# Effective Digital Watermarking Approch Using Combined DWT-DCT

V.Ashok Kumar[a] J.Sateesh[b.] P.Sirish Kumar[c]

a: Associate Professor, Department of Electronics and Communication Engineering, Aditya Institute of Technology and Management, Tekkali-532201.
b: M.Tech (2nd Year), Department of Electronics and Communication Engineering, Aditya Institute of Technology and Management, Tekkali-532201.
c. Assistant Professor, Department of Electronics and Communication Engineering, Aditya Institute of Technology and Management, Tekkali-532201.

**ABSTRACT:**

*In this paper, an effective digital image water marking algorithm based on combined Discrete Wavelet and Discrete Cosine Transform (DWT-DCT) is proposed. The proposed system provides imperceptibility and higher effective against common signal processing. A binary water marked image is embedded in certain sub bands of a 3-level DWT transformed coefficients of a host image. Then DCT Coefficients of each selected DWT sub band is computed. A randomly generated two-dimensional key is used to encrypt the watermark this 2D Key Is used to encrypt the watermark. This 2D-key provides security to the image and ownership copyrights.*

*The PN-sequence of encrypted watermark bits are embedded in coefficients of the corresponding DCT middle frequencies providing higher security. In extraction stage the same approach as that of the embedding process used extract the DCT middle frequencies of each sub band. Finally co-relation between midband coefficients and PN-Sequences is calculated to determine watermark bit which again post processed by the two dimensional key generated to drive the actual watermark. Proposed watermarking approach is superior over existing techniques in terms of PSNR and NCC.*

*Keywords: Digital watermarking, Encryption, Discrete cosine Transform, Discrete Wavelet Transform, integer wavelet transform, Bit plane complexity segmentation, PN_Sequences.*

## INTRODUCTION:

The fast development of the Internet in recent years has made it possible to easily create copy, transmit, and distribute digital data. Consequently, this has led to a strong demand for reliable and secure copyright protection techniques for digital data. Digital watermarking has been proposed as valid solution for this problem. The purpose of the watermark is to embed some additional information about the digital data without visibly modifying it. In order to be successful, the watermark should be invisible and robust to premeditated or spontaneous modification of the image. It should be robust against common image processing operations such as filtering, additive noise, resizing, cropping etc and common image compression techniques.

Watermarking techniques can be categorized in different ways. They can be classified according to the type of watermark being used, i.e., the watermark may be a visually recognizable logo or a sequence of random numbers. Another classification is based on domain which the watermark is applied i.e., the spatial domain or the transform domain. The earlier watermarking techniques were almost in spatial domain. Spatial domain techniques are not resistant enough to image compression and other image processing. Transform domain watermarking schemes like those based on the discrete cosine transform (DCT), the discrete wavelet transform (DWT) typically provide higher image imperceptibility and are much more robust to image manipulations. In these domain watermark is placed in perceptually significant coefficients of the image. However, DWT has been used more frequently in digital image watermarking due to its time/frequency decomposition characteristics, which resemble to the theoretical models of the human visual system.

### 1. Watermark Encryption:

In the proposed algorithm watermark encryption is used for security of watermark. The encryption is performed such that the encrypted image should not increase in size hence the Arnold's Cat Map (chaotic map) is used. For digital square image, discrete Arnold mapping can be achieve by using following equation.

$$\binom{x}{y}=\left[\begin{pmatrix}1 & 1\\ 1 & 2\end{pmatrix}\binom{x}{y}\right] \text{mod N}$$

The values of square matrix used in above equation can be used as key so that only same matrix can reverse the encryption.

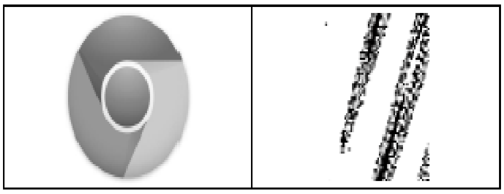

Figure 1: original and shuffled watermark

### 1.1 Digital Image Water marking:

Figure 2 shows the general block diagram of digital image watermarking. Digital Image Watermarking can protect image, video, audio from unauthorized person, noise, copyright etc. The best known image watermarking method that works in the spatial domain is the Least Significant Bit (LSB), which replaces the least significant bits of pixels selected to hide the information.

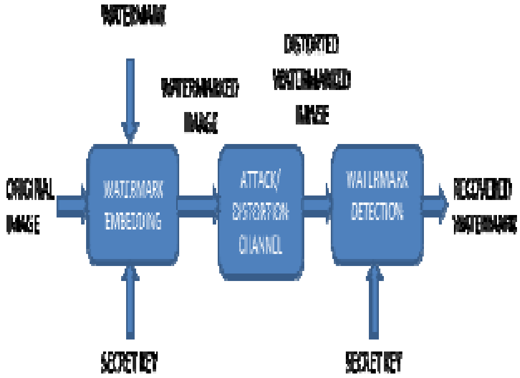


Fig.2 Basic Digital Watermarking

### *1.2 Discrete Cosine Transform (DCT)*:

A DCT based information hiding system was proposed in which the image was first segmented into non-overlapping blocks of 8x8 and forward DCT was applied to each of the block [8]. After that a selection criteria was applied followed by applying coefficient selection criteria. The watermark was embedded by modifying the selected coefficients and the final watermarked image was obtained by applying inverse DCT. Figure 3 shows a typical structure of DCT based watermarking.

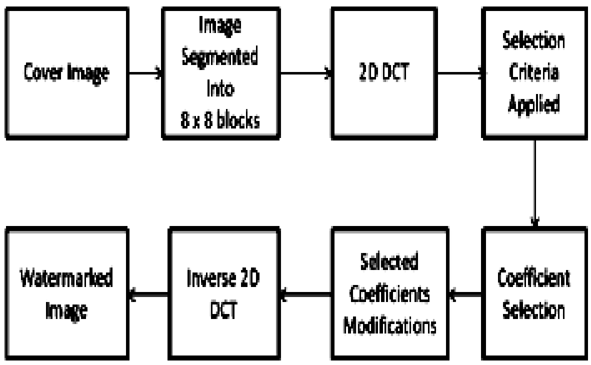


Fig.3: Typical structure of DCT based digital watermarking

Most of the energy in the DCT domain is concentrated in the low frequencies. As is known low frequencies are perceived very well by human eye, hence the chances of the watermark being perceptible was high where as high frequencies are prone to attacks such as compression and scaling. Thus the middle frequency bands were chosen such that they avoid the most visual important parts of the image without over-exposing themselves to removal through compression and noise attacks. The main advantage of DCT which makes it attractive for watermarking is its energy compaction property. This property divides the image into distinct frequency bands which makes it easy to embed the watermark in the desired area of the image. Experimentally, this technique proved to be highly resistant to JPEG compression as well as to significant amount of noise. However, it suffered from visual artifacts as DCT was done on the blocks.

### 1.3 Discrete Wavelet Transform (DWT) and Related Techniques:

DWT based techniques are very similar to theoretical model of Human Visual System (HVS). It is more frequently used due to its time/frequency characteristics. Here an image is passed through series of low pass and high pass filters which decompose the image into sub bands of different resolutions. As most of the energy is concentrated in the approximate (LL) sub band having low frequency sub bands, any change in these low frequency sub bands would cause a severe degradation of image. As the human eyes are not sensitive to high frequency sub bands, the secret information is embedded in either vertical, horizontal or diagonal (LH, HL or HH respectively) sub bands.

Fig. 4 shows a generalized DWT based watermarking scheme.

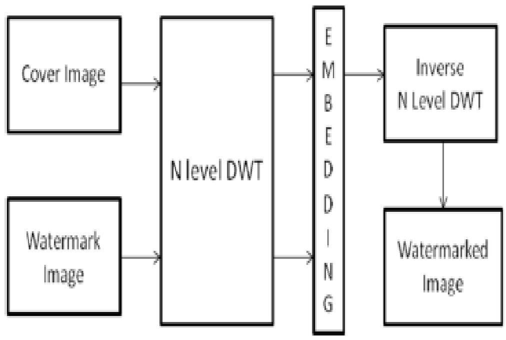


Fig.4: Generalized DWT based watermarking

A blind image watermarking scheme based on wavelet tree quantization was proposed [14]. In this approach a super tree was formed by grouping the wavelet coefficients of the host image. This super tree was quantized in such a way that it exhibits a large enough statistical difference which can be used for embedding and extracting watermark. This technique proved to be robust for both time and frequency domain attacks. An algorithm was proposed by Ramani *et al*. which were having very high data hiding capacity [15].

It was based on Integer to Integer Wavelet Transform (IWT) with Bit Plane Complexity segmentation (BPCS). IWT was used to decompose the cover image whereas BPCS takes the advantage of HVS which cannot recognize changes in complex positions of the image. The drawback with this method was that it needed separate processing for R, G and B components of the color image. A method based on combination of DWT and a Generic algorithm which can be used to find the best sub band for watermark embedding was introduced [16]. This technique provided imperceptibility and robustness simultaneously but the process was too lengthy and time consuming. 1-level DWT alpha blending technique was proposed which embeds the invisible watermark into the salient features of the original image using Daubecheis wavelets [17]. In this approach the decomposed components of both the images were multiplied by a scaling factor and then added. Result shows that the quality of the watermarked image, recovered image and extraction of watermark were dependent only on the values of the scaling factors k and q. Also the process of embedding and extracting was simpler when compared to DCT method. There was a limitation that the size of the watermark must be smaller than the host image and the frame size of both the images should be made equal.

## 2. PROPOSED ALGORITHM:

The proposed technique can be described by the following steps.

*Step 1:* Perform 3 levels DWT on the host image to decompose it into four non-overlapping multi resolution coefficient sets: LL3, HL3, LH3 and HH3.as shown in the figure 5.

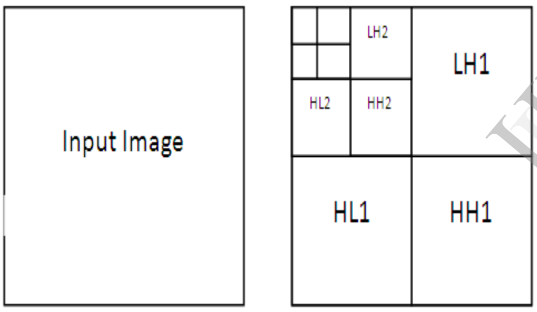


Fig 5: Image with its wavelet decomposition Blocks

*Step 2:* resize the watermark and make it equal to size ofHH3.

*Step 3:* scramble the watermark signal with Arnold algorithm for key times and gain the scrambled watermark, key times can be seen as secret key.

*Step 4:* Perform DCT of the scrambled watermark.

*Step 5:* Perform diagonal mirroring of DCT coefficients.

*Step 6:* scale down the coefficients of mirrored matrix by embedding factor.

*Step 7:* replace the mirrored coefficients matrix with HH3.

*Step 8:* Perform the 3 level IDWT to get the watermarked image.

*Step* 9: To retrieve the watermark perform 3 level DWT of the watermarked image then calculate the IDCT of HH3block, after that perform the cat map decryption.

*Step 10:* for the color image perform the whole procedure for all three (RGB) planes.

### 2.1 Evaluation and performance of the proposed method:

To evaluate the performance of the proposed method, we have to check the performance parameters. In this experiment the host image is LENA of size 512*512 and the watermark image is a symbol of size 256*256 which is shown in figure 4 respectively. In our proposed algorithm, we have set gain factor =0.5.This algorithm has been implemented using MATLAB.



**Imperceptibility**:

Imperceptibility means that the perceived quality of the host image should not be distorted by the presence of the watermark. To measure the quality of a watermarked image, the peak signal to noise ratio (PSNR) is used. The Visual quality of a watermarked image is evaluated by the peak signal-to-noise ratio (PSNR). It is defined as: Where, MSE=Mean Squared Error between Original and distorted image. which is defined

$$\text{Where MSE} = \frac{\sum_{i,j}^{m,n}\left[I(i,j)-J(i,j)\right]^2}{\sum_{i,j}^{m,n}\left[I(i,j)\right]^2}$$

$$\text{PSNR} = 10\log_{10}\frac{255^2}{M.S.E}\,dB$$

Where I (I, j) = Host Image

J (I, J) = Watermarked Image

**Robustness:**

Robustness is a measure of the immunity of the watermark against attempts to remove or degrade it, internationally or unintentionally, by different types of digital signal processing attacks. We measured the similarity between the original watermark and the watermark extracted from the attacked image using the Normalized correlation factor given below Eq.

$$NCC = \frac{\sum_{i,j}^{m,n}[I(i,j) * J(i,j)]}{\sum_{i,j}^{m,n}[I(i,j)]}$$

Where I (I, j) = Original Image
J (I, J) = Watermarked Image

**3. Experimental Results of Original Images:**

| Original image | Secret image | Water marked image | Secret Retrieval image |
|---|---|---|---|
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**PSNR and NCC Values of Original image:**

| Image | PSNR (dB) | NCC |
|---|---|---|
| Boat | 55.48 | 0.99997 |
| Peppers | 49.77 | 0.99987 |
| Lena | 59.85 | 0.99999 |

**PSNR Values of Watermarked image:**

| Image | PSNR (dB) |
|---|---|
| Boat | 49.46 |
| Peppers | 43.75 |
| Lena | 53.83 |

**4. APPLICATIONS:**

There are diverse applications of watermarking for which suitable watermarking systems are designed. Watermark can be used in copyright protection which prevents redistribution of copyrighted images. Authentication for ownership verification in case of ATM, credit cards, etc. can also be achieved. Content labeling and content protection are the most common examples of visible watermarks. Nowadays digital watermarking is also being used in biomedical and satellite imaging to highlight some peculiar regions and parts of an image. Covert communication which includes transmitting hidden data which is almost imperceptible to the intruder is being achieved using watermarking schemes having high data embedding capacity/

**5. CONCLUSION:**

The proposed method is successfully developed and implemented with improved PSNR over existing Digital image watermarking techniques. The simulation result shows that the efficiency of the proposed watermarking technique has the significant PSNR and NCC used to measure the image quality. The overall analysis also shows that the proposed technique works better even for color images. All the examples shown indicate our technique is efficient for Digital image water marking and has good subjective and objective quality.

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