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Robustness of Correlation Based Watermarking Techniques Using WGN against Different Order Statistics Filters

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***Abstract*— Digital Watermarking embeds identifying information in an image, which is not always hidden, in such a manner that it cannot easily be removed. This is used to identify the owner of the work, to authenticate the content, to trace illegal copies of the work. So many digital image watermarking techniques have been implemented to stop the illegal used of digital content. This correlation based watermarking techniques use for generation of visible watermarked image. In this paper, check robustness of correlation based detection watermarking schemes using White Gaussian Noise (WGN) against different Order Statistics Filters Attack in Spatial Domain. The robustness of the Watermarked images has been verified on the parameters of PSNR (Peak Signal to Noise Ratio), NCC (Normalized Cross Correlation) and NAE (Normalized Absolute Error).**

***Index Terms*— Correlation Based Watermarking Techniques, Digital Watermark, WGN, Spatial Domain and Order-Statistics Filters**

I. Introduction

With the continued rise of sharing over the internet, it is getting increasingly more difficult to prevent copyright infringement of digital media. Multimedia data such as photos, video or audio clips, printed documents can carry hidden information of may have been manipulated so that one is not sure of the exact data. To deal with the problem of ownership of data, authentication techniques are being developed to verify the information integrity, the alleged source of data, and the reality of data [1, 2].

Digital watermarking involves embedding a structure in a host signal to "mark" its ownership [5]. There are many different types of digital watermarking, with different goals, and many schemes to accomplish those types of watermarking. Digital watermarking is the process of embedding information into an image that can identify where the image came from or who has rights to it. In order to protect ownership or copyright of digital media data, such as image, video and audio, encryption and watermarking techniques are generally used. Encryption techniques can be used to protect digital data during the transmission from sender to the receiver. Watermarking technique is one of the solutions for the copyright protection broadcast monitoring, data authentication, indexing, medical safety and data hiding [3, 4].

II. Watermark Embedding And Extraction Using White Gaussian Noise

Consider watermark image $s(x,y)$ as the information bearing data signal and White Gaussian Noise signal $G(x,y)$ as the spreading signal. The desired modulation is achieved by applying both the watermark image and the white Gaussian Noise sequence to a product modulator. The resultant signal $W(x,y)$ is a white Gaussian noise pattern that is added to the cover image $I(x,y)$ to produce the resultant watermarked image$I_w(x,y)$. A White Gaussian Noise (WGN) signal after correlated with watermark mask $M(x,y)$ is added to the cover image $I(x,y)$ according to the equation show below [7, 8]:

$$\boldsymbol{I_w(x,y) = I(x,y) + N * M(x,y)}$$

In equation, N denoted a power of noise in dBW and $I_w(x,y)$ the resulting watermarked image. The figure 1 and 2 shows watermark embedding and extraction process using White Gaussian Noise Pattern [6, 9].

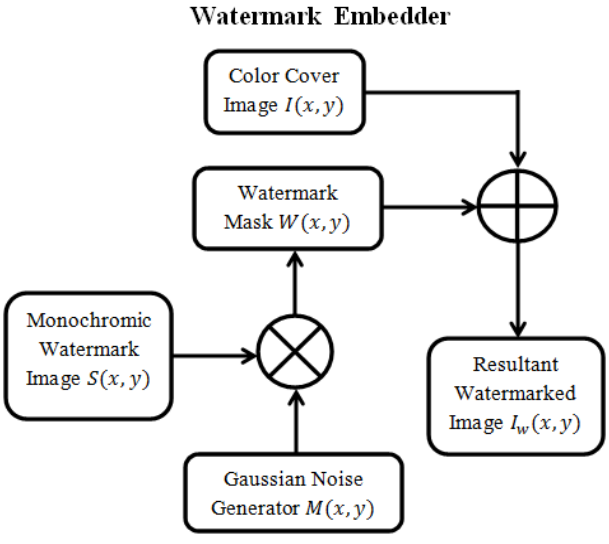


Fig.1. Watermark Embedding Process Using WGN Pattern

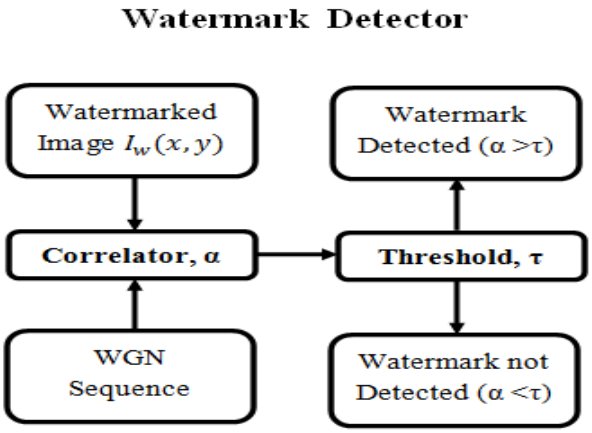


Fig. 2. Watermark Extraction Process Using WGN Pattern

III. Correlation Based Watermarking Techniques

Two different watermarking techniques in spatial domain have been chosen for the experiment. The techniques used for the comparative analysis of watermarking process are Threshold Based Correlation and Comparison Based Correlation method using White Gaussian Noise Sequence in spatial domain [8, 11].

A. Threshold Based Correlation Technique [1]

The algorithm of the above method is given below:

1). Procedure to embed watermark into the cover image:

- Set noise value for hiding message image.
- Read and determine the size of cover image.
- Read and determine the size of message image. Reshape message image into a pixel value vector.
- A White Gaussian Noise signal is generated using WGN function in Matlab using power of noise value [12].
- If message bit contains zero, add WGN Signal that portion of cover image, otherwise mask is filled with noise value. Create the watermark mask for all the size of cover image.
- Add watermark mask to cover image using noise factor value [6].

$$\boldsymbol{I_w(x,y) = I(x,y) + N * W(x,y)}$$

Where,
$\boldsymbol{I_w(x,y)}$= watermarked image, $\boldsymbol{I(x,y)}$=cover image, $\boldsymbol{N}$=SNR value, $\boldsymbol{W(x,y)}$=watermark mask

- Write the watermarked image and display the watermarked image.

2). Procedure to Recover Watermark from the Watermarked Image:

- Set noise value for recovering message image.
- Read and determine the size of watermarked image.
- Determine maximum possible message size in object.
- Read and determine the size of original watermark.
- A White Gaussian Noise signal is generated using WGN function in Matlab using power of noise values for each block; determine its correlation with base White Gaussian Noise sequence [12].
- Set correlation to 1 when patterns are identical; otherwise calculate the correlation.
- If correlation exceeds average correlation, when set message vector is zero.
- Reshape the watermark and display the recovered message image.

B. Comparison Based Correlation Technique [1]

The algorithm of the above method is given below:

1). Procedure to embed watermark into the cover image:

- Set noise value for hiding watermark image.
- Read and determine the size of cover image.
- Determine maximum watermark pixel hide based on cover image and block size.
- Read and determine the size of watermark image. Reshape watermark image into a pixel value vector.
- A two different White Gaussian Noise Signal is generated using WGN function in Matlab using Power of noise values. One for bit 1 and one for bit 0. Find tow highly un-correlation Noise signal using correlation between Noise signal on e and Noise signal zero [12].
- Now, create the watermark mask using WGN sequence and cover image.
  1. If message bit contains zero, add WGN sequence zero at that portion of watermark mask.
  2. Otherwise mask is filled with WGN sequence one; process for all the block of cover image.
- Add watermark mask to cover image using noise factor value [6].

$$\boldsymbol{I_w(x,y) = I(x,y) + N * W(x,y)}$$

Where,
$\boldsymbol{I_w(x,y)}$= watermarked image, $\boldsymbol{I(x,y)}$=cover image, $\boldsymbol{N}$=SNR value, $\boldsymbol{W(x,y)}$=watermark mask

- Write the watermarked image and display the watermarked image.

2). Procedure to Recover Watermark from the Watermarked Image:

- Set noise value for recovering message image.
- Read and determine the size of watermarked image.
- Determine maximum possible message size in object.

- Read and determine the size of original watermark.
- A two different White Gaussian Noise Signal are generated using WGN function in Matlab using Power of noise values. One for bit 1 and one for bit 0. Find two highly un-correlation noise signal using correlation between noise signal one and noise signal zero [12].
- Choose which ever correlation is higher

If correlation_one (kk)>correlation_zero (kk)

Watermark_vector (kk) =1;

Else

Watermark_vector (kk) =0;

- Process for all block of watermarked image.
- Reshape the watermark and display the recovered watermark image.

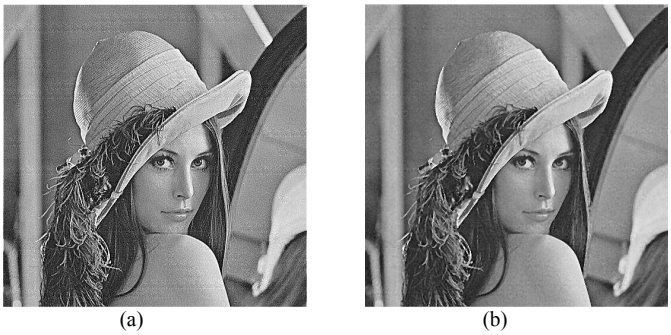
IV. Order Statistics Filters Attack

Order statistics filters are non-linear spatial filter whose response is based on ordering the pixels contained in the image area encompassed by the filter and the value of the centre pixel with the value determined by the ranking result [10]. Different size of order statistics filters like Median, Max and Min, Midpoint and Alpha-trimmed median are applied on original watermarked image. Three different size of filter are applied on original watermarked image. These filters attack are one common signal processing attack on watermarked content.

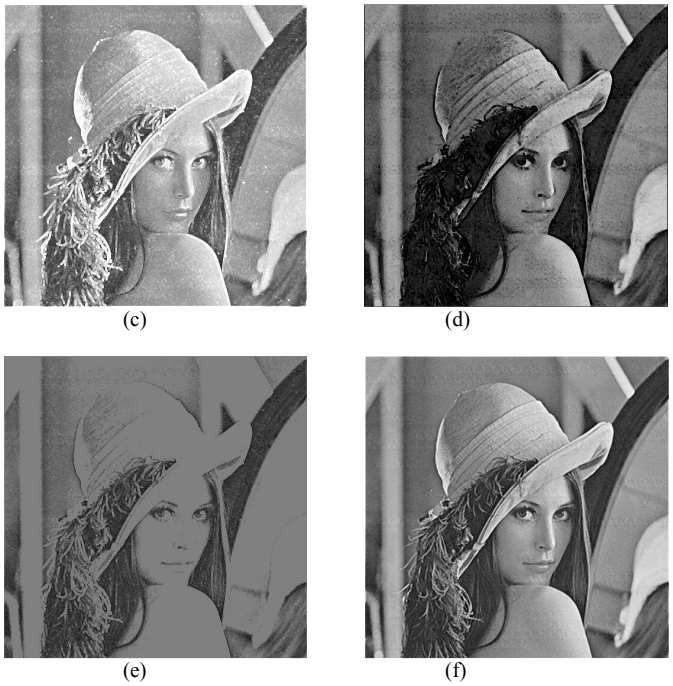
V. Experimental Results

The comparative analysis of the two watermarking schemes has been done on different order statistics filters attack. Results of the individual watermarking technique have been compared on the basis of PSNR (Peak Signal to Noise Ratio), NCC (Normalized Cross Correlation) and NAE (Normalized Absolute Error).

The different order statistics filter attack on Threshold Based Watermarked Image has been shown in Fig. 3. Table 1 shows the results of filters attack on threshold watermarked image on various parameters like Peak Signal to Noise Ratio, Normalized Cross Correlation and Normalized Absolute Error.



(a) (b)



(c) (d) (e) (f)

Fig. 3. Filters Attack on Threshold Based Watermarking Techniques using WGN: (a) Original watermarked image (b) Watermarked image after median filter (c) Watermarked image after max filter (d) Watermarked image after min filter (e) Watermarked image after midpoint filter (f) Watermarked image after alpha-trimmed mean filter

TABLE I
PERFORMANCE ANALYSIS OF THRESHOLD BASED DETECTION TECHNIQUE AGAINST DIFFERENT ORDER STATISTICS FILTERS

Filter	Size	PSNR (dB)	NCC	NAE
Median	3×3	67.66	0.88	0.11
	5×5	66.20	0.83	0.13
	7×7	65.70	0.81	0.14
Max	3×3	62.34	0.74	0.26
	5×5	59.88	0.59	0.37
	7×7	58.65	0.49	0.44
Min	3×3	61.68	0.70	0.25
	5×5	60.01	0.62	0.34
	7×7	59.12	0.58	0.40
Midpoint	3×3	63.23	0.73	0.24
	5×5	62.78	0.66	0.26
	7×7	62.55	0.61	027
Alpha-Trimmed Mean	3×3	53.45	0.91	0.99
	5×5	53.45	0.91	0.99
	7×7	53.45	0.91	0.99

The different order statistics filter attack on Comparison Based Watermarked Image has been shown in Fig. 4. Table 2 shows the results of filters attack on threshold watermarked image on various parameters like Peak Signal to Noise Ratio, Normalized Cross Correlation and Normalized Absolute Error.

Fig. 4. Filters Attack on Comparison Based Watermarking Techniques using WGN (a) Original watermarked image (b) Watermarked image after median filter (c) Watermarked image after max filter (d) Watermarked image after min filter (e) Watermarked image after midpoint filter (f) Watermarked image after alpha-trimmed mean filter

TABLE II
PERFORMANCE ANALYSIS OF THRESHOLD BASED DETECTION TECHNIQUE AGAINST DIFFERENT ORDER STATISTICS FILTERS

Filter	Size	PSNR (dB)	NCC	NAE
Median	3×3	66.03	0.84	0.16
	5×5	65.51	0.80	0.15
	7×7	64.87	0.76	0.15
Max	3×3	58.76	0.77	0.53
	5×5	56.69	0.65	0.68
	7×7	56.70	0.59	0.67
Min	3×3	56.25	0.59	0.70
	5×5	55.82	0.65	0.76
	7×7	56.03	0.63	0.74
Midpoint	3×3	62.66	0.65	0.28
	5×5	62.68	0.68	0.27
	7×7	62.27	0.59	0.28
Alpha-Trimmed Mean	3×3	53.45	0.88	0.99
	5×5	53.45	0.84	0.99
	7×7	53.45	0.81	0.99

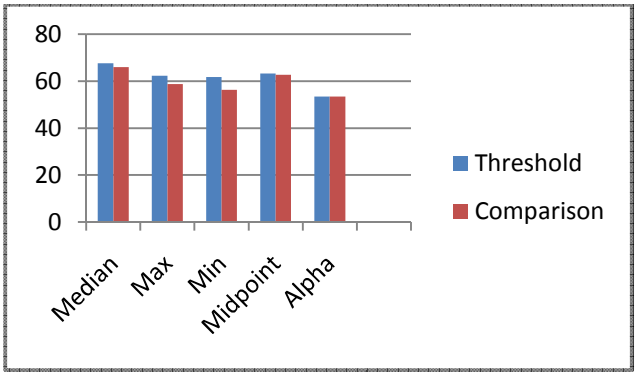


Fig. 5. Graph showing PSNR values for filters attack on different watermarking schemes

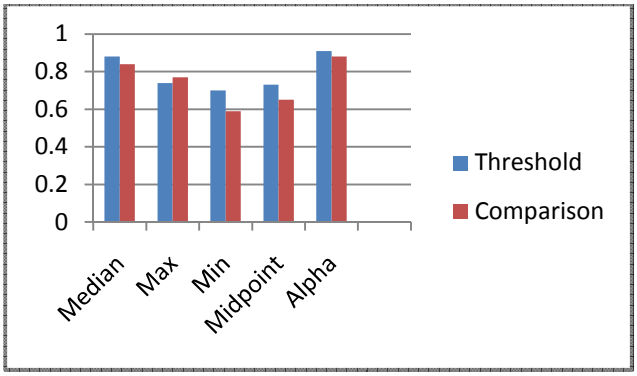


Fig. 6. Graph showing NCC values for filters attack on different watermarking schemes

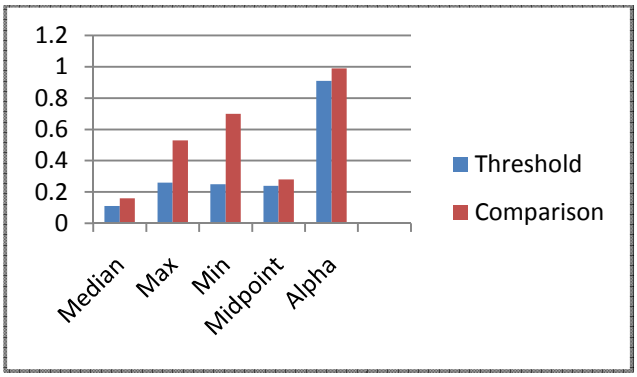


Fig. 7. Graph showing NAE values for filters attack on different watermarking schemes

The Fig. 5, 6 and 7 show the results of filters attack on two techniques of watermarking using WGN. A comparative analysis is done thereafter. Greater the PSNR value implies more robust is the watermarking technique against attack. Having a look on the Fig. 5 the Threshold Based watermarking technique is proved to be the best candidate for the digital image watermarking, since its having greater PSNR value that other technique.

VI. CONCLUSION

This paper focuses on the robustness of the correlation based watermarking techniques using White Gaussian Noise against different order statistics filters. The key conclusion of the paper is that the threshold based watermarking technique using White Gaussian Noise is the best and most robust scheme for generation of visible watermarking of digital multimedia images. This work could further be extended to the watermarking purpose of content like audio and video.

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