

A Survey of Digital Watermarking Techniques and its Classification

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Abstract- Digital watermarking is one of the technique to prevent illegal copyright of digital media. It is a method of hiding digital information in any form of multimedia data such as image, audio, video, etc. The protection of the digital content and ownership right for the digital data are provided by digital watermarking. Multimedia protection is exceedingly significant concern for the internet technology because of the simplicity in the replication, distribution and exploitation of the multimedia data. In the field of information hiding digital watermarking plays a major role in hiding the vital information in the original data for preventing illegal duplication and transmission of digital data. This paper provides a survey on the previously developed digital image watermarking methods. Watermarking techniques may be categorized on the basis of domain like transform or spatial or on the basis of wavelets. The frequency domain deals with the transform coefficients of the image and the spatial domain techniques directly work on the pixels. The review on classification of digital watermarking techniques are also presented. This paper contains different techniques based on spatial domain such as LSB technique and the transform domain such as DWT, DFT, SVD, DCT, SVD and DWT-SVD techniques. This survey states the limits and strengths of the diverse watermarking methods.

Index Terms – DCT, DWT, DWT-SVD, DFT and LSB.

I. INTRODUCTION

With use of internet is increasing day by day and with the fast advancement in technology, speed of data over networks has crossed the bars. There is urgent need to preserve the copyright of owner, which is done by using digital image watermarking. There has been significant interest in watermarking in recent years mainly because of two reasons, one is digitization of documents and second is fast and untroubled traffic over internet. Digital data offers many advantages and new potentials to the user. Digitized documents can easily be altered thus, dropping its originality. In result of that watermarking techniques came in light. To identify the owner of the image and to solve the problem of its ownership, digital image watermarking is required. Watermarking is a technique in which the cover image also known as original image is modified according to a watermark image. Certain characteristics of the cover image are reformed in order to hide the data used for the credentials of the owner of the original content. Cover image and watermark image are passed through any one of the watermarking technique and in result watermarked image is obtained.

A. Digital Watermarking

The digital watermarking is a process of information hiding. Basically digital watermarking is a method for embedding some secret information in the cover image which can later be extracted for various purposes like authentication, owner identification, content protection and copyright protection. The digital watermarking is used for the security of the digital content and to protect the data from illegitimate users and provides the rights for the digital data. An important

characteristic of digital watermarking is robustness and quietness against various types of attacks like rotation, filtering, scaling, cropping and compression.

Digital watermarking is a very emerging field and used in numerous applications which have been proved to be successful. The objective of every application is to providing security of the digital content. These are used in many applications such as Broadcast Monitoring, Digital Fingerprinting, Transaction Tracking, Copyright protection, Temper Detection, Data Hiding and Content authentication etc.

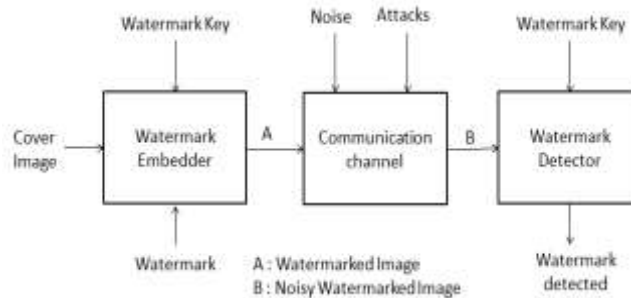


Fig.1 Digital Watermarking Process

II. LITERATURE SURVEY

Digital watermarking is an application associated with copyright protection. Any digital object can be used as a carrier to carry information. If the information is related to object then it is known as a watermark which can be visible or invisible. In this paper comparative study of two most recent digital watermarking techniques namely DWT and DWT-SVD over RGB images is presented. In case of DWT (Discrete Wavelet Transform) watermarking technique, decomposition

of the original image is done to embed the watermark and in case of DWT-SVD watermarking technique, firstly original image is decomposed according to DWT and then watermark is embedded in singular values obtained by applying SVD (Singular Value Decomposition)[1].

Digital watermarking is a technology being developed to ensure and facilitate data authentication, security and copyright protection of digital media. This paper incorporate the detail study watermarking definition, concept and the main contributions in this field such as categories of watermarking process that tell which watermarking method should be used[2].

Digital image watermarking algorithm based on DWT, DCT and SVD has been proposed in which Arnold transform has been applied to watermark image in order to ensure the watermark robustness [4].

Multimedia security is extremely significant concern for the internet technology because of the ease of the duplication, distribution and manipulation of the multimedia data. The digital watermarking is a field of information hiding which hide the crucial information in the original data for protection illegal duplication and distribution of multimedia data. This paper presents a survey on the existing digital image watermarking techniques. The results of various digital image watermarking techniques have been compared on the basis of outputs. In the digital watermarking the secret information are implanted into the original data for protecting the ownership rights of the multimedia data. The image watermarking techniques may divide on the basis of domain like spatial domain or transform domain or on the basis of wavelets. The spatial domain techniques directly work on the pixels and the frequency domain works on the transform coefficients of the image. This survey elaborates the most important methods of spatial domain and transform domain and focuses the merits and demerits of these techniques [7].

Image Watermarking is being seen as a forthcoming answer for security. At the present time, there is a wide range of watermarking plans have been proposed. This paper gives an exhaustive audit of the current calculations that have been produced and their usefulness. There is a key to check of the information and the proprietor. It hosts produced for pernicious gatherings to make open duplicates of copyrighted substance with any reward to the substance propriety. We focused on the watermarking techniques, types and its applications in this survey [8].

Digital watermarking plays an increasingly important role for proving authenticity and copyright protection. The Internet is an ideal medium for selling digital goods it also makes redistribution of pirated files very easy. Digital watermarking can be used to insert invisible data into an object helping to track down pirate copies and to prove rightful ownership in a dispute. In this paper we present a detailed survey of existing image watermarking techniques [10].

III. CLASSIFICATION

Digital watermarking techniques may be classified in several ways as follows.

A. According to characteristics

Robust: Robustness watermarking is mainly used to sign copyright information of the digital works, the inserted watermark can attack the common edit processing, image processing and lossy compression, and the watermark is not destroyed after some attack and can still be detected to provide certification.

Fragile: Fragile watermarking is mainly used for integrity protection, which must be very sensitive to the changes of signal.

Semi fragile: This watermarking is capable of bearing some degree of the change to a watermarked image, such as the addition of quantization noise from lossy compression.

B. According to attached media

Image watermarking: This is used to hide the secret information into the image and to later detect and extract that special information for the author's ownership.

Video watermarking: In this watermark is added in the video stream to control video applications. It is the extension of image watermarking. This method requires real time extraction and robustness for compression.

Audio watermarking: In this watermark is added in an audio to control audio applications.

Text watermarking: This adds watermark to the PDF, DOC and other text file to avoid the variations made to text.

Graphic watermarking: It embeds the watermark to 2D or 3D computer generated graphics to indicate the copyright.

C. According to visibility

Visible watermark: The watermark that is visible in the digital data like stamping a watermark on paper, television channels, whose logo is visibly overlaid on the corner of the TV picture.

Invisible watermarking: There is technology available which can insert information into an image which cannot be perceived, but can be interrogated with the right software.

D. According to domain

Spatial domain: This domain focuses on changing the pixels of one or two randomly selected subsets of images. It directly loads the raw data into the image pixels.

Frequency domain: In this technique values of certain frequencies are altered from their original. There are several common used transform domain methods, such as DCT, DWT, and DFT.

E. According to use of keys

Asymmetric watermarking: This is technique where different keys are used for encrypting and decrypting the watermark.

Symmetric watermarking: Here same keys are used for encrypting and decrypting the watermark.

F. According to type of users

Public Watermarking: Users are authorized to detect watermark.

Private Watermarking: Users are not authorized to detect watermark.

Steganographic Watermarking: User unaware of the presence of a watermark e.g: Used in finger printing applications.

Non-Steganographic Watermarking: User aware of the presence of a watermark. e.g.: User to detect piracy.

IV. DIGITAL IMAGE WATERMARKING TECHNIQUES

The entire digital image watermarking techniques always works in two domains either spatial domain or transform domain. Most commonly used spatial domain techniques are LSB. Most commonly used transform domain techniques is DCT, DWT and DFT.

A. Spatial Domain Watermarking

The spatial domain techniques works directly on pixels. It embeds the watermark by modifying the pixels value.

Least Significant Bit (LSB): The LSB is the simplest spatial domain watermarking technique which is used to embed a watermark in the least significant bits of some arbitrarily selected pixels of the cover image.

Example of least significant bit watermarking.

Image:

10010101 00111011 11001101 01010101....

Watermark:

1 0 1 0.....

Watermarked Image:

10010101 00111010 11001101 01010100.....

B. Transform Domain Watermarking

Transform domain techniques embed the watermark by modifying the transform domain coefficients.

Discrete Cosine Transform: DCT transform domain technique is used for the signal processing. It converts a signal from the spatial domain to the transform domain. Discrete Cosine Transform is applied in many fields like data compression, pattern recognition and every field of image processing. DCT watermarking is more robust technique as compared to the spatial domain watermarking techniques.

In DCT, for embedding the watermark information, we divide the image into different frequency bands. In Figure below, FL denotes the lowest frequency component of the block, while FH denotes the higher frequency component and FM denotes the middle frequency component which is chosen as the embedding section. The Discrete cosine transform (DCT) achieves good robustness against various signal processing assaults because of the selection of perceptually significant frequency domain coefficients [3][5].

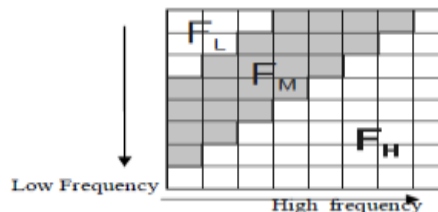


Fig.2 Discrete Cosine Transform

Discrete Wavelet Transform: Discrete wavelet transform (DWT) produces multi resolution representation of an image. The multi resolution representation provides a simple structure for deducing the image information. The Discrete Wavelet Transform analyses the signal at multiple resolution. DWT divides the image into high frequency quadrants and low frequency quadrants. The low frequency quadrant is again split into two more parts of high and low frequency quadrants and this process is repeated until the image has been entirely decomposed. The single DWT transformed 2D image into four parts where one part is the low frequency of the original image, the top right contains horizontal details of the image, the one bottom left contains vertical details of the original image and the bottom right part of decomposed image contains high frequency of the original image. The low frequency coefficients are more vigorous to embed watermark because it contains more data of the original image. The reconstruction of the cover image from the decomposed image is performed by IDWT (Inverse Discrete Wavelet Transform) [1][4][6].

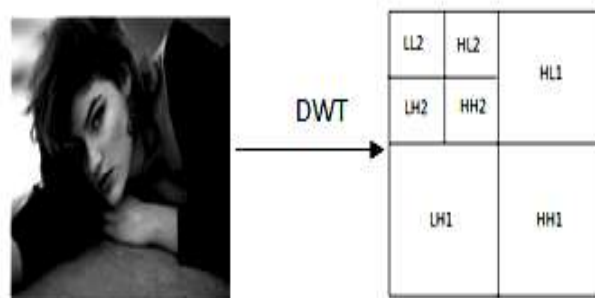


Fig.3 Discrete Wavelet Transform

Discrete Fourier Transform: DFT offers robustness against geometric assaults like rotation, scaling, cropping, translation etc. DFT decomposes an image in sine and cosine form. The DFT based watermark embedding scheme are divided in two types: one is the direct embedding and the other one is the template based embedding. In the direct embedding technique

the watermark is embedded by modifying Discrete Fourier Transform magnitude and phase coefficients. The template based embedding scheme presents the concept of templates. A template is structure which is embedded in the DFT domain for evaluation of the transformation factor. Once the image undergoes a transformation this template is searched to resynchronize the image, and then the detector is used to extract the embedded spread spectrum watermark [4][7].

DWT-SVD Watermarking Technique: In DWT-SVD method the cover image is divided into different frequency sub-bands and the Singular Value Decomposition of the low-frequency sub-band is taken. The watermark is embedded in the low frequency coefficient of the cover image. Hybrid technique is a fusion of two techniques. Here, DWT and SVD are used together to improve the quality of the watermarking. Advantages of both these techniques are employed in this. DWT and SVD are novel techniques used for watermarking so their fusion makes a very attractive watermarking technique [1][3][6].

TABLE I
 COMPARISON OF DIGITAL WATERMARKING TECHNIQUES

Algorithm	Advantages	Disadvantages
LSB	1. Easy to implement and understand 2. Low degradation of image quality 3. High perceptual transparency	1. It lacks basic robustness 2. Vulnerable to noise 3. Vulnerable to cropping, scaling
DCT	1. The watermark is embedded into the coefficients of the middle frequency, so the visibility of image will not get affected and the watermark will not be removed by any kind of attack.	1. Block wise DCT destroys the invariance properties of the system. 2. Certain higher frequency components tend to be suppressed during the quantization step.
DWT	1. Allows good localization both in time and spatial frequency domain 2. Higher compression ratio which is relevant to human perception.	1. Cost of computing may be higher. 2. Longer compression time. 3. Noise/blur near edges of images or video frames.
DFT	1. DFT is rotation, scaling and translation (RST) invariant. Hence it can be used to recover from geometric distortions.	1. Complex implementation 2. Cost of computing may be higher.
SVD	1. It reduced the number of degrees of freedom in a complex system	1. Expensive

V. CONCLUSION

Digital watermarking is an effective technique for embedding rights statistics in digital multimedia data. Digital watermarking is very useful method for providing security to the digital media on the internet technology. Survey of different techniques based on spatial domain (LSB) and the transform domain (DCT, DWT, DFT, SVD, DWT-SVD). This survey analyses the limitations and strengths of the watermarking methods.

Digital watermarking is still a challenging research field with many interesting problems, like it does not prevent distribution or copying and also cannot last in every possible attack. One future research baton is the development of truly robust, transparent and secure watermarking technique for different digital media including images, video and audio.

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