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Digital Watermarking Techniques

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Abstract: More the development of the multimedia, more the digitalization, the more is the access to internet. This fast rate of enhancement gives a sense of protection and authentication. Digital watermarking technology provides a strong solution to insecurity created by digitalization. In this paper, our focus is on the basic concepts of watermarking, their characterisation, their techniques. Extending more, we will elaborate one of the latest technique of watermarking named as “Discrete Cosine Transform” (DCT).

Keywords: Digital Watermarking, Frequency domain, Spatial Domain, Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT).

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INTRODUCTION

Today the use of growing internet and displaying of multimedia contents on the internet has become widespread activity. We all know that techniques based on the combination of multimedia and internet are well renounced all over the world. Youtube , Facebook, Torrents such video, audio, image, documents are the part and parcel of common man specially popular among young generation of today. For this it becomes very necessary to protect the rights of authors. As it is based on digital media so the need of digital protection mechanism is necessary and in-evitable.

More information is transmitted in a digital format more the danger to data. There are many types of digital information and data.

1) Digital images
2) Digital audios
3) Digital videos

A watermark [1] is a pattern of bits inserted into a digital image, audio or video file that identifies file's copyright information (authors, rights, etc).

The popular techniques used for protection are as:

1) Steganography
2) Digital Signature
3) Fingerprinting
4) Cryptography
5) Digital Watermarking

DIGITALL WATERMARKING

The process of embedding data into a multimedia elements such as images, audios, video file for the purpose of authentication [2]. This embedded data can later be entered from, or detected in, the multimedia for security purposes.

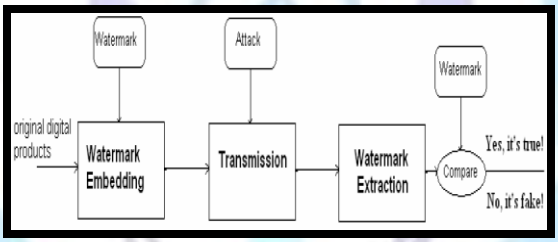

Figure 1: Digital Watermarking Process

Digital Watermarking in most suitable for still images , videos and audios

Example : Executable Files are not suitable for watermarking because they can easily be converted to a canonical format and lose the watermark.

CLASSIFICATION OF DIGITAL WATERMARKING

Some important types of watermarking based on difference watermarks [3] are given below:

a) Visible watermarks:

It is a simple, analogous to stamping a mark on paper. The data is digitally stamped. This is applicable only to images.

Example:

On television channels visible watermarking is seen when their logo is visibly superimposed in the corner of the screen.

b) **Invisible watermark**:

It is a complex concept.

It is most often used to copyright data such as author , distributor etc.

c) Fragile watermark:

This is also known as Tamper Proof Watermarks. Such watermark are destroyed by data manipulation.

PROPERITIES AND REQUIREMENTS OF DIGITAL WATERMARKING

The various properties or can say the characteristics [4] [5] that digital watermarking holds are:

Invisible The use of watermarking system comes to an extinct if it distorts the cover image to such an extent that it becomes useless, or even highly distracting. Mainly the motive is that the watermarked image should not get easily distinguishable from the original image even on the highest quality equipment.

Robust The intentional attack i.e the deliberate attempt to distort the watermark or the unintentional attempt which can generally occur by mistake should all be resistant. Under unintentional attacks cropping resizing contrast enhancement categories are included which is normally used.

Security A watermark as being used for protection must a secret and uncatchable code. Only authorised parties should have the right to access the watermark. The avoidance of unauthorised parties only help to protect the image. Watermark because of this is treated as secure requirement. As keys were used in cryptography, same way watermark can be achieved. The algorithms are being used and published to everyone to work on digital watermark. A watermark signal is related with a unique number which is used for embedding and extracting. This embedding and extracting is similar to the encryption and decryption of information .the special and unique number is used just to identify the authorised or legal user of digital information. If we focus more on robustness then the invisibility can be poor. So concluding that robustness with invisibility in digital watermarking is of great use.

DIGITAL WATERMARKING TECHNIQUES

The digital watermarking techniques can be classified into two categories.

1) **Spatial Domain Watermarking Technique:**

- In spatial Domain Transform approaches watermark is embedded directly to pixel locations.
- Using colour separation Spatial watermarking can also be applied. And watermark appears only in one of the colour bands.
- This renders the watermark visibly is rarefied. Detecting of watermark with regular viewing is difficult. However, the mark appears immediately when the colours are separated for printing.
- Journalists use this approach to check the digital pictures from a photo-stock house before buying unmarked versions[6]
- The spatial watermarks cannot survive the attacks of lossy compressions and low filtering.
- Robustness is the loop hole in this technique.

a) Least significant Bit (LSB)

The LSB is the most simple and precise method to embed watermark. Given the extraordinarily high channel capacity of using the entire cover for transmission in this methodology, multiple times embedding can be possible on smaller objects. Due to attacks if more of these is gone then even a single watermark that survived would be considered a success. Given an image with pixels, and each pixel being represented by an 8-bit sequence, the watermarks are embedded in the last (i.e., least significant) bit, of selected pixels of the image. Implementation of the methodology is easy and the rate of severe distortion of the image is less. It is not that robust to face the attacks.

b) SSM Modulation Based Technique:

Spread-spectrum techniques are methods in which energy generated at one or more discrete frequencies is deliberately spread or distributed in time. The reasons behind doing this is the prevent detection, secure communication establishment and because the resistance to natural interference and jamming is increasing. SSM watermarking algorithms embed information in the linear fashion, combining the host image with a small pseudo noise signal that is modulated by the embedded watermark [6], this is context with the digital watermarking.

2) **Frequency Domain Technique:**

The aim of frequency domain is to embed the watermarks in the spectral coefficients of the image. The commonly known transforms are the Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT). The reason for watermarking in the frequency domain is that the characteristics of the human visual system (HVS) are better captured by the spectral coefficients.

For example, the HVS is more sensitive to the coefficients based on low frequency, and less sensitive to high-frequency ones. In other words, low-frequency coefficients are more significant, and alterations to those components can cause distortion to the original image. Whereas, high-frequency coefficients are considered as insignificant; to removal the high frequency coefficient compression processing techniques are used. A balance is required between imperceptibility and robustness, and for that most algorithms embed watermarks in the middle range frequencies.

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Two important requirements of frequency Domain Technique are Watermark embedding and Watermark extracting.

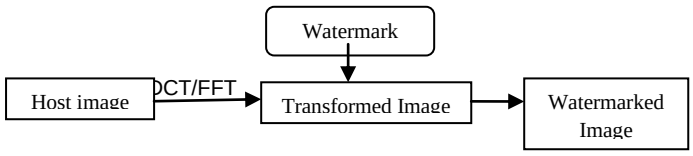

Figure 2: Watermarking embedding in Frequency Domain

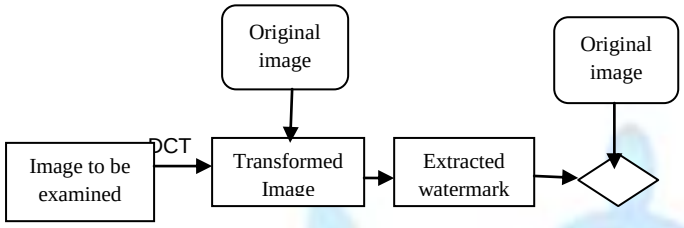

Figure 3: Watermark Extraction in Frequency Domain

a) Discrete Waveform Transform (DWT):

The Discrete Wavelet Transform (DWT) is now a-days used widely in the applications based on signal processing like in compressions of audio and video, noise removal from the audios. Wavelets energy is concentrated in time and also been well suited for the transient, time-varying signals. Time varying form of signals are mostly encountered in the real life. So based on this Wavelet Transform can suit many applications very well [7]. The most challenging task in watermarking problem is to achieve a balance between robustness and perceptivity. By increasing the strength of the embedded watermark the strength of robustness can be achieved. But side way the visible distortion[8] would also increase.

b) Discrete Cosine Transform (DCT):

The representation of data is in terms of frequency space rather than an amplitude space similar like a Fourier Transform. This is useful because that corresponds more to the way humans perceive light, so the not perceived parts can be identified and thrashed away. The techniques based on DCT based are more robust compared to spatial domain techniques. Low pass filtering, brightness and contrast adjustment, blurring etc are the simple image processing operations on which the DCT algorithms are robust. They are difficult to implement and are even more expensive.

DCT TECHNIQUE

With the character of Discrete Fourier Transform (DFT), discrete cosine transform (DCT) turn over the image edge to make the image transformed into the form of even function. The most common linear transformations in digital signal process technology [9]

It is widely used because of its good capacity of energy compression and deco-relation. DCT is faster than DFT because its transform kernel is real cosine function while it is complex exponential in DFT [10]

The most common DCT definition of a 1-D sequence of length N [9,10]

$$C(u) = \alpha(u) \sum_{x=0}^{N-1} f(x) \cos\left[\frac{\pi(2x+1)}{2N}\right]$$

For u=0,1,2,.....,N-1

Similarly, The inverse of DCT:

$$f(x) = \sum_{u=0}^{N-1} \alpha(u) C(u) \cos\left[\frac{\pi(2x+1)u}{2N}\right]$$

For x=0,1,2,.....,N-1

In both the above equations α (u) is defined as:

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$$\alpha(u) = \begin{cases} \sqrt{1/N} & for\ u = 0 \\ \sqrt{2/N} & for\ u \neq 0 \end{cases}$$

2-D DCT is a direct extension of the 1-D case & is given by:

$$C(u,v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

Where u,v= 0,1,2,....., N-1

The inverse 2-D DCT:

$$f(x,y) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u,v) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

Where x, y=0,1,2,..... N-1

Problem : Working on DCT,

Taking a simple program for a robust watermarking system in MatLab based on following the diagrams:

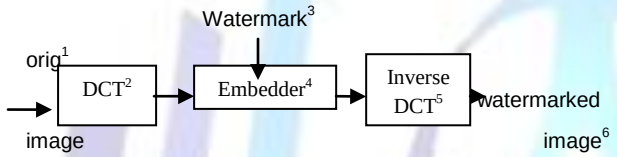


Figure 4:The Watermark embedding System

Figure 5: The Watermark Detection System

Tips:

1.) Read in the image data using the function imread().

2.) The function for 2-d DCT: dct2().

3.) Use 1-bit information as your watermark, that is, you can select to embed either w= '1' or w='0'.

4.) The embedding strategy: randomly select one coefficient x,

5.) The function for 2-d inverse DCT is idct2().

6.) Display the watermarked image using imshow() and save it using imwrite().

7.) The detector executes the inverse function of the embedder.

. Test the robustness of your system against Gaussian (white) additive noise with zero mean and increasing variance. Add Gaussian (white) noise of mean M and variance V to the image I. When M and V are not mentioned, then by default 0 and 0.01 respectively.

C. Try to change the embedding locations (low frequency (2, 2), middle frequency (128,128) and high frequency (256,256)) to find out the effect on the robustness and quality of the watermarked images.

(Comparing of the quality of the watermarked image to that of the original image using PSNR (Peak Signal to Noise Ratio).)

To calculate PSNR, first you compute the mean squared error (MSE) of the watermarked image as Follows:

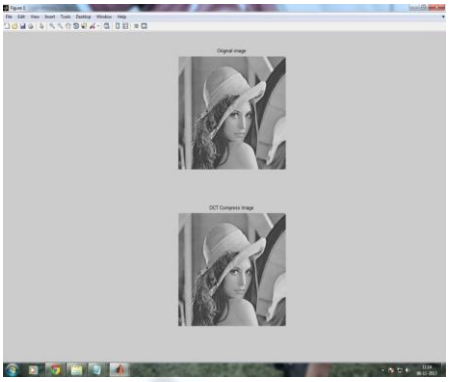
$$MSE = \sum \frac{[f(i,j) - F(i,j)]^2}{N^2}$$

The summation is over all pixels the roots mean squared mean error (RMSE) is the square root of MSE.

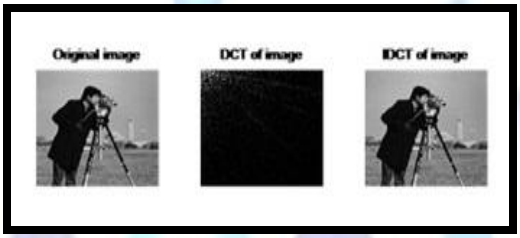
PSNR is decibels (dB) is computed by using :

$$PSNR = 20\,log_{10}(255/RMSE)$$

IMPLEMENTATION



THE DCT AND THE DCT COMPRESSED IMAGE.



INVERSE OF DCT IS ALSO SHOWN

CONCLUSION

The purpose of our paper is just to give a overview of Digital Watermarking and their relevant techniques known till now. The explanation of different techniques formulates the way they are to be implemented in digital image study .And to conclude with how Digital Watermarking is an effective and impressive tacit for the image authentication and protection from the different unauthorized means.

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