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DIGITAL IMAGE WATERMARKING APPROACH BASED ON QR AND DWT METHOD

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Abstract: *Digital watermarking is used to hide the information inside a signal, which cannot be easily extracted by the third party. Watermarking is a concept of embedding a special symbol, watermark, into an electronic document so that a given piece of copyright information is permanently tied to the data. In this paper, we proposed a method for digital image watermarking technique based onQuick Response Code (QR Code). Watermark is embedded into QR code by using Discrete-Wavelet-Transform(DWT) for an information hiding.QR code is considered as cover image and DWT is applied to decompose the cover image into different frequency sub bands. Now the watermark is embedded into the LL sub band by using bit shifting method to enhance the robustness of the watermarked image.The experimental results indicate that present approach is reliable and efficient.*

Keywords*— 2D Barcode, QR Code, Watermark, Discrete Wavelet Transform (DWT).*

I. INTRODUCTION

Illegal manipulating, copying, modifying and copyright protection have become very important issues with the rapid use of internet. so, there is a strong need of developing the techniques to face all these problems. Digital watermarking emanate as a solution for protecting the integrity, validity and ownership of digital multimedia [4,5,6,7,8,9,10,11,12].The main motivation behind Digital watermarking is copyright protection and its application are not restricted. Digital Watermarking is the process of masking or hiding an imperceptible signal (data) into the given signal(data).This imperceptible signal (data) is called watermark or metadata and the given signal (data) is called cover work. The watermark should be embedded into the cover work, so that it should be robust enough to survive not only the most common signal distortions, but also distortions caused by vicious attacks.This cove work could be an image, audio or a video file. A watermarking process consists of two methods, for embedding and for an extraction (or detection).Watermarking techniques can be widely classified into two categories: Spatial and Transform domain methods. Spatial domain methods are less complicated and not robust against various attacks as no transform is used in them. Transform domain methodsare robust I comparison to spatial domain methods. This is due to the fact that when image is inverse transformed, watermark is dispensed irregularly over the image, making the attacker challenging to read or modify. Due to the fact of localization in both spatial and frequency domain, wavelet transform is the most preferable transform among all other transforms In this technique the data is obscured within the cover image so stranger cannot get it without having proper guidance. Many methods used for the invisible Digital Watermarking required some information about the cover image. But we do not require it for secret image extraction, so it is more secure. We are using QR code [1,2,3] which itself hide the information.We can use this method to hide image in QR code and to hide QR code in an image. In both the cases the information is detectable under the influence of various attacks.

A. Discrete Wavelet Transform

DWT involves decomposition of image into frequency channel of constant bandwidth. This causes the similarity of accessible decomposition at every level. DWT is performed as multistage transformation.Level wise disintegration is done inmultistage transformation. At level1:Imageis decomposed into four sub bands : LL, LH, HL, and HH where LL denotes the raw level coefficient which is the low frequency part of the image. LH, HL and HH denote the finest scale wavelet coefficient. The LL sub band can be disintegratedfurther to obtain higher level of decomposition. Thisdecomposition can continues until the desiredlevel of decomposition is attained for the

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application. The watermark can also be embedded in the remaining three sub bands to maintain the quality of image as the LL sub band is more sensitive to human eye.Fig1 shows DWT decomposition.

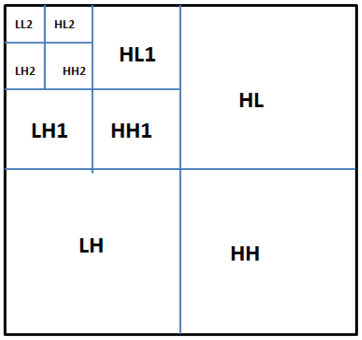

Fig.1: DWT decomposition

B Quick Response Code

QR Code is the trademark for a type of matrix barcode. Comparing to one dimensional barcode, QR code has many advantages. They are

1. Huge information density

2. QR codes can express different characters like Chinese characters, pictures and sound with error correction function. In recent years, the system has become accepted outside the industry due to its fast readability and large storage capacity compared to standard UPC barcodes. The QR code consists of black modules (square dots) arranged in a square pattern on a white background. QR Code has capability of managing all types of data, such as alphabetic characters, numeric, symbols, binary, and control codes. Characters can be encoded in one symbol up to the 7,089 characters. Data can be restored even if the symbol is partially dirty or damaged. A maximum of 30% of code words can be restored. Fig 2 shows 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 is based on a 3x3 matrix of black modules surrounded by white modules that are again enclosed 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.

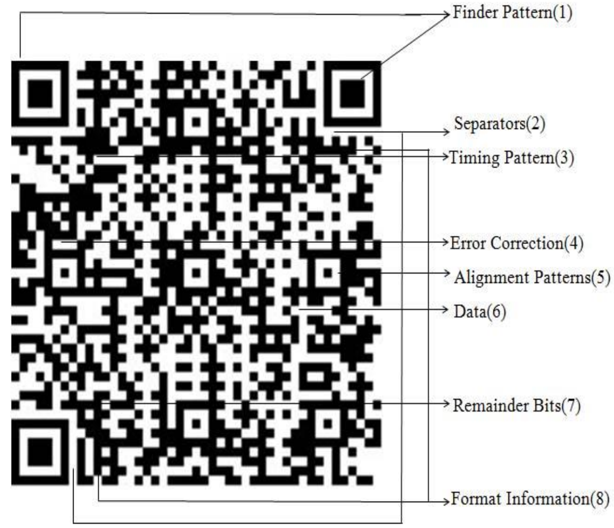

Figure 2: Structure of QR Code

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4) Error Correction:

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

5) Adjustment Patterns:

Adjustment Patterns support the decoder software in compensating for moderate image distortions. Version 1 QR Codes do not have Adjustment Patterns. With the growing size of the code, more Adjustment 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 category consists of void 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 color shade as white modules, to improve code recognition by the decoder software.

8) Format Information:

The Formation Information category 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 capability of a QR Code depends on several factors. In addition to 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 4 levels of error correction that can be chosen by the user at creation time. Higher error correction levels enhance the percentage of error correction capacity and therefore decrease error level.

The rest of the paper is organized as follows. Proposed QR and DWT method described in section II, performance analysis described in section III, experimental results are discussed in section IV and conclusions are given in section V.

II. Proposed method

The process of image embedding and image extraction is given as follows:

Image Embedding

Following is the procedure for an embedding a watermark image into cover image

- Read QR code as cover image
- Apply DWT on the cover image
- Read RGB image as watermark image
- Now the watermark image is inserted into low frequency component of cover image by using bit shifting method.
- Apply inverse DWT to get watermarked image. In order to test the robustness of watermark method, apply different attacks on watermarked image.

Image Extraction

Following is the procedure for retrieving the watermark image from cover image

- Apply DWT to the watermarked cover image, then the image is decomposed into HHW, HLW, LHW, LLW. Sub bands.
- In order to recover the watermark image from watermarked cover image, selectthe LL sub band and apply bit shifting in inverse process to the step in embedding process.

III. TESTING AND PERFORMANCE ANALYSIS

A.MATLAB

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python. we implement the proposed method by using MATLAB R2015a and 7.10 version. MATLAB is to fit perfectly in the necessities of an image processing research due to its inherent characteristics and helpful to solve problems with matrix and vector formulations.

B Quality Metrics

To find the effectiveness of the proposed method, the proposed paper used two popular and effective parameters called Normalized Correlation Coefficient(NCC) and Peak Signal to Noise Ratio (PSNR) for evaluating the performance of the proposed watermarking method.The quality of the watermark or the flexibility of the algorithm is assessed by the similarity measurements NCC between the reference watermark W and the extracted watermark W^* as given in Equation 1.

$$\rho = \frac{\sum_{i=0}^{N-1} W(i) \times W^*(i)}{\sum_{i=0}^{N-1} (w(i))^2} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where ρ is Normalized Correlation Coefficient, N is number of pixels, W(i) and $W^*(i)$ are the original watermark and the extracted watermark respectively. In the above equation $\rho = 1$ indicates perfect correlation, while an extremely low value reveals that the watermarks are dissimilar. If NCC value ranges from 0.65 to 1.0 then one can say that the image preserves high quality after inserting the watermark.

.**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(2).

$$MSE = \frac{1}{MN} \sum_{i-1}^{M} \sum_{j=1}^{N} (X_{ij} - X'_{ij})^2 \quad \ldots(2)$$

Where M and Nare respectively the length and the width of the cover image.X_{ij}denotes the original image and X’ij denotes the watermarked image.

Peak Signal to Noise Ratio (PSNR): It is the measure of the quality of the image by comparing the cover image with the watermarked imagei.e., it measures the statistical differencebetween the cover and watermarked image is calculated by using below equation(3) . The calculated

$$PSNR = 10 \log_{10} \frac{(255)^2}{MSE} \quad ....(3)$$

PSNR generally adopts dB value for quality judgment. The larger PSNR resembles higher the image quality is. On the contrary, a small dB value of PSNR indicates there is great distortion between the cover image and the watermarked image. As we know ideally MSE value should be small and PSNR value should be very high.

IV. Experimental Results

The proposed QR and DWT method is executed in MATLAB and the results are verified for various attacks. We take QR code as a cover image and logo as a secret image. The results are compared for various attacks with their PSNR (Peak Signal to Noise Ratio and MSE (Mean Square Error).

A. Robustness

The robustness of a watermark method can be assessed by applying attacks on the watermarked image and evaluating the similarity of the extracted image to the original one.

B. Capacity

The capacity of the water mark method can be easily tested by increasing the length of the watermarking message. Any watermarking method is not capable of holding more than a certain length of message then it will endanger its imperceptibility

In this proposed watermarking method host image or cover image of size **256×256** is used as shown in Figure.3AITAM logo is taken as Watermark of size 64×64 shown

Fig:3 QR code

Fig 4 AITAM logo

TableI shows attacked image and their corresponding extracted watermark

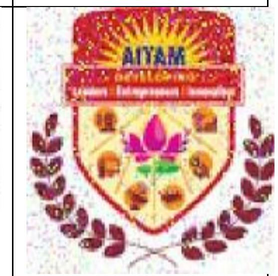
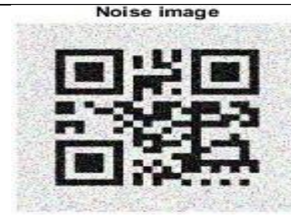
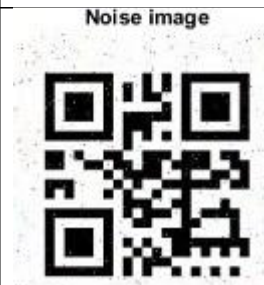
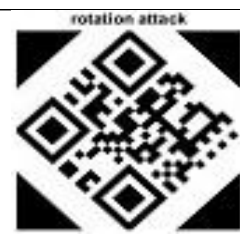
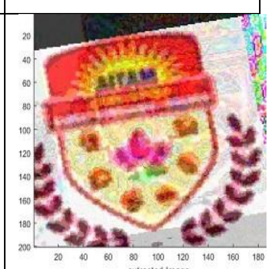
Noise	Attacked Watermarked image	Extracted watermark
Speckle		
Gaussian		
Salt and pepper noise		
Rotation		
Crop		

TABLE IResults of QR code as cover image and logo as watermark

TABLE IIPSNR and MSE of an encoded image

RGB image	PSNR	MSE
R component	60.7911	0.0542
G component	60.7776	0.0544
B component	60.7763	0.0544

The following tablesrepresents PSNR, MSE and NCC of an extracted image after applying different attacks.

TABLE III **Rotation Attack**

Color components	PSNR	MSE	NCC
R	45.1089	2.0054	0.7893
G	44.4471	2.3354	
B	44.4959	2.3098	

TABLE IV **Speckle Noise**

Color components	PSNR	MSE	NCC
R	42.9323	3.3102	0.9607
G	43.1282	3.1842	
B	43.2362	3.0365	

TABLE V **Gaussian Noise**

Color components	PSNR	MSE	NCC
R	47.24	1.1772	0.9909
G	47.4621	1.1665	
B	47.6475	1.1177	

TABLE VI **Salt and Pepper Noise**

Color components	PSNR	MSE	NCC
R	49.5296	0.7246	0.9964
G	49.5573	0.72	
B	49.7484	0.6890	

TABLE VII**Crop Attack**

Color components	PSNR	MSE	NCC
R	52.2217	0.6682	1.0
G	51.4928	0.6688	
B	51.6062	0.6686	

V.CONCLUSION

In the proposed QR and DWT method the watermark bits are embedded in the lowest frequency band of the cover image using the bit shifting method. Embedding the watermarks in lower bands, increases the robustness of the watermarks and the encrypted image is transmitted securely over the unsecured transmission media. At the receiving end, the embedded watermarks are extracted from the encrypted image using reverse process. The robustness of the proposed method is analyzed by incorporating various attacks over the transmitted encoded image. The performance of the proposed method is analyzed by calculating various image quality metrics like NCC, PSNR and MSE. The simulation results shows that the proposed QR and DWT method is robust against various attacks except Rotation attack than existing methods.

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