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A Novelblind Audio And Video Watermarking

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Abstract
Watermarking field has so many advances, all of which are trying to help the owner of a document. Information is the most valuable thing now a days, we employ many techniques to safeguard it . Still few mishaps happen, A new blind video watermarking scheme is implemented in this paper. So far techniques employed for watermarking using DTCWT(Dual Tree Complex Wavelet Transform) have a drawback of not considering Lower band at extraction of watermark and correlation coefficient for extracted watermark is find out by using a matrix of zeros in place of lower band coefficients. In the implemented method we use audio for passing the lower band of coefficients to the extraction point of watermark. Two different approaches have been used in this one is pure DTCWT and other is SVD (Singular Vector Decomposition) based DTCWT method. For the same procedure, in place of DTCWT we use DWT in order to compare DTCWT with DWT and prove the supremacy of DTCWT over conventional DWT, DTCWT yields better Imperceptibility and Robustness.

Keywords— SVD; DTCWT;DWT; Arnold Encryption; Blind video watermarking.

I. INTRODUCTION

In the advent of globalisation, there are several means of communication with ease, also with the availability of high speed broadband networks Data transfer can be done within seconds. In the present day technology data has become an ultimate weapon, people who try to steal the data are on par with the security systems employed for safeguarding the information. With those many threats need for security measure to prevent theft, copyright etc. arise. We have numerous techniques at hand to employ data security, also the type of security needed is to be considered. There are several needs for the owner regarding the data security measures few of them are authentication, copyright, data hiding, Broadcast monitoring etc.

Different techniques are available like cryptography where the data is modified in to another form by manipulation the original data based on a certain algorithm, where original data can be extracted as the reverse process of the algorithm. But after the decryption the data is not safe. Which gives rise to the need for data protection throughout the process of communication. This was when watermarking came into picture, Digital watermarking is the widely used technique for all the applications of data security these days.(Digital in the sense mostly watermarking is applied to digital data).

Watermarking is the process of embedding a file(which can be image, text, audio), in a file(which can be image, text, audio) which is to be saved from attacks, based on a particular algorithm. Here file which is embedded is called *watermark*. In most of the cases the embedding algorithm has a key which is shared between the source and destination.

In almost all the cases watermarking is done on digital data like video, audio and text files. Which made watermarking, Digital Watermarking. Definition of watermarking changes with the application for which it is being used, because of which there is no fixed definition for watermarking. Considering the recent case of Attacks on sony pictures in which hackers posted the unreleased movies in torrent sites. It was watermark of sony pictures which helped them, Court ordered ban on those websites.

SVD based watermarking was implemented on images in [1] 2007. which was non-blind watermarking. in 2009 [5], authors proposed a similar technique for colour video. Few papers has been proposed on SVD watermarking, Almost all of them were non blind.

Another method which is based on pure DTCWT is similar to [4] but we have modified the mask and Embedding algorithm, by selecting 2^{nd} level (in their case they choose 3^{rd} level). Deeper the level of embedding, Robust the algorithm, But there is a disadvantage, which is reduced correlation factor of watermark extracted.

In further sections of the paper a brief introduction of the techniques employed is presented followed by the procedure of watermarking and finally the experimental results are presented.

II. TECHNIQUES EMPLOYED

Techniques employed in this method are Dual Tree Complex Wavelet Transform (DTCWT)[4], Singular Value Decomposition (SVD) [6] and Arnold encryption method[7].

A. *DTCWT:*

It all started with the idea of Fourier transform having few useful advantages over DWT which are Shift invariance, less positive and negative oscillations in coefficients over sudden rise in input. So this idea of complex coefficients is implemented in wavelets but normal wavelets suffer from this can be rectified by increasing the sampling rate. So the final DTCWT has been developed by Nick Kingsbury in his paper [4]. In 2-D DTCWT provides good directional selectivity because of the filter orientations placed at angles +45,-

45,+15,-15,+75,-75, where as for DWT have filter orientations placed at 0,90,45.

B. *SVD:*

Singular Value Decomposition is mostly used because it decomposes the highly variable set in to lower dimensional space which helps to understand the data easily. But in case of watermarking SVD is used because the original image is decomposed in to 3 matrices and Singular Eigen value matrix is embedded into the image. Generally all the SVD based watermarking methods are non-blind.

C. *Arnold Transform:*

In this transform when applied to a image or a matrix it scrambles the pixels and arrange them in a disorderly fashion resulting in a un identified image or a scarp for people who see it. this transform is again repeated after consecutive application of the same transform there are many uses for this. The exact number of iterations needed to get the original is decided by the size of image. If (x, y) are the initial coordinates of a pixel, the outcome coordinates of the chaotic function (x', y') are given by,

$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ \alpha & \alpha+1 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \end{bmatrix} \bmod N$$

Where N denotes the width of the image and α is an integer parameter that affects the period T of the chaotic function.

III. Proposed Methodology

A. *Method-1: SVD and DTCWT combined Watermarking*

1) Watermark Creation: In this process, audio watermarking is done with the same watermark as the one used in the video watermarking. Watermark is changed for each second, since we have 24 frames per second. Every 24 frames have same watermark. A secret key K is used to change the watermark for every second, where $K \in \{1, -1\}$. K changes for every second. w is an arary of 1's and -1's [2].

$$W = \begin{bmatrix} K(1) * w & K(2) * w \\ K(3) * w & K(4) * w \end{bmatrix}$$

Keeping w constant but W varying for every second it's hard to keep track of watermark for a hacker. Size of watermark is decided based on the dimensions of 2nd level DTCWT coefficient matrix of video frame [1]. More precisely the chrominance channel in YUV (4:2:0) representation of the video frame. Watermark is embedded in this channel for more imperceptibility. Because human eye is less sensitive to changes in blue channel. Watermark is encrypted before embedding using Arnold encryption method. Which helps in keeping the watermark secured even after the attack.

$$[U^w, S^w, V^w] = SVD(W_{i,d})$$

2) Embedding algorithm: SVD decomposition is done on watermark coefficients before embedding only the S matrix is induced into the coefficients of the video frame. Simple algorithm is implemented as follows first a video frame is taken and it is converted to YC_bC_r color space. Steps as follows*:*

a) First a video frame is taken and it is converted to YC_bC_r color space.

b) C_b channel is considered and 2 level DTCWT is applied. (image coefficients '$A_{i,d}$' where i= level of decomposition and d = sub bands of each level which ranges from 1 to 6.)

c) Now SVD decomposition is done on 2nd level coefficients which gives 3 different matrices.

$$SVD(A_{i,d}) = [U^{im}, S^{im}, V^{im}]$$

d) The singular values of $U_{i,d}$ are interchanged with the singular values of Watermark(which is decomposed previously), based on the following equation.

$$S_{i,d}^{im\prime} = S_{i,d}^{im} + \gamma * S_{i,d}^{w}$$

(where $S_{i,d}^{w}$ is the singular vector of watermark and γ is the embedding strenght)

e) Later inverse SVD is applied on the 3 matrices U^i , $S^{i'}$, V^i. Which gives the watermarked frame.

$$ISVD[U^{im}, S^{im\prime}, V^{im}] = A_{i,d}^{w}$$

where $A_{i,d}^{w}$ is the watermarked coefficients.

Finally applying the inverse DTCWT we have the watermarked frame. In [1] they proposed similar method but they embedded the watermark in all 3 channels which decreases the PSNR value of the watermarked frame.

3) Extraction: In the watermark extraction process exact reverse operation of embedding algorithm is done. Watermarked frame is decomposed and singular vector of watermark is extracted as follows:

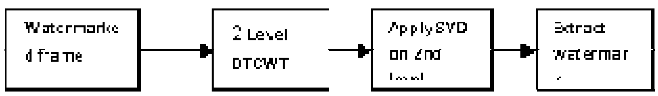


Fig. 1. Extraction algorithm

$$S_{i,d}^{w} = (S_{i,d}^{im\prime\prime} - S_{i,d}^{im})/\gamma$$

Using U^w, V^w and $S_{i,d}^{w}$ (which are created at the time of embedding process) watermark image is reproduced using Inverse Singular Value Decomposition.

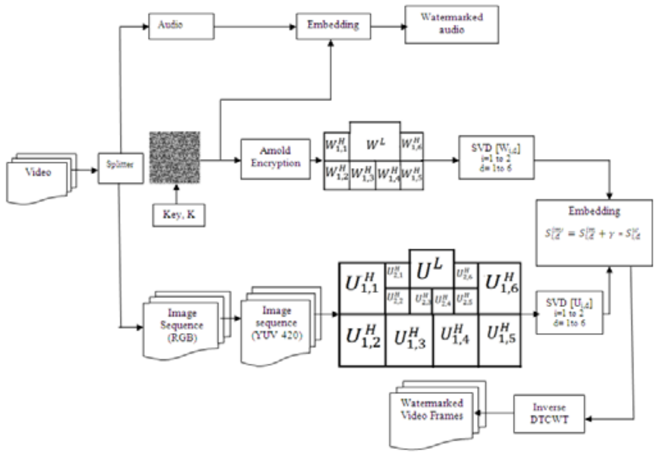


Fig.2. Embedding algorithm for SVD and DTCWT based watermarking.

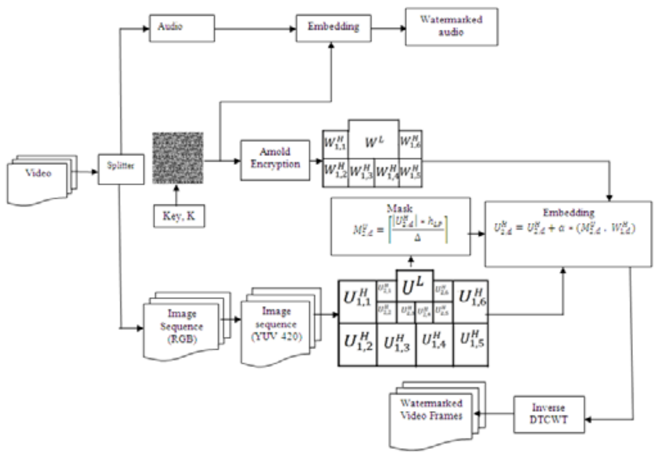


Fig.3. Embedding algorithm foe method 2.

B. *Method-2: Pure DTCWT based Watermarking:*

1) *Watermark Creation:* Same procedure as in case of the previous method is followed to create the watermark. But SVD is not applied to the watermark.
2) *Embedding:* Generally video is combination of audio and sequence of images. First audio and images are separated and then the RGB colour images are converted to YUV frames. Embedding process is done on U channel.

First a mask, M is created using the following equation,

$$M^U_{2,d} = \left\lceil \frac{\left|U^H_{2,d}\right| * h_{LP}}{\Delta} \right\rceil$$

This mask is embedded in the 2nd level of the U channel along with watermark coefficients. Here Δ is the step index which is chosen so that the overall value of

$$\dot{U}^H_{2,d} = U^H_{2,d} + \alpha * (M^U_{2,d} \,. W^H_{1,d})$$

Later the inverse DTCWT is applied which gives the watermarked frame.

3) ***Extracion:***

In the extraction stage the DTCWT coefficients of watermarked frame are multiplied with the inverse mask which finally gives us the watermarked coefficients. From images we higher band coefficients and from audio we get lower band coefficients.

$$W^{H\prime}_{1,d} = \dot{U}^{H\prime}_{2,d} \,. iM^U_{2,d}$$

Inverse mask is created by inverting all the elements present in the mask. here '.' represents element wise multiplication.

C. *Audio Watermarking:*

Watermark w is embedded in the audio. Embedding algorithm uses FFT, which divides audio in to blocks and make the use of SVD again in the FFT coefficients. Now embedding is done as, if the watermark bit is 1 the coefficients are added with threshold and if the bit is -1 threshold is subtracted. At extraction similar procedure is followed by checking the magnitude of samples watermark bits are determined as -1 or 1. A similar procedure is explained in [8].

Audio watermarking procedure explained in our paper is simple because we mainly focus on video watermarking. Using audio watermarking helps in increased security.

For the comparing the results with DWT, both the methods are performed with DWT in place of DTCWT giving us two more methods which are DWT and SVD watermarking and pure DWT.

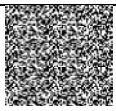
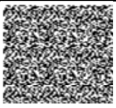
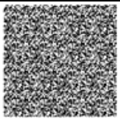
IV. EXPERIMENTAL RESULTS

Both the methods are implemented on a video with 480x480 resolution. Audio is separated using Format Factory software also at the time of transmitting same software is used to link the both.

Watermark with the size of 120x120 is used . In both the cases for every second watermark is changed with the help of key, but for audio only one watermark is used.

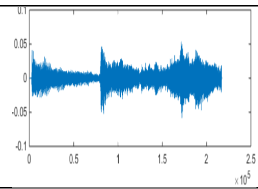
Watermarked results below are 4 frames(1, 30,60,90) each from one second is taken and the PSNR value of watermarked frame and original frame along with the correlation factor of extracted watermark for all the methods.

Table-1: Results of all watermarking methods.

Frame number	Watermark (120x120)	Watermarked frame (480x480)	PSNR(dB)				Correlation factor			
			Pure DTCWT (1)	SVD & DTCWT (2)	Pure DWT (3)	SVD and DWT (4)	Pure DTCWT (1)	SVD & DTCWT (2)	Pure DWT (3)	SVD and DWT (4)
1			**28.63**	27.63	22.2039	22.63	0.8739	**0.9630**	0.7628	0.9236
30			**28.6667**	27.6667	22.203	22.519	0.8749	**0.9627**	0.7679	0.9278
60			**28.65dB**	27.65	22.201	22.51	0.8739	**0.9624**	0.7692	0.9280
90			**28.66**	27.66	22.2053	22.49	0.8741	**0.9625**	0.772	0.9280

Audio watermarking has better results in all important parameters.

Table 2: Results of audio watermarking.

Number of samples present in the audio	Watermark (60x60)	Watermarked audio	PSNR	Correlation factor
Present: 217728. Considered for watermarking: 215681			103.6dB	1

Results show that, in case we need imperceptible and Robust Pure DTCWT method is better, but if we need better correlation factor we go for SVD and DTCWT method.
Now considering different embedding strengths we have:

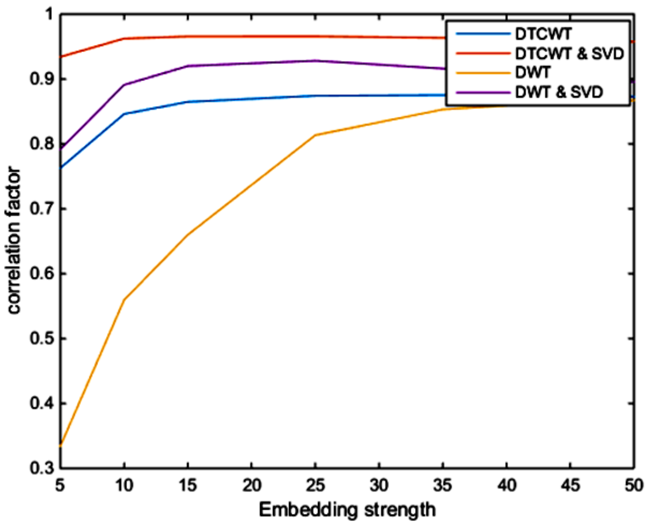


Fig.4 .For different values of embedding strength Correlation factor.

As the Embedding strength increases Correlation factor increases but PSNR of watermarked frame decreases. So between 10-20 can be any value, but better to keep it small.

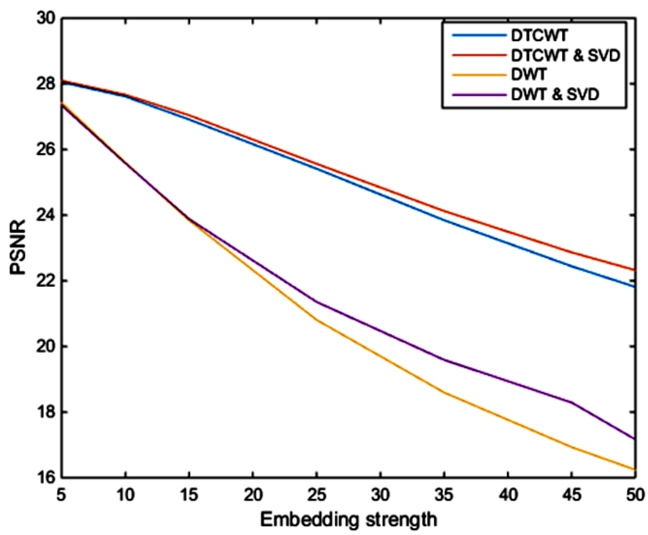


Fig. 4. PSNR value for different embedding strength.

Considering the noise in the channel we can analyze the system by inducing noise in the watermarked frame and try to extract the watermark. here proposed method is pure DTCWT methd.

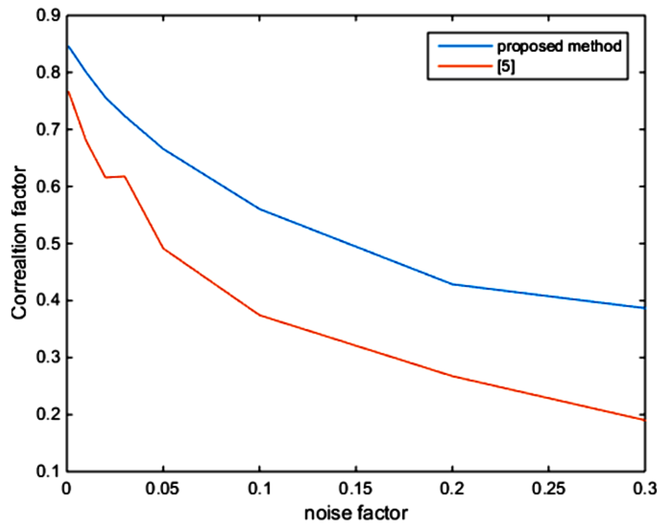


Fig. 5. Comparison for different values of noise factor.

Since watermark is embedded in all the frames this method is resistant to synchronization attacks. this method is less sensitive to geometrical distortions below a certain level, but beyond that limit this method won't work(mostly beyond certain limit no method present is better).
Embedding strength is different for each of the method. they are as follows

Table-3: Embedding strength in number of pixles.

Resolution	DTCWT	DTCWT & SVD	DWT	DWT & SVD
256 *256	6*64*64	6*64	3*64*64	3*64
480*480	6*120*120	6*120	3*120*120	3*120
512*512	6*128*128	6*128	3*128128	3*128
1024*720	6*256*256	6*256	3*256*256	3*256

V. CONCLUSION

There are many applications in signal processing field for DT-CWT because of its supremacy over DWT which is not confined to only watermarking as per this paper. Both blind and non blind algorithm are proved to be effective. This method for proof of ownership can be used in all cases of theft, also for copyright protection and for authentication. Future work is to increase the watermark embedding capacity in video frames, increase the noise tolerance of the audio watermarking and to make this method robust to geometrical distortions.

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