Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 2, Issue. 4, April 2013, pg.363 – 368

RESEARCH ARTICLE

IMPROVED IMAGE WATERMARKING WITH CURVELET WAVELET

Mr. N. Suresh Kumar[1], Mr. B. Mathan Kumar[2]

[1]Assistant Professor (Sr. Grade), Department of Computer Applications, Sri Ramakrishna Engineering College, Coimbatore, India

[2]Assistant Professor, Department of MCA, PSNA College of Engineering & Technology, Dindigul, India

[1] nsuresh2@gmail.com, [2] mathan81@gmail.com

Abstract— "Improved Method of Image Watermarking Using Cooley-Tukey Algorithm" presents a transformation and watermarking for Image Authentication. Initially, an image is taken and it is transformed by using Curvelet Transformation. This transformation was developed in order to represent edges along curves more efficient than the traditional transformations. The concept of Fast Fourier Transformation (FFT) algorithm is used in this paper to perform Curvelet Transformation. There are many FFT algorithms exists and the most common FFT is the Cooley-Tukey algorithm, which is a divide and conquer algorithm. A secret image is taken and embeds with that transformed image. Then the Inverse FFT is applied to obtain the watermarking image. Finally, the embedded secret image is extracted using extraction technique. The resultant extract image is compared with the original secret image by calculating ratios using Peek signal to Noise Ratio (PSNR). PSNR calculation of 2 images, one original and an extracted image, describes how far 2 images are equal. The higher the PSNR, the better the quality of the compressed or reconstructed image.

Key Terms: - Watermarking; Curvelet Transform; FFT; Cooley Tukey

I. INTRODUCTION

Digital watermarking [2] is defined as the process of altering a work, in order to embed information about that work. In simple terms, it is the process of embedding information into a digital signal in a way that is **difficult to remove**. The signal may be **audio, images or video**. A signal may carry several different watermarks at the same time. An **example** is the logos used in papers in currencies.

Watermarking is widely used for **copyright protection, broadcast monitoring Source tracking, etc.** In the recent years copyright protection of digital content became a serious problem due to rapid development in technology. Watermarking is one of the alternatives to copyright-protection problem. Digital Watermarking can be classified as **visible and invisible [3].**

The **visible watermarks (perceptible)** are viewable to the normal eye such as bills, company logos and television channel logos etc. This type of watermarking is easily viewable without any mathematical calculations in the case of **invisible watermarks (imperceptible)**, the locations in which the watermark is embedded or secret, only the authorized persons extract the watermark. Some mathematical calculations are required to retrieve the watermark. This kind of watermarks is **not viewable** by an ordinary eye.

Curvelet Transformation [6, 7] can be done in 2 ways:

1. Using Wrapping method and
2. Using Fast Fourier Transformation algorithm.

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A Fast Fourier transform (FFT) is an efficient algorithm to compute the discrete Fourier Transform (DFT) and its inverse. There are many distinct FFT algorithms involving a wide range of mathematics, from simple complex-number arithmetic to group theory and number theory.

The most common FFT is the Cooley-Tukey algorithm. This is a divide and conquer algorithm and was popularized by a publication of [6] J.W.Cooley and J.W.Tukey in 1965.

II. OBJECTIVE

The primary objective of this paper is to provide **copyright protection and image authentication.** This paper is developed to transform an image and to embed that image with a secret image. Also extract the secret image from the watermarked image and compare the values. Transformation is done using the FFT algorithm. Embedding and Extracting is done using the Image Watermarking.

A) EXISITING SYSTEM

The existing DFT decomposes a sequence of values into components of different frequencies. This operation is useful in many fields, but computing it directly from the definition is often too slow to be practical. Watermarking, as opposed to Steganography, has a requirement of robustness against possible attacks and it is the process of embedding transformation into another object/signal. Digital watermarking is defined as the imperceptibly altering a work in order to embed information about that work.

DRAWBACKS

a. The copyright protection of digital content became a serious problem due to rapid development in technology.
b. Computing a DFT of N points takes $O(N^2)$arithmetical operations. So it requires more time.

B) PROPOSED SYSTEM

The proposed system uses FFT which is an efficient algorithm to compute the Discrete Fourier Transformation (DFT) and its inverse. FFT can takes only O(N log N) arithmetical operations to compute N points. FFT is of great importance to a wide variety of applications, from signal processing and solving partial differential equations to algorithms for quick multiplication of large integers.

The system also uses Visible Watermarks which are viewable to a normal eye. These types of watermarks are easily viewable without any mathematical calculation.[2]

The main characteristics of [2, 3] Digital watermark are:

Robustness: The watermark should be able to withstand after normal signal processing operations such as image cropping, transformation, compression.

Imperceptibility: The viewer cannot detect that watermark is embedded in it.

Security: An unauthorized person cannot detect, retrieve or modify the embedded watermark.

BENEFITS OF PROPOSED SYSTEM:

Any function of FFT algorithm can be expressed as a sum of series of sine and cosines. So, it is very easy to study the function.

a. Any space or time varying data can be transformed into a different domain called a frequency domain. This makes processing easier.
b. Elements of digital content can be directly manipulated and information can be embedded in them.

Deterioration of the quality of digital content is minimized.

c. Deterioration of the quality of digital content is minimized.
d. Processing required for Watermarking and detection is simple.
e. Embedded watermark information cannot be eliminated without diminishing the quality of the digital content that carries the watermark.
f. The watermark information embedded in digital content can be detected as required.

III. PAPER DESCRIPTION

This paper presents an efficient transformation method and watermarking for Image Authentication. This paper deals with the process of transforming the original image using the **Fast Fourier Transformation** algorithm [7] and embedding a secret image with that transformed image. Then the Inverse FFT is applied to obtain the watermarking image. Finally, the embedded secret image is extracted using extraction technique.

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A) OVERVIEW OF THE PAPER

The paper entitled "**Improved Method Of Image Watermarking Using CooleyTukey Algorithm "**, deals with the Transformation of an image using FFT algorithm and watermarking Embedding and Extracting.

1. FAST FOURIER TRANSFORMATION(FFT)

It is speed-up technique for calculating DFT, which in turn is discrete version of continuous Fourier Transform, which indeed is origin for all its versions. So, historically continuous form of the transform was discovered, then discrete form was created for sampled signals and then algorithm for fast calculation for discrete version was invented.

- **Cooley-Tukey Algorithm**

It is one of the most common [7] FFT algorithm. This is a divide and conquer algorithm that recursively breaks down a DFT of any composite size $N=N_1, N_2$ into many smaller DFTs of sizes N_1 and N_2 along with O(N) multiplications by complex roots of unity.

The most well-known use of the Cooley-Tukey algorithm is to divide the transform in to 2 pieces of size N/2 at each step, and is therefore limited to power of two sizes, but any factorization can be used in general. These are called the **radix-2** and **mixed-radix** cases, respectively. Although the basic is recursive, most traditional implementation rearrange the algorithm to avoid explicit recursion.

Fourier Transform is an integral of the form:

$$Fn= \sum_{k=0}^{N-1} fke \ -i\frac{2\pi}{N}kn$$

The above expression is **discrete fourier transform** (DFT). Here, $\{f0,f1,\ldots f_{N-1}\}$ is input discrete function and $\{ F_0,F_1,\ldots F_{N-1}\}$ is result of Fourier Transform. It can be evaluated as:

$$X(K)= \frac{1}{N}\sum_{n=0}^{N-1} x(n)e^{-jk2pin/N} =$$

Forward transform n=0..N-1

The above formula represents forward transformation and is applied to an image.

2. INVERSE FOURIER TRANSFORM:

Then the transformed image is transformed to its original form using Inverse formula. The resultant image gets stored. The above can be evaluated as

$$X(n)= \sum_{n=0}^{N-1} x(k)e^{\mathbf{jk2pin/N}}$$

= Inverse transform k=0..N-1

2. WATERMARK EMBEDDING AND EXTRACTING:

Watermarking[4] is a technique which allows an individual to add hidden copyright notices or other verification messages to digital audio, video or image signals and documents. **Digital watermarking** can be formed of steganography, in which data is hidden in the message without the end- user's knowledge.

Transparent watermarking techniques can be:

a. Fragile b. Robust and c. Semi-Fragile.

Robust watermarks are detachable even after some image processing operations has been performed on the watermark image such as image scaling, bending, and cropping and so on. Robust watermarks are mainly used for **copyright protection.**

Fragile Watermarks became invalid even if a slight modification is done to the watermark image. Fragile watermarks are mainly used for **authentication purpose.**

Semi-Fragile watermarks allow some acceptable distortion to the watermarked image. Beyond this acceptance level if any modification is done to the watermarked image, the watermark will not be detected.

The **Watermark Embedding** scheme can either embed the watermark directly in to the host data or to a transformed version of the host data. Some common transform domain watermarking for image data can be DCT based or Wavelet based.

Transform-domain techniques are popular due to the natural framework for incorporating perceptual knowledge in to the embedding algorithm and because many of the state-of-the-art compression techniques such as JPEG work in the same framework and this allows for watermarking of the compressed bit stream with only partial decoding.

- **Peek Signal-to-Ratio Calculation:**

It was stated earlier, that the image or the mark that was extracted will contain some distortions. In order to compute the ratio to which the extracted mark differ from the initial mark or watermark image, we use a standard metric called as PSNR. Peek Signal to Noise Ratio (PSNR) is generally used to analyze quality of image, sound and video files in dB (decibels). PSNR calculation of 2 images, one original and an extracted image, describes how far 2 images are equal. Higher of the PSNR, the better the quality of the compressed or reconstructed image.

The **Mean Square Error** (MSE) and the Peak Signal to Noise Ratio (PSNR) are the 2 error metrics used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents the measure of the Peek error. The lower value of MSE, the lower the error.

To compute the PSNR the block first calculates the mean-squared error using the following equation:

$$MSE=\frac{\sum_{M,N}[I_1(m,n)-I_2(m,n)]^2}{M*N}$$

In the previous equation, M and N are the number of rows and columns in the input images, respectively. Then the block computes the PSNR using the following equation;

$$PSNR=10\log_{10}\left[\frac{R^2}{MSE}\right]$$

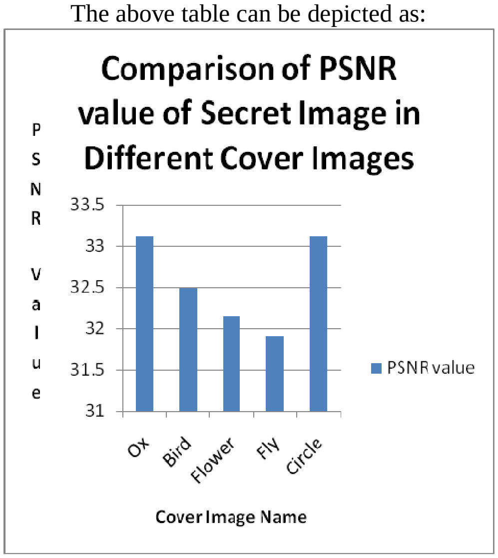
In the previous equation, R is the maximum fluctuation in the input image data type.

IV. SIMULATION RESULTS

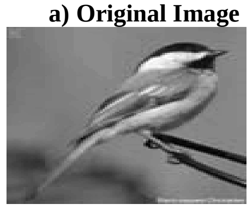
The performance of the proposed system is evaluated with five different grey scale images of size 128X128 as the original cover host image, and a 64X64 grey-scale college logo image as the watermark (secret) image. The images are shown in Fig. a to d, respectively. The sample PSNR values that were observed are tabulated as follows:

S.No	Image Name	PSNR value
1	Ox	33.12173171
2	Bird	32.49230424
3	Flower	32.15179702
4	Fly	31.89892304
5	Circle	33.12270629

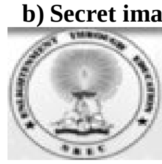
The above table can be depicted as:



a) Original Image



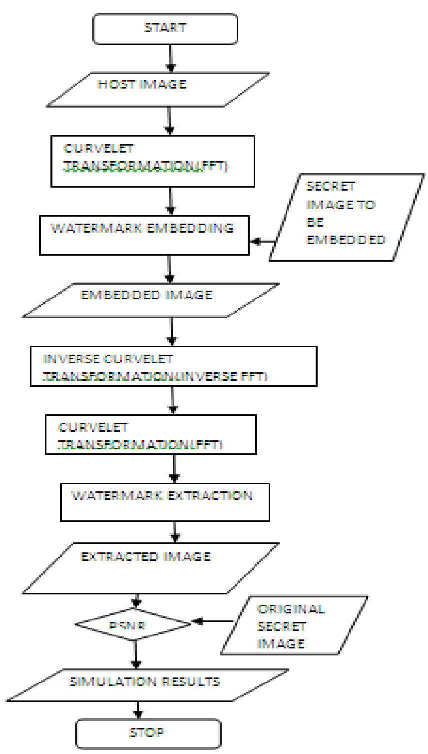
b) Secret image



c) Watermarked Image

d) Extracted Secret Image

System Flow Diagram



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V. CONCLUSION

Watermarking has its place in security. It is not intended to replace cryptography or steganography but supplement them. Watermarking technologies are aimed at Robust proof of copyright ownership. Some are intended for automated detection/ prevention; some are intended for adding value (like embedding lyrics in a song).

The most important use of watermarking techniques will probably be lying in hiding the data without visible to the viewer. Content providers are eager to protect their copyrighted works against illegal distribution and digital watermarks provided a way of tracking these materials.

This paper successfully transforms an image and embeds a secret image within it. Then the secret image is extracted. The embedded secret image and extracted image are then compares using PSNR values. 5 different types of images and the simulation results of the images are tabulated and depicted in the chart. The best results are obtained in the Ox and Circle images.

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