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# An Efficient Image Watermarking using 2-DCT and 2-DWT in Color Images

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***Abstract*:** Watermarking is technique to resolve copyright problems issue, however this must be determined by keeping a steady look for the robustness and imperceptibility of the watermark images which bring about to be its fundamental objectives. In this study, we presented a capable image watermarking applying two level discrete cosine and wavelet transform (2-DCWT). We worked on color images and split color image into three elements: red, green and blue. In this approach, we apply 2-DCT on red element, 2-DWT on blue and green element. We, then, have assessed the image watermarked quality which is found later than embedding watermarks by both PSNR with NC. Further, we have shown a few experiments to assess the execution of these computations regarding robustness, capacity, and inserting time. The experimental outcomes demonstrate that DWT based technique is suitable for restorative applications where inserting time and imperceptibility are prime concerns.

***Keywords:*** 2-DWT, 2-DCT, PSNR, NC, Digital Watermarking, etc.

## I. INTRODUCTION

Digital watermarking is a system where a hidden document, it may be a video, audio or picture, embedded in host document that it rests on it only if the observed value of content in suitable level [1]. For the watermarking of final decade digital is the greatest option for the protection of information. Digital watermarking can be categorized as (1) informed or (2) blind. This document only centered on knowledgeable watermarking, where marked signal removed through host information. This watermarking can be classified in follow [2]

- Distribution
- Embedding
- Detection or Extraction

Embedding is a procedure where hidden information like an audio, video or image is inserted in the host information which may an image or a video or audio, by a key. Afterward this embedded information is distributed or broadcast by a lousy or lossless channel that is recognized as an allocation. The third level is depending on the next, when the presence of marked signal may be noticed applying the host information with recognized key is recognized as detection. However when the marked document has improved from embedded information through recognized host information and key is recognized as an extraction.

Furthermore, two different methods based digital watermarking are:

- Spatial domain [3]
- Transform domain

Digital watermarking may be complete in either frequency or spatial domain. Approach of frequency domain is very robust compare to spatial domain [5] and it is widely used scheme. This approach is depending on FT or FFT [6], DCT [4], and DWT [7]. A complete survey on watermarking depending on frequency domain and originate that DWT based approach is very robust. As well, many watermarking approaches have been projected with DWT for watermarked medical pictures [8], [9]. Apart from these frequency domain schemes, SVD based watermarking have achieved popularity [10]. These schemes are strong to many attacks - for example rotation, noising and compression - that are designed to raze the secret watermark.

## II. LITERATURE REVIEW

Zhu Yuefeng (2015) et al present that duel watermarking algorithm for different two image watermarking, where gray image watermarking within equation is simply not enough. In this paper studies the embedding point and approach of transform domain algorithms to level the invisibility and strength of watermarking algorithm.The benefit of embedded dual watermarking, and utilize the NEC features of the algorithm is enhanced adaptive depending upon embedded form.Imperceptibility of algorithm, robustness and safety are studied for embedding procedure.[14]

Reena Anju (2013) et al presents that Digital Image Watermarking embeds classifying data in an image, in such a manner that it cannot simply be eliminated. In this work undetectable and robust combined digital watermarking algorithm depending on 3level DWT and DCT has been proposed. In this algorithm, the digital watermark knowledge that has been DCT, is placed in image extensive frequency band that has been transformed wavelet. Performance evaluation outcomes display that merging the two transforms better the presentation of watermarking algorithms which are depending on DWT transform.[15]

Md. Maklachur Rahman (2013) et al presents that knowledge of watermarking is suggested and executed. In suggested watermarking technique, the picture is reorganized by zigzag order and also DWT is useful on the rescheduled image. Then SVD and DCT are functional on each bands HL, HH and LH. After that watermark is embedded through changing bands the particular values. Extraction of watermark is achieved through watermark embedding procedure inversion. For picking of these bands it provides the ability of mid-band and high band that guarantees robustness and fine imperceptibility against various type of attacks.[16]

Sangeeta Madhesiya (2013) et al present that with the increasing popularity of digital media and internet, and suggest a watermarking technique of non-blind transform domain that is depending on the SVD, DWT and DCT by applying Arnold Transform technique. DCT based watermarking methods offers compression where as DWT depending compression provides scalability.. Thus go to for SVD depending on digital watermarking that is a data embedding technique validation in features of image with prospect to display flexibility against the numerous kind of deliberate or unintentional attacks. In paper attentions on applying DCT, DWT and SVD by applying [11]

Surya Pratap Singh (2012) et al present technique includes numerous methods to match a robust and safe watermarking. In the suggested method the watermark is implanted in the DWT 3rd level and before the embedding watermark image is approved through the chaotic encryption procedure for its protection, the other most significant object is that suggested technique embedded watermark in DCT with particular coefficient shifting algorithm to lessen effect on basic image. The presentation of the future watermarking is stronger to a variation of image processing methods, for example compression of JPEG, arithmetic functions, enhancement, and resizing.[17]

## III. PROPOSED METHOD

The DWT and DCT transforms have been extensively utilized in the numerous applications of digital watermarking. This part presents the two transforms concisely, and draw their related execution of digital watermarking.

### *A. The Discrete Cosine Transform*

This is utilized for transforming a signal into elements of basic frequency [12]. It specifies a picture as a sinusoids total of variable frequencies and magnitudes. With x as input image, DCT coefficients for y as transformed output images, are calculated according to the expression.1 displayed below. In the expression, x consuming N x M pixels, x (m, n) is the pixel intensity in column n and row m of image, and DCT coefficient is y (u, v) in column v and row u of the DCT matrix.

$$y(u,v) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_m\alpha_n\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n) * \cos\frac{(2m+1)u\pi}{2M}\cos\frac{(2n+1)u\pi}{2N}\} \dots\dots\dots\dots (1)$$

Where

$$\alpha_u = \begin{cases}\frac{1}{\sqrt{2}} & u = 0 \; or \; u = 1,2,\dots\dots,N-1\\ 1\end{cases}$$

$$\alpha_v = \begin{cases}\frac{1}{\sqrt{2}} & v = 0 \; or \; v = 1,2,\dots\dots,N-1\\ 1\end{cases}$$

The image is recreated through relating inverse of DCT function according to Equation. 2:

$$x(m,n) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_m\alpha_n\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n) * \cos\frac{(2m+1)u\pi}{2M}\cos\frac{(2n+1)u\pi}{2N}\} \dots\dots\dots\dots (2)$$

The general block-based DCT fragments image non-overlapping blocks and also applies DCT to every block. This outcomes in providing three sets of frequency coefficient: high, low and mid-frequency-sub-band. DCT-based watermarking has two facts. One is that extensive of the signal power lies at the low-frequencies sub-band which is holding the greatest significant image parts. Second is that extraordinary frequency image elements are generally eliminated by noise attacks and compression. So the watermarks are embedded by altering the coefficients of central frequency sub-band then the image perceptibility will not be consequences and by compression watermark will not be eliminated [13].

In this scheme, we generally focused on two procedures: Extracting and Embedding.

A Color Image comprise color substance that provides additional information to the state as the human eye is extra reactive to the color changes. All the colors can be resulted from the Red (R), Green (G), and Blue (B) colors. MATLAB arranged the color elements into the individual matrix and allow us to operation on any RGB element. In this work, R element is selected for inserting the hidden image into cover image.

For the first R elements of the image it will apply 2-DCT transform to embed watermark in R element. For the second G element of the image it will apply 2-DWT transform to embed watermark in G element. For the third B element of the image it will apply 2-DWT transform to embed watermark in B element.

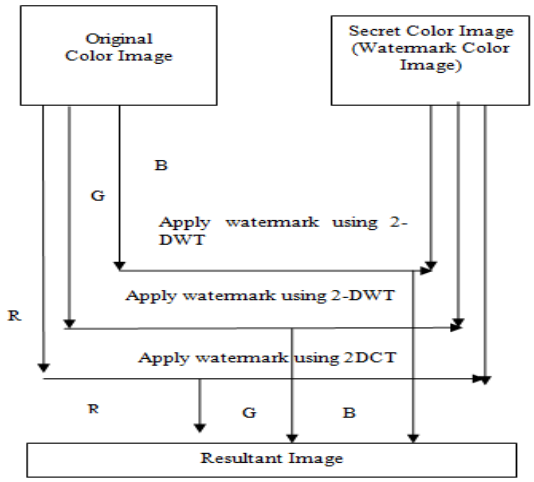



**Fig 1. Proposed Block Diagram**

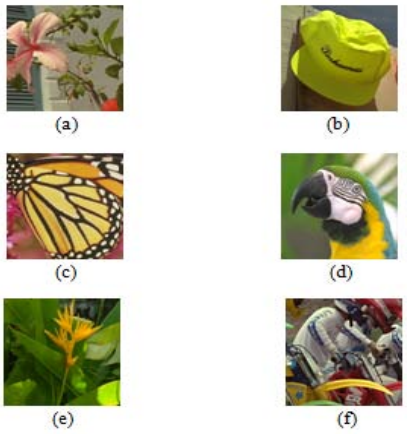



Fig 2. Image Dataset

**Proposed Algorithm**

***B. Embedding Process***

1. Take two images: one is an actual color image is denoted as 'img' and another is secret color image is denoted as 'w_img'.
2. Alter RGB images into red, green and blue elements.
3. Apply 2-DCT to block on Red element of image in the preferred coefficient sets h1. This coefficients set is chosen to observe if strength and imperceptibility of algorithms similarly.
4. Execute 2-DWT on green element of img, then split into : h_LL1, h_HH1, h_LH1 and h_HL1.
5. Perform 2-DWT on blue element of img, then split into : h_LLb2, h_LHb2, h_HLb2, h_HHb2.
6. Apply DCT to block on Red element of w_img in the chosen coefficient sets s1.
7. Perform 2-DWT on green element of w_img, then split into : s_LL1, s_HL1, s_LH1 and s_HH1.
8. Perform 2-DWT on blue element of w_img, then split into : s_LLb2, s_LHb2, s_HLb2, s_HHb2.
9. Apply inverse 2-DCT (IDCT2) on the block after the mid-band coefficients have been altered to insert the watermark bits as defined in the earlier stage.
10. Embed image using this formula:

$$S\_r=h1+\beta*s1$$
$$S\_g=h\_LL1+\beta*s\_LL1$$
$$S\_b=h\_LLb1+\beta*s\_LLb1$$

Where S_r,S_g,S_b are secret images of Red,Green and Blue element, β is scaling factor used for control strength of an image

11. Apply inverse 2-DWT (IDWT2) for reconstruct matrix.

***C. Extraction Process***

12. Extract watermark from the watermarked image using 2-DCT and also applies attacks on watermark image.
13. Execute 2-DWT on green element of watermarked image, then split into : wm_LL1, wm_LH1, wm_HL1, wm_HH1
14. Perform 2-DWT on blue element of watermarked image, then split into : wm_LLb1, wm_LHb1, wm_HLb1, wm_HHb1
15. Using this formula extract secret color image from watermarked image and original color image:

$$S\_ewatr=(wm1-h1)/\beta$$
$$S\_ewatg=(wm\_LL1-h\_LL1)/\beta$$
$$S\_ewatb=(wm\_LLb1-h\_LLb1)/\beta$$

Where S_ewatr,S_ewatg,S_ewatb are secret color images

16. Apply inverse 2-DCT (IDCT2) on the block after the mid-band coefficients have been altered to insert watermark bits as defined in earlier stage.
17. Apply IDWT2 for reconstructig matrix.
18. Calculate the PSNR &MSE of extracted image.

$$MSE(x)=\frac{1}{N}||x-x\hat{}||^2=\frac{1}{N}\sum_{i=1}^{N}(x-x\hat{})^2$$

19. Calculate NC of extracted image.
NC = sum(sum(origImg .* distImg)) ./ sum(sum (origImg .* origImg))

*1) Read Original Color Image and Secret Color Image*

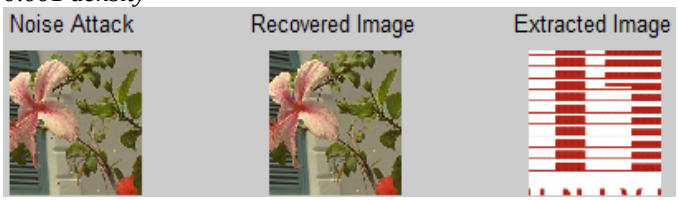

(g) (h)

**Fig3. (g) Show original color image (h) Show secret color image**

*2) Embedded Image*


**Fig4. Show Watermarked Image**

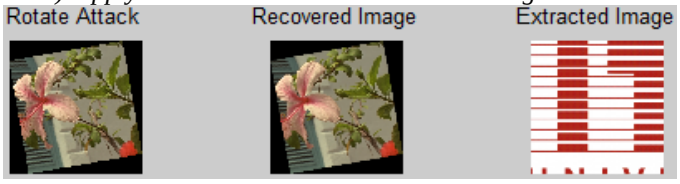
*3) Apply Noise Attack on Watermarked Image with 0.001 density*




(i) (j) (k)

**Fig5. (i) Noisy Image (j) Recovered Image (k) Extracted**
Watermark Image

*4) Apply Rotate Attack on Watermarked Image with 10°*




(l) (m) (n)

Fig6. (l) Rotate Image (m) Recovered Image (n) Extracted Watermark Image

## IV. RESULT ANALYSIS

In this segment , we have conducted two attacks, for example rotation and noise on the watermarked images to test the robustness of the proposed methods on 0.001density. Table1.&2.Gives the PSNR and NC values of the watermarked images in the presence of Noise and Rotate attack for six cover images.

**Table 1.** Our 2-DCWT Results on Noise Attack

| Image | PSNR | NC |
|---|---|---|
| (a) | 70.4114 | 0.9220 |
| (b) | 72.2166 | 0.9187 |
| (c) | 69.5960 | 0.8982 |
| (d) | 69.6678 | 0.8738 |
| (e) | 77.0926 | 0.8116 |
| (f) | 71.8553 | 0.8784 |

**Table 2.** Our 2-DCWT Results on Rotate Attack

| Image | PSNR | NC |
|---|---|---|
| (a) | 70.6612 | 0.9227 |
| (b) | 72.3613 | 0.9194 |
| (c) | 69.9062 | 0.8989 |
| (d) | 69.8629 | 0.8745 |
| (e) | 77.5592 | 0.8122 |
| (f) | 72.1192 | 0.8790 |

As all our attacks whether it is on Noise attack or the rotation attack we compared it with the existing paper results with our proposed results to explore the better results.

**Table 3.** Base Sachin MehtaResults on Noise Attack

| Image | PSNR | NC |
|---|---|---|
| (a) | 15.2614 | 0.8526 |
| (b) | 15.0542 | 0.8397 |
| (c) | 13.6317 | 0.8112 |
| (d) | 15.3536 | 0.8311 |
| (e) | 11.1334 | 0.8260 |
| (f) | 12.5107 | 0.7805 |

**Table 4**. Base Sachin Mehta Results on Rotate Attack

| Image | PSNR | NC |
|---|---|---|
| (a) | 15.5122 | 0.8561 |
| (b) | 15.3005 | 0.8432 |
| (c) | 13.8620 | 0.8146 |
| (d) | 15.6070 | 0.8345 |
| (e) | 11.3083 | 0.8294 |
| (f) | 12.6987 | 0.7836 |

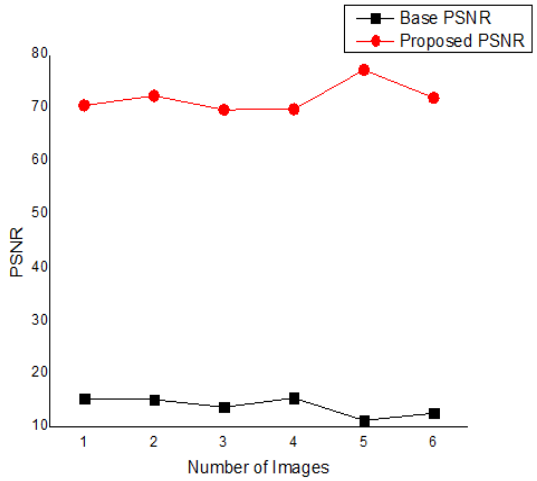



**Fig 7: Comparison of PSNR between existing and Proposed result of Noise Attack**

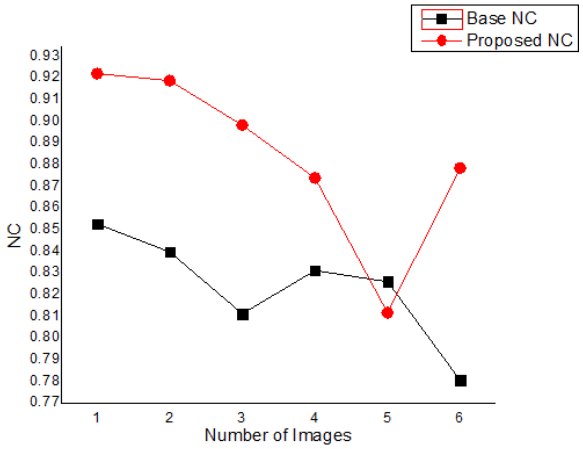



**Fig 8: Comparison of NC between existing and Proposed result of Noise Attack**

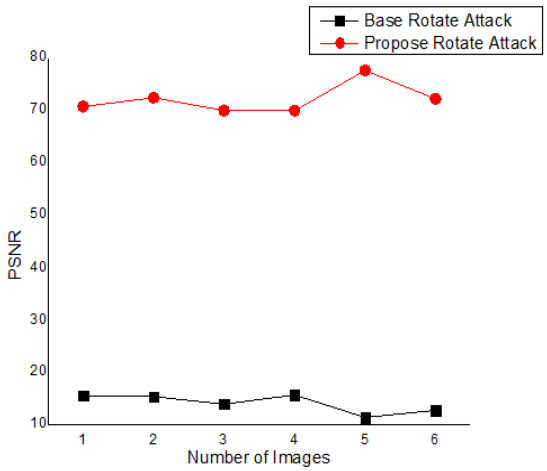



**Fig 9: Comparison of PSNR between existing and Proposed result for Rotate Attack**

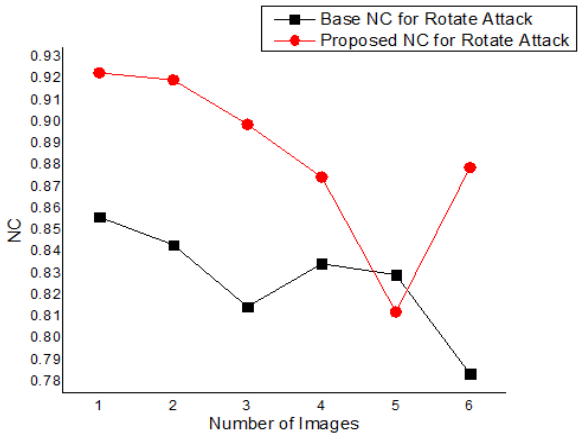



**Fig 10: Comparison of NC between existing and Proposed result for Rotate Attack**

Fig7 & Fig9 shows the PSNR values of our proposed results that lies up to 77% by applying noise and rotation attack and in existing results lies up to 15% where the impercibilty of watermarked is very low towards the security and Fig8 & Fig10 shows the NC values lies up to 0.9% in proposed results and in existing results 0.8% which also tends the security of the visibility in watermarking.

## CONCLUSION

Watermarking is the approach to solve the copyright corruption issue, however this must be determined by keeping a steady look out for the robustness and imperceptibility which bring about to be its fundamental objectives. In this study, we presented a capable image watermarking applying two level discrete cosine and wavelet transform (2-DCWT). In this approach, we apply 2-DCT on red element, 2-DWT on blue and green element. We evaluate the performance on the peak signal noise ratio (PSNR), normalized cross correlation and mean square error. PSNR value reached up to 40-77%. The tentative outcomes are prepared accessible that show the enhanced strength and imperceptibility under assaults and safeguard patents by utilizing this procedure. Other work of incorporating human visual framework attributes into our methodology is in advancement.

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