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Towards Design and Implementation of Discrete Transform Image Coding based Document Authentication Techniques

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1. Introduction

Due to swift expansion in Internet, dependency on steganographic technique increases, to authenticate legal document/content and copyright protection. Generally secret information may be hidden in one of two ways, such as cryptography and steganography. In cryptography the information is converted into unintelligent data, where as steganography hides the presence of secret data.

As per the review work done, the steganographic domain is divided into four areas, such as, “data hiding”, “authentication of documents and tampering detection”, “secret message transmission” and “ownership protection & verification”. Every domain has its own specification in respect of, quantity of data to be hidden and the degree of immunity for modification of host image. These two measurements are vice versa, if requirement forces us to increases the data to be hidden then degree of immunity for host image decreases. As an example for ownership verification small amount of secret data needs to embed, but for secret message transmission huge amount of data needs to be hidden inside the host image.

To achieve the solution of above four problems, challenges come across the way are follows:-

a) The cover image degrades due to hidden data.
b) Hiding data into the content of the file not into the header of the file, so that hidden data must remain intact with varying header format.
c) Hiding data in spatial domain so that computation cost decreases.
d) Hiding data in frequency domain for increasing the security of hidden data inside the host image.
e) Hiding data in a manner that, any usual external forces can’t temper the hidden data, such as data compression, image cropping, image rotation, Noise, ect.

The main motive of the work is to study different transform and hiding techniques by which our four requirements can be achieved by overcoming all the challenges comes across the way, to hide the presence of the data without the observer notices, even if they are perceptible or not.

The transformation techniques studied are discrete wavelet transform, discrete cosine transform, and Hough transform are discussed in section 2.

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2.1 Discrete Wavelet Transformation

In image processing each transform equation is available as pair which is reversible and termed as forward and inverse transformation respectively (Polikar, 2002). In Wavelet based forward transformation the image converts from spatial domain to frequency domain using eq (1) and eq (2), and in inverse transformation the reverse procedure is followed (eq.(3)). Mathematically the image matrixes multiply with scaling function coefficients and wavelet function coefficients to generate transform matrix (Kaplan, 2002).

$$Y_{Low}[k] = \sum_n x[n].h[2k-n] \quad (1)$$
$$Y_{High}[k] = \sum_n x[n].g[2k-n] \quad (2)$$
$$x[n] = \sum_{k=-\infty}^{\infty}\big(Y_{High}[k].g[2k-n]\big) + (Y_{Low}[k].h[2k-n]) \quad (3)$$

Where x[n] is original signal, h[x] is half band low pass filter, g[x] is Half band high pass filter, $Y_{Low}[k]$ is output of high pass filter after sub sampling by 2, $Y_{High}[k]$ is output of low pass filter after sub sampling by 2.

a) *Forward Transformation*

The *Mallat* based two-dimensional wavelet transform is used in order to obtain a set of bi-orthogonal subclasses of images (Antonini, 1992). In two-dimensional wavelet transformation, a scaling function φ(x,y) represent by eq (4).

$$\varphi(x, y) = \varphi(x)\,\varphi(y) \quad (4)$$

and if ψ(x) is a one-dimensional wavelet function associated with the one–dimensional scaling function φ(x), three two dimensional wavelets may be defined as given in eq (5). Fig1 represents functions in visual form.

$$\begin{aligned}\psi^H(x,y) &= \varphi(x)\,\psi(y)\\ \psi^V(x,y) &= \psi(x)\,\varphi(y)\\ \psi^D(x,y) &= \psi(x)\,\psi(y)\end{aligned} \quad (5)$$

Low resolution sub-image $\psi(x, y) = \varphi(x)\,\varphi(y)$	*Horizontal Orientation sub-image* $\psi^H(x,y) = \varphi(x)\,\psi(y)$

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Vertical Orientation sub-image $\psi^V(x, y)= \psi(x)\varphi(y)$	*Diagonal Orientation sub-image* $\psi^D(x,y)=\psi(x)\psi(y)$

Figure 1. Image decomposition in Wavelet transforms

As per Haar forward transform scaling function coefficients and wavelet function coefficients (Kaplan, 2002) $H_0 = ½$, $H_1 = ½$, $G_0 = ½$ $G_1 = -½$ are taken.

b) *Inverse Transformation*

Inverse transformation is just the reverse of the forward transformation with column transformation done first followed by row transformation. But the coefficient values are different for column/row transformation matrices. The coefficient for reverse transformation are $H_0 = 1$, $H_1 = 1$, $G_0 = 1$, $G_1 = -1$ (Kaplan, 2002). Reverse transform generate original image matrix as the technique is reversible.

2.2 Discrete Cosine Transformation

A discrete cosine transform (DCT) expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering.

The most common variant of discrete cosine transform is the type-II DCT, which is often called simply "the DCT" and its inverse the type-III DCT, is correspondingly often called simply "the inverse DCT" or "the IDCT".

a) *Forward Transformation*

Forward transformation with 2 x 2 masks can separate the image into one high, two middle and one low frequency components, in total four frequency components. The general equation for 2D (N by N image) DCT is defined by the equation (6).

$$C(u,v) = \frac{1}{\sqrt{2N}} \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{(2x+1)u\pi}{2N}\right]\cos\left[\frac{(2y+2)v\pi}{2N}\right] \tag{6}$$

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$$a(i) = \frac{1}{\sqrt{2}} \;\; if\ i\ is\ 0, else\ 1\ if\ i > 0$$

Here, the input image is of size N x N, f(x,y) is the intensity of the pixel in xth row and yth column, C(u, v) is DCT coefficient in uth row and vth column. Maximum signal energy concentrates in the upper left corner of the coefficient matrix.

b) Inverse transformation

The inverse transform of DCT is denoted as IDCT that is shown in equation 7.

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

$$a(i) = \frac{1}{\sqrt{2}} \;\; if\ i\ is\ 0, else\ 1\ if\ i > 0 \qquad (7)$$

2.3 Hough Transformation

The Hough transform is a technique which can be used to isolate features of a particular shape within an image. It requires the desired features be specified in some parametric form, the classical Hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc.

The Hough technique is particularly useful for computing a global description of a feature(s) (where the number of solution classes need not be known a priori), given local measurements. The motivating idea behind the Hough technique for line detection is that each input measurement (e.g. coordinate point) indicates its contribution to a globally consistent solution. Grayscale image on passing through Hough transformation with threshold, and origin as center of image, generates a matrix of rho verses theta, by eq 8 and eq 9 where limits are $1 \leq$ theta(θ) < Pi and $-N \leq$ rho(ρ) $\leq N$.

$$N = \left(\left(\frac{\sqrt{Row^2 + Col^2}}{2}\right)\right) \qquad (8)$$

$$\rho_i = (x * \cos\theta + y * \sin\theta) \qquad (9)$$

On calculation of rho for each value of theta and incrementing the matrix value of rho verses theta a butterfly like structure arise, as shown in figure 2.

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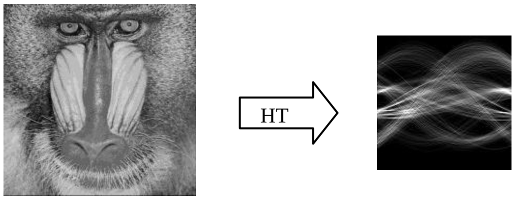
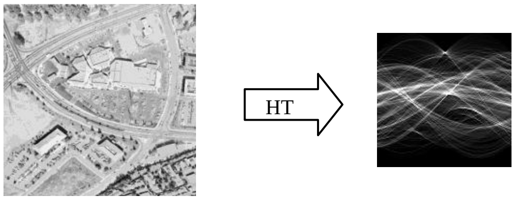


Baboon (512x512)
Threshold 200 to 255

Hough Transform Output
(128x128)



Map (512 x 512)
Threshold 235 to 255

Hough Transform Output
(128x128)

Figure 2. Hough Transformed based Signature Generation

By using these three transformations technique, steganography is realize with better performance as compare with the existing technique, few effort were done, are briefly discussed in section 3 with some results.

3.1 Self Authentication of color image through Wavelet Transformation Technique (SAWT)

In this work a self organized legal document/content authentication, copyright protection in composite domain has been carried out without using any external information. Average values of transformed red and green components in frequency domain generated through wavelet transform are embedded into the blue component of the color image matrix in spatial domain. A reverse transformation is made in RG matrix to obtain embedded image in association with blue component in spatial domain. Reverse procedure is done during decoding where transformed average values are obtained from red and green components and compared with the same from blue component for authentication. Results are compared with existing technique which shows better performance interns of PSNR, MSE & IF.

Ten PPM (Weber, 1997) images have been taken and SAWT is applied to obtain results. All cover images are 512 x 512 in dimension. Average of MSE for ten images is 14.218488 and PSNR is 36.620156 and image fidelity is 0.998740, shown in the Table I.

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Table I :Statistical data on applying SAWT over 10 images.

Cover Image 512 x 512		MSE	PSNR	IF
(a)	Mona Lisa	14.113154	36.634563	0.999212
(b)	Lena	13.226264	36.916432	0.999336
(c)	Baboon	13.058749	36.971880	0.999318
(d)	Tiffany	17.693600	35.652642	0.999585
(e)	Airplane	14.304066	36.576209	0.999592
(f)	Peppers	14.735413	36.447181	0.999114
(g)	Couple	14.864159	36.409400	0.993106
(h)	Sailboat	14.143402	36.625265	0.999288
(i)	Woodland	13.180171	36.931593	0.999449
(j)	Oakland	12.865904	37.036400	0.999400
Average Results: -		*14.218488*	*36.620156*	*0.998740*

Comparison of SAWT has been made with the recent technique of steganography PVD (pixel-value differencing) (Wu, 2005), our proposed SAWT gives optimized performance, as shown in table II for PSNR. After inserting average of 94831 bytes through PVD the PSNR drops down to 34.87 dB, where as on inserting 131072 bytes through SAWT the PSNR drops down to 36.71 approximately.

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Table II :Comparision of PSNR in PVD(Wu, 2005) with proposed SAWT for five benchmark images

Cover Image 512 x 512	PVD		SAWT	
	Capacity (Bytes)	**PSNR (dB)**	**Capacity (Bytes)**	**PSNR (dB)**
Lena	95755	36.16	131072	36.916
Baboon	89731	32.63	131072	36.972
Peppers	96281	35.34	131072	36.447
Airplane	97790	36.60	131072	36.576
Sailboat	94596	33.62	131072	36.625
Average Results: -	***94831***	***34.87***	***131072***	***36.7072***

3.2 Authentication/Secret Message Transformation Through Wavelet Transform based Subband Image Coding (WTSIC)

DWT based frequency domain steganographic technique, termed as WTSIC has been proposed where the cover PPM image transform into the time domain through DWT, resulting four sub-image components as ‘Low resolution’, ‘Horizontal orientation’, ‘Vertical orientation’ and ‘Diagonal orientation’. Secret message/image bits stream in varying positions are embedded in all three components and the experimental results against statistical and visual attack has been computed and compared with the existing steganographic algorithm like IAFDDFTT, (Ghoshal, 2008) in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Standard Deviation (SD) Analysis and Image fidelity (IF) Analysis, which shows better performances in WTSIC.

Ten PPM (Weber, 1997) images has been taken and applied on WTSIC to formulate results. All cover images are 512 x 512 in dimension and gold coin used as authenticating image of 128x128 in dimension. Table III, IV, V and VI show MSE, PSNR, IF and SD for five benchmark gray scale images on embedding 2 bits per byte from gold coin to these cover images, where the positions are selected through hash function. From the tables it is clear that average MSE for gray scale images are 4.0820276, 4.092123, and 4.290784 that of for color images are 3.891591, 3.911128 and 4.0713684. PSNR are 42.0440788, 42.03238, 41.83202 for gray scale images and 42.45973, 42.43012, 42.29586 for color images. IF for gray scale images are 0.9998488, 0.999848, 0.999842 and that of color images are 0.999817, 0.999822, 0.999813 and difference value of SD with original SD for gray scale images are -0.008038, -0.009116, -0.102461 and that of color images are 0.051921, 0.051403, 0.057572 for Horizontal, Vertical and Diagonal orientation sub-images respectively. From the observation it is very much clear that the technique for Horizontal sub images obtain minimum MSE and Maximum PSNR for gray and color images both. In case of fidelity also Horizontal orientation sub-images obtain better results. From the analysis of SD deviated from original SD value is minimum with respect of gray scale images in Horizontal sub-images but in case of color images Vertical orientation sub-images gives marginally better performances. Hence it may be interned from above observation of benchmark images that Horizontal orientation sub-images may obtain optimal distortion quality on embedding with the proposed technique graphically.

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TABLE III. MSE after embedding 2 bits of hidden data in three separate sub images.

Images	**MSE**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Elaine	3.786247	3.745972	3.831871
Boat	3.696224	3.849102	3.838825

Images	**MSE**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Clock	4.42664	4.598003	4.909153
Map	3.778519	3.692688	4.044724
Jet	4.722733	4.574852	4.829346
Airplane	4.070784	4.109852	4.467457
Baboon	3.250234	3.188728	3.348132
Lena	3.706172	3.885129	4.061348
Peppers	3.870188	3.886759	3.809952
Sailboat	3.608164	3.580195	3.572876
Average	***3.891591***	***3.911128***	***4.0713684***

TABLE IV. PSNR after embedding 2 bits of hidden data in three SEPARATE SUB IMAGES.

Images	**PSNR**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Elaine	42.348714	42.395159	42.296695
Boat	42.453221	42.277209	42.288820
Clock	41.672001	41.505111	41.220738
Map	42.357588	42.457377	42.061915
Jet	41.388870	41.527033	41.291921
Airplane	42.034023	41.992542	41.630200
Baboon	43.011657	43.094628	42.882778
Lena	42.441548	42.236749	42.044102
Peppers	42.253483	42.234927	42.321609
Sailboat	42.557940	42.591737	42.600624
Average	***42.251904***	***42.23125***	***42.06394***

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TABLE V. IF after embedding 2 bits of hidden data in three separate sub images.

Images	**IF (Image Fidelity)**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Elaine	0.999817	0.999819	0.999815
Boat	0.999806	0.999798	0.999798
Clock	0.999883	0.999878	0.999870
Map	0.999889	0.999892	0.999882

Images	**IF (Image Fidelity)**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Jet	0.999849	0.999854	0.999845
Airplane	0.999884	0.999883	0.999872
Baboon	0.999803	0.999834	0.999825
Lena	0.999814	0.999805	0.999796
Peppers	0.999767	0.999766	0.999771
Sailboat	0.999818	0.999820	0.999802
Average	***0.999833***	***0.999835***	***0.999828***

TABLE VI. SD after embedding 2 bits of hidden data in three separate sub images.

Images	**Standard Deviation (SD)**		
	Horizontal Orientation sub-image	***Vertical Orientation sub-image***	***Diagonal Orientation sub-image***
Elaine	46.033985	46.036091	46.035366
Boat	46.659157	46.656998	46.649647
Clock	56.803345	56.801373	56.802509
Map	39.400398	39.410755	39.88157
Jet	22.159605	22.156666	22.159515
Airplane	43.991947	43.992962	43.989441
Baboon	56.090149	56.093765	56.083096
Lena	58.961285	58.960365	58.959846
Peppers	66.035927	66.036728	66.026047
Sailboat	68.042831	68.040909	68.035454
Average	***50.41786***	***50.41866***	***50.46225***

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All four tables (table III to VI) gives average values of MSE, PSNR, IF and Standard Deviations (SD) respectively. It is seen from the tables that data embedding in horizontal orientations obtain better results for each of the parametric tests (MSE, PSNR, IF and SD), compared to the embedding in diagonal sub image.

3.3 Steganographic Technique Based on Minimum Deviation of Fidelity (STMDF)

A minimum deviation of fidelity based data embedding technique (STMDF) has been proposed where two bits per byte have been replaced by choosing the position randomly between

LSB and up to fourth bit towards MSB. This technique also optimized the intensity value of pixel after embedding by comparing it with original pixel value. STMDF technique has been compared with existing Wu-Tsai’s Method (Wu, 2003) and H.C. Wu Method (Wu, 2005) techniques, where proposed technique shows better performance in terms of PSNR and fidelity of the stego images.

This technique embeds two authenticating bits in each pixel within each byte of the pixel. Authenticating message/image is converted into bit stream, the technique fetch two bits per pixel of cover image (RGB separates for color image) and embed them on varying positions. After embedding fidelity adjustment is done to retain the image fidelity as close as original. The output of this stage gives stegoimage, which through traditional transmission received by the receiver. At destination stegoimage again passes through the phases of STMDF in reverse and regenerate the source image and also extract the secret message/image from the stegoimage. On comparing the extracted secret message/image with the original secret message/image, the source image at destination may be authenticated.

Benchmark (PPM) images are taken to formulate results, all cover images are 512 x 512 in dimension and gold coin of varying size is embedded into the various source benchmark images. The experiments deals with, five color images, where representation of single pixel is concatenation of three intensity values RGB (Red Green Blue) and five gray scale images, where representation is made through single pixel value. On embedding the authenticating image of color gold coin of dimension 130 x 130 (50700 Bytes) for color images and gray scale gold coin of same dimension (16900 Bytes) for gray scale images.

On applying STMDF in cover and secret images used it may be inferred that it is very difficult to detect any kind of noises in embedded and extracted images. Calculation of MSE and PSNR on extracted secret message/image at destination form embedded images gives ideal outcome that is MSE and PSNR becomes zero and ∞ (infinity) respectively.

Statistical data in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Image Fidelity (IF) between the source and embedded images are also calculated. Based on experimental results it may be inferred that STMDF shows better performances for various types of images (color or gray scale). These are represented in table VII and table VIII for color and gray scale images respectively.

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TABLE VII. Results of embedding 50700 bytes of information in color image 512 x 512

Cover Image	**Statistical Data**		
	MSE	***PSNR***	***IF***
Lena	3.46	42.73	0.999826
Baboon	3.45	42.75	0.999820
Peppers	3.54	42.62	0.999786
Couple	3.44	42.76	0.998403
Airplane	3.39	42.82	0.999903

TABLE VIII. Result of embedding 16900 bytes of information in Gray scale image 512 x 512.

Cover Image	**Statistical Data**		
	MSE	***PSNR***	***IF***
Jet	3.27	42.98	0.999968
Tank	3.45	42.75	0.999950
Truck	3.68	42.46	0.999913
Elaine	3.51	42.66	0.999954
Boat	3.36	42.86	0.999911

A comparative study has been made between Wu-TSAI'S Method and H.C. Wu Method with STMDF on the basis of capacity of hidden data verses PSNR where in Wu-Tsai's method capacity of hidden message/image in bytes ranges from 49739 to 52635 that of with H.C. Wu method it varies from 89731 to 96678, (table IX and table X respectively) shows that proposed STMDF obtained much higher PSNR values than existing Wu-Tsai and H.C. Wu method.

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TABLE IX. Comparison between Wu-Tsai's method and STMDF

Cover Images (512 x 512)	**Wu-Tsai's Method**		**STMDF**	
	Capacity	***PSNR***	***Capacity***	***PSNR***
Airplane	49739	40.13	49923	42.85
Peppers	50907	37.07	51090	42.52
Lena	51219	38.94	51483	42.11
Couple	51604	38.81	51876	42.56
Baboon	57146	33.43	57146	42.14
Truck	50065	42.72	50176	37.45
Tank	50499	41.99	50625	37.76
Elaine	51074	41.18	51076	37.60
Jet	51224	37.42	51300	37.89

Cover Images (512 x 512)	Wu-Tsai's Method		STMDF	
	Capacity	***PSNR***	***Capacity***	***PSNR***
Boat	52635	34.89	52670	37.71
Average	*51611.2*	*38.658*	*51736.5*	*40.059*

TABLE X. Compare H.C. Wu Method and STMDF

Cover Images	H.C. Wu Method		STMDF	
	Capacity	***PSNR***	***Capacity***	***PSNR***
Baboon	89731	32.63	89787	40.09
Couple	95294	36.13	96660	39.77
Lena	95755	36.16	96123	39.65
Peppers	96281	35.34	96660	39.75
Airplane	97790	36.60	98283	39.87
Boat	94596	33.62	94864	36.68
Elaine	95023	37.11	95172	36.53
Tank	96089	37.38	96100	36.64
Jet	96320	35.01	96410	36.90
Truck	96678	37.55	96721	35.97
Average	*95355.7*	*35.753*	*95678*	*38.185*

3.4 Self Authentication of Color Images through Discrete Cosine Transformation (SADCT)

A DCT based steganographic technique in frequency domain, termed as SADCT has been worked upon for authentication of color images. The cover image transformed into the time domain using 8x8 mask in row major order using DCT resulting its corresponding frequency components. Highest frequency values are fetched from red and green components of transformed RGB matrix as watermark. Using a secret key and a hash function watermarks are embedded into blue components of the cover image in spatial domain. Experimental results are computed and compared with the existing steganographic techniques like IAFDDFTT (Ghoshal, 2008) and SAWT in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Standard Deviation (SD) and Image Fidelity (IF) which show better performances in SADCT.

Ten PPM images have been taken and SADCT is applied to obtain results. All cover images are 512 x 512 in dimension. Average of MSE for ten images is 0.140964 and PSNR is 56.639810 and image fidelity is 0.9999876, all computational results are given in Table XI.

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TABLE XI. Statistical Data On Applying SADCT Over 10 Images

Cover Image 512 x 512		**MSE**	**PSNR**	**IF**
(a)	Mona Lisa	0.140781	56.645351	0.999992
(b)	Lena	0.140714	56.647430	0.999993
(c)	Baboon	0.141037	56.637473	0.999993
(d)	Tiffany	0.140362	56.658315	0.999997
(e)	Airplane	0.140831	56.643821	0.999996
(f)	Peppers	0.140333	56.659220	0.999992
(g)	Couple	0.143546	56.560899	0.999933
(h)	Sailboat	0.140466	56.655090	0.999993
(i)	Woodland	0.140369	56.658079	0.999994
(j)	Oakland	0.141201	56.632425	0.999993
Average: -		***0.140964***	***56.639810***	***0.9999876***

A comparative study has been made between IAFDDFTT and SAWT with proposed technique SADCT in terms of mean square error, peak signal to noise ratio, standard deviation and image fidelity. Comparison is done on the ten PPM images for embedding unique watermark generated from host image in random position of cover images based on hash function.Proposed SADCT applicable to color images, Table XII shows the comparison of PSNR between SADCT and IAFDDFTT, Table XIII shows the comparison of PSNR between SADCT and SAWT. From table XII and XIII it is clear that embedding in SADCT obtained better performances than existing IAFDDFTT and SAWT in case of average PSNR values for five benchmark images.

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TABLE XII. Comparison of PSNR between SADCT and IAFDDFTT

Images	**MSE & PSNR (dB)**			
	SADCT		**IAFDDFTT**	
	MSE	***PSNR***	***MSE***	***PSNR***
Airplane	0.140831	56.643821	4.907283	41.222393
Baboon	0.141037	56.637473	4.116379	41.985650
Lena	0.140714	56.647430	4.490079	41.608264
Peppers	0.140333	56.659220	4.486188	41.612029
Sailboat	0.140466	56.655090	4.412153	41.684298
Average	***0.140676***	***56.648607***	***4.4824164***	***41.62253***

TABLE XIII. Comparison of PSNR between SADCT and SAWT

Images	**MSE & PSNR (dB)**			
	SADCT		**SAWT (1st level DWT)**	
	MSE	***PSNR***	***MSE***	***PSNR***
Airplane	0.140831	56.643821	14.304066	36.576

Images	MSE & PSNR (dB)			
	SADCT		SAWT (1^{st} level DWT)	
	MSE	*PSNR*	*MSE*	*PSNR*
Baboon	0.141037	56.637473	13.058749	36.972
Lena	0.140714	56.647430	13.226264	36.916
Peppers	0.140333	56.659220	14.735413	36.447
Sailboat	0.140466	56.655090	14.143402	36.625
Average	***0.140676***	***56.648607***	***13.89358***	***36.7072***

3.5 Image Authentication using Hough Transform generated Self Signature in DCT based Frequency Domain (IAHTSSDCT)

A DCT based steganographic technique in frequency domain, termed as IAHTSSDCT has been proposed for authentication of gray scale images. The cover image passes through Hough transformation based on hash function to generate unique signature treated as secret information. The cover image again transformed into time domain using 2x2 mask in row major order using DCT resulting its corresponding frequency components. Using a secret key and another hash function the secret signature watermarks are embedded into selective DC coefficients. To generate stegoimage those frequency coefficients then passes through inverse DCT. Experimental results are computed and compared with the existing steganographic techniques like SAWT and YulinWang (Wang, 2004) in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Image Fidelity (IF) which show better performances in IAHTSSDCT.

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Ten PPM images has been taken and applied on IAHTSSDCT to formulate results. All cover images are 512 x 512 in dimension and signature used as authenticating image of 128 x 128 in dimension. Table I show MSE, PSNR and IF for ten benchmark gray scale images on embedding 2 bits per byte from secret watermark signature, where the positions are selected through hash function. From the table XIV it is clear that average MSE for ten images are 1.202637, PSNR is 47.48122 and IF is 0.999939.

TABLE XIV. Statistical data on applying IAHTSSDCT over 10 images.

Images	IAHTSSDCT		
	MSE	PSNR	IF
Baboon	1.376602	46.742719	0.999926
Boat	1.423912	46.595972	0.999925

Images	**IAHTSSDCT**		
	MSE	**PSNR**	**IF**
Clock	0.593132	50.399290	0.999984
Couple	1.269814	47.093404	0.999924
Elaine	1.432106	46.571052	0.999931
Jet	1.157242	47.496562	0.999963
Map	1.299377	46.993450	0.999962
Space	0.766533	49.285496	0.999955
Tank	1.394348	46.687091	0.999923
Truck	1.313301	46.947161	0.999892
Average	***1.202637***	***47.48122***	***0.999939***

A comparative study has been made between SAWT and Yulin Wang (Wang, 2004) Method with proposed IAHTSSDCT in terms of mean square error and peak signal to noise ratio. Comparison is done on five gray scale PPM images, embedding unique watermark signature, generated from host image, in random position of cover images based on hash function. On comparison with the existing techniques IAHTSSDCT gives optimized result as shown in table XV and table XVI respectively. The result of comparison with SAWT gives increased PSNR value by 10.1302 dB and MSE decreased by 12.6461. While comparing with Yulin Wang Method our PSNR increases by 6.698 in proposed scheme.

TABLE XV. Comparision of MSE and PSNR in SAWT with proposed IAHTSSDCT.

Cover Image	**MSE**		**PSNR (dB)**	
	SAWT	***IAHTSSDCT***	***SAWT***	***IAHTSSDCT***
Baboon	13.0586	1.3766	36.9719	46.7427
Couple	14.8642	1.2698	36.4094	47.0934
Peppers	14.7354	1.4310	36.4472	46.5745
Lena	13.2263	1.2677	36.9164	47.1006
Sailboat	14.1434	1.4523	36.6253	46.5101
Average Results: -	***14.0056***	***1.3595***	***36.6741***	***46.8043***

TABLE XVI. Comparision of PSNR in YulinWang with proposed IAHTSSDCT.

Cover Image 512 x 512	**PSNR (dB)**	
	Yulin Wang Method	**IAHTSSDCT**
Baboon	39.01	46.74
Tiffany	43.37	46.58
Man	37.92	47.07

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Peppers	41.05	46.57
Lena	39.21	47.10
Average Results: -	***40.112***	***46.81***

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