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Bi-orthogonal Wavelet Transform Based Video Watermarking Using Optimization Techniques

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Abstract

Watermarking is a component of inserting data into the multimedia, for example, image, audio or video. This paper propose a method for video watermarking using BWT and SVD to protect the copy right of images. In order to improve the efficiency of video watermarking two main processes are used namely watermark embedding process and watermark extraction process. Before embedding process the input video sequence convert into number of frames. BWT is applied in watermark image the improved artificial bee colony algorithm is proposed for generating random frame for the embedding process. The result obtain from the watermark embedding process is the watermark video sequence. Next watermark extraction process is carried out. It is the reverse process of watermark embedding. In watermark extraction process, it extracts the watermark image from the watermark video sequence.

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Keywords: Video Watermarking;Bi-orthogonal wavelet transform; artificial bee colony algorithm;Embedding process;Extraction process.

1. Introduction

The rapid growth of multimedia content in digital form has increased the need to develop secure methods for legal distribution of the digital content. With the speedy growth of the Internet and multimedia systems in distributed environments, it is easier for digital data owners to transfer multimedia documents across the Internet. Therefore, there is an increase in the concern over copyright protection of digital content [1], [2].. The advent of image processing tools has increased the vulnerability for illicit copying, modifications, and dispersion of digital images. the data hiding technologies for digital data such as digital watermarking have got a lot of attention recently [3].

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Digital watermarking is put into practice to prevent unauthorized replication or exploitation of digital data [4], [5]. Digital watermarking is a technique that provides a way to protect digital images from illicit copying and manipulation. Watermarking is the process of embedding data into a multimedia element such as image, audio or video. This embedded data can later be extracted from, or detected in, the multimedia element for different purposes such as copyright protection, access control, and broadcast monitoring [7].

For digital watermarking of video, different characteristics of the watermarking process as well as the watermark are desirable [6-10]. These requirements are:

Nomenclature

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D.2	Watermark embedding steps
D.3	Watermark extraction steps
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2. Review of Recent Researches

A handful of watermarking schemes, which employs the robustness schemes for improved performance, have been presented in the literature for protecting the copyrights of digital videos. A brief review of some recent researches is presented here.

Yan Liua and Jiying Zhao [11] have proposed a 1D DFT (one-dimensional discrete Fourier transform) and Radon transform based video watermarking algorithm. An ideal domain which obtains the temporal information without losing the spatial information has been generated by the 1D DFT for a video sequence. A fence-shaped watermark pattern has been embedded in the Radon transform domain of the frames with highest temporal frequencies which they have selected with comprehensive analysis and calculation. The adaptive embedding strength for diverse locations has preserved the reliability of the watermarked video.

Yun Ye *et al.* [12] proposed an efficient video watermarking scheme through modifying the third decoded luminance differential DC component in each selected macro block. The modification was implemented by binary dither modulation with adaptive quantization step. The scheme was based on the observation that luminance differential DC components inside one macro block are generally space correlated, so the quantization step can be adjusted according to adjacent differential components, to utilize properties of human visual system (HVS). The method was very robust to gain attacks since amplitude scaling will have the same effect on differential components and the quantization step. Experimental results showed that it can be implemented in real time with better visual quality than uniform-quantizing scheme.

3. Problem Definition

The main motive of our proposed work is to solve the problems arising like copyright protection, copy protection, fingerprinting, authentication and data hiding.

- To improve the security.
- The demerits such as low PSNR and less correlation coefficient were also to be considered.
- Bi-orthogonal Wavelet Transform is found to be an important tool in decomposing the images.
- The project implemented to extract the image having a good quality of data.
- To test the reliability of attacks such as removal, interference, geometric, cryptographic and protocol attacks.
- The problem of resistance to video attacks, it is known that robustness is the critical issue affecting the practicability of any watermarking method

4. Proposed Method

There is an insistent require for copyright protection against pirating in quick growth of network distributions of images and video. To address this matter of ownership identification different digital image and video watermarking schemes have been suggested. This research suggests a competent scheme for video watermarking scheme by means of BWT to guard the copyright of digital images. The competence of the suggested video watermarking technique is achieved by two main steps:
1) Watermark embedding process 2) Watermark extraction

4.1 Motion estimation

Motion estimation is the process of finding out the motion vector that explains the transformation from one 2D image to another; usually from adjacent frames in a video sequence. Then by comparing each nearest frames for finding image quality the mean square error (MSE) is computed. If the mean square error value is greater than the threshold value then choose that frame as the best frame.

MSE= Distance between two frames (1)

If MSE > threshold, then select that frame as the best frame for embedding process. Here the threshold value is optimized using Improved Artificial Bee Colony Algorithm.

4.1.1 Improved Artificial Bee Colony

Artificial Bee Colony (ABC) is motivated by the intelligent behaviour of honey bees. It contains three components namely, employed bees, onlooker bees and scout bees. In ABC system, artificial bees fly around in a multidimensional search space and some (employed and onlooker bees) select food sources depending on the experience of themselves and their nest mates, and fine-tune their positions. A few (scouts) fly and select the food sources arbitrarily without by means of experience. If the nectar amount of a novel source is higher than that of the earlier one in their memory, they memorize the novel position and forget the earlier one. In Fig.4, the flowchart for the Improved Artificial Bee Colony is illustrated.
Preliminary step:

Initially, produce the initial food source S_i (i=1,2,3..N) where N indicates the number of food source. This procedure is called initialization process. Using fitness function, the fitness value of the food source is computed to find the best food source. It's demonstrated in beneath,

$$fitness = MSE \tag{2}$$

Where, f_i is an objective function for the particular problem. The iteration is set to 1 after finding the fitness value. Next the employed bee phase is performed.

$$S_{ij}^{new} = S_{ij} + \gamma(S_{ij} - S_{kj}) \tag{3}$$

Where S_{ij} is the j^{th} parameter of the i^{th} employed bee; S_{ij}^{new} is a novel solution for S_{ij} in the j^{th} dimension; S_{kj} is the neighbor bee of S_{ij} in employed bee population; γ is a number arbitrarily chosen in the range of [-1,1]; *Watermarking*

4.1.2 Bi-orthogonal wavelet transform

The multi resolution 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. Wavelets also have the properties like bi Orthogonal and orthogonal wavelets.

4.2 Watermark embedding steps

Input: input video sequence and watermark image
Output: watermark video sequence

- Divide the input video sequence (V_i|i=1,2,…n) into number of shots next the segmented shots are divided into j number of frames.
- Mean square error is found out in motion estimation by comparing the each nearest frames. If the MSE value is greater than the threshold values choose that frame as the best frame for watermark embedding.
- The threshold value is optimized by using Improved Artificial Bee Colony algorithm.
- After that choose the watermark image.
- After choosing the watermark image use singular value decomposition to the chosen watermark image.
- After that use 1D-BWT to the original watermark image. Four sub bands attained in the BWT level. The four sub bands are symbolizing as LL, LH, HL, and HH.
- Select the LL sub band and find the high intensity value.
- Attain watermark video sequence.

4.3 Watermark extraction steps

The specified procedure of watermark extraction is described beneath. Watermark extraction step is the opposite process of watermark embedding process. No necessitate for the original video in watermark extraction process. For extraction steps only the watermark video and location of the embedding process are necessary.

Input: Watermark video sequence
Output: extract watermark image

- Find high intensity value of all embed frames.
- Then compare intensity value with the motion frames.
- After that extract the watermark image from each embed frames.
- Use Inverse 1D level DWT.
- To bring back the watermark image.

5. Experimental Results

The experimental result of the proposed video watermarking using hybrid BWT-SVD is explained below. In this paper efficiently embedded the watermark image into input video sequence and extract back from the watermark video sequence. The output of the proposed video watermarking has been calculated by PSNR and NC (Normalized cross Correlation). The visual quality is evaluated by the PSNR criterion for watermarked video. The extracting fidelity is computed by the NC value between the original watermark image and the extracted watermark image. The performance of the proposed watermarking method is evaluated by using two video sample sequences namely Akiyo and Hall. The result of the Akiyo video sequence of the watermark image is shown in Fig.3.

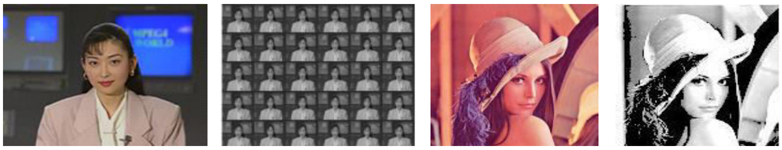

Fig.1 (a) input Akiyo video sequence (b) watermark video sequence (c) watermark image (d) extracted watermark image

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5.1 Evaluation Metrics

The quality of the system is evaluated using the quality metrics. The quality metrics calculated in our proposed methodology are:

5.1.1 PSNR (Peak Signal to Noise Ratio)

PSNR is the logarithmic value of ratio between signal and noise. It is expressed in decibels. The PSNR value is calculated using the following equation. It's shown in below,

$$PSNR = 20\log_{10}\left(\frac{MAX_i}{\sqrt{MSE}}\right) \quad (5)$$

Where,
MSE = Mean square error
MAX_i is the maximum possible pixel value of the image.

Table 1**:** PSNR values for Akiyo with and without optimization

Frames	PSNR Values for Akiyo video	
	With optimization using IABC	Without optimization using IABC
Frame 1	100	64.3399
Frame 5	100	61.0153
Frame 10	57.3365	61.2646
Frame 19	61.8701	64.9519
Frame 25	61.7854	61.4900

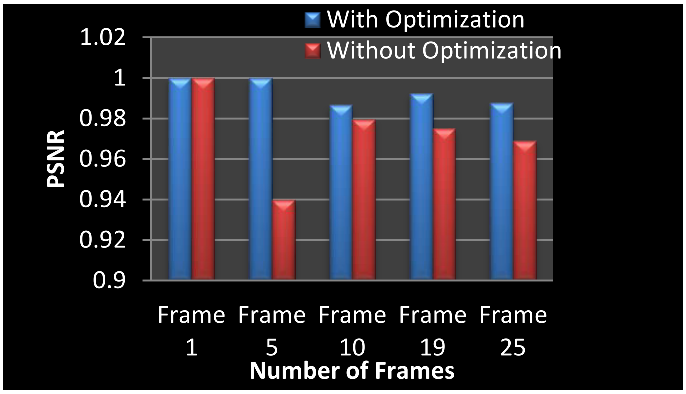

Fig.2**.** PSNR values by varying the frame number for Akiyo

5.1.2 NC (Normalized cross Correlation)

The Normalized Cross-Correlation (NC) is calculated using the following equation. It's shown in below

$$NC=\frac{\sum_{i=1}^{i=n-1}\sum_{j=1}^{j=n-1}W(i,j).W^{'}(i,j)}{\sqrt{\sum_{i=1}^{i=n-1}\sum_{j=1}^{j=n-1}(W(i,j))^{2}}.\sqrt{\sum_{i=1}^{i=n-1}\sum_{j=1}^{j=n-1}(W^{'}(i,j))^{2}}} \quad (6)$$

Where, W (i,j) = Pixel values of the original watermark $W^{'}$ (i,j) = Pixel values of the detected watermark

Table 2**:** NC values for Akiyo video with and without optimization

Frames	NC Values for Akiyo video	
	With optimization using IABC	Without optimization using IABC
Frame 1	1.000	1.0000
Frame 5	0.9967	0.9397
Frame 10	0.9863	0.9797
Frame 19	1.000	0.9751
Frame 25	0.9845	0.9689

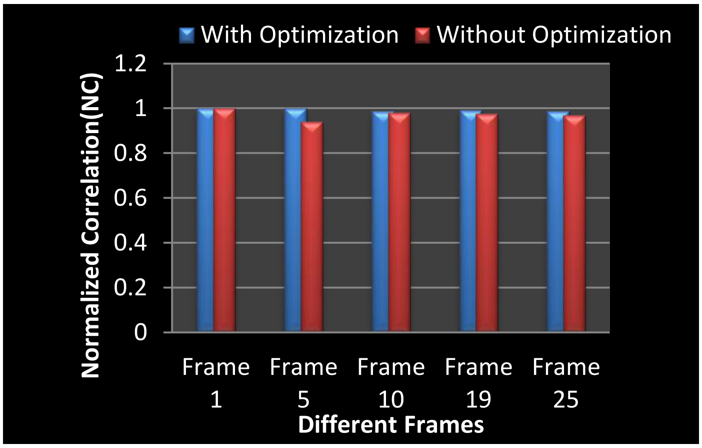

Fig..3. NC values by varying the frame number for Akiyo video

5.2 Robustness Evaluation

To verify the robustness of the proposed video watermarking scheme, the experimental results are conducted with various attacks for the watermark image.

Table 3: Performance metrics with and without applying different types of attacks for Akiyo

Attacks	Proposed method with attack		Existing Method [15]	
	PSNR	NC	PSNR	NC
Extracted Image	53.0557	0.9114	Not given	Not given
Salt & Pepper Attack	46.5010	0.9063	25.1900	0.2997
Speckle Attack	45.0711	0.9025	18.9100	0.3467
Gaussian Attack	39.6200	0.8957	19.9400	0.3164
Poisson Attack	52.0559	0.9614	26.77	0.3012

Here in Table 3 the proposed methodology performance is compared with the existing method [1] . The robustness of the watermarking scheme is analyzed based on different attacks such as Salt and Pepper noise attack , Poisson attack, speckle attack and Gaussian attack . In this table Salt and pepper noise attack of Akiyo video is compared with existing technique [1] . Our proposed method gave better robustness when compared to the existing method.

6. Conclusion

In this paper modified artificial bee colony algorithm is proposed. Watermark embedding and watermark extraction are the two main process implemented in the work in order to improved imperceptibility, efficiency and security watermarking. The input video sequence converted into number of frames before the embedding process. In watermark image singular value decomposition is applied. The improved artificial bee colony algorithm is proposed for generating random frame for the embedding process. The result obtain from the embedding process is watermark video sequence. Watermark extraction is the reverse process of embedding, it extract the watermark image from the watermark video sequence.

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