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Bi-orthogonal wavelet transform based video watermarking

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Abstract: ***This paper proposes a robust video watermarking algorithm based on Bi-orthogonal wavelet transform and singular value decomposition(SVD).This is a method that provides dual way authentication of video using QR code and Logo image which is more robust and accurate. Results show that the proposed algorithm has good robustness against common digital video attacks.Performances of the algorithm is evaluated with the help of various performance evaluation parameters.***

Keywords: Video watermarking ,Discrete wavelet transform(DWT),Singular value decomposition(SVD),Bi-orthogonal wavelet transform, Quick response code(QR).

1. Introduction

Due to the rapid increase in exchange and transmission of digital information through internet ,multimedia security and copyright protection has gained tremendous importance. Watermarking is a technology used for the copyright protection of digital applications .This is a technique of embedding one digital information into another digital information without changing the content of original information.

In the case of video watermarking most of the techniques levered in the past provide issues of security and contents inside the frame may be corrupted due to various attacks[5].More over the quality of watermarked video may be reduced. So the need for the invention of new techniques arise.Here, to improve the quality of watermarked frame some modifications based on biorthogonal wavelet are performed

2. Methodology

2.1 Bi-orthogonal wavelet transform

The multiresolution analysis (MRA) represents and analyzes images at different frequencies with different resolutions . The basic idea behind wavelet transform is using the same function by expanding and shifting to approach the original signal. The wavelet coefficients has good local characteristics both in time domain and frequency. This means that using wavelets representing the signal in the time and frequency domain at the same time.That means cut the signal into numerous parts then analyze these parts separately. Wavelets also have the properties like smoothness . Such properties are available in Bi-Orthogonal & orthogonal wavelets. However, there are other properties that are not available in the orthogonal wavelets, but exist in Bi-Orthogonal wavelets. The property of exact reconstruction and symmetry are impossible in orthogonal case except for the Haar wavelet, whereas, both properties are possible in Bi-Orthogonal wavelets. Bi-Orthogonal wavelet transform is an invertible transform.It has the property of perfect reconstruction.They have two sets of low-pass filters (for reconstruction), and high-pass filters (for decomposition),so symmetric wavelet functions exist.

In the dwt decomposition[4] an image can be decomposed in to four distinct subbands LL,LH,Hl,HH.[6]

2.2 Singular value decomposition(SVD)

SVD is an effective numerical analysis tool used for the reduction of two dimensional matrix problems.Images can be represented by two dimensional matrices. In SVD transformation[3], a matrix can be decomposed into three matrices that are of the same size as the original matrix. Formally,the singular value decomposition of an m×n real or complex matrix M is a factorization of the form follow in this equation

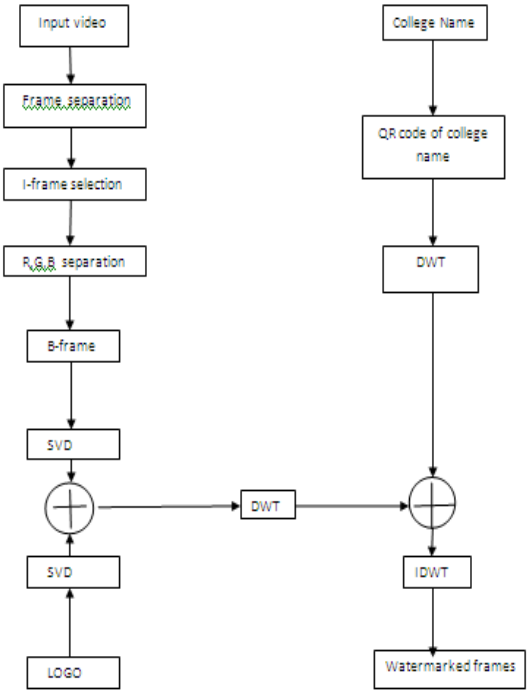
$$M = U \sum V'$$

Where U - m × m real or complex unitary matrix
$\sum is$ m×n rectangular diagonal matrix with nonnegative real numbers on the diagonal,
V'- n×n real or complex unitary matrix.

3. *Proposed Watermarking scheme*

3.1 Watermark embedding procedure

3.1.1 Block diagram



3.1.2 **Watermark embedding algorithm**

1. Read the video file & frames are separated

2. Select the first frame as the I-frame(cover image)

3. Separate R,G,B planes .

4. Select B-panel image as cover image

5. Generate QR code corresponding to the collge name

6. Apply DWT on the QR coded image

7. Apply SVD to the B-panel cover image

8. Add logo with SVD components

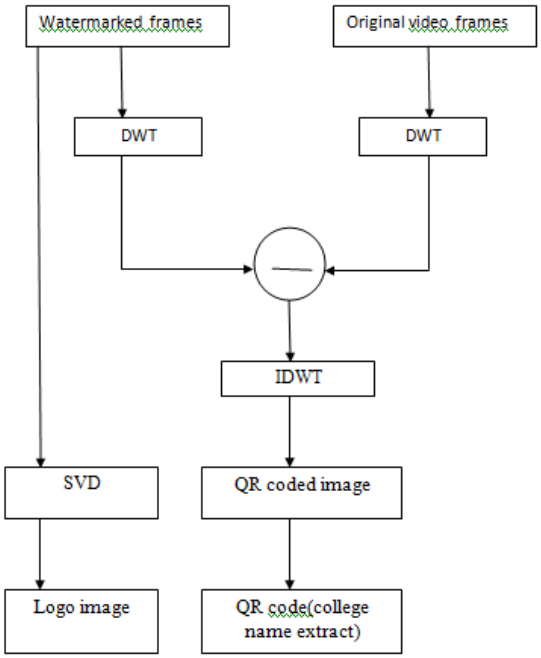
9.Apply DWT to the combined image(logo+cover image)

10.Combine the two DWT images together.

11.Apply IDWT to the combined image and obtain watermarked frames.

3.2Watermark extraction

3.2.1 Block diagram



3.2.2 Watermark extraction algorithm

1. Read the watermarked video files and extract watermarked frames

2. Read original video and extract the video files

3. Apply DWT on both type of frames

4. Substract the two DWT coefficients

5. Apply IDWT

6. Obtain the original QR[2] coded image

7. Read the original QR coded word from the QR coded image using QR code reader

8. Apply SVD to the watermarked frame and obtain logo

4. Performance analysis parameters

4.1.1 Peak signal to noise ratio(PSNR)

Here ,measure the quality of the watermarked image by compairing it with original image[1]

$$\text{PSNR} = 10\ \frac{log_{10}\,(255)^2}{MSE}\ dB \qquad (1)$$

4.1.2 Mean square error(MSE)

Here,easure the square of the eroor between original and watermarked images[1]

$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k-}x_{j,k}{}')^2 \quad (2)$$

4.1.3 Mean absolute error(MAE)

$$MAE = \sum\sum abb|x_{j,k} - x_{j,k}{}' \ | \quad (3)$$

4.1.4. Root mean square error(RMSE)

$$RMSE = \sqrt{\frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k-}x_{j,k}{}')^2} \quad (4)$$

4.1.5 Correlation coefficient(CC)

This parameter is used to find the correlation between original and extracted watermarks

4.1.6 Structural similarity index matrix(SSIM)

This is a method used for measuring the similarity between two images. It can be viewed as a quality measure of one of the images being compared, by considering the other image is regarded as of perfect quality

4. Results

Here,take a sample uncompressed avi video has the following specifications

Number of Frames: 73
Frames Per Second: 25
Width: 180
Height: 144

Then take the first frame as the cover frame.

Figure 1: Cover image

Figure 2: Logo image

Figure 3: B panel image

Figure 4: Watermarked image in DWT form

Figure 5: Reconstructed image

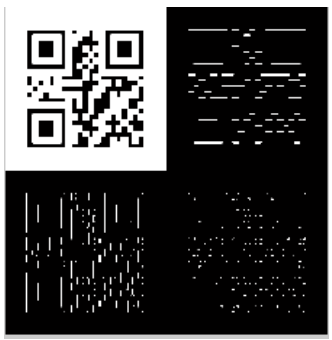


Figure 6: QR image in DWT form

Figure 7: Extracted Logo

Figure 9: Extracted QR image

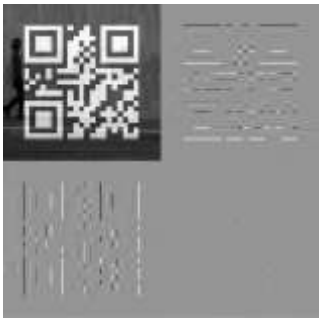


Figure 8:Extracted QR image in DWT form

Table 1: Performance analysis by using different cover frames

Frame no	PSNR	MSE	RMSE	CC
1	41.0806	14.2782	3.7786	0.9213
2	41.0638	14.3217	3.7844	0.9283
5	41.0277	14.4439	3.8052	0.9530
10	41.0155	14.4802	3.8053	0.9608
20	41.0207	14.4624	3.8029	0.9551
40	41.0557	14.3413	3.7870	0.923
60	41.0170	14.4774	3.8049	0.9587

Table 2 :Effect of various attacks on watermarked frames

Attack	PSNR	MSE	RMSE	MAE	CC	SSIM
Mean	28.15	100.32	10.01	5.13	0.6241	0.7831
Median	35.27	19.43	4.40	2.55	0.2321	0.9343
Salt & pepper	25.19	198.28	14.08	3.56	0.2997	0.6427
Gaussian	19.94	663.20	25.75	20.41	0.3164	0.1938
Poisson	26.77	137.87	11.74	9	0.3012	0.4870
Speckle	18.91	840.45	28.99	24.04	0.3467	0.1900
Rotation	12.42	3751.21	61.24	42.94	0.7243	0.1902
Histogram eq.	15.37	1899.12	43.57	37.51	0.8882	0.6242

5. Conclusion

This method has achieved the improved imperceptibility and security watermarking. By using bi-orthogonl wavelet PSNR can be improved and MSE,RMSE can be reduced. I-frames can be selected for watermark embedding which provide improved robustness against various attacks.Calculation of various performance evaluation parameters shows that this method has good robustness .

6. References

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