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A Review on Colour Image Watermarking based on Wavelet and QR Decomposition

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Abstract - A digital watermarking technique is an alternative method to protect the intellectual property of digital images. This paper presents a hybrid blind watermarking technique formulated by combining RDWT with SVD considering a tradeoff between imperceptibility and robustness. Watermark embedding locations are determined using a modified entropy of the host image. Watermark embedding is employed by examining the orthogonal matrix U obtained from the hybrid scheme RDWT-SVD. In the proposed scheme, the watermark image in binary format is scrambled by Arnold chaotic map to provide extra security. Our scheme is tested under different types of signal processing and geometrical attacks. The test results demonstrate that the proposed scheme provides higher robustness and less distortion than other existing schemes in withstanding JPEG2000 compression, cropping, scaling and other noises. Hybrid image watermarking technique is proposed in this paper which takes the advantages of different transforms like RDWT, DCT, SVD and trigonometric functions. So, all the functions are combined at one place to create a non-blind, robust and reversible watermarking scheme. The algorithm is verified on different format host images and different intensity watermarks. To measure the effectiveness of the method, the correlation based extraction mechanism is used with the tolerance level of 0.8 for robustness. And PSNR is measured to check fidelity of watermarked and extracted original image. The experimental results show that the algorithm is robust against many attacks like rotation, scaling, blurring, contrast, JPEG Compression, histogram equalization, affine transformation, mean filtering, Gaussian noise. NCC remains above tolerance level even when the image is completely distorted and also the visual quality of extracted original image is indistinguishable. It can be used for various applications like copyright protection, ownership problems, content verification, authentication and sensitive applications which require high robustness and reversibility of the original content.

Keywords: *digital watermarking, redundant discrete wavelet transform, DCT, SVD, non-blind, —blind watermarking technique; modified entropy; watermark insertion; watermark extraction; redundant wavelet transform I*

1. INTRODUCTION

A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as audio, video or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for banknote authentication. Like traditional physical watermarks, digital watermarks are often only perceptible under certain conditions, i.e. after using some algorithm. If a digital watermark distorts the carrier signal in a way that it becomes easily perceivable, it may be considered less effective depending on its purpose. Traditional watermarks may be applied to visible media (like images or video), whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models. A signal may carry several different watermarks at the same time. Unlike metadata that is added to the carrier signal, a digital watermark does not change the size of the carrier signal. The needed properties of a digital watermark depend on the use case in which it is applied. For marking media files with copyright information, a digital watermark has to be rather robust against modifications that can be applied to the carrier signal. Instead, if integrity has to be ensured, a fragile watermark would be applied.

Both steganography and digital watermarking employ steganographic techniques to embed data covertly in noisy signals. While steganography aims for imperceptibility to human senses, digital watermarking tries to control the robustness as top priority. Since a digital copy of data is the same as the original, digital watermarking is a passive protection tool. It just marks data, but does not degrade it or control access to the data. One application of digital watermarking is *source tracking*. A watermark is embedded into a digital signal at each point of distribution. If a copy of the work is found later, then the watermark may be retrieved from the copy and the source of the distribution is known. This technique reportedly has been used to detect the source of illegally copied movies.

1.1 Mobile Experiences and Watermarking

The watermarks can be easily embedded into all forms of media content, including magazines, newspapers, packaging, posters, brochures and more. And, unlike 2D barcodes or QR codes that are being used in some mobile campaigns, digital watermarks are imperceptible to humans and do not take up precious space on printed materials, making the technology much more "brand friendly". The digital ID in the watermark can be matched to a URL in a backend database that is then returned to the consumer' phone. The opportunities and experiences enabled by the technology include proprietary content for paid subscribers, contests and promotions, video contents, games etc.

1.2 Biometric Authentication

Biometric authentication is a security process that relies on the unique biological characteristics of an individual to verify that he is who is says he is. Biometric authentication systems compare a biometric data capture to stored, confirmed authentic data in a database. If both samples of the biometric data match, authentication is confirmed. Typically, biometric authentication is used to manage access to physical and digital resources such as buildings, rooms and computing devices.

Once seen mostly in spy movies (where it might be used to protect access to a top-secret military lab, for example), biometric authentication is becoming relatively commonplace. In addition to the security provided by hard-to-fake individual biological traits, the acceptance of biometric verification has also been driven by convenience: One can't easily forget or lose ones biometrics. The oldest known use of biometric verification is fingerprinting. Thumbprints made on clay seals were used as a means of unique identification as far back as ancient China. Modern biometric verification has become almost instantaneous, and is increasingly accurate with the advent of computerized databases and the digitization of analog data.

1.3 Image Processing

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually **Image Processing** system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too. *Image processing basically includes the following three steps*. Importing the image with optical scanner or by digital photography. Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs. Output is the last stage in which result can be altered image or report that is based on image analysis.

1.4 Cryptography

Cryptography is a method of protecting information and communications through the use of codes so that only those for whom the information is intended can read and process it. The pre-fix "crypt" means "hidden" or "vault" and the suffix "graphy" stands for "writing." In computer science, cryptography refers to secure information and communication techniques derived from mathematical concepts and a set of rule-based calculations called algorithms to transform messages in ways that are hard to decipher.

These deterministic algorithms are used for cryptographic key generation and digital signing and verification to protect data privacy, web browsing on the internet and confidential communications such as credit card transactions and email.

2. TRADITIONAL METHODS

This research presents a watermarking scheme using RDWT combined with SVD for protecting copyrights. Our scheme utilizes a modified entropy to determine the embedding regions with less distortion. A watermark image is scrambled by Arnold transform to provide extra security of the confidential information. The scrambled watermark is embedded in the host image by examining U3, 1 and U4, coefficients obtained from RDWT-SVD used on the host image. Our scheme is tested against different types of signal processing and geometric attacks. Test results of our scheme show an improvement in terms of SSIM values and NC values compared to other existing schemes. The proposed scheme confirms satisfactory results, however, our scheme requires little higher computational cost due to Arnold transform and RDWT. It can be accepted because our aim is to improve the robustness against different types of attack. [1]

There has been a remarkable increase in the data exchange over web and the widespread use of digital media. The mounting interest with reference to digital watermarking throughout the last decade is certainly due to the increase in the need of copyright protection. Applications of video watermarking in copy control, broadcast monitoring, finger printing, video authentication, copyright protection etc is immensely rising. The main aspects of information hiding are capacity, security and robustness. The skill of anyone detecting the information is security and robustness refers to the resistance to modification of the cover content before concealed information is destroyed. Video watermarking algorithms normally prefers robustness. In robust algorithm it is not possible to eliminate the watermark without rigorous degradation of the cover content. In this paper, we introduce the notion of Video Watermarking and features required to design a robust watermarked video for valuable application and focus on various domains of video watermarking techniques.

Technique the watermark design and the watermark insertion procedures do not involve any transforms. Simple techniques like addition or replacement are used for the combination of watermark with the host signal and embedding takes place directly in the pixel domain. The watermark is applied in the pixel or coordinate domain the main strengths of pixel domain methods are that they are conceptually simple and have very low complexities. As a result they have proven computational to be most attractive for video watermarking applications where real-time performance is a primary concern. However, they also exhibit some major limitations: The need for absolute spatial synchronization leads to high susceptibility to de-synchronization attacks lack of consideration of temporal axis results in vulnerability to video processing and multiple frame collusion and watermark optimization is difficult using only spatial analysis techniques. In the paper we revised various video watermarking technique proposed in the literature in various domains. New approaches are expected to come out and may merge existing approaches. For example cascading two powerful mathematical transforms; the Discrete Wavelet Transform (DWT) and the Singular Value Decomposition (SVD). The two transforms are different transform domain techniques and thus provide different, but complementary, levels of robustness against the same attack.[2]

In this paper, a algorithm based video watermarking scheme in the discrete wavelet transform (DWT) domain is proposed. Scene change analysis is first conducted to decompose video into different scenes. Each frame of the video is transformed to wavelet domain by DWT. The watermark image is decomposed into 8-bit planes, scrambled and embedded into the mid-frequency DWT coefficients. The quality of the watermarked video is enhanced by GA. Experimental results demonstrate that it is robust to common attacks in video watermarking such as frame dropping, frame averaging additive noise and lossy compression.

In this paper I propose a scene-based watermarking scheme. The scheme is robust against various attacks because we does not require original video as well as watermarked video for original video and watermark video recovery. Experiment has been done on these novel video watermarking schemes to test an show its performance. The robustness of our approach is demonstrated using the calculation of NC.[3]

Digital video contents now become easily available through internet and various medium. Easy availability made digital video more popular than analog media. And it attains a sharp attention regarding its ownership. The ownership integrity can be easily violated using different video editing software. In this regard we are proposing a chip level framework in accordance with our already proposed LSB framework for video that is able to embed a color watermark logo into the video frames of a video content. The quality of original video won't degrade, because in watermarked video, the color watermark is perceptually invisible to Human Visual System (HVS). As we are proposing blind extraction scheme, at the time of extraction prior knowledge of that watermark or the original video is not required. The security is also employed with a hash function and a secret key. If a forger tries to perform watermark extraction with an inappropriate key he'll get a video frame which resembles noise. We named our proposed chip informally as BLIND CHIP as we've used blind extraction method. The robustness of the proposed framework is also proven against different intentional attacks.

Detailed experiment has been performed and it is found that our proposed framework is able to embed color watermark into video sequence in a very efficient manner and more over it ensures the persistency of quality of watermarked video. In watermarked video, the watermark is perceptually invisible to HVS. The extraction has done blindly i.e., neither the watermark nor the original video is needed at the time of watermark extraction. The security issue has enhanced with a secret key and hash function. Through the chip based solution the portability is also enhanced that takes us to greater horizon such as mobile communication. Our proposed system is proven robust against intentional attacks. The limitation of proposed system is high computational complexity and need of uncompressed video for watermark embedding. For that reason the proposed framework is not suitable for real time video streaming like broadcast monitoring where embedding and extracting the watermark is performed in real time. But our system is extremely appropriate in other application fields like copyright protection, fingerprinting, copy control of DVD, TV shows those are not encoded and broadcasted in real time. As a future research scope we'll extend our proposed framework related to video compression like MPEG-4, MJPEG etc. [4]

The sudden increase in watermarking interest is most likely due to the increase in concern over copyright protection of content. With the rapid growth of the Internet and the multimedia systems in distributed environments, digital data owners are now easier to transfer multimedia documents across the Internet. However, current technology does not protect their copyrights properly.

This leads to wide interest of multimedia security and multimedia copyright protection and it has become a great concern to the public in recent years. In the early days, encryption and control access techniques were used to protect the ownership of media. Recently, the watermarking techniques are utilized to keep safely the copyrights. In this thesis, a fast and secure invisible video watermark technique has been introduced. The technique based mainly on DCT and Low Frequency using pseudo random number (PN) sequence generator for embedding algorithm. The system has been realized using VHDL and the results have been verified using MATLAB. The implementation of the introduced watermark system done using Xilinx chip (XCV800). The implementation results show that the total area of watermark technique is 45% of total FPGA area with maximum delay equals 16.393ns. The experimental results show that the two techniques have mean square error (MSE) equal to 0.0133 and peak signal to noise ratio (PSNR) equal to 66.8984db. The results have been demonstrated and compared with conventional watermark technique using DCT.

Watermarking is a copy protection system that allows tracking back illegally produced copies of the protected multimedia content. The main advantage of watermarking is that the watermark is embedded permanently in visual data of the content but at the cost of slight loss in fidelity. After noticing the importance of the multimedia security and video watermarking in nowadays internet world and reviewing the state-of-the-arts technologies of the audio watermarking, image watermarking and video watermarking, a video watermarking scheme is proposed. [5]

Currently, robust, invisible double digital watermarking technology becomes the most popular and challenging direction, it has aroused great concern in the international community in recent years. The single watermark algorithms always merely have single function. In order to overcome the drawbacks, a multi-purpose dual watermark algorithm based on wavelet transform and image partition is presented in the paper. The algorithm embeds both robust watermark and fragile watermark to one video sequence by using DWT and multiple embedded methods. The later embedded fragile watermark is served for the early robust watermark. The experiment results show the proposed algorithm is more robust and imperceptible, and it can achieve copyright protection and content authentication at the same time.

This paper presents a video dual watermarking algorithm, it has the advantages of strong robustness for robust watermarking, and sensitive tampering and tamper localization for fragile watermark. It scrambes binary image by using chaotic encryption technology. Through HVS, watermark is selectively embedded in blocks which is more secretive with the human visual system, it enhances shear capacity of the watermark, improves the watermark invisibility. Experimental results show the algorithm solves the contradiction between robustness and invisibility, and it is good at robustness to shearing, JPEG compression, and noise attacks.[6]

Secret image sharing is introduced into the scheme of watermark generation in this paper, secret image sharing can reduce the amount of information bits substantially that embedded into video cover while guaranteeing the watermarking authentication. Base on this scheme a blind video watermarking algorithm for copyright protection is proposed, the value of the selected coefficient is modified adaptively according to the energy value of neighboring coefficients and the binary watermark bits.

Experimental data show that the proposed algorithm improves the watermarking robustness against some common signal processing attacks liking salt-pepper noise and re-compression while maintaining the high video quality.

In this paper, an adaptive video watermarking scheme on H.264 has been proposed. First, introduce the idea of secret sharing into the scheme of watermark generation algorithm; then we propose a secret image sharing method derived from the (t, n) threshold scheme. The original watermark is decomposed into n copies of the shadow, choose a shadow as the watermark to be embedded in, the remaining n-1 copies of shadow are saved for verification key, the proposed method can save a lot of redundancies. Base on the (n, n) threshold scheme, we propose a blind DCT-domain video watermarking scheme, the value of the selected coefficient is modified according to the energy value of neighboring coefficients and the binary watermark bits adaptively. The experimental results show that this method improves the watermarking robustness while maintaining the high video quality.[7]

Digital video is one of the popular multimedia data exchanged in the internet. Due to its perfectly replicable nature many illegal copies of the original video can be made. Methods are needed to protect copyrights of the owner and prevent illegal copying. A video can also undergo several intentional attacks like frame dropping, averaging, cropping and median filtering and unintentional attacks like addition of noise and compression which can compromise copyright information, thereby denying the authentication. In this paper, the design and implementation of scene based watermarking where

extraction will be a blind method, is proposed. The developed method embeds 8 bit-plane images, obtained from single gray scale watermark image, into different scenes of a video sequence. In this algorithm, some of the luminous values in the video pictures are selected and divided into groups, and the watermark bits are embedded by adjusting the relative relationship of the member in each group. A sufficient number of watermark bits will be embedded into the video pictures without causing noticeable distortion. The watermark will be correctly retrieved at the extraction stage, even after various types of video manipulation and other signal processing attacks.

With Multimedia becoming more and more popular and readily accessible, the copyright and ownership issues also assume significant importance. The design and implementation of blind watermarking algorithm for uncompressed video is proposed. The algorithm successfully embeds bit plane watermark bits into the luminous pixel value for each video frames. Scene change detection algorithm is used for detecting scenes in the video. In each scene same bit plane image is embedded and different scene contains different bit plane image. The extraction process is blind and the watermark can be extracted without any distortion from the watermarked frame. Experimental results demonstrate that the proposed technique is robust against attacks such as frame dropping, temporal shifts and addition of noise. Robustness of the scheme can be further improved by combining video with audio watermarks. This can considerably increase the robustness of the watermark since most of the specified attacks are on the video channel. [8]

Due to the extensive use of digital media applications, multimedia security and the copyright protection has gained tremendous important. Digital watermarking is a technology used for the copyright protection of digital application.

In this paper we have compressive approach for digital video watermarking is introduced, were watermark image is embedded in to the video frame each video frame is decomposed in to sub images using 2 level Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) Transform is applied for each block in the two bands LL & HH. [1, 2] combining the two transform improved the performance of the watermark algorithm. The scheme is tested by various attacks. Experimental result shows no visible difference between watermark frame and original video frame, it shows the robustness against a wide range of attack such as Gaussion noise, salt & pepper Noise, median filtering, rotation, cropping etc. The Proposed scheme is tested using number of video sequences .its experimental result shows high imperceptibility where there is no noticeable difference between the watermark video frame and original video frame. Without attacking any noise on to the watermark video frame the computed normalized correlation (NC) is 1 and Peak Signal to Noise Ratio (PSNR) having high Score which is 44.097. The algorithm implemented using DWT-PCA is robust and imperceptible in nature and embedding the watermark in LL sub band helps in increasing the robustness of embedding procedure without much degradation in the video quality. [9]

In this paper, we presents a novel fast and robust video watermarking scheme for RGB uncompressed AVI video sequence in discrete wavelet transform (DWT) domain using singular value decomposition (SVD). For embedding scene change detection is performed. The singular values of a binary watermark are embedded within the singular values of the LL3 sub-band coefficients of the video frames. The resultant signed video exhibits good quality. To test the robustness of the proposed algorithm six different video processing operations are performed. The high computed PSNR values indicate that the visual quality of the signed and attacked video is good. The low bit error rate and high normalized cross correlation values indicate a high correlation between the extracted and embedded watermark. Time complexity analysis shows that the proposed scheme is suitable for real time application. It is concluded that the embedding and extraction of the proposed algorithm are well optimized. The algorithm is robust and shows an improvement over other similar reported methods.

In the present work, a novel fast and robust DWT-SVD based video watermarking algorithm is proposed. The singular values of the LL3 sub-band coefficients are modified by the singular values of the binary watermark image. The low time complexity of proposed algorithm makes it suitable for watermarking of video on a real time scale. The computed values of all parameters are within the expected range. The perceptible quality of the video frames is very good as indicated by high PSNR values. Watermark recovery is also found to be good as indicated by high cross correlation values and low bit error rate between embedded and extracted watermarks. It is concluded that the embedding and extraction of the proposed algorithm are well optimized. The algorithm is robust and shows an improvement over other similar reported methods. [10]

There has been a remarkable increase in the data exchange over web and the widespread use of digital media. The mounting interest with reference to digital watermarking throughout the last decade is certainly due to the increase in the need of copyright protection.

Applications of video watermarking in copy control, broadcast monitoring, finger printing, video authentication, copyright protection etc is immensely rising. The main aspects of information hiding are capacity, security and robustness. The skill of anyone detecting the information is security and robustness refers to the resistance to modification of the cover content

before concealed information is destroyed. Video watermarking in robust algorithm algorithms it is normally not possible prefers to eliminate the watermark without rigorous degradation of the cover content. In this paper we first perform a survey on available video watermarking techniques then we perform a comparative analysis based on robustness and computational complexity of different watermarking algorithms.

We have reached the conclusion that robustness, geometric attack, imperceptibility, PSNR (Peak Signal to Noise ratio) & NC (Normalized Correlation) are the most important requirements for a watermarking system. The performance analysis shown in this paper for different watermarking techniques is considering different Parameters. From the literature survey the performance is analyzed accordingly poor, acceptable and good. By observing this paper one can say the DWT (Discrete Wavelet Transform) and PCA (Principle Component Analysis) techniques have superior performance as compared to other techniques. [11]

Today's life internet offers great convenience in transmitting large amount of data in different parts of the world. However, the safety and security of long distance communication remains an issue. In order to solve this problem has led to the increase in the need of copyright protection. The application of video watermarking in copy control, broadcast monitoring, copyright protection, video authentication, finger printing, annotation etc. is immensely rising. The main objectives of video watermarking are undetectability, robustness, and capacity of hidden data. Video watermarking algorithms normally prefers robustness. In this paper, techniques used in video watermarking are discussed with the literature survey and then the shortcoming are analyzed and as conclusion proposal for new points for hiding watermark in video is given. This paper is study of various video watermarking techniques given by researcher till now but after study it is concluded that the previously techniques are not that much efficient to provide security and these techniques are very common in the field so can be detected very easily by hackers for extraction of watermark inserted in videos. So there is need for new robust technique which will be able to hide watermark at such place in frames so cannot be extracted easily and provide more security over video watermarking old techniques. For this as a new research in same field an algorithm with efficient point finding will be proposed to hide watermark in video to provide robust and secured watermarking.[12]

3. METHODOLOGY

The process of watermark insertion is described in Algorithm 1 and Fig. 1. A watermark image is embedded by examining the entries $U3, 1$ and $U4, 1$ of the 1st column of U. The relationship between these coefficients is considered to determine watermark bit of 0 or 1.

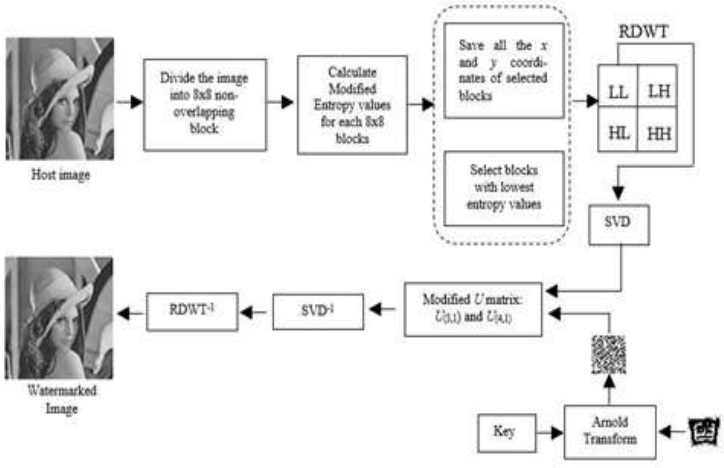

Figure1: Watermark insertion.

Algorithm 1: Insertion process

Input: Host image, watermark; T=0.055

Pre-processing:

Step 1: A host image is divided into 8×8 pixels.

Step 2: Compute a modified entropy for each non-overlapping block

Step 3: Select blocks that have lowest modified entropy values and save the location coordinates.

Step 4: A binary watermark is scrambled using Arnold chaotic using a secret key.

Watermark Insertion:

Step 5: Selected blocks are transformed using RDWT, the first level of LL sub-band coefficients is applied by SVD.

Step 6: The following rules are used to embed the watermark bits:

Rule 1: if the $U3$, 1 or $U4$, 1 coefficient are negative values, then x= -1, α= -T, otherwise if the $U3$, 1 or $U4$, 1 coefficients are positive, we set x= 1, α= T. Then, calculate the average $U3$, 1 and

$U_{4,1}$ coefficients by: $m = \frac{|U_{3,1}| + |U_{4,1}|}{2}$

Rule 2: if the binary watermark bit =1,

$$U3, 1 = x \cdot m + \alpha/2,\ U4, 1 = x \cdot m - \alpha/2$$

Rule 3: if the binary watermark bit =0,

$$U3, 1 = x \cdot m - \alpha/2,\ U4, 1 = x \cdot m + \alpha/2$$

Post-processing after embedding:

Step 7: Apply the inverse SVD, then perform the inverse RDWT on each selected block.

Output: Watermarked image containing a logo *B. Extraction Algorithms*

Steps of watermark extraction are given in Algorithm 2 and Fig. 2.

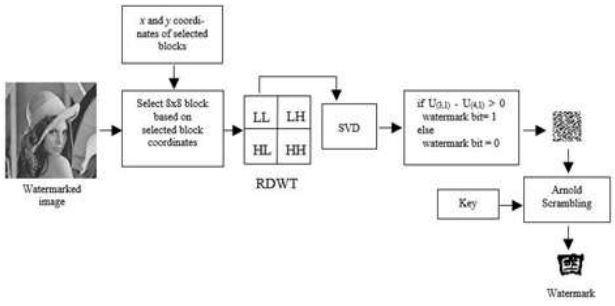

Figure2: Watermark extraction.

Algorithm 2: Extraction process

Input: Watermarked image; selected block locations

Pre-processing:

Step 1: The selected block locations are utilized to extract the watermark. Selected regions are split into 8×8 pixels.

Step 2: Apply the first level of RDWT on each selected block.

Step 3: Decompose LL sub-band of RDWT coefficients using SVD into U, S and V.

Watermark extraction:

Step 4: $U3, 1$ and $U4, 1$ coefficient are used to determine the watermark bits using a rule as follows:

If $|U3, 1| - |U4, 1| > 0$, then set the watermark bit =1, else the watermark bit = 0.

Post-processing:

Step 5: After extraction process, apply the inverse Arnold transform using the same key to recover the watermark image.

Output: Watermark extraction

4. CONCLUSION

This research presents a watermarking scheme using RDWT combined with SVD for protecting copyrights. Our scheme utilizes modified entropy to determine the embedding regions with less distortion. A watermark image is scrambled by Arnold transform to provide extra security of the confidential information. The scrambled watermark is embedded in the host image by examining U3, 1 and U4, 1 coefficients obtained from RDWT-SVD used on the host image. Our scheme is tested against different types of signal processing and geometric attacks. Test results of our scheme show an improvement in terms of SSIM values and NC values compared to other existing schemes. The proposed scheme confirms satisfactory results, however, our scheme requires little higher computational cost due to Arnold transform and RDWT. It can be accepted because our aim is to improve the robustness against different types of attack.

5. AUTHORS REVIEW

Authors are review many papers and they found Design & Development of a Hybrid Algorithm for Watermarking of Color Images Using Wavelet Decomposition, QR Code Decomposition, Cryptography, & other allied techniques. Design of Suitable Algorithms for Improving the Recovery Probability of Watermarks in Tampered, Cropped & Noisy Images. Design of Suitable Algorithms for Handling Compression of Watermarked Images Using Various Lossy & Lossless Methods. Development of Multi-Faceted Algorithm for Watermarking of Various Media such as Grayscale Images, Color Images & Audio Streams in Color Images. Usage of Multi-Bit Vector Stegenography Techniques For Watermarking Multiple Media In a Single Cover Image. Usage of Advanced Cryptography Regimes For Enhancing Security of the Embedded Watermarks & Avoid Unintended Recovery. Extension of the Above System to Allow For Color Video to Be Watermarked With Multiple Media with Enhanced Cryptographic Security.

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