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An Efficient Approach for Video Watermarking using Wavelet Transform

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Abstract—Digital video watermarking is used for copyright protection and authentication of multimedia data in a networked environment like government information , military and defence data etc. It makes possible to identify the author, owner, distributor or authorized consumer of a document. In this paepr, we propose a new video watermarking approach based on discrete wavelet transform(DWT), discrete cosine transform(DCT) and singular value decomposition(SVD) technique in order to protect digital media copyright efficiently. The aim for this work is to achieve low payload with high robustness. The robustness of this technique is tested by applying different types of attacks. Proposed scheme is used to get good image quality of watermark image with better peak signal to noise ratio(PSNR), correlation coefficient(CR) and payload.

Keywords –Video watermarking, DWT, DCT, SVD

I. INTRODUCTION

Nowadays, In every field there is a broad use of digital contents. Digital documents can be easily copied by large numbers of people without any cost. People can download image, audio, and video, and they can share them with friends. Due to this reason, there is more probability of copying of digital information. Therefore, there is need of restriction on such illegal document copyright of digital media. Digital watermarking is the major solution to this problem[3].

Digital watermarking is the process of embedding digital code into digital multimedia (images, audio and video sequence). The embedded information or watermark can be a serial number or random number sequence, ownership identifiers, copyright messages, control signals, transaction dates, information about the creators of the work, bi-level or gray level images, text or other digital data formats[1].

Video watermarking is different from image watermarking, because additional data are available here that allows information to be more redundantly and reliably embedded. Digital video is a sequence or collection of images. The amount of information that can be embedded in

the video sequence is called payload. Digital watermarking is a method for providing security to the digital content on the internet.

There are three factors such as robustness, security, perceptual fidelity, which are required for video watermarking system.

There are 3 main processes involved in watermarking:
1. Insertion of watermark
2. Detection of watermark
3. Removal of a watermark

The requirements for a watermarking technique can vary according to the intended application, most watermarks share a common set of requirements. Watermark is designing to satisfy all the requirements can be challenging, therefore it may be necessary to reach a compromise between them. A properly designed watermarking technique is not only imperceptible to the observer, but should also provide a high data payload. The watermarking technique needs to be robust to enable media to undergo signal conversions and small alterations without destroying the watermark[3].

II. RELETED WORK

Here a brief overview of watermarking types are described.

A. Discrete Wavelet Transform

The DWT is a mathematical tool that decomposes an image or video frame into a lower-resolution approximation image (LL) and three detail components, vertical (LH), diagonal (HH) and horizontal (HL). The approximation image (LL) is the low-frequency part and detail components LH, HH and HL are the high- frequency part with decompositions able to be conducted at different DWT levels. 1-level DWT which decomposes an image into LL1 which is lower resolution approximation coefficient and LH1, HL1, HH1 which are detailed components of an image shown in figure 1[4].

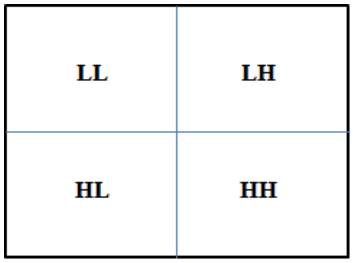

Fig 1 : 1-level DWT

B. Discrete Cosine Transform

In watermark embedding, Original image is first divided into 8x8 sub blocks and then embed watermark bit is spread over middle frequency band DCT coefficient values in the image blocks. The spreading is done by two pseudo- random (PN) sequences, one for zero bit and other for one bit of watermark. At last, watermarked image comes from taking Inverse Discrete Cosine Transform (IDCT).In watermark recovery it is an inverse process of embedding which finds correlation between middle frequency band DCT coefficient values in the image and corresponding two PN sequences and recovery of watermark . The middle frequency coefficients are usually chosen due to their moderate variance property. The mid-frequency region is a popular choice for data embedding in order to limit the distortion and enable the algorithm to be robust against a multitude of image manipulating attacks. The mid-frequency regions of the DCT coefficient blocks are used to embed the hidden data as shown in Figure 2, where f_L, f_M, f_H represent the low, medium and high frequency bands respectively[5].

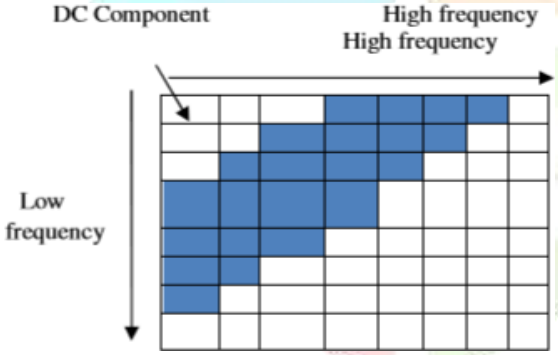

Fig 2 : Mid-frequency DCT region used to embed the watermark data

C. Singular Value Decomposition

Singular value decomposition is a linear algebra technique used to solve many mathematical problems. Any image can be considered as a square matrix without loss of generality. So SVD technique can be applied to any kind of images. The SVD belongs to orthogonal transform which decompose the given matrix into three matrices of same size. To decompose the matrix using SVD technique it need not be a square matrix. Let us denote the image as matrix A. The SVD decomposition of matrix A is given using following equation .

$$A=USV^T$$

U and V are unitary matrices such that

$$U*U^T=I$$

$$V*V^T=I$$

Where, I is an Identity matrix.

S is the diagonal matrix having in its main diagonal all non-negative singular values of A. These positive singular values can be used to embed watermark. The order of singular matrix S is same as original matrix A[6].

III. PERFORMANCE MATRICS

A. Peak Signal to Noise Ratio (PSNR)

The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image.

$$PSN = 10 * \log_{10} \frac{L * L}{MSE}$$

Where, L is highest possible pixel value in the image.

B. Mean Square Error (MSE)

The MSE represents the cumulative squared error between the compressed and the original image. The lower the value of MSE, the lower the error.

$$MSE = \frac{1}{M * N} \sum_{\substack{0 \le i \le M-1 \\ 0 \le j \le N-1}} (\text{Original Image} - \text{Reconstructed Image})^2$$

Where, M and N are the number of rows and columns respectively.

C. Correlation Coefficient(CC)

Correlation Coefficient shows the similarity between the original watermark image and the watermark image and it is extracted by

$$NC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} w(i,j)w^{*}(i,j)}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w^{2}(i,j)}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w^{*2}(i,j)}}$$

Where w(i , j) and w*(i , j) is the original and extracted watermark respectively.

IV. PROPOSED SYSTEM

In video watermarking technique there are different methods used in it like DWT, DCT and SVD. Combination of different method like DWT (Discrete Wavelet Transform), DCT (Discrete Cosine Transform) and SVD (Singular Value Decomposition) gives better result. Frame extraction is done using scene change detection technique. Scene change detection uses canny edge detector to detect an edges.

A. Fully Watermark Approach

In the fully watermark approach, full watermark has been inserted on each and every frame. In this approach, the payload used is highest compare to all other approaches[1].

Watermark Embedding Algorithm

1. Apply DWT to decompose the original image into four sub-bands LL, LH, HL, HH.
2. Consider LL band and divide it into 8*8 square blocks, perform DCT to each block and collect the DC value of each DCT coefficient matrix.
3. Apply SVD to the matrix and generate U^y,S^y,V^y.
4. Choose an appropriate watermark image and apply SVD on it and generate U^w,V^w,W^w.
5. Modify the singular values S^y by embedding the watermark as per the equation
   $S^{net} = S^y + \alpha * S^w$
   Where, α is embedding strength.
6. For the coefficient matrix in step 2 change the DC value and obtain new coefficient matrix and apply inverse DCT to produce watermarked LL band.
7. Apply inverse DWT and get watermark image.

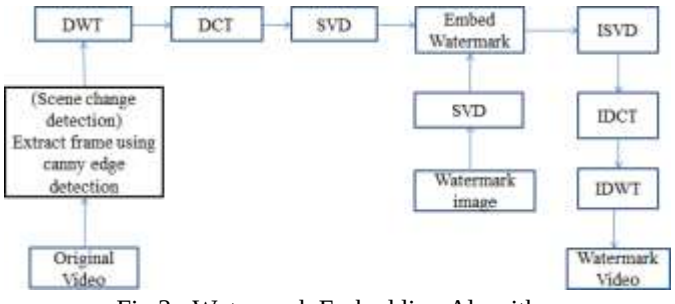

Fig 3 : Watermark Embedding Algorithm

Watermark Extraction Algorithm

1. Perform DWT on the original and watermark video.
2. Apply SVD on the LL sub-bads of original and watermark video.
3. Extract the watermark as per the following equation
$$S^{ext} = \frac{S^w - S^y}{\alpha}$$
Where, S^{ext} is matrix of the singular values of the extracted watermark.
4. Reconstruct the watermark by using singular value decomposition.
$$W = U^w S^{ext} V^{w'}$$

B. Random Number of Frame Approach

In this approach, some random number of frames have been selected and then insert full watermark on the selected frames. In this approach, the payload becomes very less as compared to the previous approach as they have inserted the watermark in few randomly selected frames[1].

Watermark Embedding Algorithm

1. Generate a series of random numbers and choose the frames as per the random number.
2. Repeat steps 1-6 given in first approach.

Watermark Extraction Algorithm

1. Extraction has been performed as per the algorithm given in first approach.

C. Scene Change Detection Approach

In the scene change detection approach, watermark is inserted only in scene change frame not by some random number generation. The detected frames are considered to be the most important frames of the video as these frames contains the scope of video and more importantly, scene change scheme divides the whole video into multiple shots of certain number of frames so that by using this schemes all the parts of the video are covered and full maximum attainable performance can be achieved[1].

Watermark Embedding Algorithm

1. Compare the consecutive frames of the used video and then apply some appropriate threshold to decide whether or not the next frame considered to be the scene change or not.
2. Repeat steps 1-6 given in first approach.

Watermark Extraction Algorithm

1. Extraction has been performed as per the algorithm given in first approach.

V. RESULT AND DISCUSSION

The proposed system will be tested on different kind of videos that are shown in Table 1. It shows original image of video extracted image and watermark image for different videos.

Table 1 : Analysis of Proposed System

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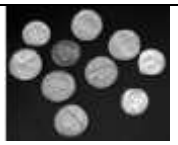
Original Image	Watermark Image	Extracted Image
		
		
		
		
		

Analysis of Performance matrics for all frame approach, random frame approach and scene change detection are shown in following table.

Table II : Peak Signal to Noise Ratio (PSNR) Table

Attack	Fully approach	watermark	Random of frame	Number approach	Scene detection	change approach
Performance Matrics	**PSNR**	**CC**	**PSNR**	**CC**	**PSNR**	**CC**
Gaussian noise	13.8036	0.6547	13.7874	0.6548	13.7230	0.7865
Salt & pepper	11.9656	0.7915	10.9702	0.4754	11.7253	0.5160
Gaussian LPF	14.1551	0.4551	14.1789	0.4549	14.9587	0.4933
Wiener Filter	18.9927	0.9595	18.9684	0.7693	17.7606	0.9743
Median Filter	17.6306	0.7356	17.6807	0.7471	17.9737	0.7579
No Attacks	27.9224	0.9973	34.4311	0.9913	36.5614	0.9934
Payload	27648		13548		382	

VI. CONCLUSION

Video watermarking can be done using variety of different methods but still these methods have some drawbacks so new efficient methods is designed for it by using DWT, SVD, DCT, etc. Scene change detection is done using different methods like histogram technique and canny edge detection technique, etc. Canny edge detection gives better result as compare to another technique. Using this new approach we get maximum Peak Signal to Noise Ratio**(**PSNR), lowest payload and Correlation Coefficient (CR).

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