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An Invisible QR Code Video Watermarking Scheme Based on Wavelet Transform and Tensor Algebra

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Abstract: ***Digital Watermarking is a technology used for the copyright protection and authentication of digital application. The commercial activity on the internet and media require protection to enhance security. We proposed a new invisible non-blind video watermarking in Quick Response (QR) code technique. In one video frame we embed text message into QR Code image and further embed logo into QR-Code image. For hiding environment video watermarking or in the video to send the message or details to the receiver and show the authentication. Decomposition of Discrete Wavelet Transform (DWT) and Tensor Algebra is used. In that we use it for non-blind video watermarking in the DWT domain for tensor algebra. We use two methods singular value decomposition of 2D array and multidimensional tensor singular value decomposition. These experimental results are achieved acceptable imperceptibility and Peak Signal to Noise Ratio (PSNR) value.***

Index Terms: Video Watermarking, Tensor Algebra, DWT, QR-Code, PSNR

I. INTRODUCTION

The main idea of watermarking is the encoding of secret information into data under the assumption that others cannot seen or read the secret information in the data. It checks the logo encoded in data or not. Based on the type of document to be watermarked. Text watermarking: line shift coding, word shift coding, feature coding. Visible watermark: the information is visible in the picture or video. Typically, the information is text or a logo, which identifies the owner of the media. Invisible Watermark: An invisible watermark is an overlaid image which cannot be se en, but which can be detected algorithmically. Dual Watermarking: dual watermark is a combination of a visible and an invisible watermark. In this type of watermark, an invisible watermark is used as a backup for the visible watermark. It can be used to verify ownership. A QR code is a two dimensional barcode invented by the Japanese corporation Denso Wave. Information is encoded in both the vertical and horizontal direction, thus holding up to several hundred times more data than a traditional bar code Figure 1. QR Codes hold a considerably greater volume of information than a 1D Barcode Figure 2. QR Code can encode in many types of characters such as numeric, alphabetic character, Kanji, Kana, Hiragana, symbols, binary, and control codes.

Figure 1. 1-D bar code

Figure 2. 2-D QR Code

II. RELATED WORKS

Hirak Kumar Maity, and Santi Prasad Maity [1] have proposed a joint robust and reversible watermarking scheme that shows its efficiency in terms of integrity, authenticity and robustness.Digital watermarking has an important application to protect and authenticate the medical images. To perform accordingly one of the most commonly used methods is region based operation, i.e. the whole image is partitioned into two regions called region of interest (ROI) and region of non-interest (RONI).

Vinay pandey et al., [2] have proposed for protecting the transmission of medical images. The presented algorithms will be applied to images.This work presents a new method that combines image cryptography, data hiding and Steganography technique for denoised and safe image transmission purpose.

Hamid Shojanazeri et al., [3] have proposed the state of the art in video watermarking techniques. It provides a critical review on various available techniques. In addition, it addresses the main key performance indicators which include robustness, speed, capacity, fidelity, imperceptibility and computational complexity.

Peter Kieseberg et al., [4] have proposed paper examines QR Codes and how they can be used to attack both human interaction and automated systems. As the encoded information is intended to be machine read- able only, a human cannot distinguish between a valid and a maliciously manipulated QR code. While humans might fall for phishing attacks, automated readers are most likely vulnerable to Structured Query Language (SQL) injections and command injections. Our contribution consists of an analysis of the QR Code as an attack vector, showing different attack strategies from the attackers' point of view and exploring their possible consequences.

Emad E.Abdallah et al., [5] presented a robust, hybrid non-blind MPEG video watermarking technique based on a high-order tensor singular value decomposition and the discrete wavelet transform (DWT). The core idea behind our proposed technique is to use the scene change analysis to embed the water mark repeatedly into the singular values of high-order tensors computed form the DWT coefficients of selected frames of each scene. Experimental results on video sequences are presented to illustrate the effectiveness of the proposed approach in terms of perceptual invisibility and robustness against attacks.

Loganathan Agilandeeswari and Kumaravel Muralibabu [6] have proposed a novel video watermarking technique using Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD) based on subband selection procedure. To increase the level of authentication, the two watermarks are used: one is the original watermark and the other is the owners' fingerprint. From the experimental analysis, we found that the proposed watermarking technique is more robust to all possible attacks than existing video watermarking technique.

Hanane H.Mirza, et al [7] have proposed a new digital video watermarking scheme based on Principal Component Analysis. A video file is a continuous collection of static images, and each image is composed of three color channels, their proposed algorithms allow us to embed a watermark in the three color channels RGB of an input video file. The preliminary results show a high robustness against most common video attacks, especially frame dropping, cropping and rescalling for a good perceptual quality.

S.Poongodi and B.Kalaavathi [8] presented a advanced network technology, security of data transformation is a big problem in this society. Cryptography is a tool that can be used to keep information confidential and to ensure its integrity and authenticity. The proposed technique is simple to implement and has high encryption rate of security and this method embed the data into the image. The image is encrypted using secret key method and then watermarked into video signal. This encrypted image is transmitted through video signal and the security analysis is measured using some parameters.

Rashel Sarkar and Vindhya.V [9] presented how a text data is encrypted using the chaotic text encryption and Encrypted data is watermarked using LSB two bit encoded. Proposed method is convenient, feasible and practically can be used for copyright protection. Comparison between single level SVD decomposition for logo image watermarking and proposed method that uses multilevel watermarking techniques to provide strong security for text and image are done.

Gaurav Bhatnagar and Balasubramanian Raman [10] have proposed a Wavelet Packet Transform (WPT)-based robust video watermarking algorithm is proposed. A visible meaningful binary image is used as the watermark. The sequence frames are extracted from the video clip. Then, WPT is applied on each frame and from each orientation one sub-band is selected based on block mean intensity value called robust sub-band. Watermark is embedded in the robust sub-bands based on the relationship between wavelet packet coefficient and its Distance 8-neighbour (D8) coefficients considering the robustness and invisibility. Experimental results and comparison with existing algorithms show the robustness and the better performance of the proposed algorithm.

III. METHODOLOGY

Watermark is an invisible signature embedded in an image to show authenticity or proof of ownership. Here, we discuss about the QR code, MPEG compression, SVD, DWT and proposed method

A. QR Code

The standard specifies 40 versions (sizes) of the QR code from the smallest 21x21 up to 177x177 modules in size. An advantage with QR code is also there relatively small size for a given amount of information The QR code is available in 40 different square sizes each with a user selectable error correction level infour steps (referred to as error correction level L, M, Q and H). With the highest level of error correction used up to nearly 30% of the code words can be damaged and still be restored as shown in figure 3. The maximum capacity for QR codes depending on the encoding scheme (using the lowest possible error correction overhead).

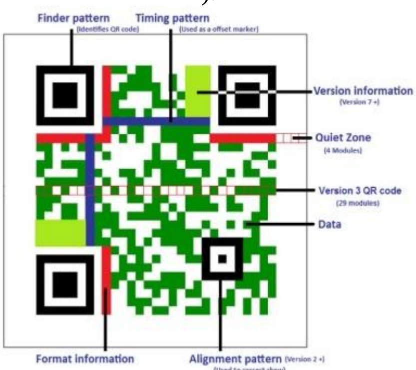


Figure 3: Structure of QR Code

(1) Finder Pattern:

The finder pattern consists of three identical structures that are located in all corners of the QR-code except the bottom right one. Each pattern isbased on a 3x3 matrix of black modules surrounded by white modules that are again surrounded by black modules. The Finder Patterns enable the decoder software to recognize the QR Code and determine the correct orientation.

(2) Separators:

The white separators have a width of one pixel and improve the recognizability of the Finder Patters as they separate them from the actual data.

(3) Timing Pattern:

Alternating black and white modules in the Timing Pattern enable the decoder software to determine the width of a single module.

(4) Error Correction:

Similar to the data section,error correction codes are stored in 8 bits long code words in the error correction section.

(5) Alignment Patterns:

Alignment Patterns support the decoder software in compensating for moderate image distortions. Version 1 QR Codes do not have Alignment Patterns. With the growing size of the code, more Alignment Patterns are added.

(6) Data:

Data is converted into a bit stream and then stored in 8 bit parts (called code words) in the data section.

(7) Remainder Bits:

This section consists of empty bits of data and error correction bits cannot be divided into 8 bit code words without remainder. The entire QR Code has to be surrounded by the Quiet Zone, an area in the same colour shade as white modules, to improve code recognition by the decoder software.

(8) Format Information:

The Formation Information section consists of 15 bits next to the separators and stores information about the error correction level of the QR Code and the chosen masking pattern.

(9) Capacity and Error correction code:

The capacity of a QR Code depends on several factors. Besides the version of the code that decides its size the chosen error correction level and the type of encoded data influence capacity. Error Correction in QR Codes is based on Reed-Solomon Codes, a specific form of BCH error correction codes. There are four levels of error correction that can be chosen by the user at creation time. Higher error correction levels increase the percentage of error correction capacity and therefore decrease error level.

B. MPEG-2 Video compression

MPEG-2 Video is similar to MPEG-1, but also provides support for interlaced video (the format used by analog broadcast TV systems). All standards-conforming MPEG-2 Video decoders are fully capable of playing back MPEG-1 Video streams. An HDTV camera generates a raw video stream of 24*1920*1080*3 = 1,49,299,200 bytes per second for 24fps video. This stream must be compressed if digital TV is to fit in the bandwidth of available TV channels and if the movies are to fit on DVDs. TV cameras used in broadcasting usually generate 25 pictures a second (in Europe).

Digital television requires that these pictures be digitized so that they can be processed by computer hardware. MPEG-2 specifies that the raw frames be compressed into three kinds of frames: intra-coded frames (I-frames), predictive-coded frames (P-frames), and bidirectionally-predictive-coded frames (B-frames). An I-frame is a compressed version of a single uncompressed (raw) frame. It takes advantage of spatial redundancy and of the inability of the eye to detect certain changes in the image. Unlike P-frames and Bframes, I-frames do not depend on data in the preceding or the following frames. The raw frame I is divided into 8 pixels by 8 pixel blocks. The result is an 8 by 8 matrix of coefficients.

The transform converts spatial variable into frequency variations, but it does not change the information in the block; the original block can be recreated exactly by applying the inverse cosine transform. The advantage of doing this is that the image can now be simplified by quantizing the coefficients. Many of the coefficients, usually the higher frequency components, will then be zero. The penalty of this step is the loss of some subtle distinctions in brightness and colour. Error level Symbolic constant Error correction capacity.

C. Singular Value Decomposition (SVD)

Singular value decomposition (SVD) is a factorization of a real or complex matrix, with many useful applications in signal processing and statistics. Formally,the singular value decomposition of an m×nreal or complex matrix M is a factorization of the form follow in this equation (1).

$$M = U \sum V' \qquad \text{-------- (1)}$$

Where U is an m × m real or complex unitary matrix, Σ is an m × n rectangular diagonal matrix with non negative real numbers on the diagonal, and V* is an n × n real or complex unitary matrix. A non-negative real number σ is a singular value for M if and only if there exist unit-length vectors u in K^m and v in K^n such that show as equation (2) & (3).

$$Mv = \sigma u \quad \text{-------- (2)}$$

$$M * u = \sigma v \quad \text{-------- (3)}$$

The vectors u and v are called left-singular and right singular vectors for σ, respectively.

D. Discrete Wavelet Transform

An image that undergoes Haar wavelet transform will be divided into four bands at each of the transform level. The first band represents the input image filtered with a low pass filter and compressed to half. This band is also called 'approximation'. The other three bands are called 'details' where the high pass filter is applied. These bands contain directional characteristics.

The size of each of the bands is also compressed to half. Specifically, the second band contains vertical characteristics, the third band shows characteristics in the horizontal direction and the last band represents diagonal characteristics of the input image. Conceptually, Haar wavelet is very simple because it is constructed from a square wave. Moreover, the Haar wavelet computation is fast since it only contains two coefficients and it does not need a temporary array for multi-level transformation. Thus, each pixel in an image that will go through the wavelet transform computation will be used only once and no pixel overlapping during the computation

IV. PROPOSED APPROACH

A. Encoding Process

In the embedding process a video file, we have taken the I frame as a cover image. Insert a logo and take DWT on both I- frame with logo and QR code image. Next, apply IDWT to obtain the watermarked image. Finally, watermarked I-frame add in a video file. The block diagram of representation of extracting process was given in the Figure 4.

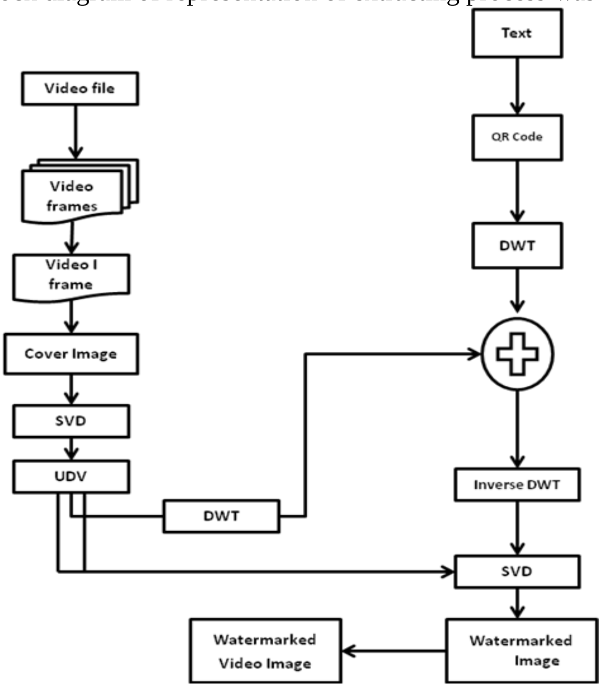


Figure 4. Block diagram of proposed encoded process.

1) Algorithm For Embedding Process

Step 1: Read the AVI video file and extract the frames.
Step 2: Read the first frame (I Frame) image as a cover image.
Step 3: Generate a QR code image with company name.
Step 4: Apply SVD to I frame and get three singular value coefficients as U, D, and V.
Step 5: Apply DWT on the both SVD cover image and QR code image to get combined image.
Step 6: Take the Inverse DWT (IDWT) on the combined image to Watermarked Frame.
Step 7: Apply SVD with U and V Coefficients to get watermarked frame.
Step 8: Get the watermarked I frame image and the video files.

B. Decoding Process

In extracting process, DWT is applied to watermarked image and recover the logo. Apply DWT on original video file and watermarked I-frame, take the IDWT to obtain the QR code image. Finally extract the verification text. The schematic representation of extracting process was given in the Figure 5.

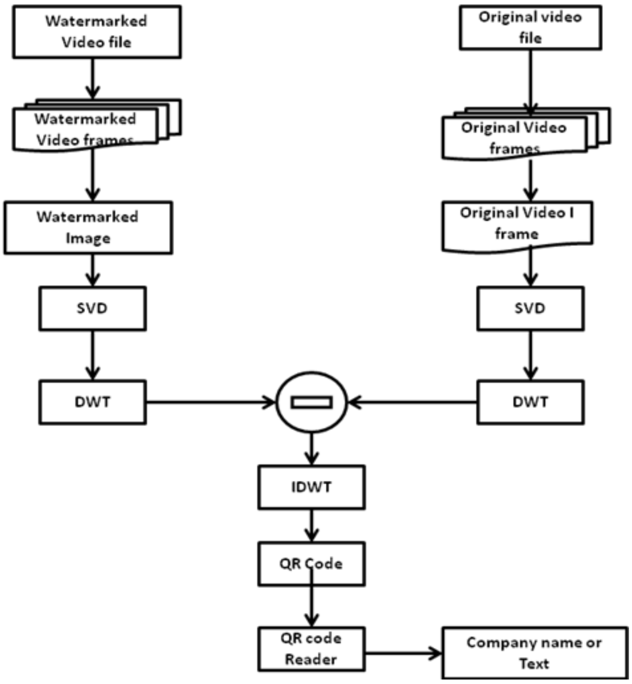


Figure 5. Block Diagram of decoding process.

2) Algorithm For Embedding Process

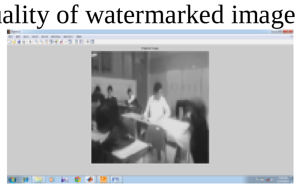
Step 1: Read the watermarked video files and extract watermarked I frame.
Step 2: Read the original video file and extract original video I frame,
Step 3: Apply SVD on both videos I frames.
Step 4: Apply DWT on both the sides.
Step 5: Subtract watermarked video I frame coefficient with original video I frame coefficient and take Inverse DWT to get a QR code image.
Step 6: By using QR code reader extract company name from QR code image.

V. TESTING AND PERFORMANCE ANALYSIS

In our experimental Video sequence Image127.jpg in 512X512 and gray format are used for watermarking embedding. The standard JPEG compression format with 1150kbits (bit rate) and frame rate is 25 to 30. The length of Video sequence is 200 frames in 8 Sec. The Video sequence is watermarking in size of 75X75 is selected as raj.jpg. To evaluate the performance of the proposed method by using Matlab R2013a and 7.10 version.

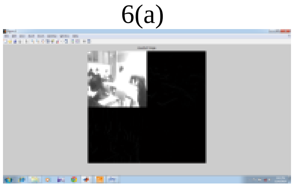
A. Quality Metrics

Image Quality of watermarked image was tested on various quality parameters

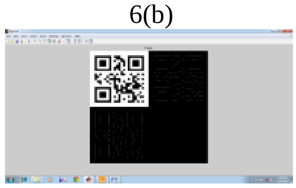


6(a)

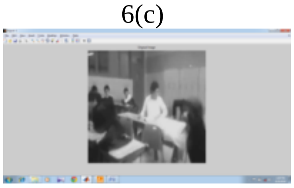
6(b)



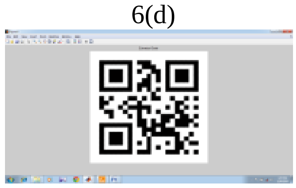
6(c)



6(d)



6(e)



6(f)

Raja

6(g)

Figure 6(a). Video I frame, Figure 6(b). QR code image, Figure 6(c) & 6(d). DWT of cover and QR code image, Figure 6(e). Watermarked I frame, Figure 6(f). Recovered QR code, Figure 6(g). Name (verification text).

1) *Mean Square Error(MSE):*

It is defined as the square of the error between cover image and watermarked image. The distortion in the image can be measured using MSE and is calculated using Equation.

$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})^2$$

-------- (4)

Where $x_{j,k}$ -cover I frame.

$x'_{j,k}$ - Water\marked frame.

2) *Peak Signal to Noise Ratio(PSNR):*

It is the measure of the quality of the image by comparing the cover image with the watermarked image, i.e., it measures the statistical difference between the cover and watermarked image is calculated by using below Equation 5.

PSNR= $10\frac{\log_{10}(255)^2}{MSE}dB$ ------ (5)

3) *Normalized Cross Correlation (NCC):*

This is also similarity measurement method to evaluate the performance as shown in Equation 6.

$$NCC = \sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k} - x'_{j,k})\frac{1}{\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k})^2}$$

--------- (6)

VI. RESULTS AND DISCUSSION

The various quality video frames are evaluated. The MSE, PSNR and NCC are illustrated in the Table 1.In Table 1 the MSE values are 2 to 1 and PSNR value are between 45 to 50 dB.The NCC values are nearly equal to 0 to 1.The above values are shown our watermarking system achieves the high security level.

Table 1: Performance of video frame quality metrices

Cover Image	Payload Image	MSE	PSNR	NCC
Image1.jpg	raj.jpg	6.0024	40.3476	1.0025
	aa.jpg	3.6843	42.4673	1.0052
Image3.jpg	raj.jpg	5.9455	40.3526	1.0025
	aa.jpg	3.6638	42.4915	1.0053
Image5.jpg	raj.jpg	6.0141	40.3391	1.0026
	aa.jpg	3.7052	42.4427	1.0053
Image7.jpg	raj.jpg	5.9555	40.3816	1.0027
	aa.jpg	3.6219	42.5414	1.0046
Image9.jpg	raj.jpg	6.0326	40.3258	1.0025
	aa.jpg	3.7370	42.4056	1.0052

VII. CONCLUSION

This proposed method has achieved the improved imperceptibility and more security in watermarking. In this QR code encoding process and get excellent performances. In the first method watermark was embedded in the diagonal element. On the other hand embedding text messages in the QR code image. So, the dual process given two authentication detail.

The logo is located very safely in the QR code image. This method is convenient, feasible and practically used for providing copyright protection. Experimental results show that our method can achieve acceptable certain robustness to video processing.It is extended to apply other wavelet filters also.

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