermark from the watermarked image the value of k is kept constant at 0.0009 and q is varied from 0.004 to 0.001.The best result is obtained for q=0.0025.For the higher values of q ie 0.004 the watermark becomes almost invisible and as the value of q is reduced best result is obtained, and if q is further reduced the recovered watermark becomes darker and PSNR decreases as shown in Table1. The PSNR for the best result is at 5.5955.The values of the mean square error & PSNR are calculated for various values of the scaling factors k & q as shown in the table1,2 and 3. The mean square error gradually decreases as the value of the PSNR increases which is shown in the Fig, 2, 3, 4 and 5.

Img. : 1 Lena (Original image)

Img. : 2 Watermark

4.1 Watermarked images using wavelet transform for various values of scaling factors k

Img.: 3 k=0.002

Img. :4 k=0.001

Img. : 5 k=0.0008

Img. : 6 k=0.0002

Note-Scaling factor q=0.0009 for all watermarked images

4.2 *Recovered images using wavelet transform*

Img : 7 PSNR=6.2459 Img . : 8 PSNR=6.2331 Img. : 9 PSNR=6.2302 Img. : 10 PSNR=6.2281

4.3 Recovered Watermark using Wavelet Transform

Img. : 11 PSNR=5.5955 Img. : 12 PSNR=5.5941 Img. : 13 PSNR=5.5822 Img. : 14 PSNR=5.5613

Table : 1 PSNR and MSE for recovered watermark

S. no.	k	q	MSE(For Recovered watermark)	PSNR(For Recovered Watermark)	Obser-vation
1	0.0009	0.004	1.7904E+04	5.6014	
2	0.0009	0.0035	1.7915E+04	5.5987	
3	0.0009	0.003	1.7924E+04	5.5965	
4	0.0009	0.0028	1.7925E+04	5.5963	
5	0.0009	0.0025	1.7928E+04	5.5955	Best Result
6	0.0009	0.0022	1.7934E+04	5.5941	
7	0.0009	0.002	1.7983E+04	5.5822	
8	0.0009	0.0018	1.8070E+04	5.5613	
9	0.0009	0.0015	1.8140E+04	5.5445	
10	0.0009	0.001	1.8177E+04	5.5355	

Table : 2 PSNR and MSE for recovered image.

S. no.	q	k	PSNR(For Recovered image)	MSE(For Recovered Image)	Obser-vation
1	0.0009	0.0035	6.2618	1.5378E+04	
2	0.0009	0.0032	6.2609	1.5381E+04	
3	0.0009	0.003	6.2592	1.5387E+04	
4	0.0009	0.0028	6.2563	1.5397E+04	
5	0.0009	0.0025	6.2459	1.5434E+04	
6	0.0009	0.0022	6.2331	1.5480E+04	
7	0.0009	0.002	6.2302	1.5490E+04	Best Result
8	0.0009	0.0018	6.2281	1.5498E+04	
9	0.0009	0.0015	6.1974	1.5608E+04	
10	0.0009	0.0012	6.1949	1.5617E+04	

Table : 3 Watermarked image for various values of Scaling factors k and q.

S. no.	q	K	Observation
1	0.0009	0.002	
2	0.0009	0.001	Best Result
3	0.0009	0.0009	
4	0.0009	0.0008	
5	0.0009	0.0007	
6	0.0009	0.0006	
7	0.0009	0.0005	
8	0.0009	0.0004	
9	0.0009	0.0003	
10	0.0009	0.0002	

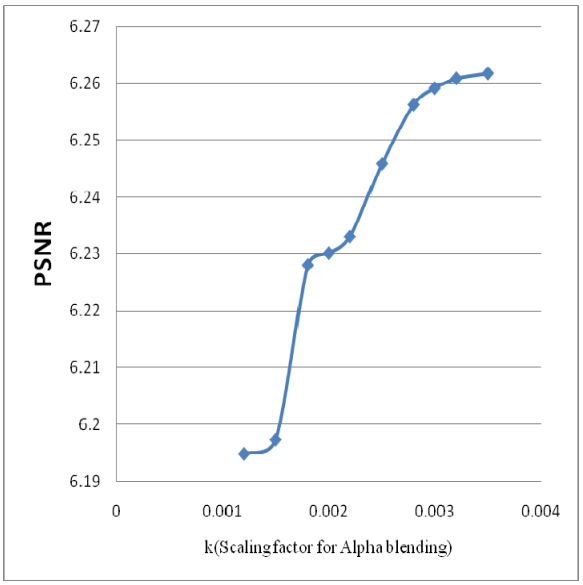

Fig. : 2 PSNR for recovered image

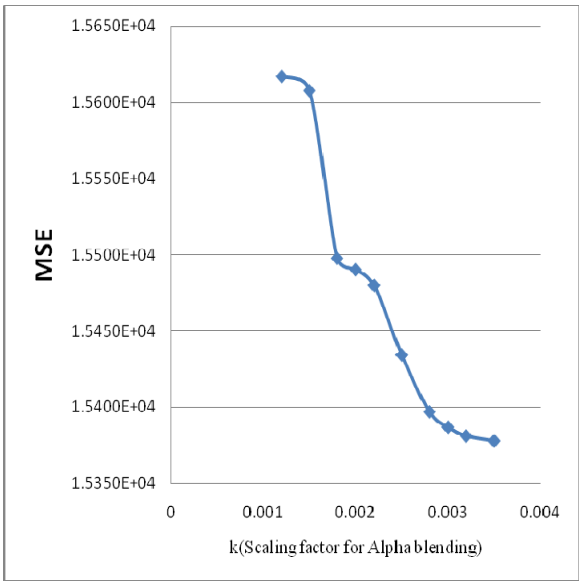

Fig. : 3 MSE for recovered image

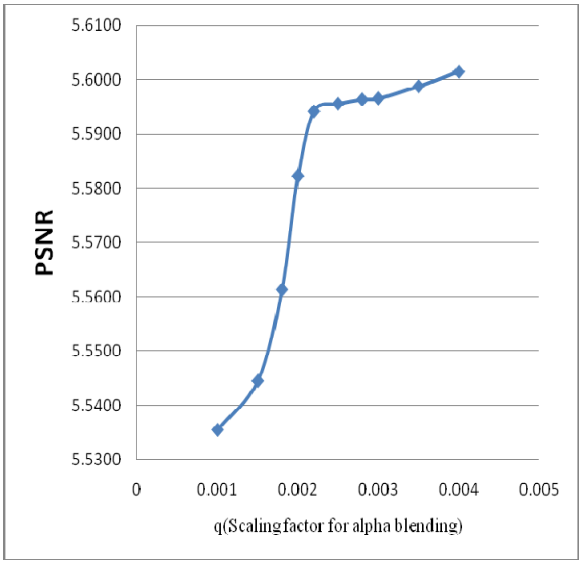

Fig. : 4 PSNR for recovered watermark

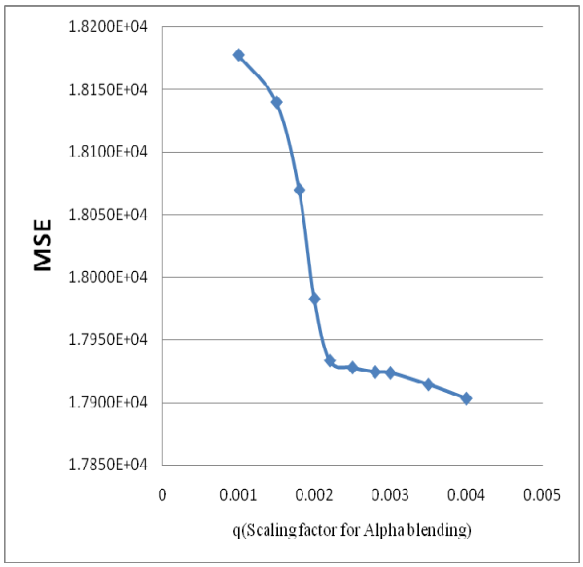

Fig. : 5 MSE for recovered watermark

5. Conclusion

In this paper the watermark insertion and extraction was done using the DWT (Discrete Wavelet Transform) and IDWT(Inverse Discrete Wavelet Transform) respectively. In this method of watermarking we have used alpha blending technique.As it is shown in the results that the quality of the watermarked image,recovered image and the revovered watermark are dependent only on the scaling factors k and q also the embedding and extraction of watermark in this technique is simpler in comparison to DCT[2] which can be verified by the architecture of the watermarking model in both the cases. All the results obtained for the recovered images and the watermark are identical to the original images.

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