INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Image Hiding Technique Using Wavelet

Dr. S. J. Basha
Professor, ETC Department, RIT, Shiroda, Goa, India

Abstract:
Image to Image hiding technology is called Watermarking. It is a technique in which another image is embeds inside an image to show authenticity or proof of ownership. Various watermarking techniques are there which use Wavelets in the decomposition and embedding of watermark in image with various methods like chaotic systems to increase security as proposed in this paper.

Keywords: *Watermarking image, watermark embedding, watermark extraction, DWT, Arnold key, Chaos*

1. Introduction

Digital Image Watermarking is a technique which provide solution for Copyright, image authentication and other issues Watermarking deals with decomposing original image called Cover image using some wavelet Transforms[2] and embedding watermark into one of the sub band (LL,LH,HL,HH) the obtained image is called watermarked image (Stego Image) this image have transmitted through Channel Where various noise Affect watermarked Image [1][2].At receivers Side embedded watermark has extracted from watermarked image[2].For watermark embedding Discrete Wavelet Transform(DWT) has used, DWT is a Wavelet Transform which use Dyadic Filters to decompose M×N Image in to N-Levels, we can embed watermark into one of the sub band, For Extraction of Watermark Inverse Discrete Wavelet Transform (IDWT) is used[2] Analysis of Image has based on Performance Parameters like Signal to Noise Ratio (SNR) of original & watermarked Image Peak signal to Noise ratio(PSNR) & WPSNR are some other factors to analyze Performance. Various Image compression techniques has described in. Biorthogonal wavelet has used to analyze watermarking .Various attacks on watermarked image like Gaussian Noise attack, salt& pepper attack, JPEG Compression, speckle attack etc.

2. Discrete Wavelet Transform

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process. Wavelets are created by translations and dilations of a fixed function called mother wavelet. This section analyses suitability of DWT for image watermarking and gives advantages of using DWT as against other transforms. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four non-overlapping multi-resolution sub-bands LL_1, LH_1, HL_1 and HH_1. The sub-band LL_1 represents the coarse-scale DWT coefficients while the sub-bands LH_1, HL_1 and HH_1 represent the fine-scale of DWT coefficients. To obtain the next coarser scale of wavelet coefficients, the sub-band LL1 is further processed until some final scale N is reached. When N is reached we will have 3N+1 sub-bands consisting of the multi-resolution sub-bands LL_N and LH_x, HL_x and HH_x where x ranges from 1 until N. Due to its excellent spatio-frequency localization properties, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. In general most of the image energy is concentrated at the lower frequency sub-bands LL_x and therefore embedding watermarks in these sub-bands may degrade the image significantly. Embedding in the low frequency sub-bands, however, could increase robustness significantly. On the other hand, the high frequency sub-bands HH_x include the edges and textures of the image and the human eye is not generally sensitive to changes in such sub-bands. This allows the watermark to be embedded without being perceived by the human eye.

2.1. Characteristics of DWT

The wavelet transform decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal. Hence wavelets reflect the anisotropic properties of HVS more precisely. Fig. 1 shows DWT decomposition of an image using three level pyramids.

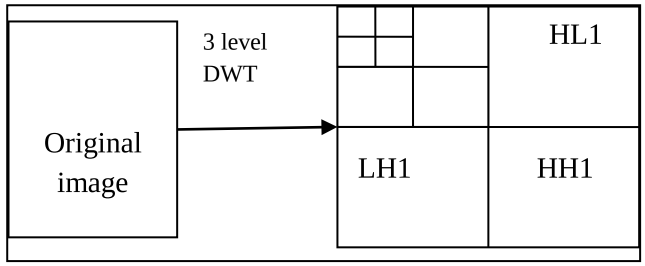

Figure 1: DWT Decomposition of Image Using 3-Level Pyramid

1. Wavelet Transform is computationally efficient and can be implemented by using simple filter convolution.
2. With multi-resolution analysis, image can be represented at more than one resolution level. Wavelets allow image to be described in terms of coarse overall shape and details ranging from broad to narrow.
3. Magnitude of DWT coefficients is larger in the lowest bands (LL) at each level of decomposition and is smaller for other bands (HH, LH, and HL).
4. The larger the magnitude of wavelet coefficient, the more significant it is.
5. Watermark detection at lower resolutions is computationally effective because at every successive resolution level, less no. of frequency bands are involved.
6. High resolution sub bands help to easily locate edge and textures patterns in an image.

2.2. Advantages of DWT

The suitability of wavelet transform for image watermarking can be considered because of following reasons.

1. Wavelet transform can accurately model HVS than other transforms like Discrete Fourier Transform (DFT) or Discrete Cosine Transform (DCT) [1]. This allows higher energy watermarks in regions where HVS is less sensitive. Embedding watermark in these regions allow us to increase robustness of watermark, with no much degradation of image quality.
2. Wavelet coded image is a multi-resolution description of image. Hence an image can be shown at different levels of resolution and can be sequentially processed from low resolution to high resolution. The advantage of such approach is that the features of an image that might go undetected at one resolution may be easy to spot at another.
3. Visual artifacts introduced by wavelet coded images are less evident compared to DCT because wavelet transform doesn't decompose image into blocks for processing. At high compression ratios, blocking artefacts are noticeable in DCT as against wavelet transformed images.
4. DFT and DCT are full frame transform. Hence, any change in the transform coefficients affects entire image except if DCT is implemented using a block based approach. However DWT has spatial frequency locality. It means it will affect the image locally, if watermark is embedded.
5. Another advantage is that current image compression standard JPEG 2000 is based on wavelet transform.

3. Chen's Chaotic System

Chaos is a dynamical system that relies heavily on its initial conditions that is random and unpredictable. Despite this unpredictability there is an underlying order to chaos are dependence on initial conditions, being a deterministic system, and a periodic behaviour. Determinism is the idea that everything is the result of initial characteristics. This means that ideally everything can be predicted due to their initial events and actions. The dependence on initial conditions is very important in chaos, because of the way they affect the outcome. It is a part of Arnold Transform or Arnold cat map. One of the amazing qualities of chaos is if the initial conditions are changed completely new result will be obtained. In the early 1960s, Edward Lorenz started looking for equations that could predict the weather [3]. After discovered the equations, he noticed that when you varied the initial conditions, x_0, y_0, and z_0, the weather patterns would change dramatically. Out of this interest came the Lorenz's equations, which make up the most common chaotic system and they are:

$$\begin{cases} \frac{dx}{dt} = \sigma(y - x) \\ \frac{dy}{dt} = rx - y - xz \\ \frac{dz}{dt} = xy - bz \end{cases}$$

Here σ, r, and b are parameters, where σ is the Prandtl number and r is the Rayleigh number, [3]. As well as being completely chaotic throughout the whole system some dynamical systems are chaotic within a certain subset of phase space; one way that this can happen is if a dynamical system is chaotic in a certain attractor. The image encryption will use Chen's chaotic system which was developed in 1999 by Professor G. Chen [3], and it is a three dimensional or third-order system. This dynamical system is made up of differential equations that are similar to Lorenz's system; it differs mostly due to the c in front of the y in the second equation. Chen's equations are shown below:

$$\begin{cases} \dfrac{dx}{dt} = a(y-x) \\ \dfrac{dy}{dt} = (c-a)x - xz + cy \\ \dfrac{dz}{dt} = xy - bz \end{cases}$$

4. Watermark Embedding Algorithm

The flow diagram of embedding process is shown in Fig. 2. The steps in the process of embedding are follows:

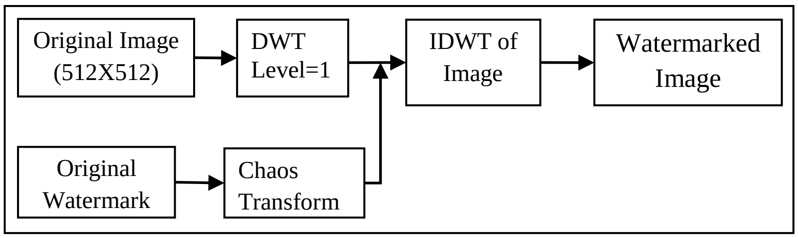

Figure 2: Watermark Embedding Algorithm

Take the original image and resize it to 512x512image. Make one-level wavelet decomposition of the original image and all frequency band as the embedded domain. The wavelet coefficient of all bands are singular value decomposed by block size of Take the Arnold transform of the watermark and resize it to 64X64 bit binary image. After the Arnold transformation, apply Arnold transformed watermark original image. Perform the embedding of the watermark in the original image the obtained image will be watermarked image. Take inverse DWT of watermarked image to transform image back into domain.

5. Watermark Extraction

Watermark extraction is reverse process of watermark embedding, the steps for extraction of watermark without attacks is given below:

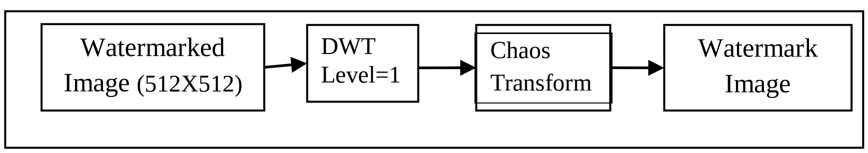

Figure (3) Watermark Extraction

Receive watermarked image considering without attack. Take one level DWT of watermarked image and calculate value of bands .Perform Arnold transforms on singular value decomposed image. The obtained image is Watermark image.Figure (3) shows flow diagram for Extraction algorithm.

6. Parameters Used

For simulation and result analysis of this method two parameters are calculated:

1. PSNR: the Peak signal to noise ratio shows degree of noise present in image where E is mean square Error is given by

$$PSNR = 10\lg(\frac{255^2}{E})$$

$$E = \frac{1}{M \times N}\sum_{i=1}^{N}\sum_{j=1}^{M}[(f(i,j) - f'(i,j)]^2$$

7. Results

Figure (4) shows Original watermark of 32X32 size and figure (5) shows Arnold transformed watermark of 32X32 size.

Figure 4

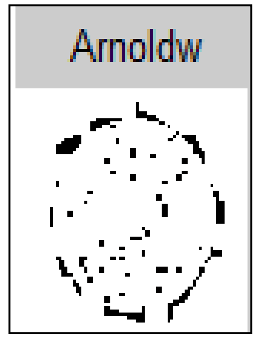

Figure 5

The original image of size 512X512 is used with watermarked image obtained of 512X512 sizes. Figure (6) & figure (7) figure (8) shows original and watermarked images & Extracted watermark with PSNR 74 dB

Figure 6: original image

Figure 7: Watermarked image

Figure 8: Extracted Watermark

8. Conclusion

The chaos and DWT based image watermarking technique was developed in this paper and obtained PSNR was 74dB which satisfies robustness criteria of algorithm.

9. References

i. Alexander Herrigel, Sviatoslav Voloshynovskiy, and Yuriy Rytsar , **"**The Watermark Template Attack DCT - Digital Copyright Technologies Research & Technology", Stauffacher-Strasse 149 CH-8004 Zurich Switzerland *****CUI - University of Geneva Department of Computer Science 24 rue Général Dufor,CH-1211 Geneva 4 Switzerland.

ii. Gursharanjeet Singh Kalra, "Robust Blind Digital Image Watermarking Using DWT and Dual Encryption Technique", Third International Conference on Computational Intelligence, Communication Systems and Networks 2011.

iii. Gabriel Peterson, "Arnold's Cat Map".

iv. Lin,S. and C. Chin, "A Robust DCT-based Watermarking for Copyright Protection," IEEE Trans. Consumer Electronics, 2000, 46(3): 415-421.

v. Sanjay Rawat , "A Chaos-Based Robust Watermarking Algorithm For Rightful Ownership Protection", International Journal of Image and Graphics Vol. 11, No. 4 (2011) 471–493

vi. X. G. Xia, C. G. Boncelet, G. R. Arce, "A Multiresolution Watermark for Digital Images. In: Image Processing Proceedings", International Conference on Image Processing. 1997; Santa Barbara, CA, USA; vol.1: 548 – 551.