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Comparative Analysis of Spatial Watermarking Method with & without estimator approach

Neha Y. Joshi[1], Kavindra R. Jain[2]

Assistant Professor, Dept. of ECE, GCET, V.V.Nagar, Gujarat, India[1]

Assistant Professor, Dept. of ECE, GCET, V.V.Nagar, Gujarat, India[2]

Abstract: In this paper we propose a watermarking method in which Estimator based approach is used. Due to this approach simple spatial method could resist different noise attacks. For the evaluation of Imperceptibility & Robustness of the proposed method we have calculated different quality measure parameters. We have tested watermarked image against different noise attacks at different noise densities. Due to the use of estimator & the parameter so calculated gives the measure of perceptible quality of embedded & extracted images.

Keywords: Spatial digital watermarking, LSB Method, quality attribute, noise densities, Estimator, Correlation Coefficient, PSNR

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I. INTRODUCTION

The rapid growth of technology and innovative techniques have made the availability of digital information in the form of audio, video & images quiet easily and immensely in reach to public via web. Hence the chances of data manipulation increases and the data authenticity becomes a big question. Watermarking schemes so available is a smart solution for the same. The main concern in such techniques is the robustness & imperceptibility.

Information hiding is an age old technique. Data hiding, stenography & digital watermarking are sub discipline of information hiding [1]. Nowadays technologies are changing so to use digital watermarking instead of the age old techniques for hiding information & protecting multimedia data has become the greatest area of interest.

The watermarking can be applied to the multimedia data like Images, text, audio & video. Watermarking technique mainly contains two processes embedding & extracting for that different types of watermark & various watermarking techniques are available. According to the properties of watermark it can be divided into two main categories visible & invisible watermark [2]. Human audio & video system means Human visual perception decides the properties of watermark. Watermarking technique can also be classified based on the extraction process. According to it, we can divide it into three types Blind, Semi-Blind & Non-Blind. Techniques which do not require the original data or signal fall into the first category which is blind. Techniques which require the original watermark are considered as a Semi-Blind watermarking & techniques which require the original signal for extraction process is the Non-Blind technique. Based on domain, watermarking can be classified as Spatial & Frequency watermarking. One cannot directly embed watermark image in the cover image in frequency domain watermarking, for that first need to convert original signal & watermark into frequency domain using different transforms while in spatial domain one can directly apply watermark by changing pixel values or by using spread spectrum approach [3].

To achieve data protection the watermarking technique should be imperceptible with high level of security i.e. watermarked image should not reveal any things about hiding information. The basic way to check or measure imperceptibility of any technique is to calculate different quality attributes. The whole paper has been divided into V sections. Section II comprises of problem defination & solution for the same to extract the digital watermarked image. In section III (A) the various Estimator to make the method robust against noisy attack. We being discussed in Section III (B) the quality attributes to be evaluated for extracting the original watermark image. Section IV proposes various quality attributes being measured on various images & Result of applied approach. In our last section we conclude our paper by enhancing the result of spatial method against noise attack using estimator technique.

II. PROBLEM DEFINITION

As seen watermarking technique has emerged as a solution to the problem of copying the digital content. Recently so many watermarking schemes have been developed in the image domain. There are different ways to watermark image like spatial domain & using different transform in frequency domain [4].

The basic problem of Spatial domain method is that it could not resist the simple noisy attack. The biggest advantage of this method is that the embedding & extracting process is simple & another one is that we can achieve high level of imperceptibility which we cannot achieve in wavelet domain. So as a solution purpose if we add one step after extraction process which is the estimator then we could get the better result at the output side. So for that in our approach we have applied M-estimator to remove the effect of different noises at the extraction part.
The basic flow of our algorithm has shown in below figure1, in which we have shown the basic method of watermarking & after that the block shown is based on estimator method.

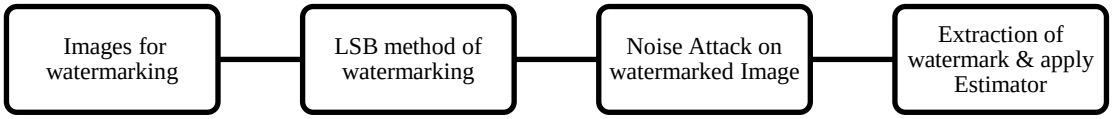


Figure 1. Proposed approach

Basically estimator estimates the data & fit a line which effectively rejects the outlier & makes the system robust against outlier. In our case the outlier is noise so that if we apply estimator after extraction process then it estimates the noise pixels & effectively rejects it. As a result the perceptual quality of watermark becomes better. After applying estimator we have evaluated our scheme using different quality attributes. We have also compared these results with the result of simple spatial embedding method.

III. MATERIALS & METHODS

In our proposed algorithm, hiding of watermark in cover image has been done using spatial domain with & without estimator. For that we have chosen different grey scale images which are shown below:

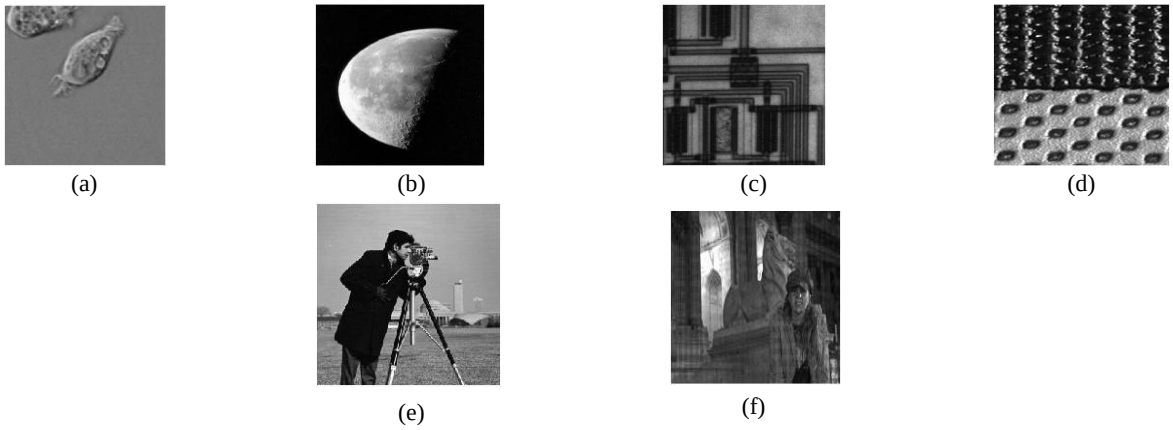


Figure 2. (a) Cell (used as a Watermark Image) and
(b) Moon, (c) Circuit, (d) Bag, (e) Cameraman, (f) Mandi ((b),(c),(d),(e) used as a Cover Image)

IV. ESTIMATOR

Estimator basically works as a filter but the advantage of estimator is that it gives filtering result with preservation of fine detail. Normally, the available denoizing filter blurs the image after filtering. From the available estimators we have used M estimator. The robustness of any estimator depends on two parameters: Influence Function & Breakdown Point [5]. Influence Function gives the change in an estimate caused by insertion of outlying data and Breakdown Point is the largest percentage of outlier data points that will not cause a deviation in the solution. So the robustness of any estimator depends on these two parameters. The outlier in our case is noise attack. M estimator effectively rejects the outlier so that we can use it to remove from the extracted watermark without knowing the noise density. The Robustness of any estimator is defined by the above explained two parameters. We have applied M estimator on the extracted watermark & the given result shows the same.

V. QUALITY ATTRIBUTES

To measure the imperceptibility & robustness of any watermarking technique PSNR & MSE are the two major parameters.

MSE: Mean Square Error & Root Mean Square Error is usually used to measure perceptual quality of image. It finds error between watermarked image and the one without watermark [6]. In below equation f(i ,j) signifies the original image and g(i, j) signifies the extracted image.

$$MSE = \frac{1}{M \times N} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} (f(i,j) - g(i,j))^2 \dots\dots (1)$$

PSNR: Peak Signal To Noise Ratio usually used to measure the imperceptibility of watermarking method. It gives the measure of invisibility of watermark in the original signal [6].

$$PSNR = 10 * \log_{10} \left(\frac{255 \times 255}{MSE} \right) \dots\dots\dots (2)$$

Correlation Coefficient: It gives the correlation between original watermark & extracted watermark.
This attributes are based on the objective criteria. So it is necessary to check same technique on different objects to measure the perfect range or value. Steps of the propose algorithm for the process of watermark embedding is mention in table1 & for extraction of the same is in table 2.In the extraction method we have applied estimator to reject the effect of Noise. We have here described the algorithm with Estimator approach.

TABLE I
WATERMARK EMBEDDING PROCESS

Sr. No.	Steps
1	Select one grey scale image as a host image.
2	Take one watermark image of same size.
3	Shift first three MSB of watermark to LSB by making MSB zero.
4	Set last three LSB of host image zero.
5	The Result is watermark embedded image.

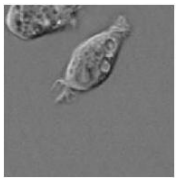
TABLE II
WATERMARK EXTRACTION PROCESS

Sr. No.	Steps
1	First take the watermarked image.
2	Apply different noise attack on watermarked image.
2	Take the shifted watermark and do anding operation with watermarked image.
3	Shift the bits in the result.
4	Resultant image is extracted watermark which one is embed previously.
5	Apply Estimator on extracted watermark image.

VI. RESULT & ANALYSIS

To check the fidelity of our approach we have applied the algorithm on four different greyscale images. In below figure we have shown the result of applied approach for one image.

TABLE IIII
COMPARISON OF EXTRACTED WATERMARK WITH & WITHOUT ESTIMATOR

 Cover Image	 Watermark Image	 Watermarked Image
 Salt & Pepper Noise(density 0.05) Attack on watermarked Image	 Extracted Watermark Without Estimator Approach	 Extracted Watermark Without Estimator Approach

After applying estimator we have compare the two results of applied approach by calculating different quality attributes. We have used three different noises for attack.
In below table 4, we have given the value of quality attributes which are evaluated with and without estimator approach on five different cover images ((b), (c), (d), (e), (f)). We have compared the result of LSB with Estimator approach & simple LSB method. In below table 4, three different noises are used A represents Salt & pepper noise, B for Gaussian noise & C for Speckle noise.

TABLE IIIV
COMPARISON OF QUALITY MEASURES FOR DIFFERENT EXTRACTED WATERMARK IMAGES

Test Images		**Moon**		**circuit**		**bag**		**cameraman**		**mandi**	
Method		LSB With Estimator	LSB	LSB With Estimator	LSB	LSB With Estimator	LSB	LSB With Estimator	LSB	LSB With Estimator	LSB
MSE	**A**	757.3355	1.08e +003	777.5703	1.11e +003	772.3623	1.12e +003	752.3472	1.0877e+ 003	879.3409	1.09e +003
PSNR		38.6758	35.42	38.44	35.44	38.5052	35.24	38.73	35.5314	37.37	35.44
Correlation Coefficient		0.9880	0.966 7	0.9870	0.966 9	0.9874	0.965 6	0.9845	0.9667	0.9829	0.966 8
MSE	**B**	4.8834e+0 03	8.57e +03	1.88e+003	6.94e +003	2.6357e+0 03	7.14e +003	1.50e+003	6.64e+00 3	2.22e+003	6.93e +003
PSNR		22.48	17.60	30.75	19.42	27.8436	19.17 68	32.6969	19.8162	29.3090	19.44
Correlation Coefficient		0.8133	0.684 8	0.9313	0.764 9	0.9028	0.764 6	0.9457	0.7937	0.9191	0.770 6
MSE	**C**	2.31e+003	1.06e +03	1.28e+003	5.21e +003	1.13e+003	4.72e +03	1.25e+003	4.82e+00 3	1.4303e+0 03	5.58e +003
PSNR		28.9616	36.20	34.0880	21.92	35.13	22.76	34.26	22.59	33.15	21.31
Correlation Coefficient		0.9148	0.968 4	0.9543	0.836 8	0.9592	0.848 8	0.9548	0.8464	0.9484	0.832 5

VIII. CONCLUSION

From the above results we conclude that by adding the estimator step at the extraction part gives better results compare to without estimator. From the given result we can observe that MSE decreases and PSNR increases. The value of correlation coefficient shows the correlation between extracted images with M estimator is higher compare to simple LSB method. The disadvantage of estimator is that if the noise density is less then it does not give effectively good result. So, we could suggest to apply estimator after extraction process. The value of MSE & correlation coefficient shows that perceptibility of watermark increases though the watermarked image contains high density noise.

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BIOGRAPHY

Neha Joshi Graduated in Electronics & Telecommunication Engineering from the Government Engineering College, Bharuch, South Gujarat University (Surat), Gujarat, India in 2010. She is pursing her Master's in Communication Engineering from G H Patel College of Engineering and Technology, V.V.Nagar, Gujarat technological University(GTU) & also working in G H Patel College of Engineering and Technology(GCET), Vallabh Vidyanagar,Gujarat, India since 2011.

Mr. Kavindra R. Jain Graduated in Electronics & Instrumentation Engineering from the GTBKIET, Malout, Punjab India in 2006. He has done his Master's in Communication Engineering from G H Patel College of Engineering and Technology, V.V.Nagar, Sardar Patel University(SPU) in 2009. He is working as a Assistant Professor in G H Patel College of Engineering and Technology(GCET), Vallabh Vidyanagar,Gujarat, India since 2006. He has published several National & International Conference Papers as well as international Journal paper based on Machine Vision and Image processing.