# ROBUST DIGITAL INVISIBLE WATERMARKING FOR COPYRIGHT PROTECTION OF IMAGE USING DCT (DISCRETE COSINE TRANSFORM)

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**Abstract** - Digital watermarking is an important issue for the copyright protection and ownership authentication in multimedia applications. We implement the watermarking algorithm using frequency domain technique by using DCT (Discrete Cosine Transform) on images. Here, the invisible watermarking is used to protect copyrights of multimedia contents. The invisible watermarks are new technologies which could solve the problem of enforcing the copyright protection is required for ownership identification as well as hidden information can also be identified. Where, the watermark is invisible to the human eye. Also, the authenticity of the information in the image can be obtained by comparing the watermarked image with the original image.

**Keywords** - Invisible watermarking, DCT (Discrete Cosine Transform), Copyright protection, PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error).

## I. INTRODUCTION

Digital watermarking is an act of hiding one information inside information. Here, the hiding of data is invisible format. The main aim of watermarking is to hide one data into the original data. The watermark is the practice or an act of hiding a message about an image, audio clip, video clip or other work of media. It is a process of embedding information into a digital media which is difficult to remove. In order to protect the data from illegal copying such digital invisible watermarking scheme is used. Here, the frequency domain watermarking technique is used. Where, the watermark is embedded after taking image transforms, because the frequency domain methods are more robust than the spatial domain techniques [1].

## II. COPYRIGHT PROTECTION

To verify the authenticity of the carrier signal or to show the identity of owners the copyright protection is required in digital watermarking process. Invisible watermarking is used as an proof of ownership. Robustness is resists a designated class of transformations. Robust watermarks may be used in copy protection applications to carry copy and no access control information. The invisible-robust watermark is embedded in such a way that alternations made to the pixel value are perceptually not noticed and it can be recovered only with appropriate decoding mechanism [8].

## III. INVISIBLE WATERMARKING TECHNIQUE

**Embedding Procedure**:
The method in which we add one image with another image, i.e; known as embedding. Here, one is an original image another one is the watermark image. We have taken here logo.jpg as original image and name.jpg as watermark image. The watermark is embedded in to the original image. Where, thewatermark is invisible to human eye. In order to embed an image watermark, we split the image watermark into blocks and transform them into DCT domain. Then these DCT coefficients are quantized and adjusted[3].

The embedding procedure is given below;

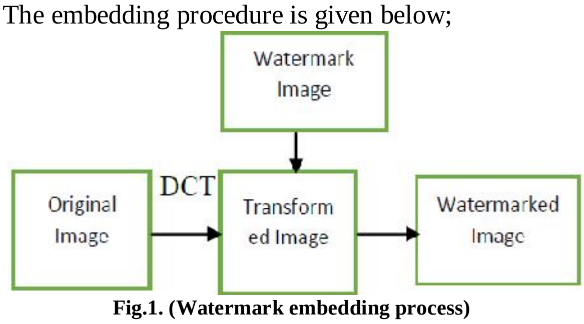



**Fig.1. (Watermark embedding process)**

**Extraction Procedure**
The watermark is extracted from the watermarked image.The method in which we separate the watermark image from the original image i.e; known as extraction process. Where the original image is to be extracted.

be extracted.

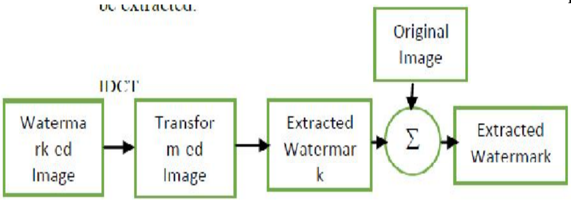



**Fig.2. (Watermark Extraction Process)**

## IV. PROPOSED SCHEME

The proposed scheme is Discrete Cosine Transform (DCT). A DCT expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. The DCT is an important to numerous applications in science and engineering, from lossy compression of audio (MP3) and images (JPEG). Where, small high frequency components can be discarded to spectral methods for the numerical solution of partial differential equations. The use of cosine function rather than sine functions is critical for compression. The DCT is a Fourier related transform similar to the Discrete Fourier Transform(DFT), but using only real numbers. The DCT is generally related to Fourier series coefficients of a periodically and symmetrically extended sequence whereas, DFTs are related to Fourier Series coefficients of a periodically extended sequence. This method operates in the frequency domain embedding a watermark image in a selected set of DCT coefficients. Watermark casting is performed by exploiting the masking characteristics of the Human Visual System, to ensure watermark invisibility[3].

### The Discrete Cosine Transform (DCT)

The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT is like the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain.
The DCT is performed on an N × N square matrix of pixel values and it yields an N × N matrix of frequency coefficients. Here, N most often equals 8 because a larger block, though would probably give better compression, often takes a great deal of time to perform DCT calculations; creating an unreasonable tradeoff. As, a result, DCT implementations typically break the image down in to more manageable 8 × 8 blocks.

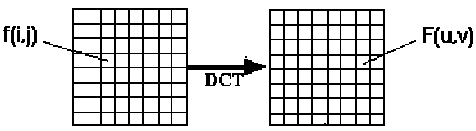



**Fig.3. DCT blocks**

-Here, an image into non-overlapping blocks where (8 x 8) blocks are commonly used and applies DCT to each block. This will divide an image into three main regions as shown in figure 2; low frequencies sub-band (FL), middle frequencies sub-band (FM) and high frequencies sub-band (FH) which makes it easier to select the band in which the watermark is to be inserted. Many studies indicate that the middle frequency bands are commonly chosen, because embedding the watermark in a middle frequency band does not scatter the watermark information to most visual important parts of the image. The third step is to apply block selection criteria based on the knowledge of Human Visual System (HVS). In addition, the fourth step applies coefficient selection criteria (e.g. highest, middle, lowest).The remaining steps involves embedding the watermark by modifying the selected coefficients and finally applying inverse DCT transform on each block. watermark is embedded into an image by modifying the coefficients of the middle frequency sub-band, this is done so that the visibility of the image will not be affected, and the watermark will not be removed by compression [2].

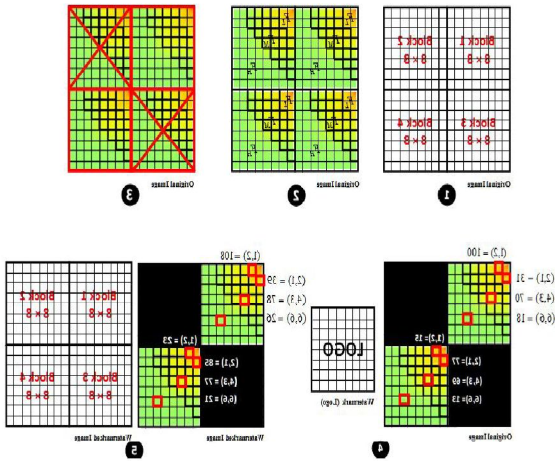


**Fig.4. 8 × 8 block using DCT [2]**

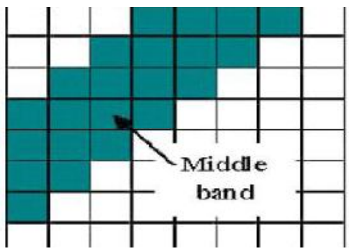



**Fig.5.Middle Band Frequencies In 8x8 Dct Block [5]**

**DCT Encoding**:
The general equation for a 1D (N data items) DCT is defined by the following equation:

$$F(u) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \Lambda(i).\cos\left[\pi.\frac{u}{2N}(2i+1)\right] f(i) \quad ----Equation(1)$$

and the corresponding inverse 1D DCT transform is simple F-1(u),
i.e.: where,

$$\Lambda(i) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \xi \\ 1 \end{cases} = 0, \text{otherwise} ---- \text{Equation}(2)$$

The general equation for a 2D (N by M image) DCT is defined by the following equation:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \Lambda(i).\cos\left(\pi.\frac{u}{2N}(2i+1)\right) \sum_{j=0}^{M-1} \Lambda(j).\cos\left(\pi.\frac{v}{2M}(2j+1)\right).f(i,j)\text{--------}$$
Equation(3)

and the corresponding inverse 2D DCT transform is simple F-1(u,v),
i.e.:where

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \xi = 0, \text{otherwise} \\ 1 \end{cases}$$-------Equation(4)

**The basic operation of the DCT is as follows**:
The input image is N by M;
f(i,j) is the intensity of the pixel in row i and column j; F(u,v) is the DCT coefficient in row k1 and column k2 of the DCT matrix. For most images, much of the signal energy lies at low frequencies; these appear in the upper left corner of the DCT. Compression is achieved since the lower right values represent higher frequencies, and are often small **-** small enough to be neglected with little visible distortion. The DCT input is an 8 by 8 array of integers. This array contains each pixel 's gray scale level; 8 bit pixels have levels from 0 to 255.

Therefore an 8 point DCT would be;
where,

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \xi = 0, \text{otherwise} \\ 1 \end{cases}$$---Equation(5)

The popular block-based DCT transform segments of an image non-overlapping blocks and applies DCT toeach block. This results in giving three frequencysub-bands: low frequency sub-band, mid-frequencysub-band and high frequency sub-band. DCT-based watermarking is based on two facts. The first fact isthat much of the signal energy lies at low-frequenciessub-band which contains the most important visualparts of the image. The second fact is that high frequency components of the image are usually removed through compression and noise attacks. The watermark is therefore embedded by modifying thecoefficients of the middle frequency sub-band so that the visibility of the image will not be affected and the watermark will not be removed bycompression [4].

## V. EXPERIMENTAL RESULT AND ANALYS

The above procedure has been implemented using the DCT transform in MATLAB and the results are tested with two gray scale images respectively. Where, one is the original image and another one is the watermark image. For the original color image (6), watermark color image (7), original gray scale image (8), watermark gray scale image (9), watermarked image (10), extracted watermark image (11).

**Fig. 6. Original color image**

**Fig. 7.Original watermark image**

**Fig.8. Original gray scale image**

**Fig. 9.Gray scale Watermark image**

**Fig.10. Watermarked image**

**Fig.11.Extracted Watermark image**

COMPARISONS (Comparing different value of watermark strength factor alpha)

After embedding the watermark image in to an original image there is a variation of characteristics of the final watermarked image. According to the addition of % of watermark we obtain different values of PSNR (Peak signal to noise ratio) and MSE (Mean square error).

For the restoration result that requires a measurement of image quality. Hence, there are two methods which are commonly used for this purpose. Such as; Mean-squared error and Peak signal to noise ratio.

**MSE (Mean square error):** The mean square error (MSE) is the error or difference between the original image and watermarked image. Let us, consider that the original image is g(x, y) and the watermarked image is g^$(x,y)$ then the MSE can be calculated as;**emse** = $\frac{1}{MN}\sum_{n=1}^{M}\sum_{m=1}^{N}[g^{n,m} - g(n,m)]^2$

But, one problem in Mean square error is that it depends strongly on the image intensity scaling.

**PSNR (Peak signal to noise ratio):** The PSNR is a good measure for comparing restoration results for the same image, but between image comparison of PSNR are meaningless. For example, if one image with 15 dB PSNR may look much better than another image with 30 dB PSNR. The PSNR is measured in decibels(dB). But, PSNR avoids the problem of MSE by scaling the MSE according to the image range.

**PSNR=$-\log(emse^2)$in dB**

**MSE Extraction**: The difference between the error between final watermarked image and extracted watermark image.

**PSNR Extraction**: The difference between the Peak signal to noise ratio between final watermarked image and extracted watermark image.

**Comparison Table:**

**Table no.1**

| Sl NO. | Watermark strength factor(Alpha) | MSE for Embedding | PSNR for Embedding (in dB) | MSE for Extraction | PSNR for Extraction (in dB) |
|---|---|---|---|---|---|
| 1. | 0.089 | 0.0437 | 29.6702 | 1.9998e +003 | -77.6418 |
| 2. | 0.0008 | 0.0452 | 29.3405 | 0.0103 | 44.0937 |
| 3. | 0.0689 | 0.0439 | 29.6145 | 1.1906e +003 | -72.4558 |
| 4. | 0.7 | 0.0491 | 28.5111 | 1.2618e +005 | -119.0881 |
| 5. | 0.0342 | 0.0449 | 29.3947 | 284.6479 | -58.146 |

**Graphs:**

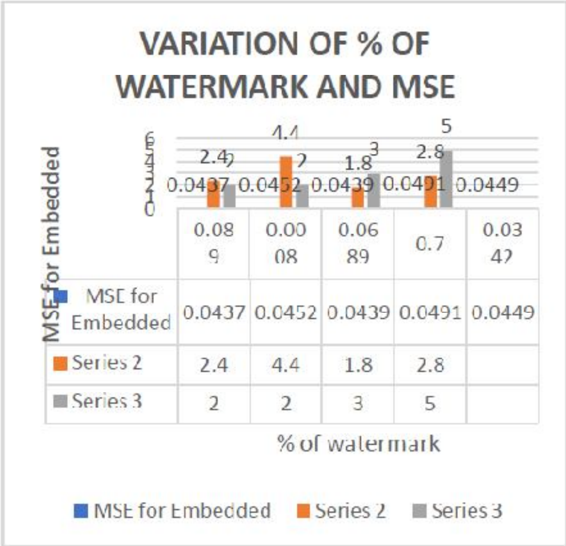
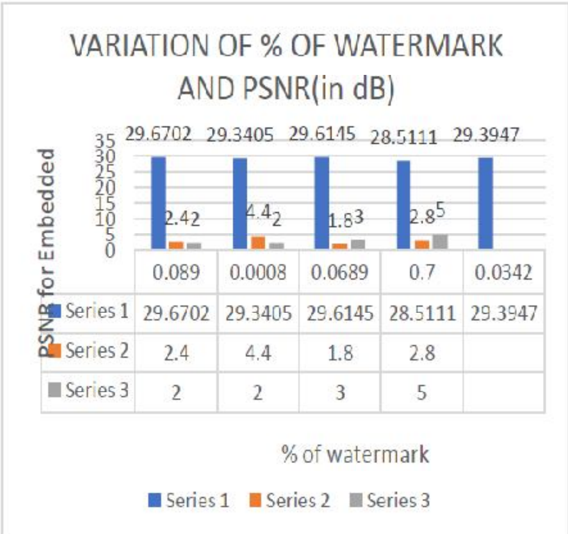
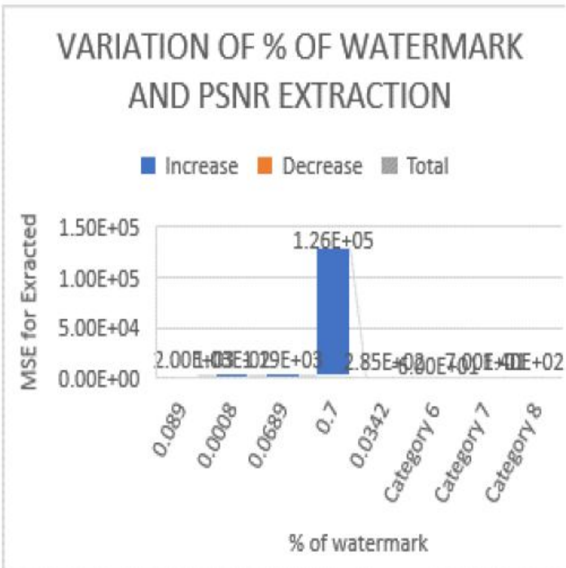


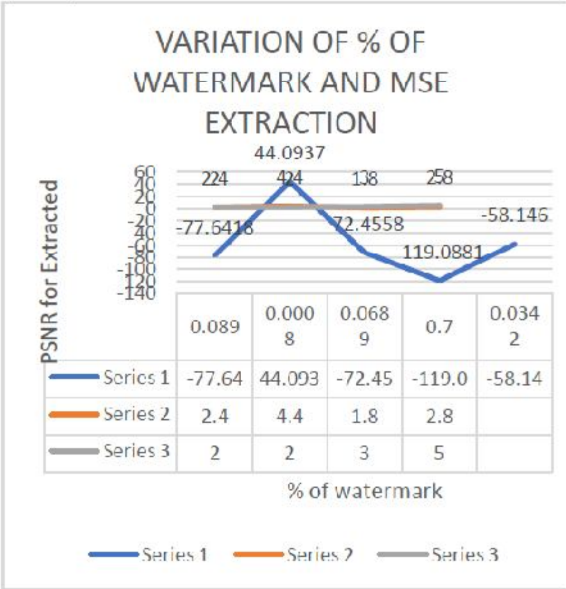

**Fig.12 (a) Variation % of watermark and MSE**




**(b).Fig. % of watermark and PSNR (in dB)**




**(c). Fig. % of watermark and PSNR Extraction (in dB)**




**(d). Fig. % of watermark and MSE Extraction**

## VI. VARIOUS APPLICATIONS OF INVISIBLE WATERMARKING

The DCT and the DCT-II is used in signal and image processing especially for lossy compression, because it has a strong energy compaction property. Digital watermark technique can be used in consumer electronic devices like digital still camera, digital video camera, DVD players etc.

Applications of DCT leads to mapping of image to the frequency domain. It is represented as a combination of DCT basic functions appropriate DCT coefficients, representing different horizontal and vertical intensities [6].

**Telivision Broadcasting**: Broadcast monitoring also watermarking technique is able to track when a specific video is being broadcast by a TV station.

**Copyright Protection**: Copy control is a very promising application for watermarking. In this application, the watermarking can be used to prevent the illegal copying of songs, images, movies by embedding a watermark in them, that would instruct watermarking in a compatible DVD or CD writer to not write the song or more because it is an illegal copy.

**Source tracking**: Such method has been used to detect the source of copied movies. Where the different recipients get differently watermarked content.

## CONCLUSION

DCT is one of the most common linear transformations in digital signal process technology.The DCT domain watermarking can survive against the attacks such as noising, compression, sharpening, and filtering [5]. Due to good performance, it has been used in JPEG standard for image compression.DCT techniques are more robust compared to spatial domain techniques. Such algorithms are robust against simple image processing operations like adjustment, brightness, blurring, contrast and low pass filtering and so on [7]. Here, we conclude that according to addition of % of watermark strength factor the invisibility of watermark is as much as better for the protection of the image.

## FUTURE WORK

The future work of robust digital watermarking can be designed on color image,video, audio etc. through embedding secret key for more secure of datas. Which can be implemented with secret-key embedding.

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