

Secure Invisible Digital Watermarking for Copyright Protection Based on DWT-DCT Transforms

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ABSTRACT: The Internet is an excellent distribution system for digital media. Digital multimedia provides a robust and easy editing and modifying of data. Digital data can be copied without any loss in quality and content. This poses a more problem for the protection of intellectual property rights of copyright owners. However, content owners also see a high risk of piracy. With the development of digital image production and applications, digital image security has become very important in today's world. This paper proposes image confidentiality relying on combination of DWT-DCT watermarking technique and image scrambling based on Arnold transformation. By using combined DWT-DCT digital watermarking technique, it is implemented imperceptibility of watermark which are supported for copyright protection and security of images.

KEYWORDS: Watermarking, Transforms, DCT, DWT, Arnold transformation, digital image, scrambling.

I. INTRODUCTION

In this era of internet technology has done development of network and digital communication. Data of different format like audio, video, text or images are transferred from one device to another device while doing the communication. However, Bank CTS uses cheque image as data and transfer it to drawee branch of bank for payment through the clearing house. Thus, there is need of security and copyright protection for cheque images. Security to image can be provided by various methods such as encryption and decryption, digital watermarking, etc. In this paper, it is going to discuss working of combination of DWT-DCT watermarking technique and image scrambling based on Arnold transformation for CTS of bank. To build digital watermarking technique used for CTS of bank requires software like Window XP, language like Matlab R2013a, Dot Net 3.0, compiler of Matlab R2013a & hardware as ram of 1gb or higher. Computer security related to system and network security has been widely studied. With the development of multimedia processing and applications, several types of media security have been taken in consideration.

II RELATED WORK

The technological innovations are demanding the simplest way of leading the life in this real time world. The banking system and telemedicine are becoming the main part of the life day by day. The entire banking system and medical fields have been computerized which is helping the system to deliver the credentials in time. For the faster clearing of cheques, so a cheques truncation system is used. CTS of bank sends electronic cheques images to drawee branch for payment through the clearing house and for giving immediate treatment from the good doctors, now days telemedicine is popular. It is actually believed that the system is safe and secure. The effective utilization of digital

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water marking in this financial transaction would be very much helpful for the banker to discharge the duties timely. Image encryption strategy make utilization of characteristics properties of image like high redundancy and strong spatial connection.

III. METHODS OF WATERMARKING OF IMAGE.

Digital watermarking of image (like cheque, medical image etc) is the process in which watermark is embedded in covered image, to provide authenticity, copyright protection & cheque security. Watermarking of cheque can be done by two method i.e. a) spatial domain technique and b) transforms domain technique [1, 2, 7, and 9]. There are different watermark used for copyright protection such as visible watermark, invisible watermark, private watermark, public watermark, fragile watermark, etc.

A. Spatial Domain Technique

In spatial domain technique, watermarking of digital cheque image is done on the basis of pixel location. Since spatial domain technique is very simple and easy wherein covered image is directly replace by watermark using substitution method. Spatial domain techniques are very fragile and poorly vigorous to external attack on watermarked image [2, 4, 8, and 11].

B. Transform Domain Technique

In transform domain technique, transform is applied on covered image of cheque. Watermark is used to embed into middle band frequencies co-efficient of transformed image of cheque, and then apply the inverse transforms to get watermarked cheque image. There are various transforms most widely used like DCT, DFT, SVD, DWT, Gabor transforms etc [13, 14, 15, and 16].

IV. WORKING OF DWT TRANSFORM

Discrete wavelets transform consist of discrete sample of wavelet. It has ability to hold both location information and frequency. With the help of this property, the filter is used to divide the bank cheque image in four non-overlapping subbands like LL, LH, HL, and HH. LL sub-band is low pass band and remaining three sub-bands are high pass band: HL denoteshorizontal sub-band, LH denotes vertical sub-band and HH denotes diagonal sub-band as shown in figure. The coarse scale of DWT co-efficient is represented by LLI sub-band andthe finite scale DWT co-efficient is represented by LHI, HLI, and HHI sub-bands. The sub-band LL1 is processed further and divide into four non-overlapping sub-bands like LL2, LH2, HL2and HH2 to obtain the next coarse scale of DWT co-efficient. This process continue until some final coarse scale of wavelet co-efficient. Energy of image is concentrated at lower frequency sub-band LLx and therefore embedding watermark in such sub-band may degrade the quality of image. However, embedding the watermark in these lowfrequency sub-bands may increase robustness. The edges and texture of image is included in high frequency sub-band HHx and human vision is not generally sensitive to change in suchsub-band. This property allows the watermark to embed without being perceived by the human vision. Many DWT algorithm used for digital watermarking is to embed thewatermark in the middle frequency sub-bands LHx and HLx from where robustness, imperceptibility performance can be achieved.

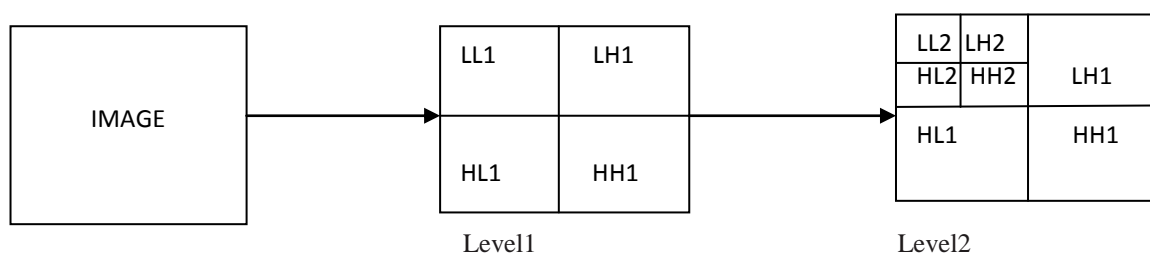


Fig:1 2D DWT process for images

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V. WORKING OF DCT TRANSFORM

A discrete cosine transform (DCT) can also be expressed as a sum of cosine functions oscillating at different frequencies which has a sequence of finitely many data points [1,4,6,8]. The equation of discrete cosine transform and definition of DCT Regions is as shown below:

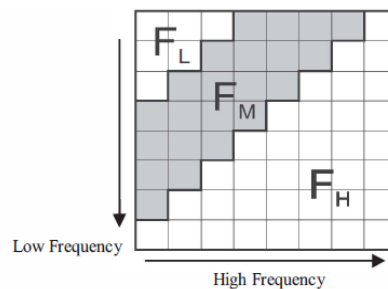


Fig:2 DCT Regions used to embed the watermark

2D-DCT:

$$C(u,v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \cos\left[\frac{(2x+1)v\pi}{2N}\right]$$

For $x,y = 0,1,\dots,N-1$

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2D-IDCT:

$$f(x,y) = \sum_{u=0}^{N-1} \alpha(u)\alpha(v) c(u,v) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \cos\left[\frac{(2x+1)v\pi}{2N}\right]$$

VI. ARNOLD TRANSFORMATION FOR DIGITAL IMAGE SCRAMBLING

We can define Arnold transformation as follows:

Let (x, y) is pointing in the unit square. It is move to (x',y') by the following equation.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \text{ mod } N$$

L is the length of the unit square. This transformation called 2-D Arnold transformation. For digital image we can define Arnold transformation as follows. Let (i, j) be pixel for square digital image $I = I[i, j]_{N \times N}$ its move to another pixel using the following transform.

$$\begin{bmatrix} i' \\ j' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} i \\ j \end{bmatrix} \text{ mod } N$$

Arnold transformation is a periodic and invertible mapping. Besides, the Arnold transformation is valid for square images only. The Arnold transformation is used to scramble the digital images and has many applications, especially in digital watermarking.

VII. DWT-DCT WATERMARKING ALGORITHM

A. Watermark Embedding Process

Step 1: Select any image (like cheque, medical image) [2, 9].

Step 2: Decomposed the cover image of bank cheque or medical image into

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non overlapping multi resolution sub-division bands like LL1, LH1, and HL1 and HH1 on applying DWT. [2,9].

Step 3: Again decomposed the non overlapping multi resolution sub-division bands i.e. HL1 sub-division bands is divided into four smaller sub-division bands and HL2 subband are selected [2,9].

Step 4: The sub-division band HL2 is divided into 4x 4 blocks [2, 9].

Step 5: Discrete cosine transform is applied to every block in selected sub-division band HL2 [2, 9].

Step 6: Grey scale image of watermark is re-formulated into vector of one's & zeros [2, 9].

Step 7: Create two pseudorandom sequences which are not similar to each other. One sequence is used to insert watermark bit 0 and other sequence is used to insert watermark bit 1. The elements present in PN_sequence should be exactly equal to the number of middle band frequency elements of DCT transformed DWT sub-bands [2, 9].

Step 8: If the watermark bit is 1 then
 $Z' = Z + k * PN_1$ (i)
 Otherwise,
 If the watermark bit is 0 then
 $Z' = Z - k * PN_0$ (ii)

Step 9: After modification of its middle band frequency coefficient, inverse discrete cosine transform is applied for embedding watermark bits [2, 9].

Step 10: To produce the watermark cover image of bank cheque the inverse discrete wavelet transform is applied on the DWT transformed image of cheque which includes the modified sub-division bands.

Block diagram

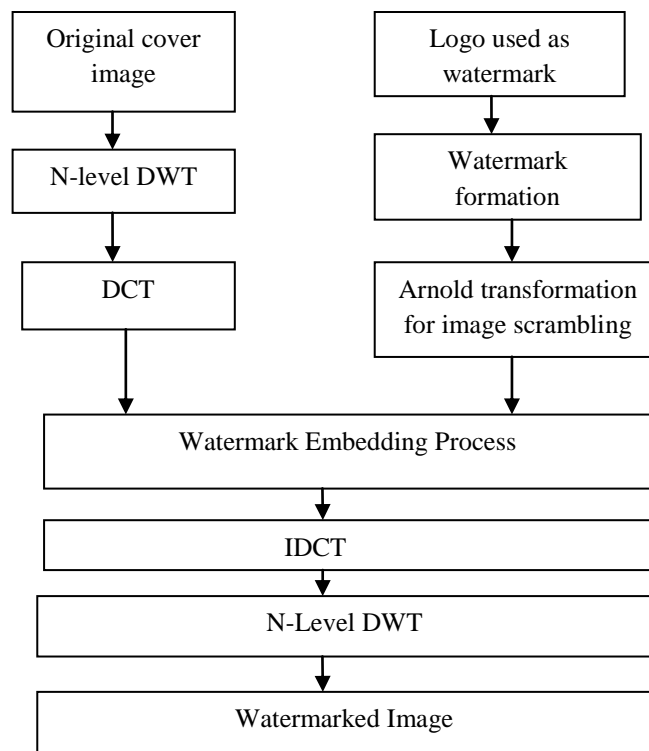


Fig3: Watermark embedding process

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B. Watermark Extraction Process

Step 1: Select watermarked image (like cheque, medical image) [2, 9].

Step 2: Decomposed the watermarked cheque image of bank into four different bands which are non-overlapping multiresolution band such as LLL, LH2, HL1, and HHI on applying DWT [2, 9].

Step 3: Again decomposed the non-overlapping multiresolution sub-bands i.e. HL1 sub-division band is divided into four smaller sub-division bands and HL2 band is selected [2, 9].

Step 4: HL2 sub-division band is divided into 4x4 blocks [2, 9].

Step 5: Middle band frequency coefficients from each block of DCT transformed

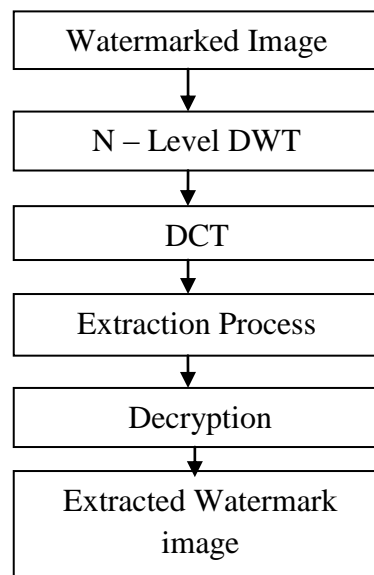


Fig4: Watermarking extraction process

image are extracted from selected sub-division band of HL2 after DCT is applied to each block [2, 9].

Step 6: The same seed are used to create again PN₀ and PN₁ as two pseudorandom sequences which were utilized in watermark embedding process [2, 9].

Step 7: Create two pseudorandom sequences PN₀ and PN₁ and the correlation between the middle band frequency coefficient is calculated for each block in the sub-division band of HL2. The extracted bit of watermark is consider as 1 if the correlation with PN₀ is lower than PN₁, if not extracted bit of watermark is consider as 0 [2, 9].

Step 8: Calculate the similarity between the original watermark and extracted watermark by reconstruction of the watermark using extracted watermark bits [2, 9].

Step 9: After receiving the watermarked cheque to drawee branch, it will select watermarked image of cheque with the help of extraction part of digital watermarking embedding & extraction software.

Step 10: After selection of watermarked cheque image, click on watermark extraction button to extract the watermark from cheque.

Step 11: After extraction of watermark logo from watermarked cheque image, we get extracted watermark logo and the original cheque image from which we can calculate the imperceptibility and robustness of watermark by comparing the extracted watermark logo with original watermark logo.

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VII. CALCULATING IMPERCEPTIBILITY

To calculate the imperceptibility, by using following equation.

$$\begin{aligned} \text{PSNR}_{\text{db}} &= 10 \text{Log}_{10} \{ \text{Max}^2 / \text{MS E} \} \\ &= 20 \text{Log}_{10} \{ \text{Max}^2 / \text{MS E} \} \end{aligned}$$

Watermarked image quality is measure in terms of imperceptibility. Cover image of cheque quality should not disturbed due the presence of watermark. However, peak signal to the noise ratio i.e imperceptibility is calculated in decibels(dB).

VIII. EXPERIMENTS AND RESULTS

Following diagram shows the software snapshots screen which is used for Digital watermarking embedding and extraction process.

Figure 5 explains selection of cover image and secret image for embedding the watermark for copyright protection .In this process Load cover image button is used to select the cheque image. Load secret image button is used to select the watermark logo of bank which is used for embedding process. Then Encrypt secret image button is used to get the Arnold transformed scrambled image .After press the Embed button get the watermarked image.

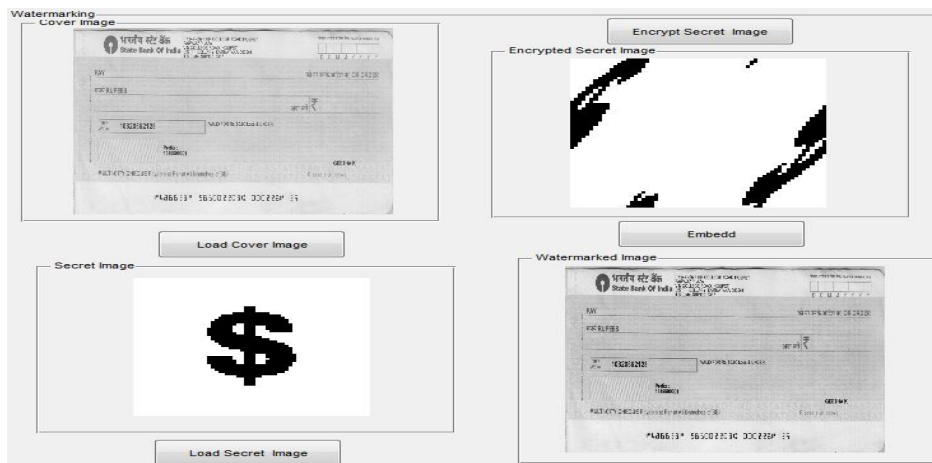


Fig5: Result of watermark embedding process

Figure 6 explains extraction process of watermark logo from watermarked cheque. Extraction process is generally occurred on receiving side. Press Extract and Decrypt button watermark logo get extracted. After extraction of watermark peak signal to the noise ratio i.e. imperceptibility is calculated.

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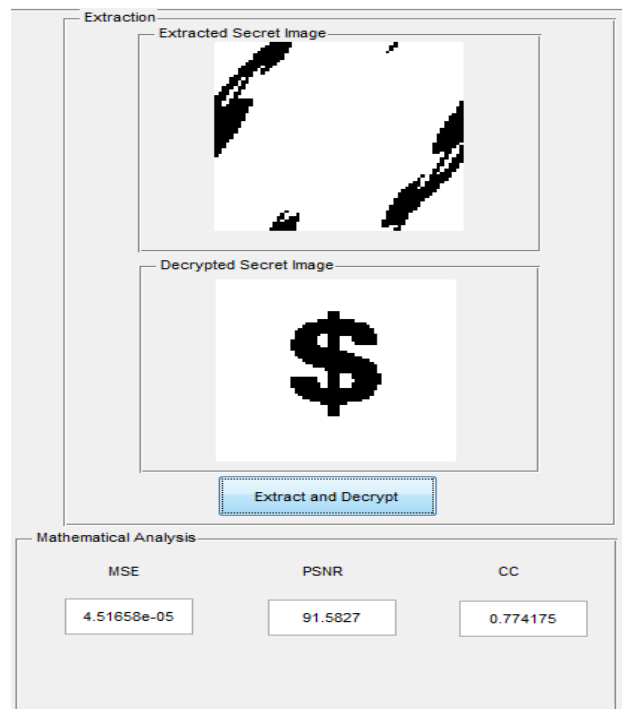


Fig6: Result of watermark extraction process

IX. Conclusion

In this paper, describes a digital image watermarking algorithm based on combining two transforms DWT and DCT. Watermarking is done by altering the wavelets coefficients of carefully selected DWT sub-bands, followed by the application of the DCT transform on the selected sub-bands. Encrypt the watermark image using Arnold algorithm for protect the data and scrambling the image. It allows users to embed special pattern or some data into digital contents without changing its perceptual quality. Watermarking is a key process for the protection of copyright ownership of electronic data.

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