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Research paper

Reversible Video Watermarking Scheme using DWT-SVD for Data Integrity of Noisy Multimedia Data

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Abstract

In this paper DWT-SVD scheme is presented to achieve data integrity of noisy multimedia data. Spatial domain methods are simpler but prone to attacks. DWT offers simultaneous localization in time and frequency domain and SVD is powerful technology in matrix decomposition. As SVD is computationally expensive, this paper combines DWT and SVD. The proposed method modifies diagonal singular coefficients of LL sub-band. The overall system model consists of embedding algorithm at sender side and noise removal algorithm followed by extraction algorithm at receiver side. During transmission, there is a possibility of noise inclusion due to various sources. This degrades the watermarked video quality and affects watermark extraction at receiver side. To provide a solution to this problem, noise removal algorithm is implemented as a pre-processing step prior extraction algorithm. This provide quality multimedia data for data integrity detection in the watermark extraction process. Experimental results demonstrate significant improvement in quantitative measures PSNR, SSIM and CC values.

Keywords: *Dwt; SVD; Noisy Multimedia Data; Video Watermarking; Data Integrity.*

1. Introduction

Digital watermarking is widely used in the field of medical applications, law enforcement and military communication [1]. These fields have huge data storage and data transmission that is required to protect against malicious attack and unauthorized access. Data integrity and authentication are important requirement to provide security to this data [2]. Many watermarking techniques results in data distortion which is not desirable in many applications.

Reversible watermarking is a lossless technique which recovers the watermark and original multimedia data without any distortion. Spatial domain methods are simpler but more admitting of geometric and non-geometric attacks [3]. Transform domain methods meets characteristics of robustness and invisibility, but computational cost is higher. DCT FFT, DWT, DFT are various examples of transforms [4 - 6]. To achieve high performance watermarking technique, transform domain method DWT is employed in this paper. Advantage of DWT is that it offers localization in time and frequency domain, but computational cost and compression time is higher [7], [8]. SVD is powerful technique in matrix decomposition [9]. This paper combines DWT and SVD methods. Watermark is embedded without digital degradation, because of the level of embedding operation is too small for human to notice the change. Noise can appear in watermarked multimedia data from various sources [10 - 12]. Noise inclusion fails to achieve data integrity at receiver side. In this paper, the noise removal process is implemented as a pre-processing step prior to watermark extraction process.

2. Proposed Reversible Video Watermarking

The current work focuses on DWT-SVD based technique. A given video is segregated into the frames which are then separately processed. Watermark is embedded into all video frames.

2.1. Embedding Algorithm

The architecture of the proposed embedding process is shown in Figure 1 and works as follows:

1) Get a dynamic access code (Ks) for transmission security.
2) Input video is separated into frames. A frame rate typically depend on the format of the video as well as video quality.
3) The frames are sequentially stored in memory.
4) Each frame is divided into red, green, blue planes.
5) Decompose frame into 4 frequency band using 1 level DWT.
6) Singular value decomposition is applied on each colour plane.
7) Performed below operations to derive the singular value of watermarked image.

$$A = U^A \, S^A \, V^A \tag{1}$$

$$B = U^B \, S^B \, V^B \tag{2}$$

$$S^C = S^A + \propto S^B \tag{3}$$

$$C = U^A \, S^C \, V^A \tag{4}$$

8) Apply I-SVD and I-DWT.

9) A watermarked frame is obtained by combining red, green, blue planes.
10) The frames are combined sequentially to get the watermarked video.

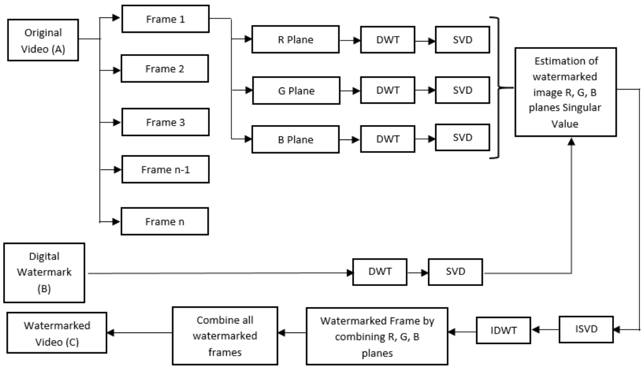

Fig. 1: Proposed Architecture of the Embedding Process.

2.2. Noise Removal Algorithm

Undesirable effects can be produced by noise such as unrealistic edges and corners, unseen lines, blurred objects, disturbed background screen. De-noising is a necessary pre-processing step before forwarding watermarked video to extraction algorithm. Histogram or probability density function can be used to model the noise. It is considered as a noise is present in every video and various filters are applied to suppress the noise. The architecture of the proposed noise removal process is shown in Figure 2 and works as follows:

1) Enter a dynamic access code (Kr) and compare it with Ks. If same then the user allowed to process the watermarked video for noise removal.
2) Apply the adaptive wiener filter. For the first frame, if CurrentPSNR < PreviousPSNR, then it shows the adaptive wiener filter is not suitable to remove the noise. Thus, apply the next filter mentioned in step 3.
3) Apply the mean filter. For the first frame, if CurrentPSNR < PreviousPSNR, then it shows the mean filter is not suitable to remove the noise. Thus, apply the next filter mentioned in step 4.
4) Apply the adaptive median filter. For the first frame, if CurrentPSNR < PreviousPSNR, then it shows the adaptive median filter is not suitable to remove the noise. Thus, declare video as noise-less.
5) Forward noise-less watermarked video as input to extraction algorithm.

2.3. Extraction Algorithm

The architecture of the proposed extraction process is shown in Figure 3 and works as follows:

1) Separate watermarked video into frames.
2) The frames are sequentially stored in memory.
3) Each frame is divided into red, green, blue planes for the purpose of watermark extraction.
4) Decompose frame into 4 frequency band using 1 level DWT.
5) Singular value decomposition is applied on each colour plane.
6) Performed below operations to derive the singular value of watermark image.

$$C = U^C S^C V^C \tag{5}$$

$$A = U^A S^A V^A \tag{6}$$

$$S^{C'} = (S^C - S^A)/\propto \tag{7}$$

$$C' = U^C S^{C'} V^C \tag{8}$$

7) Apply I-SVD and I-DWT.
8) Watermark is obtained by combining red, green, blue planes.

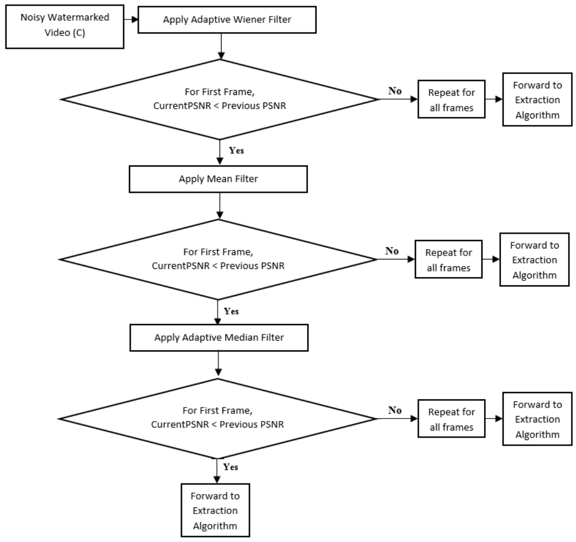

Fig. 2: Proposed Architecture of the Noise Removal Process.

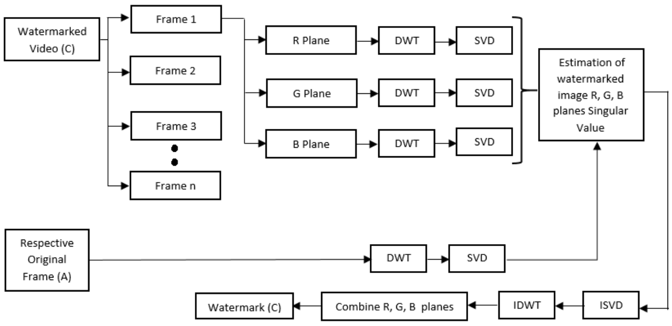

Fig. 3: Proposed Architecture of the Extraction Process

3. System Model

The architecture of proposed system model is shown in Figure 4 and works as follows:

Step I: Select original video and watermark. Apply embedding algorithm to create watermarked video.

Step II: Generate dynamic access code (Ks) and send it to the receiver. Transmit watermarked video to a receiver through a transmission channel.

Step III: Receiver will enter a dynamic access code (Kr) sent by sender. If Ks is equal to Kr, then a receiver is allowed to process the watermarked video to get the original watermark.

Step IV: Apply noise removal algorithm.

Step V: Watermark is extracted using extraction algorithm.

Step VI: Data integrity is checked by comparing the extracted watermark with the original watermark.

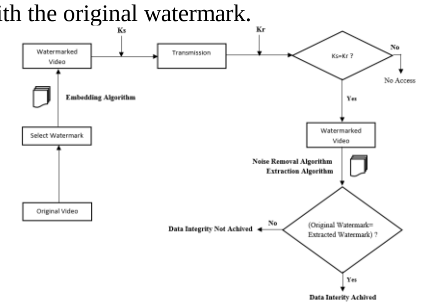

Fig. 4: The Proposed Architecture of the System Model.

4. Performance Measures

Performance is evaluated using PSNR, SSIM, CC quantitative measures.

$$PSNR = 10log_{10}\left(\frac{255^2}{MSE}\right) \quad (9)$$

$$SSIM = \frac{(2\mu_f\,\mu_h + C_1)\,(2\sigma_{fh} + C_2)}{(\mu_f^2 + \mu_{h+}^2\,C_1)\,(\sigma_f^2 + \sigma_{h+}^2\,C_2)} \quad (10)$$

$$CC = corr2(A, B) \quad (11)$$

5. Experimental Results

Performance is evaluated by selecting five videos (video 1 to video 5) and four watermarks (W1 to W4) shown in Figure 9 to Figure 12. Threshold value for coefficients of correlation is considered as 0.98 for every video. Various noises with variance 0.01 are induced in Video 1. Table 3 shows quantitative measures which are calculated before the implementation of noise removal algorithm. Here average CC is less than threshold value 0.98. In this case data integrity is not achieved. The same video is passed through the proposed model. Table 4 shows average CC is greater than threshold value 0.98. This demonstrate that removing noise as pre-processing steps gives better results in terms of quantitative measures. Experimental results gives the efficiency of proposed algorithm with reference to visual effects and analysis of qualitative and quantitative measures for PSNR, SSIM and CC.

Fig. 5: Input Image

Fig. 6: Watermark Image

Fig. 7: Watermarked Image

Fig. 8: Extract Watermark

Fig. 9: Watermark 1 (W1)

Fig. 10: Watermark 2 (W2)

Fig. 11: Watermark 3 (W3)

Fig. 12: Watermark 4 (W4)

Table 1: Calculation of Average PSNR between the Original and Watermarked Video

Input Video	W1	W2	W3	W4
Video 1	24.9570	25.2897	25.1398	24.0701
Video 2	24.9579	25.2896	25.1402	24.0708
Video 3	25.0150	25.3251	25.1854	24.1033
Video 4	24.9896	25.2929	25.1572	24.0803
Video 5	24.9905	25.3001	25.1482	24.0802

Table 2: Calculation of Average CC between the Original and Extracted Watermark

Input Video	W1	W2	W3	W4
Video 1	0.9957	0.9950	0.9896	0.9940
Video 2	0.9961	0.9953	0.9904	0.9943
Video 3	0.9961	0.9953	0.9903	0.9944
Video 4	0.9960	0.9952	0.9898	0.9941
Video 5	0.9962	0.9956	0.9904	0.9944

Table 3: BEFORE Implementation of Noise Removal Algorithm as Pre-Processing Step

Type of Noise	PSNR	SSIM	CC
Salt Pepper (Var=0.01)	23.6059	0.9714	0.9756
Gaussian (Var=0.01)	21.1042	0.9340	0.9271
Speckle (Var=0.01)	23.3630	0.9657	0.9683

Table 4: AFTER Implementation of Noise Removal Algorithm as Pre-Processing Step

Type of Noise	PSNR	SSIM	CC
Salt Pepper (Var=0.01)	24.8796	0.9841	0.9938
Gaussian (Var=0.01)	23.9709	0.9683	0.9886
Speckle (Var=0.01)	24.8068	0.9764	0.9903

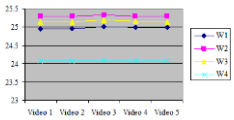

Fig. 13: PSNR Between the Original and Watermarked Videos.

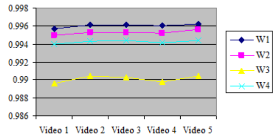

Fig. 14: CC Between the Original and Extracted Watermarks.

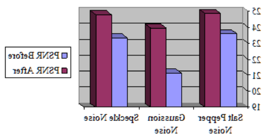

Fig. 15: PSNR Value Improvement after Implementing the Proposed Noise Removal Algorithm as Pre-Processing Step.

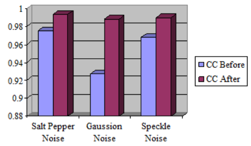

Fig. 16: CC Value Improvement after Implementing the Proposed Noise Removal Algorithm as Pre-Processing Step.

6. Conclusion

In this paper we proposed a DWT-SVD scheme to achieve data integrity of noisy multimedia data. The overall system model consists of embedding algorithm at sender side and noise removal algorithm followed by extraction algorithm at receiver side. For a scaling factor 0.1, there is no degradation in watermarked video. Video becomes lighter when a scaling factor is increased more than 0.1. We have modified diagonal singular coefficients of LL sub-band. Noise removal algorithm is applied to noise multimedia data. This provides quality multimedia data for data integrity detection in the watermark extraction process. For qualitative evaluation, the original watermark is compared with the extracted watermark. Quantitative evaluation is performed by statistical measures PSNR, SSIM and CC.

References

[1] Aree A. Mohammed, Nyaz A. Ali, "Robust video watermarking scheme using high efficiency video coding attack", *Multimedia Tools and Applications*, Vol.77, No.2, (2018), pp.2791–2806, available online: https://doi.org/10.1007/s11042-017-4427-1.

[2] Kh. Manglem Singh, “A robust rotation resilient video watermarking scheme based on the SIFT”, *Multimedia Tools and Applications*, Vol.77, No.13, (2018), pp.16419–16444, available online at: https://doi.org/10.1007/s11042-017-5213-9.

[3] Lei Chen, Jiying Zhao, “Contourlet-based image and video watermarking robust to geometric attacks and compressions”, *Multimedia Tools and Applications*, Vol.77, No.6, (2018), pp.7187–7204, available online: https://doi.org/10.1007/s11042-017-4628-7.

[4] Garima GuptaV. K. GuptaMahesh Chandra, “An efficient video watermarking based security model”, *Microsystem Technologies*, Vol.24, No.6, (2018), pp.2539–2548, available online: https://doi.org/10.1007/s00542-017-3689-x..

[5] Rashmi Jakhmola, Rajneesh Rani, “Enhanced Digital Video Watermarking Technique Using 2-Level DWT”, *Progress in Advanced Computing and Intelligent Engineering*, Vol.713, (2018), pp.415-424, available online: https://doi.org/10.1007/978-981-13-1708-8_38.

[6] Loganathan, Agilandeeswari & Kaliyaperumal, Ganesan & Muralibabu, K., “A Side View Based Video in Video Watermarking Using DWT and Hilbert Transform”, *Communications in Computer and Information Science*, Vol.377, (2013), pp.366-377, available online: https://doi.org/10.1007/978-3-642-40576-1_36..

[7] M, Rizvana., “A Video Watermarking Technique Using DWT and SVD”, *International Journal for Research in Applied Science and Engineering Technology*, Vo.5, (2017), pp.2217-2226, available online: https://doi.org/10.22214/ijraset.2017.10327.

[8] Pabitra Pal, Partha Chowdhuri, Biswapati Jana, “Weighted matrix based reversible watermarking scheme using color image”, *Multimedia Tools and Applications*, Vol.77, No.18, (2018), pp.23073-23098, available online: https://doi.org/10.1007/s11042-017-5568-y.

[9] Yu-Fei Gao, Guan Gui, Xun-Chao Cong, “Multi-linear sparse reconstruction for SAR imaging based on higher-order SVD”, *EURASIP Journal on Advances in Signal Processing*, Vol.44, (2017), available online: https://doi.org/10.1186/s13634-017-0479-7.

[10] Paras Jain, Vipin Tyagi, “A survey of edge-preserving image denoising methods”, *Information Systems Frontiers*, Vol.18, (2016), pp.159-170, available online: https://doi.org/10.1007/s10796-014-9527-0.

[11] Cristina Stolojescu-Crisan, “A Hyperanalytic Wavelet Based Denoising Technique for Ultrasound Images”, *Bioinformatics and Biomedical Engineering*, (2015), pp.193-200, available online: https://doi.org/10.1007/978-3-319-16483-0_19.

[12] Gabriela Ghimpețeanu, Thomas Batard, Marcelo Bertalmío, “Denoising an Image by Denoising Its Components in a Moving Frame”, *Image and Signal Processing*, (2014), pp.375-383, available online: https://doi.org/10.1007/978-3-319-07998-1_43.