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A Review Paper on Digital Watermarking

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Abstract: This paper include the detail study of Digital watermarking explanation, concept and the main contributions in this field such as categories of watermarking process that tell which watermarking method should be used. It starts with overview, classification, features, framework, techniques, application, challenges, limitations, quality performance and performance metric of watermarking and a capable analysis of some major watermarking techniques. In the survey our most important apprehension is image only.
Index Term: Applications, Attacks, Techniques, and Quality Performance Measure.

1. INTRODUCTION

In recent years, as digital media are achievement wider popularity, their security related issues are suitable superior concern. Digital watermark was first discovering in 1992 by Andrew Tirkel and Charles Osborne [11, 14]. Watermark is derived from the german term "Wessmark. The first watermarks devolved in Italy during the 13th century, but their use apace spread across Europe. Watermarking can be measured as special techniques of steganography where one message is embedded in another and the two messages are related to each other. Digital watermarking is similar to watermarking technique which allows an individual to add exclusive rights notices or other verification messages to digital media. Image authentication's one of the applications of digital watermarking, which is used for authenticating the digital images. A digital watermark is a kind of marker covertly embedded in a noise-tolerant image such as audio or image data. It is typically used to identify ownership of the copyright of such image. "Watermarking" is the process of hiding digital information in an image the hidden information should but does not need to contain a relation to the image. The security and enforcement of academic property rights for digital media has become an important issue [1]. The way to understand this feature is to embed a level of the authentication signature into the digital image using a digital watermark. In the case of the image being tampered, it can easily be detected as the pixel values of the embedded data would change and do not match with the original pixel values. There are many spatial and frequency domain techniques are available for authentication of watermarking. Watermarking techniques are judged on the basis of their performance on a small set of properties. Watermarking schemes are developed according to the requirements of the application and all applications do not require each of these properties in their entirety i.e. watermarking requirements are application dependent and some most desirable properties for these applications are conflicting in nature. Digital signature is also a verification scheme that is used for verifying the reliability and authenticity of the image content. A digital signature can be either an encrypted or a signed hash value of image contents and image characteristics. The paper is organized as Section 2 describes the watermarking and cryptography method. Section 3 discusses the background of digital watermarking technology, and then we discuss digital watermarking and its characteristics, properties, classification, architecture, style of robust watermarking, , application, attack challenges of digital watermarking, analysis &quality performance and classification techniques of digital watermarking. Section 4 discusses the related work on digital watermarking.

2. WATERMARKING AND CRYPTOGRAPHY

Watermarking and cryptography are nearly related techniques but watermarking is discrete from encryption. In the digital watermarking system, it is containing information carrying the water is embedded in an original image. The watermarked image is transmitted or stored and then decoded to be determined by the receiver. Cryptography scrambles the image so that it cannot be implicit. In Figure 1 explain the principal of cryptograph, in which plain text encrypted in to cipher text which is then decrypted into plain text.

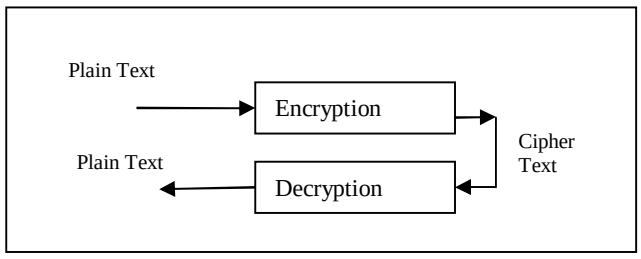

Figure 1 Principal of Cryptography

The objective of watermarking is not to limited access to the original image, but to ensure that embedded data remain recoverable. Figure 2 (a) explain embedded process; the input to the watermarking algorithm is the image which is to be watermarked and is encrypted by public or secret key which will produce watermarked image.

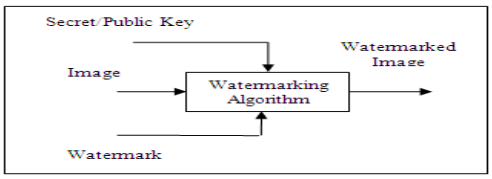

Figure 2 (a) Embedding process

Figures 3 explain (b) decoding process; the test image is decrypted using the same secret/public key for the watermark detection.

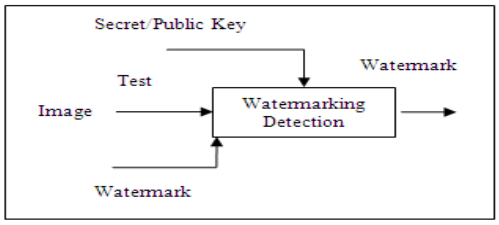

Figure 2 (b) Decoding process

3. DIGITAL WATERMARKING TECHNOLOGY

Digital watermarking rapidly growing research area of digitised images, video and audio has urged the need of copyright protection, which can be used to produce verification against any illegal attempt to either reproduce or manipulate them in order to change their identity. Digital watermarking is technique providing embedded exclusive rights information in images. Digital watermarking is a collection of emerging of technology, such as signal processing, cryptography, probability theory and stochastic theory, network technology, algorithm design and other techniques.

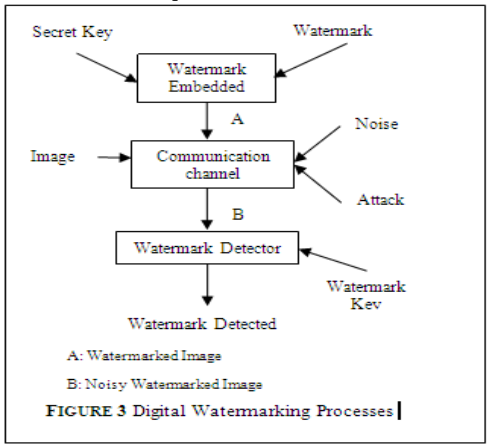

FIGURE 3 Digital Watermarking Processes

3.1 Characteristics of Digital watermarking

There are a number of important characteristicsthatwatermark can exhibit, Jalil and Mirza (2010), Bandyopadhyay and Paul (2010). The main characteristics of digital watermarking are classified into major categories as follows.

- Robustness: The watermark should be capable to resist after normal image processing operations such as image cropping, transformation, compression etc.
- Imperceptibility: The watermarked image should appear like same as the original image to the ordinary eye. The observer cannot detect that watermark is embedded in it.
- Security: An unauthorized someone cannot detect, retrieve or change the embedded watermark.

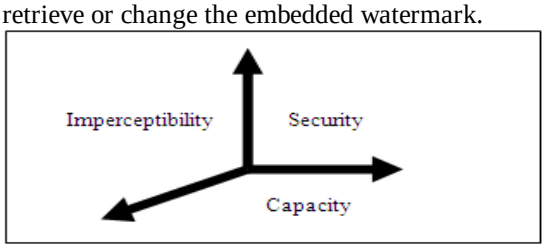

Figure 4 characteristics of digital watermarking [11]

- Transparency: Transparency relates to the properties of the human sensory. A transparent watermark causes no artifacts or feature loss.
- Capacity: Capacity describes how many information bits can be fixed. It addresses also the possibility of embedding multiple watermarks in one document in parallel. Capacity requirement always effort against two other important requirements, that is, imperceptibility and robustness (Fig 4). A higher capacity is usually obtained at the expense of either robustness strength or imperceptibility, or both.

3.2 Properties of Digital water marking

Watermarking system has some very important popular properties. Some of these properties such as

- Effectiveness: It is the probability that the message in a watermarked image will be correctly detected; it ideally needs this probability to be 1 [23].
- Image fidelity: Watermarking is a process that alters an original image to add a message to it; therefore it certainly affects the image's quality. We want to keep this poverty of the image's quality to a minimum, so no obvious difference in the image's fidelity can be noticed [23].
- Payload size: In which every watermarked work is used to hold a message. The size of this message is often essential as many systems require a comparatively big payload to be embedded in a cover work [23].
- False positive rate: It is number of digital works that are identified to have a watermark embedded when in reality they have no watermark embedded. This should be reserved very low for watermarking systems [23].
- Robustness: In which a watermarked work is altered during its lifetime, either by transmission over a loss channel or several malicious attacks that try to remove the watermark or make it undetectable. A robust watermark should be able to withstand additive Gaussian noise, compression, printing and scanning, rotation, scaling, cropping and many other operations [23].

3.3 Classification of Digital water marking

In this section the digital watermarking discus various type of classification and segmented into various categories.

1. According to Robustness: There are classified into three categories.

- Robust: A digital watermark is called robust if it resists a selected class of transformations. Robust

watermarks may be used in copy protection applications to carry copy and no access control information [11].

- Fragile: Fragile watermarks are mainly used for tamper detection (integrity). Fragile watermarking is very sensitive to the change of signal [11].
- Semi fragile: Semi-fragile watermarks generally are used to detect mean transformations. It is capable of tolerating some degree of the change to a watermarked image [11].

2. According to Document: There are classified into four categories [11].

- Image watermarking: In this watermarking hide the essential information into the image and to detect or extract that essential information.
- Text watermarking: In this watermarking only marked on PDF, DOC and text file to prevent the change s made to text.
- Audio watermarking: In this watermarking only work on internet music, MP3 etc.
- Video watermarking: In this watermarking the video stream to control video applications. It is the addition of image watermarking. This process requires real time extraction and robustness for compression.

3. According to perceptivity: There are classified into two categories.

- Visible watermarking: In this watermarking that is visible in the digital data like stamping a watermark on paper document, (ex.) television channels, like Zee TV, whose logo is visibly superimposed on the corner of the TV picture [11].
- Invisible watermarking: In this watermarking, this can insert information into an image which cannot be seen, but can be detecting with the right software [11].

4. According to watermark type: There are classified into two categories [11].

- Noise type: Noise type has pseudo noise, Gaussian random and chaotic sequences.
- Image type: There are binary image, stamp, logo and label.

5. According to Purpose: There are classified into four categories [11 3].

- Copyright protection watermarking: In which owner want others to see the mark of the image watermark, then the watermark can be seen after adding the watermark to the image, and the watermark still exists even if it is attacked.
- Tampering tip watermarking: In which protects the truth of the image satisfied, labels the modified content and resists the usual loss compression formats.
- Anti counterfeiting watermarking: In which added to the building process of the paper notes and can be detected after printing, scanning, and other processes.
- Anonymous mark watermarking: In which hide important annotation of confidential data and restrict the illegal users to get confidential data.

6. According to domain: There are classified into two categories.

- Spatial domain: In this domain focuses on modifying the pixels of one or two randomly selected subsets of images. There are some algorithms are used in technique LSB, SSM Modulation [11 2 15].
- Frequency domain: In this domain, values of confident frequencies are altered from their original [11 3 20].

7. According to detection process: There are classified into three categories.

- Visual watermarking: Visual watermarking needs the original data in the testing option, it has stronger robustness, but its application is limited [11].
- Semi blind watermarking: In which does not require an original media for detection [11].
- Blind watermarking: In which does not must original data, which has wide application field, but requires a higher watermark technology [11].

8. According to use of keys:

- Asymmetric watermarking: In which technique where different keys are used for embedding and detecting the watermark [11].
- Symmetric watermarking: In which same keys are used for embedding and detecting the watermark [11].

3.4 Architecture of Digital watermarking

A Simple Digital watermarking is a technology in which a watermark (secret information) is hidden in the digital medium using a suitable algorithm for the authentication and identification of original owner of the product and after we get is watermarked image. Simple digital watermarking technique consists of two modules. First module is watermark embedding into watermark detection modules and second is extraction module. Watermark detection and extraction module is used to verify whether the data contains individual watermark or she/he watermark can be extracted. In Watermark process apply watermark and secret key on input image and output comes watermarked image fig 5.

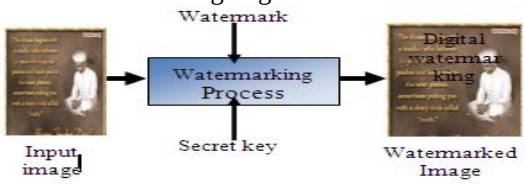

Figure 5 Architecture of digital watermarking

3.5 Styles of Robust Watermarks

There various types of style watermarks as follow [16].

- **Noise Watermark**: Noise watermark is most generally used type of robust watermark. For the reason of security and statistical un-detectivity, it is verified that the watermark is most secure, if it is in the form of Gaussian random sequence. To measure the similarity between original and extracted sequence, the correlation value is used to specify the similarity.
- **Logo Watermark**: Logo is another form of robust watermark. The logo is small image pattern in binary form. It can be company logo used in commercial applications. The quality of logo image is measured by

human awareness. That is, it is individual measure of verifying authenticity of the digital satisfied.

- **Message Watermark**: Message watermark is comprised of text. Message watermark has the advantage of easy to use in comparison with noise type watermark or logo watermark. However, the message watermark require bit error rate similar to zero, because any bit error will source key error in the final result. In most cases it is required that information with at least 64 bit (or 8 ASCII character can be carried by multimedia).

3.6 Application based on Digital Watermarking

The following application of Digital watermarking is given.

- **Copyright protection**: It is used to identify and protect official document ownership [21].
- **Digital right management**: It can be used for description, identification, trading, protecting, monitoring and tracking of all forms of usages over tangible and intangible assets [21].
- **Tamper proofing**: It is used for fragile in nature [22].
- Broadcast monitoring: In which application the number of television and radio channels delivering content has notably expanded [22].
- **Fingerprinting**: Fingerprints are the description of an object that tends to differentiate it from other small objects [22].
- **Medical application**: Names of the patients can be printed on the X-ray reports and MRI scans using techniques of visible watermarking.[11 20 22]
- **Image and content authentication**: In this application the objective is to detect modification to the data. The characteristics of the image, such as its edges, are embedded and compared with the current images for differences.

3.7 Attacks on Digital Watermarking

There are various possible malicious intentional or unintentional attacks that a watermarked matter. The accessibility of wide range of image processing soft ware's made it possible to achieve attacks on the robustness of the watermarking systems. The aim of these attacks is foil the watermark from performing its intended purpose. A brief introduction to various types of watermarking attacks is follows.

- **Removal Attack**: In this attacks mean to remove the watermark data from the watermarked object [23].
- **Geometric attack**: All manipulations that distress the geometry of the image such as flipping, rotation, cropping, etc. should be detectable [11].
- **Protocol Attack**: In this attacks do neither mean at destroying the embedded information nor at disabling the detection of the embedded information [23].
- **Cryptographic attacks**: It is deal with the brilliant of the security [23].

3.8 Challenges and limitations of Digital Watermarking

There are various technical challenges in watermarking research. The robustness and imperceptibility trade-off makes the research quite interesting. To achieve imperceptibility, the watermark should be additional to the high frequency components of the original message. On the other hand, for robustness the watermark can be further to the low frequency components only. Thus, the watermarking method can be successful if the low frequency mechanisms of the original message are used as the host for watermark insertion. We discuss the various technical issues related to watermarking, such as properties of the human visual system and spread-spectrum communication, which are commonly exploited for making watermarking schemes successful [13].

3.9 Analysis & Quality Performance Measures

In order to calculate the quality performance of the watermarked images, there are some quality measures such as SNR, PSNR, MSE, and BER.

Mean square error (MSE): It is defined average squared difference between to reference image and distorted image.It is calculated by the formula given below.

$$MSE=1/XY[\sum_{i=1}^{x}\sum_{j=1}^{y}(c(i,j)-e(i,j))^2]$$

Where,
X and Y are height of the image.
C (i, j) is the pixel value of the cover image.
e (i, j) is the pixel value of the embed image.

Signal to noise ratio (SNR): It measures the signal strength relative to the background noise.It is calculated by the formula given below

$$SNR = 10\log_{10}\left(\frac{P_{signal}}{P_{noise}}\right)$$

Where,
P_{Signal} measures the signal strength relative to P_{noise} the background noise.

Peak signal to noise ratio (PSNR): It is used to determine the degradation in the embedded image with respect to the host image [ijeit]. It is calculated by the formula as,

$$PSNR = 10\log_{10}(L * L/MSE)$$

Where,
L is the peak signal value.

Bit error ratio (BER): It **is** the ratio that calculates how many bits received in error over the number of the total bits received.

$$BER = \frac{P}{(H * W)}$$

Where,
H and W are height and width of the watermarked image.
P is the count number initialized to zero.

3.10 Classification of Watermarking Techniques

Watermarking is the method of hiding the secret information into the digital media using some strong and suitable algorithm. Algorithm plays an essential role in watermarking as, if the used watermarking technique is capable and strong then the watermark being embedded using that technique cannot be easily detected. The attacker can only destroy or detect the secret information.

There are some various algorithms are used to hide the information.

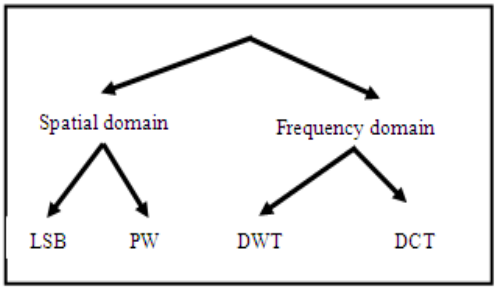

Figure 5 Techniques of watermarking

Spatial domain: Algorithms directly load the raw data into the original image [2]. Spatial watermarking can also be applied using colour separation. In this way, the watermark appears in only one of the colour bands. This renders the watermark visibly subtle such that it is difficult to detect under regular viewing.

Least Significant Bit: Old popular technique embeds the watermark in the LSB of pixels. This method is easy to implement and does not generate serious distortion to the image; however, it is not very robust against attacks [11]. LSB is very sensitive to noise and common signal processing and cannot be used in practical applications.

Patchwork Algorithm: Patchwork is a data hiding technique developed by Bender et al. and published on IBM Systems Journal, 1996 [11]. It is based on a pseudorandom, statistical model. Patchwork imperceptibly inserts a watermark with a particular statistic using a Gaussian distribution [11].

Frequency domain: Compared to spatial-domain methods, frequency domain methods are more commonly applied. The aim is to insert the watermarks in the spectral coefficients of the image. The most commonly used transforms are the Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), the reason for watermarking in the frequency domain, that is the characteristics of the human visual system (HVS) are better captured by the spectral coefficients [4].

Discrete cosine transforms (DCT): DCT represents data in conditions of frequency space relatively than an amplitude space. It is useful, because that corresponds more to the way humans observe light, so the part are not supposed can be identified and thrown away. DCT based watermarking techniques are robust compared to spatial domain techniques. Such algorithms are robust against simple image processing operations like low pass filtering, brightness and contrast adjustment, blurring etc. However, they are difficult to implement and are computationally more costly [18].

Discrete wavelet transforms (DWT): Wavelet Transform is a recent technique frequently used in digital image processing, compression, watermarking etc. The transforms are based on small waves, called wavelet, of varying frequency and limited duration. The wavelet transform decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal [19].

Table1. Comparisons of different watermarking techniques [11 2 10 18]

Algorithm	Advantage	Disadvantage
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.
Patchwork	High level of robustness against most type of attacks.	It can hide only a very small amount of information.
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.

4. RELATED WORK

In 2000, Chen et al.'s [24] proposed an adaptive watermarking scheme. This scheme embeds a binary image as watermark in DCT approach. The watermarked image is imperceptible by human visual system. It uses a feature based method to locate the watermark positions during embedding and extracting. The feature-based method uses the sobel edge-detector to obtain the gradient magnitude and this result is proportional to the amount of watermark bits.In 2008, Wang H. et al. [4] proposed a chaotic watermarking scheme for authentication of JPEG images. The quantized DCT coefficients after entropy decoding are mapped to the initial values of the chaotic system, and then the generated watermark information by chaotic iteration is embedded into JPEG compressed domain. Requantization operation does not invalidate tamper detection due to direct modification of DCT coefficient after quantization. Extraction is also performed in the compression domain. Extraction is fast and

complexity of method is claimed to below.In 2009, Chen et al.[13] proposed a spatial domain watermarking technique based on the idea of incorporating block-wise dependency information in watermarking procedure for thwarting VQ attack without compromising on localization capabilities of the scheme. The block-wise dependency relationship between the blocks of the image is established using fuzzy clustering criteria; a fuzzy C-means algorithm is used for this purpose. This method allows one piece of data to belong to two or more clusters unlike other traditional hard clustering schemes like k-means algorithm that assign data points to a specific cluster. The scheme consists of authentication data embedding procedure and tamper detection procedure.In 2011, Bhattacharya et al. [6] proposed a new approach which makes use of both fragile and robust watermarking techniques. The embedded fragile watermark is used to assess the degradation undergone by the transmitted images. Robust image features are used to construct the reference watermark from the received image, for assessing the amount of degradation of the fragile watermark.In 2011, Yan et al. [7] presented a blind watermarking approach to protect vector geo-spatial data from illegal use. The presented method is rarely affected by data format change, random noise, similarity transformation of the data, and data editing.In 2012, Chen et al. [8] proposed a watermarking technique based on the frequency domain. A modified algorithm is presented to improve the defect of the JPEG quantification in order to reduce the bit error rate (BER) of the retrieved watermark. In Addition, two parameters called controlling factors are used to adjust the value of the DCT coefficient in order to trade-off the qualities between the watermarked images and retrieve watermark. Moreover, the proposed algorithm is design as a blind mechanism. Thus, the original image and watermark are not needed for extracting watermark.In 2012, Kannammal et al. [9] proposed a digital watermarking framework in which the Electrocardiograph (ECG) and Patients demographic text ID act as double watermarks. By this method the medical information of the patient is protected and mismatching of diagnostic information is prevented. Transform domain techniques are in greater use now a days in place of spatial domain techniques as much is known about the properties of these transforms to achieve better watermark characteristics.In 2012, Chitla Arathi [10] presented a semi-fragile watermarking technique based on block based SVD (singular value decomposition). Semi-fragile watermark is fragile to malicious modifications while robust to incidental manipulations .The scheme can extract the watermark without the original image. SVD transformation preserves both one-way and non-symmetric properties that are not obtainable in DCT and DFT transformations. This technique can also detect tamper made on the image.

5. CONCLUSION

In this paper we have obtainable various aspects for digital watermarking like introduction, outline, techniques, and applications. Separately from it a brief and relative analysis of watermarking techniques is presented with their advantages and disadvantages which can help the new researchers in these areas. We also tried to classify the digital watermarking in all the known aspects like robustness, perceptivity, purpose, watermark type, domain, and detection process. In this paper we tried to give the whole information about the digital watermarking which will help the new researchers to get the maximum awareness in this domain.

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