INTERMEDIATE REPORT ON COMPLETION OF SECOND YEAR AS JRF, UNIVERSITY RESEARCH SCHOLAR

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

An intermediate report submitted in partial fulfilment for the requirements of the PhD Degree in Computer Science and Engineering at The University of Kalyani
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By

MADHUMITA SENGUPTA

Under the supervision of

Dr. JYOTSNA KUMAR MANDAL
Professor
Computer Science & Engineering

Department of Computer Science and Engineering
University of Kalyani, Kalyani, Nadia
West Bengal, India

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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 this research 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 and Daubenchies wavelet transform. The section two emphasises the techniques of document authentication over different transform domain.

2.1 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.

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.

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 : -	*94831*	*34.87*	*131072*	*36.7072*

2.2 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.

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
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***

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
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

Images	Standard Deviation (SD)		
	Horizontal Orientation sub-image	*Vertical Orientation sub-image*	*Diagonal Orientation sub-image*
Sailboat	68.042831	68.040909	68.035454
Average	***50.41786***	***50.41866***	***50.46225***

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.

2.3 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 VII.

Table VII. 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 VIII shows the comparison of PSNR between SADCT and IAFDDFTT, Table IX shows the comparison of PSNR between SADCT and SAWT. From table VIII and IX 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.

Table VIII. 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 IX. 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
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***

2.4 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.

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 X 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 X it is clear that average MSE for ten images are 1.202637, PSNR is 47.48122 and IF is 0.999939.

Table X. 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 XI and table XII 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 XI. 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 XII. 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
Peppers	41.05	46.57
Lena	39.21	47.10
Average Results: -	***40.112***	***46.81***

2.5 Authentication of Images through Non Convoluted DCT (AINCDCT)

In this paper a DCT based gray scale image authentication technique in frequency domain, termed as AINCDCT has been proposed. The cover image transformed into the spatial domain through 2 x 2 mask in row major order using nonconventional DCT, resulting corresponding frequency components.

Higher frequency components having less energy, replaced by secret bits using secret key and a hash function. Reverse procedure is followed during decryption. Experimental results obtained compared with the existing authentication techniques Luo et. al. and WTSIC in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Image Fidelity (IF) which show better performances in AINCDCT.

Table XIII. Statistical data on applying AINCDCT

Cover Image 512 x 512 gray scale	MSE	PSNR	IF
(a) Baboon	1.367210	46.774500	0.999926
(b) Boat	1.417877	46.614417	0.999925
(c) Clock	2.029839	45.056189	0.999946
(d) Couple	1.489227	46.401194	0.999911
(e) Elaine	1.423622	46.596856	0.999931
(f) Jet	1.539734	46.256347	0.999951
(g) Map	1.484451	46.415144	0.999956
(h) Space	1.624458	46.023718	0.999904
(i) Tank	1.398453	46.674326	0.999923
(j) Truck	1.429077	46.580247	0.999882
Average	***1.5203948***	***46.3392938***	***0.9999255***

2.6 Authentication in Wavelet Transform Domain through Hough Domain Signature (AWTDHDS)

In this paper a wavelet based steganographic technique in frequency domain termed as AWTDHDS has been proposed to authenticate the cover image using Hough domain signature. Using the secret key and a hash function the Hough generates signature has been embed into the frequency components of the transformed image. Authenticating technique will be used for copyright protection/ownership verification. Experimental results are computed and compared with the existing steganographic techniques like WTSIC [1] and H. Luo et al [6] in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Image Fidelity (IF) which show better performances in AWTDHDS.

Table XIV. Statistical data on applying AWTDHDS

Cover Image 512 x 512	MSE	PSNR	IF
(a) Baboon	2.766724	43.711146	0.999851
(b) Boat	2.474030	44.196755	0.999869
(c) Clock	1.712708	45.793972	0.999955
(d) Couple	1.918163	45.301948	0.999885
(e) Elaine	2.419235	44.294023	0.999883
(f) Jet	1.910416	45.319525	0.999939
(g) Map	2.312576	44.489843	0.999932
(h) Space	1.500019	46.369836	0.999911
(i) Tank	2.372910	44.377992	0.999869
(j) Truck	2.087845	44.933821	0.999827
Average	***2.147463***	***44.87889***	***0.999892***

2.7 Ownership Verification in Wavelet Domain (OVWD)

In this work a transform domain based steganographic technique in grayscale as well as color images has been proposed for high payload data embedding/authentication. The number system of pixel values of secret image is changed from decimal to quaternary which are embed into the horizontal and diagonal frequency components of the transformed cover image. The embedding technique is associated with a hash function along with a secret key which is also embedded into the cover image for the purpose of authentication.

Results are computed on various benchmark images and the same has been compared with existing techniques such as Zeng et al. [1] and ATFDWT [2] which shows better performance in terms of MSE, PSNR and IF.

Table XV. Statistical data on applying OVWD over Gray scale image

Cover Image 512 x 512 Gray scale	MSE	PSNR	IF
(a) Boat	6.645756	39.905360	0.999650
(b) Baboon	6.011864	40.340712	0.999677
(c) Couple	7.057007	39.644598	0.999578
(d) Elaine	6.735260	39.847260	0.999675
(e) Jet	8.409279	38.883216	0.999731
(f) Clock	8.648556	38.761368	0.999771
(g) Map	6.970551	39.698133	0.999796
(h) Space	7.728855	39.249652	0.999547
(i) Tank	6.736778	39.846281	0.999631
(j) Truck	6.902256	39.740893	0.999434
Average :-	*7.1846162*	*39.591747*	*0.999649*

Table XVI. Statistical data on applying OVWD over color image

Cover Image 512 x 512 Color Image	MSE	PSNR	IF
(a) Mona Lisa	5.872684	40.442437	0.999672
(b) Lena	6.886714	39.750683	0.999654
(c) Baboon	5.723869	40.553907	0.999701
(d) Tiffany	7.276881	39.511351	0.999829
(e) Airplane	7.549129	39.351835	0.999784
(f) Peppers	7.002546	39.678244	0.999579
(g) Couple	9.269754	38.460122	0.995700
(h) Sailboat	6.306887	40.132653	0.999683
(i) Woodland	5.933936	40.397375	0.999752
(j) Oakland	6.103235	40.275203	0.999715
Average: -	*6.7925635*	*39.855381*	*0.9993069*

2.8 An Authentication Technique in Frequency Domain through Wavelet Transform (ATFDWT)

In this paper a DWT based steganography in frequency domain, termed as ATFDWT has been proposed where the cover image transform into the time domain signal 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 "Vertical orientation sub-image" followed by reverse transformation to generate embedded/encrypted image. The decoding is done through the reverse procedure. The experimental results against statistical and visual attack has been computed and compared with the existing technique like IAFDDFTT[1], in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Standard Deviation(SD) and Image Fidelity(IF) analysis, which shows better performances in ATFDWT.

Table XVII. MSE, SD, PSNR and IF in embedding 2 bits of hidden data.

Cover Image 512 x 512	MSE	PSNR	SD for Stegoimage	IF
(a) Mona Lisa	3.293662	42.954014	74.755318	0.999816
(b) Lena	3.885129	42.236749	58.960365	0.999805
(c) Baboon	3.188728	43.094628	56.093765	0.999834
(d) Tiffany	3.999738	42.110488	41.921524	0.999906
(e) Airplane	4.109852	41.992542	43.992962	0.999883
(f) Peppers	3.886759	42.234927	66.036728	0.999766
(g) Couple	4.343258	41.752647	32.373444	0.997985
(h) Sailboat	3.580195	42.591737	68.040909	0.999820
(i) Woodland Hill	3.255777	43.004257	43.152962	0.999864
(j) Oakland	3.398177	42.818344	43.334167	0.999841
Average	***3.694128***	***42.479033***	***52.866214***	***0.999652***

2.9 Transformed IRIS Signature fabricated Authentication in Wavelet based Frequency Domain (TISAWFD)

In this work a wavelet based steganographic technique TISAWFD has been proposed to automatically identify or authenticate prosecute to prevent or investigate crime. Secrete cameras or CCTV is used to take inputs from active mob, then iris of every visible eye are located and captured from where only IRIS are fetched and enhanced through scaling. IRIS are then transformed into signature through Hough transform and hide itself inside the documents/images in any of the three frequency components generated by wavelet transform using a secret key and a hash function.

Experimental results are computed and compared with the existing steganographic techniques like PMEDF (Guo, 2011) and JIN's method (Jin, 2008) 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 TISAWFD.

Table XVIII. Statistical data on applying TISAWFD

Cover Image 512 x 512	MSE	PSNR	IF
(6.a) Zelda	3.791641	42.342531	0.999213
(6.b) Girl1	2.370743	44.381959	0.999883
(6.c) Girl2	1.941788	45.248786	0.999861
(6.d) Tiffany	2.450638	44.238012	0.999946
(6.e) Elaine	2.522552	44.112401	0.999878
(6.f) Monalisa	2.572540	44.027182	0.999871
(6.g) Lena	2.247620	44.613575	0.999859
(6.h) Man	2.318619	44.478510	0.999792
(6.i) Baboon	2.666580	43.871257	0.999856
(6.j) Couple	1.872742	45.406025	0.999068
Average	***2.4755463***	***44.2720238***	***0.9997219***

2.10 An Authentication Technique in Frequency Domain through Daubechies Transformation (ATFDD)

In this paper a Daubechies based steganography in frequency domain termed as ATFDD has been proposed where the cover image is transformed into the time domain signal through Daubechies forward transformation, 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 3rd coefficient of every sub image, along with delicate adjustment followed by reverse transformation to generate embedded/encrypted image. The decoding is done through the reverse procedure. The experimental results against statistical and visual attack has been computed and compared with the existing technique like Yuancheng Li's method, Region-Based method and SCDFT in terms of Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Image Fidelity (IF) analysis, which shows better performances in ATFDD.

Table XIX. Data on applying ATFDD over 10 Images with original image verses stego-image S_1, secret image of dimension 128 x 128

Cover Image 512 x 512	*MSE*	*PSNR*	*IF*
(a) Baboon	0.262009	53.947647	0.999986
(b) Boat	0.715179	49.586653	0.999962
(c) Clock	0.766239	49.287160	0.999980
(d) Couple	0.685902	49.768185	0.999959
(e) Elaine	0.711601	49.608437	0.999966
(f) Jet	0.667007	49.889497	0.999979
(g) Map	0.686550	49.764081	0.999980
(h) Space	0.675129	49.836936	0.999960
(i) Tank	0.702309	49.665523	0.999961
(j) Truck	0.688847	49.749578	0.999943
Average	***0.656077***	***50.110370***	***0.999968***

Table XX. Data on applying ATFDD over 10 Images with original image verses stego-image S_2, secret image of dimension 128 x 128

Cover Image 512 x 512	***MSE***	***PSNR***	***IF***
(a) Baboon	0.476444	51.350683	0.999974
(b) Boat	1.239418	47.198626	0.999935
(c) Clock	1.364662	46.780552	0.999964
(d) Couple	1.201420	47.333856	0.999928
(e) Elaine	1.238247	47.202731	0.999940
(f) Jet	1.164917	47.467854	0.999963
(g) Map	1.198395	47.344805	0.999965
(h) Space	1.190872	47.372152	0.999930
(i) Tank	1.224697	47.250517	0.999933
(j) Truck	1.199280	47.341598	0.999901
Average	***1.149835***	***47.664337***	***0.999943***

Table XXI. Data on applying ATFDD over 10 Images with original images verses stego-image S_3, secret image of dimension 128 x 128

Cover Image 512 x 512	***MSE***	***PSNR***	***IF***
(a) Baboon	0.318607	53.098246	0.999983
(b) Boat	0.747833	49.392756	0.999961
(c) Clock	0.800278	49.098396	0.999979
(d) Couple	0.721790	49.546693	0.999957
(e) Elaine	0.744541	49.411916	0.999964
(f) Jet	0.701042	49.673362	0.999977
(g) Map	0.722511	49.542357	0.999979
(h) Space	0.710747	49.613655	0.999958
(i) Tank	0.736221	49.460720	0.999960
(j) Truck	0.724335	49.531411	0.999940
Average	***0.692791***	***49.836951***	***0.999966***

Average of MSE, PSNR and IF for ten images with secret image 256 x 128 in dimension have been obtained. MSE for stego-image S_2 is 24.743158 and for S_3 is 14.046639 that of PSNR for stego-image S_2 is 34.241409 and for S_3 is 36.700684. Image fidelity for stego-image S_2 is 0.998790 and S_3 is 0.999313 as given in table XXII and XXIII.

Table XXII. Data of ATFDD over 10 Images with original image verses stego-image S_2, secret image of dimension 256 x 128

Cover Image 512 x 512	***MSE***	***PSNR***	***IF***
(a) Baboon	19.617638	35.204337	0.998946
(b) Boat	22.909039	34.530735	0.998791
(c) Clock	32.021030	33.076451	0.999152
(d) Couple	24.974838	34.155777	0.998506
(e) Elaine	22.307346	34.646325	0.998920
(f) Jet	28.417187	33.594993	0.999088
(g) Map	22.661404	34.577936	0.999335
(h) Space	29.030556	33.502250	0.998292
(i) Tank	22.272560	34.653102	0.998776
(j) Truck	23.219986	34.472184	0.998089
Average	***24.743158***	***34.241409***	***0.998790***

Table XXIII. Data of ATFDD over 10 Images with original image verses stego-image S_3, secret image of dimension 256 x 128

Cover Image 512 x 512	***MSE***	***PSNR***	***IF***
(a) Baboon	11.130989	37.665466	0.999402
(b) Boat	13.031605	36.980825	0.999312
(c) Clock	18.207264	35.528357	0.999518
(d) Couple	14.157825	36.620838	0.999153

Cover Image 512 x 512	***MSE***	***PSNR***	***IF***
(e) Elaine	12.651691	37.109318	0.999387
(f) Jet	16.133610	36.053488	0.999482
(g) Map	12.843517	37.043964	0.999623
(h) Space	16.503735	35.954981	0.999029
(i) Tank	12.635933	37.114730	0.999306
(j) Truck	13.170216	36.934875	0.998916
Average	***14.046639***	***36.700684***	***0.999313***

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