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BLOCK BASED ROBUST BLIND IMAGE WATERMARKING USING DWT, SVD AND TORUS AUTOMORPHISM

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Abstract

Digital watermarking is a technique used for hiding secretes information into digital image, audio or document. Watermark image involves two stages named embedding and extraction. Embedding of data in image is more robust in frequency domain than spatial domain. Frequency domain is more robust against signal and non-signal attacks. In frequency based extraction, watermark will be extracted in frequency domain which requires both original and watermarked cover image. In this paper, we proposed a blind image watermarking technique which embeds watermark into image in frequency domain using discrete wavelet transform, singular value decomposition and torus auto orphism techniques. Existing frequency based methods not only provides robustness against geometric attacks but also compatible to popular image processing standards

***Keywords**: Discrete Wavelet Transform(DWT), Singular Value Decomposition(SVD), Torus Automorphism, PSNR* **.**

I. INTRODUCTION

Just a decade ago, dependencies on Internet with capabilities and luxuries were unthinkable, but today our lifestyle has been influenced. This has greatly affected the usage of digital multimedia content such as image, audio, video etc. These contents are now easily available and accessible on the Internet. On the other hand, these contents have lead to misuse, piracy and forgery when fall into the wrong hands. Thus, there has been observed a need of authenticity for protecting these digital contents. Digital watermarking technology is proposed as one of the alternatives to deal with these concerns. Thus, continuous efforts for introducing new watermarking systems for gray-scale images are crucial as strong foundational development [1]. Watermarking is a technique for labeling digital pictures by hiding secret information in the images. The information to be embedded in signal is called as digital watermark. Digital watermarking is a process to provide authenticity by hiding a data into an image or audio or document. Digital image watermarking is the technology that has been developed to protect digital images from illegal manipulations. The signal where

watermark is to be embedded is called as host signal. Watermark system is usually divided into three steps: embedding, attack and detection. In embedding, algorithms accept the host and the data to be embedded and produces watermark signal. Then the watermarked signal is transmitted or stored, usually transmitted to other person. If this person makes a modification, is called an attack. Detection is an algorithm which is applied to the attacked signal to attempt to extract the watermark from it. In watermarking information can be embedded into the image which is going to be distributed over the media and extracted the embedded data whenever necessary to prove ownership. The embedding of information can be done in spatial domain or in frequency domain. The embedding of information is easier and less robust in spatial domain than frequency domain. In this paper we are using frequency domain for embedding the information in host image [1]. Watermark technique is classified into two methods i.e. blind and non-blind. In non-blind method, watermark extraction requires both original and watermarked

II. LITERATURE SURVEY

Over one thousand years earlier, although the art of paper marking was invented in China, paper watermarks did not appear until about 1282 in Italy. The marks were made by adding thin wire patterns to the paper molds. The paper would be slightly thinner where the wire was and hence more transparent. The meaning and purpose of earliest watermarking are uncertain. They may have been used for practical functions such as identifying the molds on which the sheets of paper were made, or as trademarks to identify the papermaker. On the other hand, they may have represented mystical signs, or might simply have served as decoration. By the 18th century, watermarks on paper made in Europe and America had become more clearly utilitarian. They were used as trademarks, to record the date the paper was manufactured, and to indicate the sizes of original sheet. It was also about this time that watermarks began to be used as ant counterfeiting measures on money and other documents. The term watermark seems to have been coined near the end of the 18th century and may have been derived from German term watermark.

Bors and I. Pitas developed a method based on DCT transform. In this method input image will be divided into blocks of size 8x8. DCT will be performed on this blocks. From this blocks few blocks are selected based on a Gaussian network classifier decision and accordingly DCT coefficients are modified in those blocks according to watermark[4]. Cox et al. developed DCT based watermarking algorithm. In this algorithm, the embedded watermark in DCT domain that uses human visual system properties. In this methods either all the coefficients or few coefficients of the image are used in watermarking. The amount of

embedded information is an important parameter because it influences the watermark transparency. If more the embedded information then lower the watermark transparency [5]. F Huang, Zhi Hong Guan developed a watermarking method which is based on a hybrid DCT and SVD, in which SVD transform and DCT are performed on the watermark and the original image respectively Only the singular values of the watermark are embedded into the DCT coefficients of original image. He developed this method in order to increase the transparency [6]. Kapre Bhagyashri S, Joshi M. Y. also used the DWT and SVD to watermark the host image, she embedded watermark in high frequency image, which was constructed from HH band of DWT of input image and then SVD was used to watermark[7].

III. ARCHITECTURE SPECIFICATION

Input given to the system is firstly converted into binary form.Using torus automorphism, resultant will be scrambled upto five times that helps in reducing burst errors. This resultant data is converted into bipolar form and rearranged as 1D signal and thus will be used as watermark to be embedded into the image on which the one level 2D DWT will be applied. LL band is selected as a host data and subdivided into 8*8 size blocks.SVD is then applied on each of these blocks resulting in a three matrices $U \times S \times V^T$. One watermark bit is embedded to individual block and inverse DWT will be performed. While extracting watermark,the extraction method does not need to have original cover image.Again the one level 2D DWT is computed on watermarked image and LL band is divided into 8_8 size blocks.Watermark is then extracted and results are rearranged in matrix form and torus automorphism is applied to get the original image[1][3].

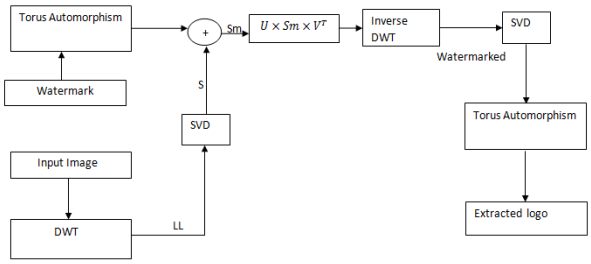

FIGURE 1: ARCHITECTURE DIAGRAM

IV. DISCRETE WAVELET TRANSFORM, SINGULAR VALUE DECOMPOSITION

A. DISCRETE WAVELET TRANSFORM

The process to transform the image into its transform domain varies and thus, the resulting coefficients are different. Wavelet transforms use wavelet filters to transform the image. Single level decomposition gives four frequency representations of the images. These four

representations are called the LL, LH, HL, HH sub-bands. DWT is very much suitable to identify the frequency regions of the image signal where watermark can be embedded effectively [1].

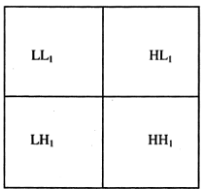

FIGURE 2: DWT

B. SINGULAR VALUE DECOMPOSITION

The singular value decomposition (SVD), a tool of linear algebra, is a factorization and approximation technique which effectively reduces matrix into a smaller invertible and square matrix. SVD can be performed on any real m×n matrix. It decomposes A into three matrices namely U, S and V such that

$$A = U \times S \times V^T$$

where,

U and V are orthogonal matrices .

S is a diagonal matrix.

Let S having p number of rows and q number of columns.

U is m × p, p_m, and V is n ×q with q _ n.

The diagonal entries of S are the positive square roots of the eigen values of AA^T and are called the singular values of A. The decomposition $A = U \times S \times V^T$ is called a singular value decomposition of A. It can be written as

A=s1u1vT1+s2u2vT2+.....+snunvTn

where, ui and vi are the ith columns of the matrices U and V respectively.

s1,s2,....sn the singular values of A[2].

C. TORUS AUTOMORPHISM

Automorphism is a spatial transformation of plane region. After some iteration torus automorphism produces same image. It is periodic in nature. The binary watermark is spatially dispersed using a chaotic system called torus automorphism. Then watermark will be inserted into SVD of each block of LL band of image. Torus automorphism avoids burst errors [1].

In this method, we insert each watermark bit into SVD of one block of LL band of host image, before inserting the watermark, the binary watermark is spatially dispersed using torus automorphism.

Figure 4(a): IMAGE to be watermarked

FIGURE 4(B): AFTER TORUS AUTOMORPHISM

V. EMBEDDING AND EXTRACTION PROCESS

A. EMBEDDING PROCESS

A pseudorandom set of pixels is selected and the least significant bits of their intensity levels are modified in such way that to form a statistical property which describes only a specific set of pixels. This method is very fast and reliable.

We embed one watermark bit to one individual block in SVD domain. So that this bit distributes over 64 pixels, even though we loss some data, we will be able to extract that bit. The embedded equations is given below.

$$[U\ S\ V] = = SVD(I_{block})$$

$$S(2, 2) = \alpha 1 * S(3, 3) + \alpha\ 2 * wmbit$$

$$I_{wmblock} = U * Sm * V^{T}$$

where $\alpha 1$ and $\alpha\ 2$ are scaling factors.

Increase in scaling factor results in a decrease in PSNR and the watermark extraction is robust [1].

B. EXTRACTION PROCESS

Watermark extraction method is a blind that means

it does not require original cover image while extracting watermark. Watermark is extracted based on below equation and compared against threshold value to assess whether the final result is zero or one[1]. This result is re-arranged

as matrix and then torus auto orphism will be performed to

extract original logo. Following equations are used for watermark extraction

$$[Um\ Sm\ Vm] = S\ V\ D\ (Iwmblock)$$

$$wmbit = \begin{cases} 0, & Sm(3,3)*\alpha 1 > Sm(2,2) \\ 1, & \text{else} \end{cases}$$

VI. CONCLUSION

The work in this project, primarily focus on to provide good tradeoff between perceptual quality of the watermarked image and its robustness to different attacks. For this purpose, we have discussed digital watermarking algorithms in discrete wavelet domain (DWT), in which the altered region of the image can be detected correctly. The algorithm in this paper has good invisibility and can be used to authenticate the content of image. Thus, the method used in this paper is robust against different kinds of geometric and signal processing attacks. Furthermore, same embedding method can be applied to all sub bands of the host image in DWT domain to make this technique more robust against different filtering attacks.

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