# Analysis of Multiple Users Watermarking in Spatial Domain

# Rohit M. Thanki, Rahul K. Kher, Divyang D. Vyas

Abstract— An image authentication technique by embedding digital "watermarks" into cover image is proposed. Digital watermarking is the process of inserting a digital signal of a defined pattern into digital data. This is used identify the owner of the work, to authenticate the content, to trace illegal copies of the work and other similar purposes. This paper provides a study of multiple users watermarking schemes in spatial domain where different user are embed different watermark or message into one cover image which provides using one watermarked image, we transmit more information in secure manner to reception side. The implement provides good knowledge about basic digital right management system. The analyses of different stage watermarked image have been done by parameters like PSNR (Peak Signal to Noise Ratio), NAE (Normalized Absolute Error) and MSE (Mean Square Error).

Index Terms— Digital Watermark, Multiple User, Noisy Image and Spread Spectrum Watermarking

## I. INTRODUCTION

THE inherent flexibility of internet facilitates uses to transact with one another to create, distribute, store, peruse, subscribe, enhance, modify and trade digital content in various forms like text documents, databases, ebooks, still images, audio, video, computer software and games. While the technology for information has changed much with the advent of the digital age, the need for concealing information is as present today as it has ever been. In recent years, much attention has been paid to watermarking applications using digital images. Although digital watermarking is still a young filed, a variety of techniques have been developed to implement the hiding of information within digital images [2, 3].

Digital watermarking is a relatively new research area that has attracted the interest of numerous researches both in academia and industry and has become one of the hottest research topics in the multimedia signal processing community. The definition of watermarking is that the practice of imperceptibly altering a piece of data in order to embed

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information about the data. The above definition having two important characteristics of watermarking; first, information embedding should not change to the host medium (sometimes called cover medium or cover data. Second, the message should be related to the host media.

# II. MULTIPLE USERS WATERMARKING

This method of watermarking can become a foundation for the design of a Digital Right Management. We can consider multiple used watermarks overlaid one over the other so that clarity of the image seen by the end used depends on the digital rights of a person [1, 8, 11].

In this method, initially we consider the original image as watermarked image, and then it is noisified using first watermark. This noisified image is first watermarked image and then add second user watermark image into first watermarked image. This process continues as layered watermarking for N number of users watermarked image [5]. Fig. 1 show how multiple watermarks or messages embed in to one cover image.



Fig. 1. Multiple Users Watermark Embedding

Consider multiple users watermarking with different watermarked with three different watermark images like  $W_1(x,y)$ ,  $W_2(x,y)$  and  $W_3(x,y)$ . Let the PN Sequences be  $P_1(x,y)$ ,  $P_2(x,y)$  and  $P_3(x,y)$ . Assume that if a user 1 has partial rights, he can only added one of the watermark into original images and this process will be continues take place up to N users [5,6]. The key for adding the noise is dependent on the watermark ifself,  $2^{nd}$  watermark or noise is added to the watermarked image as using below mathematical expression [6]:

$$I_{w2}(x, y) = N_2 \times W_2(x, y) + I_w(x, y)$$
  

$$I_w(x, y) = N_1 \times W_1(x, y) + I(x, y)$$
  

$$I_w(x, y) = N_1 \times i_1(x, y) \times P_1(x, y) + I(x, y)$$

Where,  $i_1(x,y) =$  Embedded 1<sup>st</sup> watermark image

 $\begin{array}{l} P_1(x,y) = \text{Spreading Signal} \\ W_1(x,y) = 1^{\text{st}} \text{ Watermark Mask} \\ W_2(x,y) = 2^{\text{nd}} \text{ Watermark Mask} \\ I_w(x,y) = \text{Watermarked Image} \\ I_{w2}(x,y) = \text{The image after } 2^{\text{nd}} \text{ watermark image is} \\ \text{embeds in to the } 1^{\text{st}} \text{ watermarked image} \\ N_1, N_2 = \text{Noise Values} \end{array}$ 

The image which is getting after all N users watermark will be embed and called as  $N^{th}$  user watermarked image, noisified by N watermarks is sent to the end user. Now, depending upon the rights of the user, permissions are giving to remove the watermarks and noise induced based on them. Initially the top most, i.e. the last embedded watermark is removed can be mentioned as the reverse procedure of embedding the watermark as shown in Fig. 2.

The mathematical expression for watermark image retrieval from  $n^{th}$  watermarked image below where depending on the rights given to the users, the watermark can be removed as:

$$I_{ww2}(x, y) = I(x, y) - N_2 \times W_2(x, y)$$
  
$$I_{ww1}(x, y) = I(x, y) - N_1 \times W_1(x, y)$$



Fig. 2. Watermark Image retrieval for Nth Users Watermarked Image

The watermark which is embedded last is recovered first as it is on the top layer. Proceeding this way, the watermark embedded first is recovered last.

### III. EXPERIMENTAL RESULTS

As described multiple users watermarking, as the length the image is considering large the effect of the signal energy on the watermarking scheme is almost negligible. The three different watermarking techniques in spatial domain like Threshold Based Correlation Detection method, Comparison Based Correlation Detection method and Spread Spectrum watermarking method [4, 9, 10] are demonstrated for multiple users where many hide their own watermark as per their digital rights using these techniques [2, 7].

In this experiment, we have take Lena image having size of  $512 \times 512$  pixels and take two different watermarks one is symbol of circle and another is text image 1748 and show how two users embed their own watermark or message image into one common image and what effect taken place in HVS of watermarked image and comparison of all method based on their results like PSNR, NCC, NAE and MSE. This process extended up to N users [7].

Fig. 3 shows results of multiple users hide their watermark in one common cover image using threshold based detection method and table I shows results like PSNR, NCC, NAE and MSE for threshold based detection method.



1st User Watermarked Image



Recovered watermark 1



2<sup>nd</sup> User Watermarked Image

Fig. 3. Watermarked image and Retrieval watermark image for Threshold Based Detection Method

TABLE I Performance Analysis Of Threshold Based Detection Technique For Multi User Watermark Embedding

User	NCC	NAE	MSE	PSNR (dB)
1	0.98	0.03	91.27	76.66
2	0.98	0.02	77.41	77.37



1st User Watermarked Image



Recovered watermark 1



2<sup>nd</sup> User Watermarked Image



Recovered watermark 2

Fig. 4. Watermarked image and Retrieval watermark image for Comparison Based Detection Method

TABLE II PERFORMANCE ANALYSIS OF COMPARISON BASED DETECTION TECHNIQUE FOR MULTI USER WATERMARK EMBEDDING

User	NCC	NAE	MSE	PSNR (dB)
1	0.96	0.07	290.45	71.63
2	0.87	0.26	7238	57.67

Fig. 4 shows results of multiple users hide their watermark in one common cover image using comparison based detection method and table II shows results like PSNR, NCC, NAE and MSE for threshold based detection method.

Fig. 5 shows results of multiple users hide their watermark in one common cover image using comparison based detection method and table III shows results like PSNR, NCC, NAE and MSE for threshold based detection method.





1st User Watermarked Image



Recovered watermark 1

2<sup>nd</sup> User Watermarked Image



Recovered watermark 2

Fig. 5. Watermarked image and Retrieval watermark image for Spread Spectrum Watermarking Method

TABLE III PERFORMANCE ANALYSIS OF SPREAD SPECTRUM WATERMARKING TECHNIQUE FOR MULTI USER WATERMARK EMBEDDING

User	NCC	NAE	MSE	PSNR (dB)
1	0.55	0.40	3788.3	60.48
2	0.80	0.30	2400.9	62.46

### IV. CONCLUSION

The results show that threshold based detection method is best candidate for multiple user watermarking schemes in term of retrieval watermark image. The multiple user watermarking schemes is gives basic idea of digital rights management system where which users have rights to get watermark as per given key and size of watermark image given to users. This schemes also shows first input and last output phenomena for watermarking. This work could further be extended to the watermarking purpose of content like audio and video.

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