Hybrid Approach for Robust Digital Video Watermarking.

Shikha Choudhary[1], Mr. Jay D. Amin[2]

[1] PG Student, Information Technology, LJIET, Ahmedabad, Gujarat, India
[2] Assistant Professor, Information Technology, LJIET, Ahmedabad, Gujarat, India

ABSTRACT

With the growing popularity of internet and digital media, digital watermarking techniques have been developed to protect the copyright of multimedia objects such as text, audio, video, etc. So, we have proposed a hybrid video watermarking technique which takes the advantages of different transforms like DWT, DCT, SVD and Arnold Transform, which enhances more security and provides robustness to the watermark, because there is lack of security in the existence system. In this paper method, video is divided into several groups of frames, and watermark will be embedded in every tenth of these video frames. Before embedding watermark in frames it will be pre-processed with Arnold Transform which will provide security to it. The planes of these video frames are decomposed using DWT and high frequency band HH; middle frequency bands LH, HL are transformed with DCT. The DCT coefficients are SVD transformed which are embedded with corresponding transformed coefficients of watermarks along with Arnold Transform. The embedded watermark is extracted with inverse process of embedding. The proposed algorithm is tested with various video sequences using MATLAB 2013a. Reported experimental results show the watermarked frames are indistinguishable from the original frames subjectively and demonstrate the effectiveness of the proposed algorithm against the geometric attacks such as blurring, rotating and salt and pepper.

Keyword: - *Digital Watermarking, Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT), Singular Value Decomposition, Arnold Transform.*

1. INTRODUCTION

Nowadays, advances in digital multimedia like Internet video, wireless video, video phones, video conferencing and many others shows great interest in protecting the copyright ownership of multimedia. Digital watermarking is technique of hiding data in a multimedia object like image, audio and video [1]. Digital watermarking has been identified as a means to identify the owner and distribution path of digital data. The watermark is embedded and extracted as per the requirement [2]. The general framework of watermarking contains [6]: (1) embedding function which embeds the watermark in to the multimedia content (2) communication channel which then distributes the data to the concerned bodies. It is the place where the images are vulnerable to attacks. (3) Extraction function contains the extraction or detection algorithm to detect or extract the watermark as per requirements [6].

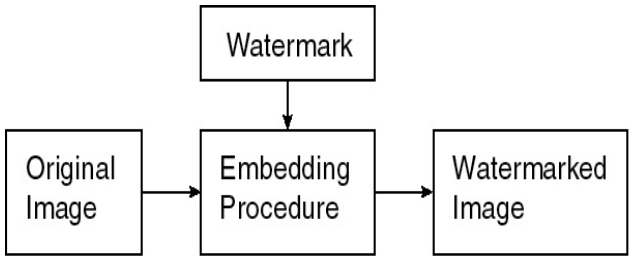


Figure 1. Basic Watermarking Model

Digital video is a sequence or collection of consecutive still images. The amount of information that can be embedded in the video sequence is called payload. In reality, video watermarking techniques need to meet other challenges than that in image watermarking schemes such as large volume of inherently repeated sequence of data between frames [2]. The watermarking can be done either in spatial domain or transform domain. Spatial domain technique embeds the watermark by directly modifying the pixel values of the original data [2]. In transform domain technique, the watermark will be embedded by modifying the transform coefficients of the host data, for instance: discrete cosine transform (DCT), discrete wavelet transform (DWT), and singular value decomposition (SVD). In the transform domain the manipulation of watermark is more difficult than in spatial domain. This is due to the fact that when image is inversed transformed, watermark is distributed irregularly over the host image which makes the attacker difficult to read and modify [2].

In this paper a DWT – DCT – SVD with Arnold Transform based video watermarking technique has been used for embedding watermark. The defined methods combine the advantages of four transforms which can improve the imperceptibility, security, robustness very well.

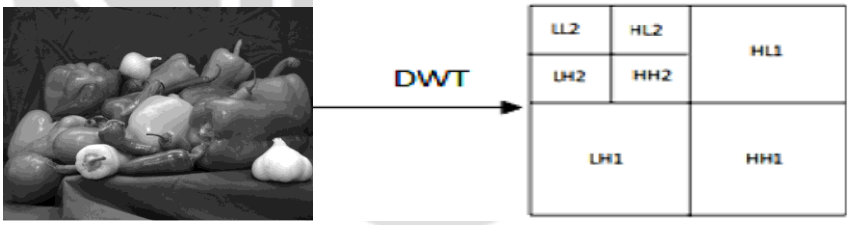
The remainder of the paper is organized as follows: -

In Section II, we briefly describe the background of Discrete Cosine Transform, Discrete Wavelet Transform and Singular Value Decomposition, Arnold Transform related to watermarking. Section III presents Proposed System, while the Experimental Results of proposed work is described in Section IV.

2. BACKGROUND REVIEW

Section II contains the jest of the frequency domain transform being used for proposed watermarking. Discrete Wavelet Transform, Discrete Cosine Transform, Singular Value Decomposition and Arnold Transform are the methods that are elaborated in this section and worked on.

A. DISCRETE WAVELET TRANSFORM: Discrete wavelet transform (DWT) of the image produces multi resolution representation of an image. The DWT analyses the signal at multiple resolution. DWT divides the image into high frequency quadrants and low frequency quadrants. The low frequency quadrant is again split into two more parts of high and low frequencies and this process is repeated until the signal has been entirely decomposed [8].For the first stage decomposition by DWT the image is divided into its LL, LH, HL, and HH plane. The low frequency coefficients are more robust to embed watermark because it contains more information of the original image. The reconstruct of the original image from the decomposed image is performed by IDWT [8].



a. Host Image **b. DWT transformed image**

B. DICRETE COSINE TRANSFORM: Discrete Cosine Transform (DCT) used for the signal processing. It transforms a signal from the spatial domain to the frequency domain. DCT watermarking is more robust as compared to the spatial domain watermarking techniques. The main steps which used in DCT [8]:

In DCT, for embedding the watermark information, we divide the image into different frequency bands. In Figure 2 FL denotes the lowest frequency component of the block, while FH denotes the higher frequency component and FM denotes the middle frequency component which is chosen as the embedding region which provides strong robustness [8].

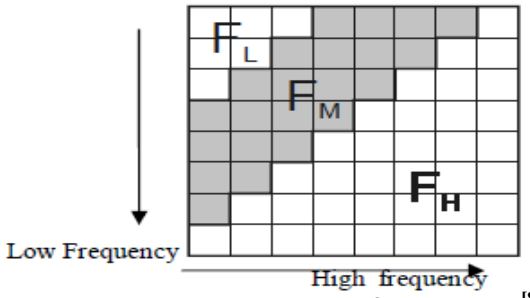


Figure 3 Discrete Cosine Transform Region [8]

C. SINGULAR VALUE DECOMPOSITION: The Singular Value decomposition yields the purpose of reduction of complexity by dividing the non-negative image (M) matrix into:

$$M=U*S*V^{T},$$

Where, U and V are orthogonal matrices and S known as singular matrix is a diagonal matrix carrying non-negative singular values of matrix M.

The usage of singular values volumes to the robustness of the image, i.e. when any perturbation is added to the image large variations in the singular values do not occur [3].

D. ARNOLD TRANSFORM: To confirm the security and improve the robustness of the proposed watermarking scheme, the watermark should be pre-processed before embedded into the original image. It is applied in original watermark [9].

3. PROPOSED WORK

The proposed method which performs watermark embedding into video content is based on hybrid technique using DWT, DCT, SVD and Arnold Transform. The video is first divided into frames and every tenth frame of video is transformed with proposed hybrid techniques. Here, the watermark which is to be embedded in every tenth frame is pre-processed using arnold transform which ensure security and provide robustness against attacks such as blurring, salt & pepper and rotation. Thus we will get watermarked video and inverse process of embedding will give original video and original watermark image used.

A. Watermark Embedding Process: The video watermarking algorithm proposed will embed same logo into group of frames in the video using four powerful mathematical transforms. In this technique, original color video is split into group of frames and R, G and B planes are isolated from every tenth color frame. By applying DWT, in every tenth frame plane are decomposed into four sub bands LL, LH, HL and HH. Take three of these four sub bands: LH, HL, and HH. Apply DCT to these selected sub bands and SVD is performed on the DCT coefficients to get singular value matrix. In the present work every tenth frames should carry same watermark logo.

Take color logo as watermark. The same procedure is applied to the watermark also to obtain singular values matrix which plays an important role while extracting the watermark from watermarked video. The singular values of the original video frame and watermark are added at chosen scaling factor to form the modified singular values. Then perform inverse DCT followed by inverse DWT to obtain watermarked frame. Reconstruct the watermarked frames into final watermarked video. Once embedding is done, watermarked video is subjected to attacks.

B. Watermark Recovery Process: Watermarked video is partitioned into group of frames and separate the R, G, B planes from every tenth frame of video. Each plane is decomposed into multi frequency bands using DWT. Then

DCT is applied on selected sub bands: LH, HL and HH followed by SVD to separate modified singular values from watermarked frame. Watermark is extracted by subtracting the singular values obtained in the embedding process. Then inverse DCT and inverse DWT are performed to recover the color watermark. The block diagram for watermark embedding and extraction are shown in Figure 4 and Figure 5.

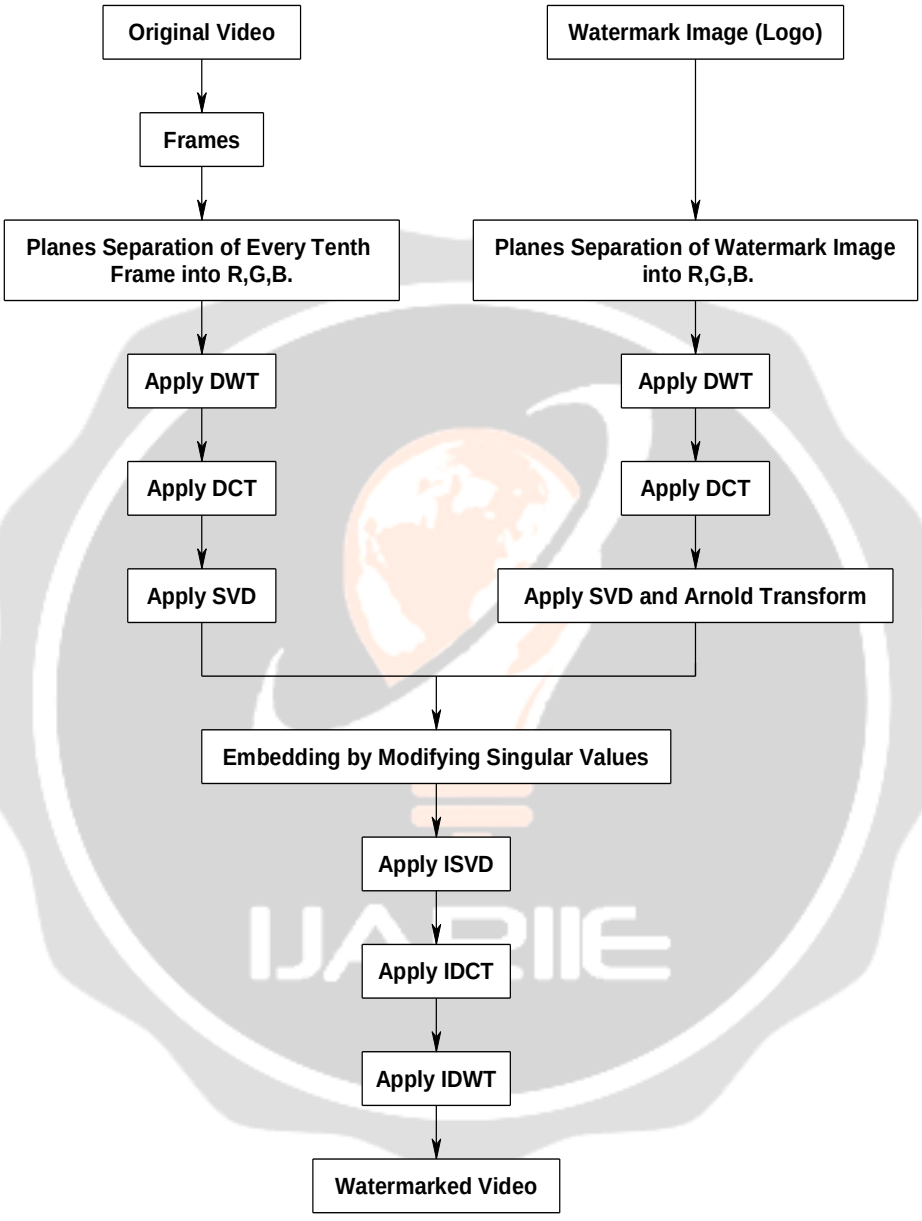


Figure 4 Watermark Embedding

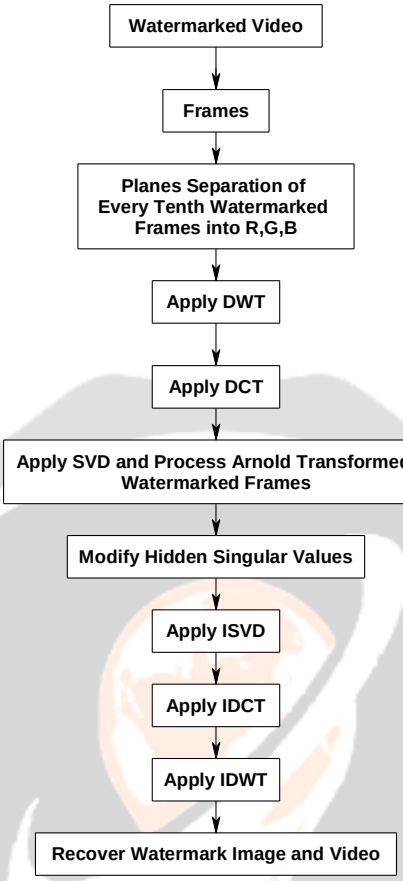


Figure 5 Watermark Extraction

3.1 PERFORMANCE EVALUATION

PSNR (The Peak Signal-to-Noise Ratio): The Peak Signal to Noise Ratio (PSNR) is the ratio between maximum possible power and corrupting noise that affect representation of image. PSNR is usually expressed as decibel scale. The PSNR is commonly used as measure of quality reconstruction of image. The signal in this case is original data and the noise is the error introduced. A greater value of psnr indicates a lower degree of distortion for generated image. To compute the PSNR, the block first calculates the mean-squared error using the following equation [7]:

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

In the above equation, *M* and *N* are the number of rows and columns in the input images, respectively. I1 is original and I2 is watermarked image. Then the block computes the PSNR using the following equation:

$$PSNR = 10 \log_{10}\left(\frac{R^2}{MSE}\right)$$

In the above equation, *R* is the maximum fluctuation of pixels.

MSE (Mean Square Error): The MSE represents the average of the squares of the errors between the actual and the noisy image. The error is the amount by which the values of the original image differ from the degraded image. Lower the value of MSE higher the quality of image [7].

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

The ***Mean Square Error (MSE)*** and the ***Peak Signal to Noise Ratio (PSNR)*** are the two error metrics used to compare image compression quality.

SNR (Signal-to-Noise Ratio): Signal to noise ratio may be defined as the ratio of the desired signal (meaningful information) to the background noise i.e. unwanted signal. SNR is typically articulated in decibels (dB). An attempt is made to maximize the SNR ratio.

```
SNR=snr(input image, watermarked image);

fprintf('SNR is % f db\n',SNR);
```

3.2 EXPERIMENTAL RESULT

In this experiment, implementation of the proposed video watermarking algorithm has been done under the MATLAB 13 environment. The AVI video used is of 141 frames and watermark image i.e. GTU Logo of 512 x 512 sizes can be embedded in selected group of 14 frames. The proposed scheme is also tested against common image processing and geometrical attacks.

	PSNR	**MSE**	**SNR**
Without Attack	71.8478	0.0064	0.17245
Blurring Attack	9.8088	17.29669	0.07052
Rotation Attack	10.2465	69.76544	0.01465
Salt & Pepper Attack	9.5812	19.57644	0.18366
Extracted w/m	35.3195	144.0000	0.16342

Table 1 Parameters Value

The above table 1 shows different parameters value of without attack, blurring, rotation, salt & pepper attack and extracted in dB with below graphs of the same.

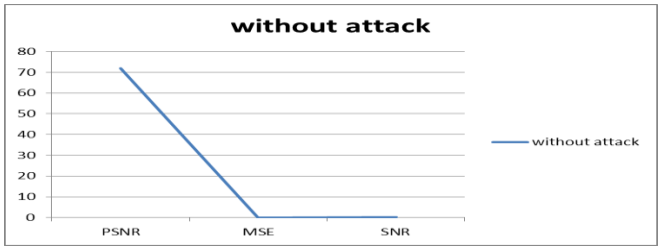


Figure 6 Without Attack Parameters Value

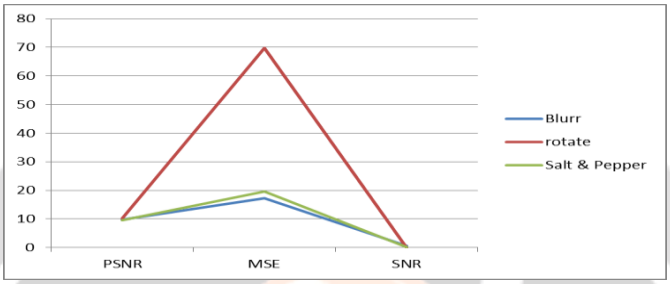


Figure 7 Different Attacks Parameters Value

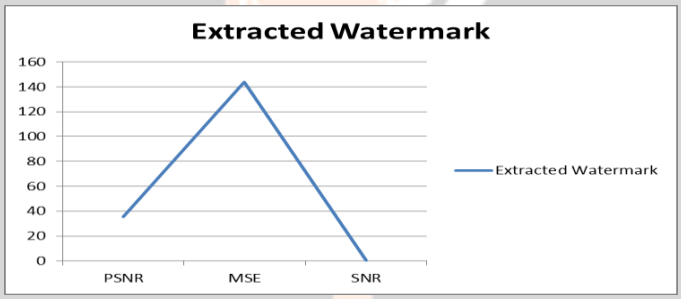


Figure 8 Extracted Watermark Parameters Value

4. CONCLUSIONS

In this paper, a Digital Watermarking Algorithm based on DWT-DCT-Singular Value Decomposition and Arnold Transform is proposed. The DCT-SVD based method is very time consuming while the process of SVD-DWT-DCT and Arnold Transform method is found to be very fast and this new method was found to satisfy all the requisites of an ideal watermarking scheme such as imperceptibility, robustness and good capacity. This method can be used for authentication and data hiding purposes as well as copyright protection.

5. REFERENCES

1. C. N. Sujatha and P. Satyanarayana, "Analysis of Robustness of Hybrid Video Watermarking against Multiple Attacks", International Journal of Computer Applications (0975 – 8887) Volume 118– No.22, ISSN: 0975 – 8887,pp.12-19, May 2015.

2. C.N. Sujatha, P. Satyanarayana, "High Capacity Video Watermarking based on DWT-DCT-SVD", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 2, ISSN: 2278 – 7798, pp. 245-249, February 2015.

3. Preeti Sharma and Tapan Jain, "Robust Digital Water-marking for Coloured Images using SVD and DWT Technique", IEEE, ISBN 978-1-4799-2577, pp.1024-1027, 2014.

4. Krishna Rao Kakkirala and Srinivasa Rao Chalamala, "Block Based Blind Image Watermarking Using Discrete Wavelet Transform", IEEE 10th International Colloquium on Signal Processing & its Applications (CSPA2014), 7 - 9 Mac. 2014, Kuala Lumpur, Malaysia, ISBN 978-1-4799-2577,pp. 58-61, 2014.

5. Xueyi Ye, Xueting Cheng, Meng Deng, Shuyun Hui, Yunlu Wang, "A Multiple-Level DCT Based Robust DWT- SVD Watermark Method", 2014 Tenth International Conference on Computational Intelligence and Security, IEEE, ISSN: 2355-2359 pp. 479-483, 2014.

6. Anu Bajaj, "Robust and Reversible Digital Watermarking Technique Based On RDWT-DCT-SVD, IEEE International Conference on Advances in Engineering & Technology Research (ICAETR - 2014), August 01-02, 2014, Dr. Virendra Swarup Group of Institutions, Unnao, India, ISSN: 2347-9337,pp 1-5.

7. Jayprakash Pandey and Gajendra Singh, "Digital Color Image Watermarking Using DWT-SVD Techniques in YUV and RGB Color Spaces" , International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 1, pp.470-479, January 2015.

8. Preeti Parashar and Rajeev Kumar Singh, "A Survey: Digital Image Watermarking Techniques", International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 7, No. 6 (2014), ISSN: 2277-128X pp. 111-124.

9. Sangeeta Madhesiya and Shakil Ahmed, "Advanced Technique of Digital Watermarking based on SVD-DWT-DCT and Arnold Transform", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) ,Volume 2, No 5, ISSN: 2278-13 pp. 1918-1923 May 2013.