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A Comprehensive Survey on Digital Watermarking- Schemes, Techniques and properties for Color Images

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Abstract -The digital watermarking has attracted significant number of researchers in the early to mid-1990's. Since then many researchers have contributed significant work to protect copyrights of the information owner. Because of its inexpensiveness and speed, the Internet has become the excellent means for distribution of digital media. In order to strengthen the intellectual property right of a digital image, a trademark of the owner could be selected as a watermark and embedded into the protected image. The image that embedded the watermark is called a watermarked image. Then the watermarked image could be published, and the owner can prove the ownership of a suspected image by retrieving the watermark from the watermarked image. According to the retrieved results, we can determine the ownership of the suspected image. In this article, we discuss about need for effective watermarking process and watermark retrieval process, keeping in mind the basic properties; Robustness, Fidelity and Capacity.

Keywords— Robustness, Capacity, Fidelity, Fragile, Semi-Fragile

I. INTRODUCTION

The evolution of computers has contributed well in the field of Information Security and Image Processing. Recent developments in image processing techniques facilitated information hiding in the fields like, Steganography and Digital watermarking etc. However, it is desired that watermarks survive image-processing manipulations such as rotation, scaling, image compression and image enhancement. Data is embedded into an image which may be used to verify its authenticity or the identity of its owners, called digital watermarking. The watermark information, if it is visible in the picture is called visible digital watermarking; if it is not visible is called invisible digital watermarking. If copying of the base signal is done, then the embedded information (watermark) also carried in the copy. A base signal may carry several different watermarks at the same time. Digital watermarking is one of the major sectors of research in the field of Image Processing and Pattern Recognition. Major applications of Digital Watermarking are - Copyright protection, Source tracking (different recipients get differently watermarked content), Broadcast monitoring (television news often contains watermarked video from international agencies), Covert communication etc.

Digital watermarking has been widely used to protect the copyright of digital images. Generally, a practical and useful watermarking scheme has to meet the various requirements.

- A watermarking scheme should resist destruction from standard image processing and malicious attacks. The watermarked image has to survive the legitimate usage such as lossy compressions, conversions, re-samples, and other non-malicious operations. On the other hand, the watermarked image may be incurred in several of the intentional or the unintentional attacks to try to remove the embedded watermark. A robust watermarking scheme has to ensure the retrieved watermark is recognized, when the image quality does not get seriously harmed. Without robustness, an embedded watermark can be removed easily even in a legal procedure, and is unable to be proven.
- A watermark can be embedded into an image as either visible or invisible. The visible watermark is perceptible and is just like noise. It mostly can be removed by a noise removing process. In order to decrease the risk of cracking, most of the proposed watermarking schemes are invisible. On the other hand, the quality of the watermarked image is also important. If the watermark embedding process seriously affects the quality of the watermarked image, the watermarked image will draw the attention of attackers or even lose its value. Therefore, the quality between the original image and the watermarked image should not be seriously degraded.
- The watermark must be able to be easily and securely embedded and retrieved by the owner. Reversible digital watermarking satisfies such requirement. It not only provides the protection of the copyright by embedding the assigned watermark into the original image but also can recover the original image from the suspected image. The retrieved watermark can be used to determine the ownership by comparing the retrieved watermark with the assigned one. Similar to conventional watermarking schemes, reversible watermarking schemes have to be robust against the intentional or the unintentional attacks, and should be imperceptible to avoid the attraction of attacks and value lost. Therefore, the reversible water marking also has to satisfy all requirements of the conventional watermarking such as robustness, imperceptibility, and readily embedding and retrieving.

- Some of the conventional watermarking schemes require the help of an original image to retrieve the embedded watermark. However, the reversible watermarking can recover the original image from the watermarked image directly. Therefore, the reversible watermarking is blind, which means the retrieval process does not need the original image.
- The capable size of embedding information is defined as the embedding capacity. Due to the reversible watermarking schemes having to embed the recovery information and watermark information into the original image, the required embedding capacity of the reversible watermarking schemes is much more than the conventional watermarking schemes. The embedding capacity should not be extremely low to affect the accuracy of the retrieved watermark and the recovered image. The procedure of conventional and reversible watermarking schemes can be illustrated by using the flowcharts in Figure 1. The steps of conventional watermarking and reversible watermarking are similar except there is an additional function to recover the original image from the suspected image. Therefore, the reversible watermarking is especially suitable for the applications that require high quality images such as medical and military images. In addition, there are two research fields often connected with digital watermarking: data hiding (Steganography) and image authentication. The purpose of data hiding is using the cover image to conceal and transmit the secret information. And the purpose of image authentication is to verify the received image whether it be tampered or not. In order to achieve the goals, the data hiding scheme should have a large embedding capacity to carry more secret information, and it has to be imperceptible to keep the secret undetectable. The image authentication schemes also require embedding some information into the protected image, and also has to keep the imperceptibility between the preprocess image and processed image. As in the definition, the goals of the reversible watermarking are to protect the copyrights and can recover the original image. The robustness, imperceptibility, high embedding capacity, readily embedding and retrieving, and blind are the basic criterions of the reversible watermarking. A reversible data hiding scheme and a reversible image authentication scheme can be also defined as the schemes which can recover the original image from the embedded image.
- A fragile watermark is a mark, becomes undetectable after a cover work is modified in any way. For authentication purposes fragility will be an advantage. If a high fragile mark is detected in cover information, it can be stated that the work has probably not been altered since the watermark was embedded and verifying that there has been no malicious alteration.
- A semi-fragile watermark describes a watermark that is unaffected by legitimate distortions, but destroyed by illegitimate distortions. As such, it provides a mechanism for implementing selective authentication. If the distinction between legitimate and illegitimate distortions is roughly based on perceptibility, creating a semi-fragile watermark is similar to creating a robust watermark. After all, the goal of robustness is to ensure that the watermark survives manipulations until the cover Work is so damaged that its value is lost. Beyond that point, we do not care whether a robust watermark survives. With a semi-fragile watermark, we still want to ensure that the watermark survives manipulation up to the point at which the Work's value is lost, but we also want to ensure that the watermark does not survive beyond that point. This often can be achieved by carefully tuning a robust watermark so that it is likely to be destroyed if the distortion exceeds a particular level. The problem of designing a semi-fragile watermark becomes more difficult when the list of legitimate distortions is more specific, as is the case for the medical and legal applications. In these cases, there is a need of mark to survive certain distortions, and not survive others, even when the perceptual impact of the illegitimate distortions may be negligible. Thus, in these circumstances, the semi-fragile watermark must be designed with the specific legitimate distortions in mind. There is a wide variety of distortions that might be considered legitimate, and each distortion might require its own specific type of semi-fragile watermark.This document is a template. An electronic copy can be downloaded from the Journal website. For questions on paper guidelines, please contact the journal publications committee as indicated on the journal website. Information about final paper submission is available from the conference website.

II. LITERATURE SURVEY

(Liu Ping Feng et.al., 2010) have proposed a DWT-DCT based blind watermarking algorithm for copyright protection. (Chou and Liu, 2010) have identified the limitation of the HVS in discriminating colors of small differences does provide a considerable amount of perceptual redundancy in color images. The visual model presented by them measures the perceptual redundancy inherent in three color channels of the host color image and in estimating the JND for each coefficient in the wavelet domain. (Foo Dong, 2010) has proposed an image watermarking scheme, which is very robust against image processing operations and geometric attacks. (Megalingam et. al., 2010) have implemented a novel spatial domain watermarking scheme using Verilog HDL in Xilinx FPGA. (K.Ramanjaneyulu and K.Rajarajeswari: 2010) have presented a novel and oblivious watermarking scheme based on DHT and MDC. (Bravo-Solorio et. al., 2010) have observed that most fragile watermarking methods cannot differentiate among images watermarked with the same key. Furthermore, keeping track of the key used for every single image may become unmanageable when the number of cover images increase significantly. They have revisited Fridrich's scheme as a suitable solution for this problem, and addressed its security limitations in applications where higher localization accuracy is needed. (Ajay Goel et. al., 2010) have introduced several new techniques, which enable large quantities of data hiding in images and video and which implement channel codes such as block, convolution and concatenated odes. (S. Radharani and M.L. Valarmathi, 2010) have presented an overview of the various concepts of content-based image watermarking. (Song et. al., 2010) have

proposed that when the image is transmitted by channels, it is unavoidable that the image is coded by the image compression methods and is tampered by communication noise. Thus, the embedded image compression and communication noise both are desired as the acceptable processing. They presented a novel semi-fragile image watermarking scheme based on wavelet is proposed which is robust to the embedded wavelet compression methods to a pre-determined bit-plane, and is tolerant to the communication noise (*e.g.* Gaussian noise and Salt & Pepper noise) to some extent at the same time, but rejects other malicious attacks.

(Franklin Rajkumar.V et.al., 2011) presented an entropy based robust watermarking scheme using Hadamard transformation technique. Rajesh B Raut (2011) presents a color image watermarking scheme using Just Noticeable Difference (JND) Sampling Technique in spatial domain. The quantization levels have been computed using the technique for each of the basic colors R, G and B respectively for sampling color images. A watermark is scaled to half JND image and is added to the JND sampled image at known spatial position. For transmission of the image over a channel, the watermarked image has been represented using Reduced Biquaternion (RB) numbers. The original image and the watermark are retrieved using the proposed algorithms. The detection and retrieval techniques presented in this paper have been quantitatively benchmarked with a few contemporary algorithms using MSE and PSNR. They quote "proposed algorithms outperform most of them". Fengmei LIANG, Lijia WANG (2011) proposed an improved color image watermark algorithm based on wavelet transform. According to the different thresholds, a binary image is embedded in the low frequency and medium frequency component of the wavelet decomposition, which made great improvement on invisibility and quantity of embedded information. Detection process does not require the original image and other additional data, which increases the speed of watermark detection. (Siau Chuin Liew and Jasni Mohd. Zain, 2011) have proposed a scheme that is reversible and has tamper localization and recovery capability for the usage in ultrasound images. (Peng Zhu and Mingsheng Zhao, 2011) have proposed a color image watermarking algorithm based on iteration mapping. (Bibi Isac and V. Santhi, 2011) have worked on digital image and video watermarking schemes using neural networks.

(Rama Seshagiri Rao Channapragada et.al., 2012), proposed digital watermarking algorithm based on CCC - FWHT technique. Dolley Shukla and Manisha Sharma (2012) quoted that Watermarking for copy protection is a new and emerging area of research, It may be unlikely that a bullet-proof solution will ever be found, but the discussions are converging on what technical mechanisms should be involved and against what these can protect. Dhandapani Samiappan and Krishnan Ammasai (2012) here they proposed digital color image watermarking algorithm which is blind and robust. The watermarking technique embeds the watermark in the Discrete Wavelet Transform (DWT) domain. The watermark is a binary logo and is embedded in the subband of the wavelet decomposition. It is demonstrated that the proposed watermarking technique is robust to several attacks like JPEG compression, Gaussian filtering, median filtering, sharpening, rotation, scaling, cropping, Gaussian noise and salt and pepper noise. Satyanarayana Murty.P et.al (2012) In this paper they proposed three semi-blind reference watermarking algorithms. Those algorithms were DCT-SVD, DWT-SVD and DWT-DCT-SVD. The watermark was visually meaningful gray scale image. In the proposed algorithms DWTSVD has good imperceptibility. In the proposed algorithms, the DCT-SVD was superior to the other two algorithms in additive Gaussian noise and cropping attacks. For remaining attacks they found that DWT-DCT-SVD algorithm has good robustness when compared with other two algorithms. P.B.Khatkale et.al (2012) presented a new high capacity frequency domain blind algorithm for color digital image watermarking; this algorithm uses the green channel for watermarking embedding. By comparison the proposed algorithm to others, they conclude that the maximum numbers of bits that can be hidden and recovered successfully from the watermarked images have been increased. They observed relatively good performance for the embedding process for an embedding strength. It has also been demonstrated that for this embedding strength the signature is immune to a variety of attacks, including filtering, contrast balancing, compression, and geometrical transforms such as resizing. Image Adaptive Self Embedding Watermarking is robust against various attacks performed. They also concluded that the use of semi-fragile property helps to detect the location of fraud in the image and especially in the field of cyber frauds, court evidences, and certificate or identity forgery and even in the preservation and transmission of cultural heritage images. Priyanka D. Godase et.al (2012) presented robust digital watermarking for color images using fuzzy vault. They selected the DCT algorithm to do the application test of digital image copyright protection. They quoted that the "experiment proves DCT-based watermark can well withstand a variety of image processing, and the watermark can survive after compression, cropping, and other attacks". Th. Rupachandra Singh et.al (2012) proposes an image watermarking scheme based on visual cryptography in discrete wavelet transform. Experiments are conducted to demonstrate that the proposed scheme is robust against median filtering, scaling, JPEG compression, injection of impulse noise, injection of Gaussian noise, blurring, sharpening, Gamma correction, cropping, rotation attacks etc.

(Bhupendra Ram 2013) has proposed digital image watermarking technique using discrete wavelet transform and discrete cosine transform and shown improved resistance to attacks on the watermark, and demonstrated that this proposed technique is robust to most of the signal processing techniques and geometric distortions. (K. Chaitanya et.al., 2013) have developed the digital color image watermarking scheme using DWTDCT coefficients in RGB Planes. (Pratibha Sharma and Shanti Swami 2013), have devised a digital image watermarking technique using 3 level discrete wavelet transform and demonstrated that quality is dependent on scaling factors. (D.Phani Kumar et.al., 2013), presented a contrast based color watermarking scheme using Lagrange Polynomials Interpolation in Wavelet Domain. (Abdelhamid Benhocine et.al., 2013) have proposed new image watermarking scheme based on singular value decomposition. (Huming Gao et.al., 2013), have presented digital watermarking algorithm for color image based on DWT. (Hongshou Yan, Weimin Yang2013), proposed a watermarking algorithm based on wavelet and Hadamard transform for color image. (Aris

Marjuni et.al., 2013), have presented an improved DCT-Based image watermarking scheme using Fast Walsh Hadamard Transform. Neha Chauhan et.al (2013) have addressed the attack detection in watermarked images with PSNR and RGB intensity. In this paper they introduced the new solution based image watermark detection method that is used to recover the geometrically distorted image before detecting the watermark. it can be implemented by the blind based DWT based watermarking scheme. Wadood Abdul et.al (2013) have proposed Error correcting codes for robust color wavelet Watermarking. This article detailed the conception, design, development and analysis of invisible, blind and robust color image watermarking algorithms based on the wavelet transform. Using error correcting codes, the watermarking algorithms are designed to be robust against intentional or unintentional attacks such as JPEG compression, additive white Gaussian noise, low pass filter and color attacks (hue, saturation and brightness modifications). Considering the watermarking channel characterized by these attacks, repetition, Hamming, Bose Chaudhuri Hocquenghem and Reed-Solomon codes are used in order to improve the robustness using different modes and appropriate decoding algorithms. And also they compared the efficiency of different type of codes against different type of attacks. Henri Bruno Razafindradina et.al (2013) proposed a "robust" watermarking method that adds TW component of the mark, after Schur decomposition, in the DCT of the host image. UW component of the brand is used as a key for decoding because the watermarker must possess it before extraction. This technique could be used to watermark digital signatures with the photo of the owner, but there is a need to improve resistance to geometric attacks such as rotation. This outlook will turn to a variant of the method that is very robust against the geometric attacks by combining the transformations that are resistant to geometric attacks such as Fourier transform. It could also be considered that replacing the DCT by the DLT transform which is much more efficient. Finally to improve the imperceptibility, it could be imagined a scheme based on WHT transform. Kranti Burman, Rahul Gedam (2013) used LSB for watermarking, clarity is enhanced by modifying the algorithm slightly not making it complex. This work also enhanced the visibility and robustness of the watermark. In this work, they have proposed a new scheme for authenticating 24-bit RGB images. By embedding R, G, B component of watermarking image in the R, G, B component of original image, the scheme is capable of representing the 3d histogram of image. Histogram basically used for color enhancement, multi resolution histogram, resolution selection. The histogram of R, G, and B model is used in color monitor (CRT & LCD), video cameras. Ching-Yu Yang (2013) has presented a novel watermarking scheme for color images based on the RWM and the feature-embedding technique. The combined use of the RWM decision policy, X sampling technique, and directional-sampling technique showed that the stego-images generated using the proposed scheme are robust against various manipulations, such as compression, color quantization, bit truncation, noise addition, cropping, blurring, mosaicking, zigzagging, inversion, (edge) sharpening, and so on. The stego-images perform well in resisting attacks from JPEG2000 compression and JPEG compression. The extracted watermarks are recognized, even if the stego-images have been compressed by JPEG2000 with a compression ratio of approximately 195. A steganographic method based on the RWM decision policy with the LSB substitution technique was suggested to provide an extra option for people to hide their private data (or sensitive messages). Experiments confirmed that the perceived quality of the stego-image is desirable, whereas the PSNR is high. The payload generated using the proposed method is also superior to that generated by existing approaches. Alimohammad Latif (2013) has proposed an adaptive scheme for digital image watermarking using parametric slant-Hadamard transform . this scheme is a key dependent method and makes it more stable, compare with other existing algorithms such as DCT.

(Piyush .V. Gattani and C. S. Warnekar,2014) suggested a new invisible digital watermarking scheme for color images based on the amalgamation of wavelet transform (SWT2) with singular value decomposition (SVD), and advanced encryption scheme (AES). (Anu Bajaj,2014) surveyed that still there is a necessity in order to significantly improve performance of digital watermarking. New secure techniques can be proposed for copyright protection so that the performance of algorithms can be enhanced by combining with security techniques. Most of the work had been done for increasing the robustness of the techniques, but there are some applications like tamper proofing which require fragile watermarks; new techniques can be proposed for fragility. New schemes for medical images can be proposed for medical database. (Shuchi Sirmour, Archana Tiwari, 2014) developed a hybrid DWTSVD based algorithm for watermark embedding and extracting process. The suggested method is performed by modification on singular value decomposition of images in Discrete Wavelet Transform (DWT) domain. Modification of the appropriate sub-bands leads to a watermarking scheme which favorably preserves the quality. They shown good robustness by using hybrid DWT-SVD method in comparison with DWT based watermarking algorithm using Haar wavelet. (S.Manikanda prabu and Ayyasamy, 2014) have proposed a watermarking algorithm based on DWT and FFT Approach. (Apoorv Tiwari et.al., 2014) have developed digital image watermarking using fractional Fourier Transform with Different Attacks. (M. Kim et.al., 2014) proposed an algorithm that has improved the extraction performance by accurately extracting the hidden information in the 2D barcode from the detected watermark. Also, combining the dual transform method, DWT and DFRNT, has improved the imperceptibility and robustness of the watermark against basic image signal processing attacks. (Hongqin Shi et.al.,2014) presented a new color watermark embedding technique with circulation, based on non-overlapping Singular Value Decomposition (SVD) for hiding important information in images.(Kaushal R. Patel and Nabila Shaikh, 2014) proposed a Robust color image watermarking based on DWT-HT.An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

III. METHODOLOGY

Digital Watermarking process involves binding up of cover information and secret information through effective embedding process and effective retrieval of secret information. The Fig.1 depicts the conventional digital watermarking scheme.

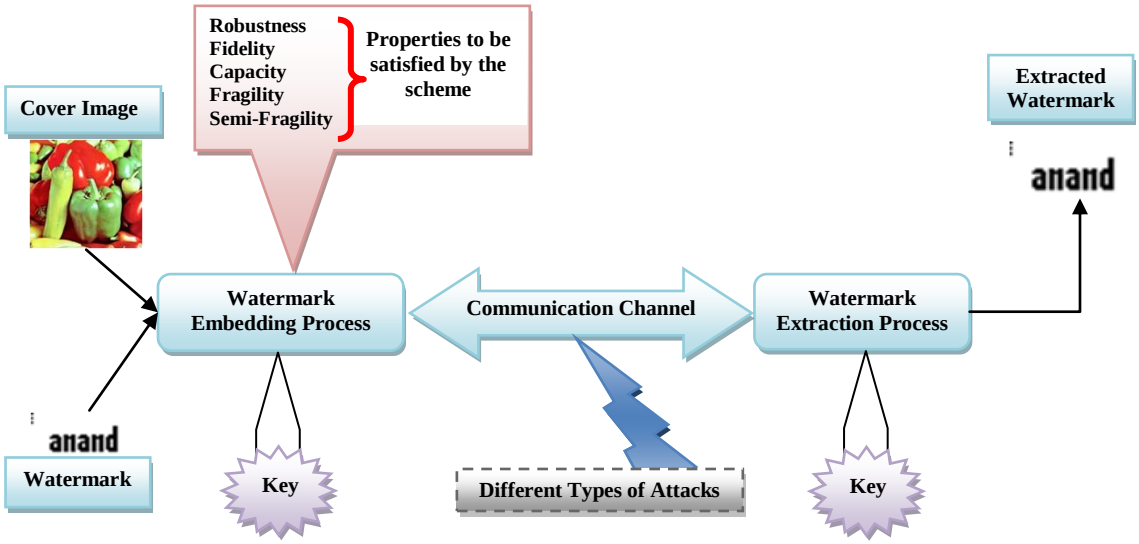

Fig.1 Conventional Watermarking Scheme

There is need for an effective watermarking system to be introduced. The requirements are application-dependent, but some of them are common to most practical applications.

- **i.** By using a secret key to generate the watermark for security purpose.
- **ii.** Hiding the watermark in such a way that the watermark is impossible to notice. However, this requirement conflicts with other requirements such as robustness, which is an important requirement when facing watermarking attacks. For this purpose, the characteristics of the human visual system (HVS) for images are exploited in the watermark embedding process.
- **iii.** An unauthorized person should not detect the watermark by means of statistical methods. For example, the availability of a great number of digital works watermarked with the same code should not allow the extraction of the embedded mark by applying statistically based attacks. A possible solution is to use a content dependent watermark.
- **iv.** Resistance to geometric manipulations, such as translation, resizing, rotation and cropping.

IV. CONCLUSIONS

Several watermarking schemes and techniques are used for wide range of applications. Still there is a scope to examine and determine the suitability of a watermarking scheme with respect to properties like; fidelity, capacity and robustness. Detecting the watermark in many types of distortions, such as lossy compression, filtering, resizing, contrast enhancement, cropping and rotation by measuring the higher psnr and correlation. Estimating the capacity of cover image to insert watermark without affecting the quality of the cover image. Achieving the high perceptual similarity between cover image and watermarked image by measuring the higher psnr. Devising very high fragile watermarking scheme by measuring the lower psnr and correlation. Minimizing false-negative / positive-error in the absence of attacks or signal distortions. Content based watermarking can also be done by increasing the capacity of the watermark and its robustness by preserving the invisibility of the watermark.

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