Attacks Analysis for Keyed Blind Multiresolution Watermarking Algorithm

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Abstract: - This paper presents noise and compression attacks results for a blind multiresolution watermarking scheme based on a modified Xia's algorithm. The results are based on Levels 2, 5 and 8 of a DWT scheme at different scale factors (α) used in the watermark insertion.

Key- Words: - Blind image watermarking, discrete wavelet transform, copyright protection, noise attack, compression attack, cross correlation.

1 Introduction

Internet is becoming the main carrier for multimedia such as documents, images, audio and video data. Some of this digital information needs a copyright protection by inserting a visible or invisible mark to identify and protect the owner.
Watermarking is adding an invisible code (a watermark or signature) to digital information such as an image in order mark it to identify image owner [1], [2], [3],[4],[5].
In this paper we describe a modified watermarking technique based on Xia's algorithm [6]. The modified version is a keyed blind multiresolution algorithm at discrete wavelet transform [7],[8],[9],[10],[11],[12],[13].

2 Xia's algorithm

Xia's algorithm is a non-blind watermarking algorithm. The embedding strategy used in this algorithm is an additive watermarking algorithm.
In this strategy, a signal is embedded in the points of the selected coefficients of the transform domain.
Watermarking in the discrete wavelet domain (DWT) consists of an encoding (embedding the watermark) stage and the decoding stage (extraction stage).
The encoding stage (Figure 1) can be described as follows:

– An image is decomposed into several bands using the DWT.
– The watermark is added to the large coefficients which are not located in the lowest frequency band of an image $y[m,n]$.
The watermark is a pseudo-random sequence (Gaussian noise) $N[m,n]$ with mean 0 and variance 1 to the DWT coefficients $y'[m,n]$.
The embedding formula:

$$y'[m,n] = y[m,n] + \alpha (y[m,n])^2 N[m,n] \quad (1)$$

Where α is a parameter to control the level of the watermark, y is the DWT coefficient of the original image, ý is the DWT coefficient of the watermarked image, the square 2 indicates the amplification of the large DWT coefficients.
– Finally, the inverse transformation IDWT is applied on the modified DWT coefficients and the unchanged DWT coefficients at the lowest frequency.
The decoding stage (Figure 2) can be summarized as follows:
– Decompose both the watermarked image and the original image with DWT into four bands LL1, LH1, HL1, HH1, respectively, then take the difference of the DWT coefficients in HH1 bands of the received and the original images.
– Compare the signature added in the HH1 band and the difference by calculating their cross correlations.

– If there is a peak in the cross correlations, the signature is called detected. Otherwise, compare the signature added in the HH1 and LH1 bands with the difference of the DWT coefficients in the HH1 and LH1 bands. If there is a peak, the signature is detected. Otherwise, we consider the signature added in the HL1, LH1 and HH1 bands. If there is still no peak in the cross correlations, we continue to decompose the original and the received signals in the LL1 band into four additional sub bands LL2, LH2, HL2 and HH2 and so on until a peak appears in the cross correlations. Otherwise, the signature can not be detected.

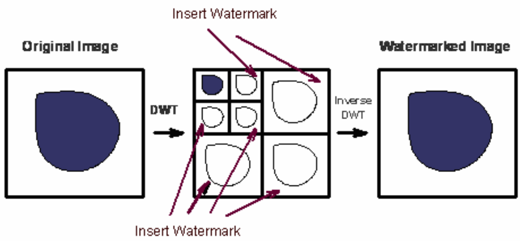

Figure 1: Encoding in Xia's Algorithm

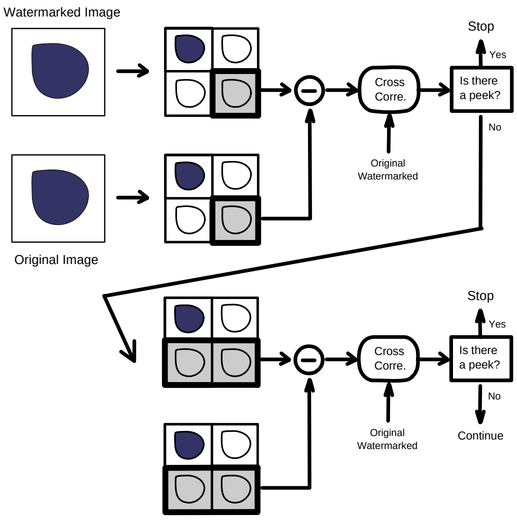

Figure 2: Decoding in Xia's Algorithm

The modifications to above algorithm can be summarized as follows:

– Xia's algorithm was modified to be a blind watermarking which means that the original image is not needed in the detection process.

– A key is used to add the watermark in some selected coefficients.

– The steps of embedding the watermark are similar to Xia's algorithm. The only difference is the step on inserting the watermark. The watermark is embedded into the detail wavelet coefficients of the host image with the use of a key. This key is randomly generated based on a seed. This key consists of zeros and ones and is used to select the exact locations in the wavelet domain in which to embed the watermark. For each coefficient within the wavelet domain, the key has a corresponding value of one or zero to indicate if the coefficient is to be marked or not, respectively. The number of ones in the key must be greater or equal to the size of the watermark.

– The embedding formula used is the same as Xia's but without the square [14], i.e.:

$$y'[m,n] = y[m,n] + \alpha(y[m,n])N[m,n] \quad (2)$$

– The steps of decoding the watermark are different than Xia's algorithm. Here, we don't need the original image for the detection. The equation used for watermark detection is similar to the one used in [14].

3 Experimental Results

We have performed encoding and decoding to test the image using DWT with Levels 2, 5, and 8 and with different α (scale factor used in watermark insertion). The tested image is Lena having 256x256 size (Figure 3)

Figure 3: Test Image

Watermarks are detected and compared. Noise and compression attacks have been added and images are analyzed. Three different tests have been performed as follows:

3.1 Basic watermark with encoding and decoding

Table 1 summarizes the results, Figure 4-9 shows watermarked images for level 5. As α is increased watermark will be robust.

#of levels				
5				
α	**Correlation**	**Threshold**	**Figure**	**Watermark detect**
0.01	0.2664	0.0564	4	Yes
0.1	1.3267	0.5654	5	Yes
0.15	1.8983	0.8493	6	Yes
0.2	2.4686	1.1333	7	Yes
0.5	5.8200	2.8641	8	Yes
1.0	10.9825	6.4640	9	Yes

Table 1: Correlation and threshold for level 5 with different α

Figure 4: watermarked image (level=5, alpha=0.01)

Figure 5: watermarked image (level=5, alpha=0.1)

Figure 6: watermarked image (level=5, alpha=0.15)

Figure 7: watermarked image (level=5, alpha=0.2)

Figure 8: watermarked image (level=5, alpha=0.5)

Figure 9: watermarked image (level=5, alpha=1.0)

Table2 summarizes the results for level 2 and Table 3 summarizes the results for level 8.

Figure 10 shows the relation between α and Correlation-Threshold for Tables 1, 2 and 3.

#of levels			
2			
α	**Correlation**	**Threshold**	**Watermark detect**
0.01	-0.0476	6.8627	No
0.1	0.6544	0.3868	Yes
0.15	1.0667	0.5802	Yes
0.2	1.4746	0.7729	Yes
0.5	3.8476	1.9434	Yes
1.0	7.6644	4.4502	Yes

Table 2: Correlation and threshold for level 2 with different α

#of levels			
8			
α	**Correlation**	**Threshold**	**Watermark detect**
0.01	-0.0506	0.0610	No
0.1	1.0707	0.6092	Yes
0.15	1.6754	0.9132	Yes
0.2	2.2810	1.2173	Yes
0.5	5.8625	3.0568	Yes
1.0	11.3763	6.8627	Yes

Table 3: Correlation and threshold for level 8 with different α

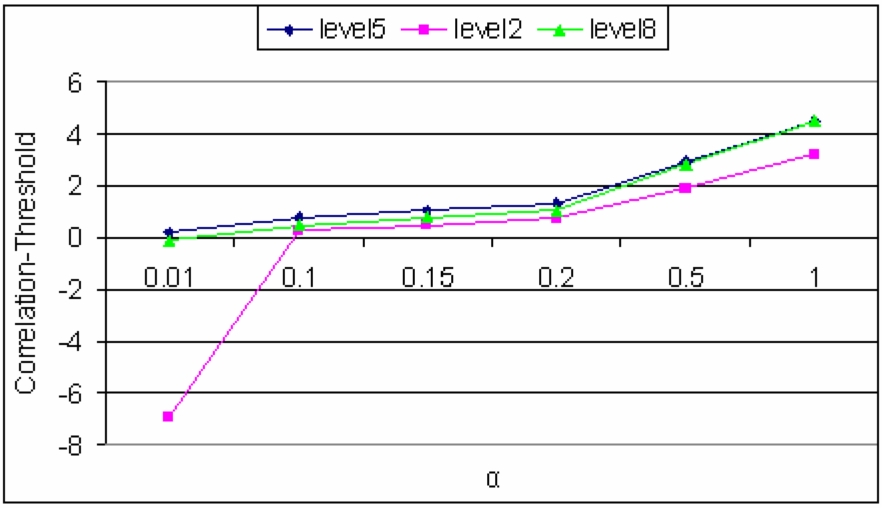

Figure 10: Relation between α and Correlation-Threshold

Above result confirm that level 5 and 8 can detect watermark for all α, level 2 does not detect for α=0.01. Also level 5 results are more robust than level 8 or level 2.

3.2 Noise attacks

All noise attack tests were performed with α=0.1 for Levels 5, 2 and 8 and with different mean and variance.

Figure 11 and Figure 12 show the relation between mean and Correlation-Threshold with variance=0.001 and variance=0.005 respectively. Both Figures confirm that level 5 is the robust.

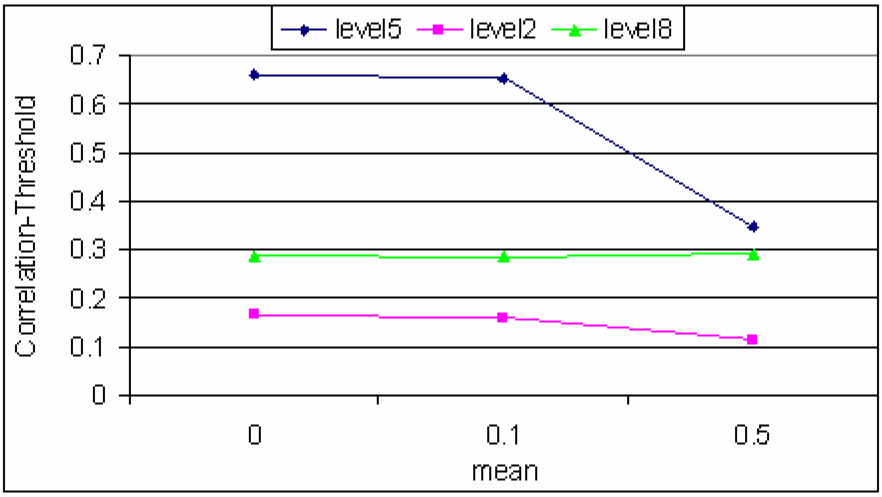

Figure 11: Relation between mean and Correlation-Threshold with variance=0.001

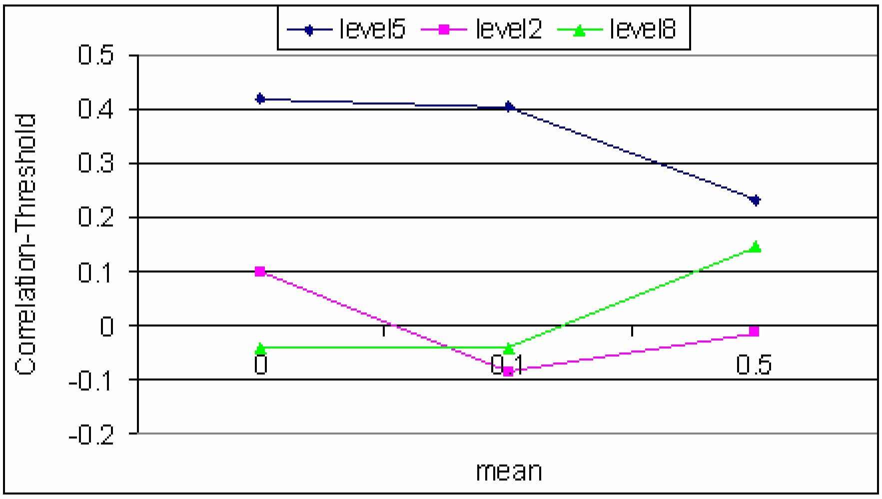

Figure 12: Relation between mean and Correlation-Threshold with variance=0.005

3.3 Compression Attack

Figure 13 shows the relation between compression and Correlation-Threshold for the Levels 5, 2 and 8 and α=0.1. Again level 5 are the robust.

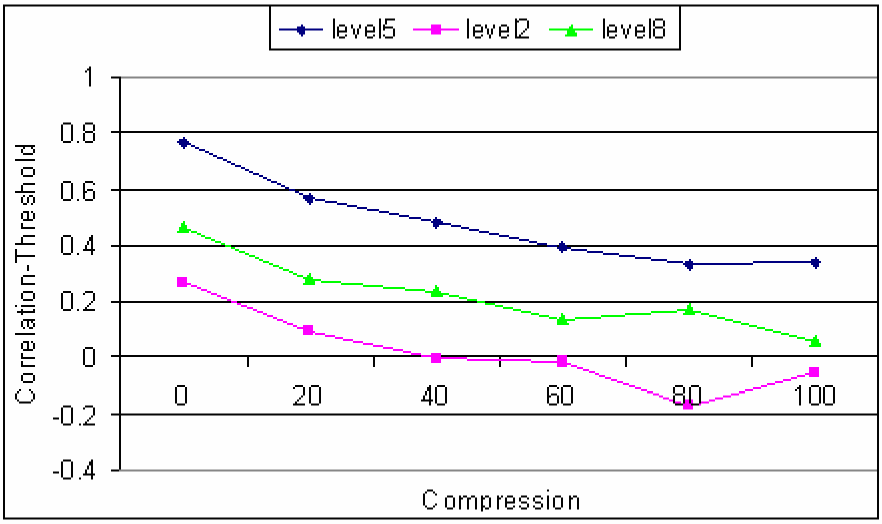

Figure 13: Relation between compression and Correlation-Threshold

4 Conclusion

The robustness of the proposed algorithm was examined against JPEG compression and additive noise. Results show that this algorithm is robust against image distortions for the proper selection of DWT Level and the watermark insertion scale factor. DWT Level 5 gave the best results when compared to Levels 8 and 2. From above results, we can summarize best parameters using Level 5 and watermark insertion scale factor of 0.1.

Parameter	Value
Correlation-Threshold	0.7613
Mean	0 - 0.1
Variance	0.001
Compression	0 - 20%

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