Histogram Feature-based Digital Video Watermarking Scheme

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Abstract

Digital watermarking has become a significant discipline in the information process community. In current research trend, frequency based watermarking technique and transform based watermarking techniques are lacked from a problem of geometrical attack. The aim of the study is to propose a feature extraction based video watermarking technique. The extracted first order histogram feature of image are used by applying the principle component analysis. For embedding process, the histogram features and groups the same number of histogram value which are called component. According to the component, the embedded feature are selected based on the key value. The obtained results show that the propose approach offers good imperceptibility and generates watermarking videos robust against various attacks with high quality watermark.

Keywords: histogram, PCA, digital watermarking, video watermarking

1. Introduction

Recently, there was a tremendous increase in the amount of digital multimedia transmitted over the Internet. Digital watermarking consists of inserting an imperceptible mark into a cover file. This mark is a random sequence of bits, a binary logo, or a message, depending on the targeted application [2]. The insertion of watermark must not affect the visual quality of the cover media.

Watermarking can be classified, according to the embedding-extraction domain, into spatial-based [1], and transform based [7] schemes. Recently, color image watermarking has attracted an increasing number of researchers. Despite that a large amount of works was devoted to image watermarking, a relatively less number of works have tackled video watermarking [5]. The histogram shifting technique is used to embed the data on poles and carrier space. It provides a low embedding capacity. In difference expansion technique [4], provided a high embedding capacity which computed the difference between the set of adjacent pixels and the one bit data is embedded into each set.

The discrete wavelet transform, discrete Fourier transform [3] which embed a template in magnitude spectrum in DFT domain. Results revealed that the watermark is robust opposed to both affine transformation and JPEG compression. The aim of the study is to propose a feature extraction based video watermarking technique. For watermark embedding, the features of the cover image are assembled into components, each of which has the same number of features, thus the PCA are generated. The percentage of number of features in each component are calculated and encoded as a twelve digit of key. The rest of the paper is classified as follows: section 2 describes the proposed system and briefly discuss the procedure of the system. Section 3 describes the related methodologies of this study and explains the analytical results in section 4.

2. Proposed Video Watermarking System

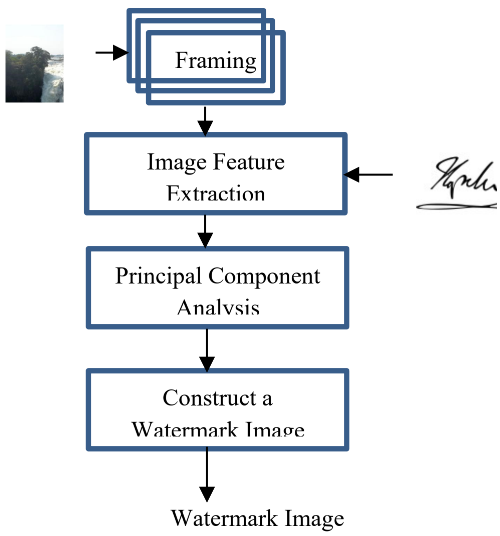


Figure 1. Block diagram of proposed system

This paper proposes a framework to support video watermarking with a user defined password security to include as much as necessary components so as to prove the authenticity or integrity of the carrier signal or to show the identity of its owners. The block diagram of the proposed video watermarking system is shown in

Figure 1. cover video to frame detection can be done 45 frames per second in video based on Matlab software. In this process, edge change ratio is one which will determine the number and position of the edge and hence we can compare the actual content of two frames by transforming both the frames to edge pictures.

After that, first order histogram features are took out from the extracted frames of cover image and host image. In the third step, the extracted features are used to anlalyze with principal component analysis. The authorized signature image to be embedded in the host video file. The image in which host image will be embedded in the cover image which extracted from the video file. After embedding process the video is called "watermarked video". In the final step, construct the watermarked video with authorized signature.

3. Related Methodology

3.1 Feature Extraction

Feature extraction is an important component of digital watermarking and image processing. Multimedia data have three features which are color features, texture features and dimensions features. Texture feature is very important feature for feature extraction for the purpose of digital watermarking technique. The following section describes the detail explanation of feature extraction methods.

3.1.1. First-Order Histogram Features

Texture features of. Histogram that will consider are statistical based features, where the histogram is used as a model of the probability distribution of the intensity levels. This statistical feature provides that with information about the characteristics of the intensity level distribution for the image [5]. The first order histogram probability, P (g), as:

$$P(g) = \frac{N(g)}{M} \qquad (1)$$

The mean, standard deviation, skew, energy, and entropy are the first order feature of Histogram.

The mean is the average value which can be defined as follows:

$$Mean = \bar{g} = \sum_{g=0}^{L-1} gP(g) \qquad (2)$$

where g=represents the value of intensity level, L= total number of intensity levels.

The standard deviation, which is also known as the square root of the variance, tells that something about the contrast. It is defined as follows:

$$\sigma_g = \sqrt{\sum_{g=0}^{L-1} (g-\bar{g})^2 P(g)} \qquad (3)$$

The skew calculates the asymmetry about the mean in the intensity level distribution. It is defined as:

$$\text{SKEW} = \frac{1}{\sigma_g^3} \sum_{g=0}^{L-1} (g-\bar{g})^3 P(g) \qquad (4)$$

The energy means how the intensity levels are distributed:

$$ENERGY = \sum_{g=0}^{L-1} [P(g)]^2 \qquad (5)$$

Entropy defines the number of bit to code in intensity level

$$ENTROPY = -\sum_{g=0}^{L-1} P(g) log_2\,[P(g)] \qquad (6)$$

When the entropy value increases, the pixel values of the image are dispensed among more intensity levels. Entropy value are higher in complex image than simple one.

3.1.2. Principal Component Analysis

Standard Principle Component Analysis (PCA) is whiten the tested features before processing in ICA [6]. This transform observed vector x linearly so that obtain a new vector $\tilde{x}$ which is white. Features are uncorrelated and their variances equal unity.

$$E\{\tilde{x}\tilde{x}^T\} = I \qquad (7)$$

Eigen-value decomposition (EVD) is the popular method of whitening: covariance matrix $E\{\tilde{x}\tilde{x}^T\} = EDE^T$, where E is orthogonal matrix of eigenvectors of $E\{xx^T\}$ and D is the diagonal matrix of its eigenvalues$D = diag(d_1 \ldots\ldots d_n)$. Note that $E\{xx^T\}$ can be calculated in a standard way from the features sample $x(1) \ldots\ldots x(T)$ whitening process is evaluated by

$$\tilde{x} = ED^{1/2}E^T X \qquad (8)$$

For example, rank of D is equal to two for original and watermarked signal, meaning that observed and linear signal are uncorrelated. On the other hand, if the signal is correlated, this mixtures are actually the combination of one signal only, hence, the rank of D will be reduced to one. The embedding processing take place in the combination of image features.

4. Experimental Analysis

In this paper, a video watermarking scheme based on first order histogram and principal component analysis is proposed. In this section, all experiment based on different video sequences from different sources including the movies and on-line videos from CNN and YouTube as the cover video. For watermark embedding, the features of the cover image are assembled into components, each of which has the similar index of features, thus the PCA are generated. The percentage of number of features in each component are calculated and encoded as a twelve digit of key. If the correlation coefficient feature estimate the value of correlation is zero then embedding process is done. Then some features in component are moved to form a specific patter in the histogram distribution, indicating the watermark. In the video watermark extraction, the key is used to decode and the features in the watermarked image are grouped into component with a key. In the opinion of histogram feature distribution in each component, the watermark signature is extracted.

4.1. Feature Analysis

Cover video to frame detection can be done 45 frames per second in video based on Matlab programming. Histogram features such as skewness, kurtosis etc., are extracted from the extracted image and authorized signature image. The sample features are shown in the following table 1. Histogram features were then evaluated for all images in both cover and authorized signature. The extracted features from cover and authorize signature image were used for correlation analysis.

Table 1. Sample Histogram Features

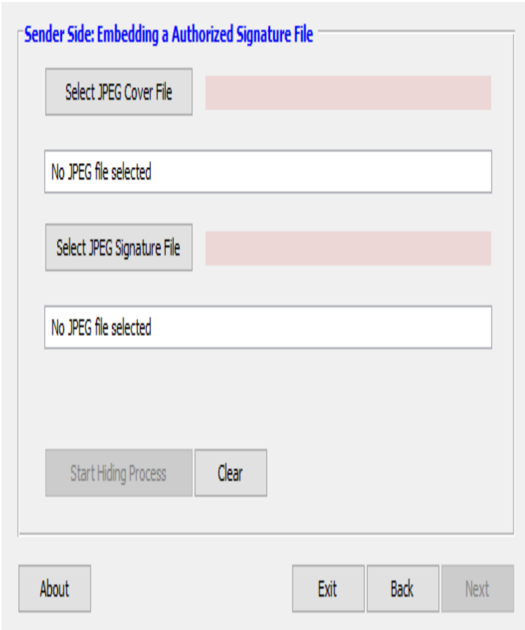
No of Image	Histogram Features				
Image1	4.594	1.426	0.255	2.819	...
Image2	4.890	0.610	-0.247	3.108	...
Image3	4.886	0.699	-0.204	2.890	...
Image4	4.290	2.013	0.013	1.993	...
Image5	4.353	1.348	0.045	2.271	.....
. .					

4.2. Principal Component Analysis

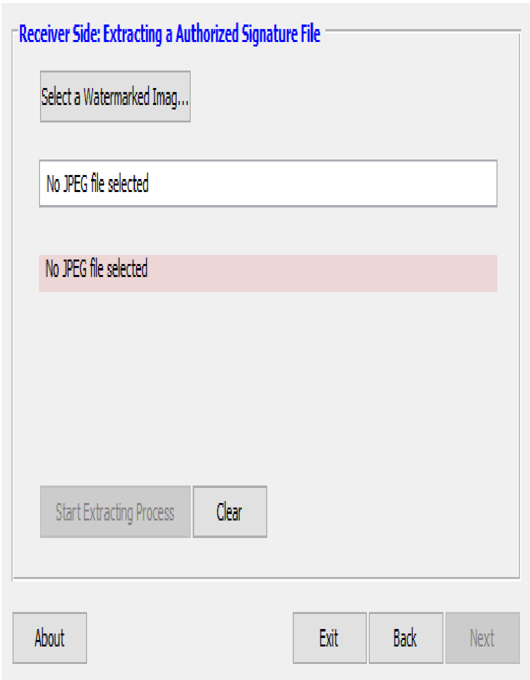
In this analysis, eigenvectors and eigenvalues are calculated from the feature vector of cover and host image. Eigenvector with the highest eigenvalue is the principal component of the data set. If the eigenvalues are small, the information will be much more accurate. Matrix of vectors is built by taking the eigenvectors and constructing a matrix with selected eigenvectors in the columns. Formerly the components (eigenvectors) picked to retain the feature vector have been assembled. Soon after the rearrange vector was evaluated and multiply it on the left over of the original component and new one.

4.3. Analytical Results

We carry out the proposed technique in the cover video with 3 minutes long which are separated into images. Figure 2 (a) and (b) describe the screen shot image of sender side: embedding an authorized signature image and receiver side: extracting an authorized signature file. The resulting watermarked image and the extracted signature is shown in Figure 3.



(a)



(b)

Figure 2. Implementation of video watermarking system

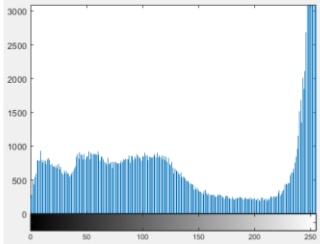
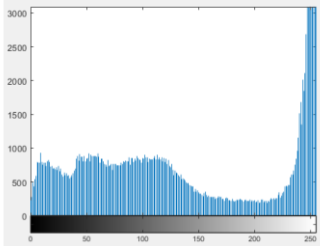
Original Image	
Histogram of Original Image	
Watermarked Image	
Histogram of Watermarked Image	

Figure 3. Visual Analysis of Original image histogram and watermarked image histogram

In Figure 3, the results obtained do not visually allow detecting distortions generated by the concealment process. For this reason, similarity and distortion measurements were calculated by comparing the original images and the watermarked images. Quantitative distortion measures are much more efficient and allow a fair comparison between different methods compared to subjective assessment measures:
Peak signal to noise ratio: PSNR evaluate the quantity of noise added to the image cover during the integration process.
Mean squared error: MSE calculate the diversity between the original image and watermarked image. Larger the MSE higher the level of degradation.
Number of pixels changed ratio: Calculate the number of pixels (NPCR) difference.
Number of colorimetric values changed ratio: Calculate the number of modified color value (NVCR).

According to the table results, the high PSNR value described that the proposed watermark approach is highly imperceptible and less of distortion in watermark image. The number of colorimetric values that have been changed by the watermarking process is represented by the matric NVCR and NPCR represent the number of changed pixels. The best results of feature based principal component results which justifies a higher NVCR rate and better imperceptibility for this approach.

Table2. Analysis of Imperceptibility Results

Watermarked image	PSNR	MSE	NVCR	NPCR
Signature1	4315	04218	48775	22583
Signature2	4011	04210	48792	22707
Logo1	4861	12176	49211	23668
Logo2	4836	12116	49304	23165

Several attacks were executed upon the watermarking images such as JPEG compression, filtering, blurring, cropping and image sharpening for classifying the robustness of the proposed watermark approach. The normalized correlation (NC) is applied to evaluate the robustness of the watermark scheme by comparing the original and extracted watermark. There is a significant relationship between the original and extracted watermark is NC>0.8 which are shown in Figure 4.

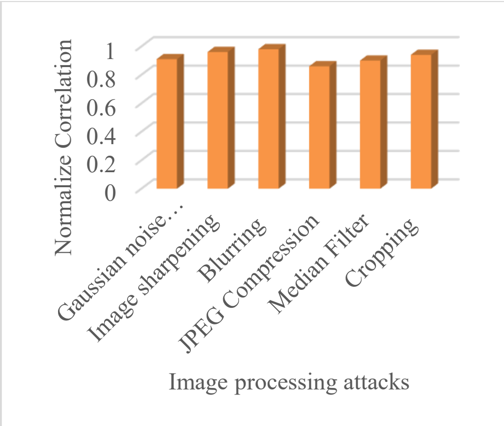


Figure 4. Robustness Analysis

5. Conclusion

The color image watermark is hidden into the host image of video file based on the combination of image feature extraction with principal component analysis is proposed in this paper. The proposed histogram feature based PCA scheme embeds the authorized signature image in the same components which are correlated with histogram features of cover and host image. The results revealed that the proposed watermark approach can resist most of the attacks caused by the image processing, such as image compression, brightness and contrast adjustment. The imperceptibility result analysis showed that the better PSNR, NVCR and NPCR value for watermarked image.

The proposed method of digital watermarking technique provide great security of digital multimedia data.

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