"Comparison & Performance Analysis of different Digital Video Watermarking Techniques"

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Abstract:

Past few years have witnessed rapid growth in Digital video watermarking. Security and copyright protection are becoming important issues in multimedia applications and services. Watermarking techniques have been proposed for these purposes in which the copyright information is embedded into multimedia data in order to protect the ownership. In this paper we first performed a survey on available video watermarking techniques, feasibility study on watermarking techniques meeting the requirements. And we have suggested the transform domain method for digital video watermarking for embedding invisible watermarks behind the video. It is used for copyright protection as well as proof of ownership. then we perform a comparative analysis based on robustness and computational complexity of different watermarking algorithms.

***Keywords*: Digital Video Watermarking, Copyright protection, Discrete wavelet transform, Principal component analysis Discrete cosine transform, Transform domain watermarking.**

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1 Introduction:

Recently, the users of networks, especially the world wide web are increasing rapidly. The reproduction, manipulation and the distribution of digital multimedia (images, audio and video) via networks become faster and easier. Hence, the owners and creators of the digital products are concerned about illegal copying of their products. As a result, security and copyright protection are becoming important issues in multimedia applications and services. Watermarking techniques have been proposed for these purposes in watermark can be detected or extracted at later times in order to make an assertion about the object. The main purpose of digital watermarking is to embed information imperceptibly and robustly in the host data. Typically the watermark contains information about the origin, ownership, destination, copy control, transaction etc. Potential applications of digital watermarking include which the copyright information is embedded into multimedia data in order to protect the ownership. Research is now being focused on public key cryptography/watermarking schemes to protect multimedia content. Digital watermarking is a technology that can serve this purpose. A large number of watermarking schemes have been proposed to hide copyright marks and other information in digital images, video, audio and other multimedia objects. [1]. A watermark is a digital data embedded in multimedia objects such that the transaction tracking, copy control, authentication, legacy system enhancement and database linking etc. [2].

In the Past years, different digital video watermarking algorithms have been proposed. Some techniques embed watermark in the spatial domain by modifying the pixel values in each frame but these

methods are not robust to attacks and common signal distortions. In contrast, other techniques are more robust to distortions when they add the watermark in the frequency domain. In these types of schemes, the watermark is embedded by modifying the transform coefficients of the frames of the video sequence. The most commonly used transforms are the Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelet Transform(DWT). Several researches concentrated on using DWT because of its multi-resolution characteristics, it provides both spatial and frequency domain characteristics so it is compatible with the Human Visual System (HVS).

2 VIDEO WATERMARKING:

2.1 Digital watermarking: Digital watermarking also known as watermark insertion or watermark embedding, represents the method of inserting information into multimedia data also called original media or cover media e.g. text, audio, image, video. The embedded information or watermark can be a serial number or random number sequence, ownership identifiers, copyright messages, control signals, transaction dates, information about the creators of the work, bi-level or gray level images, text or other digital data formats. In the literature large number of text [3]-[5], image [6]-[9], audio [10] and video [11]-[15] watermarking algorithms can be found. These algorithms modify the original media to generate the watermarked media. There may be no or little perceptible differences between the original media and the watermarked media.

Fig.1 gives an overview of different types of watermarking methodologies depending on their working domains, cover media, perceptibility and application areas. And fig .2 shows the different types of watermarks can be used. After embedding watermark, the watermarked media are sent over Internet or some other transmission channels. Whenever the copyright of the digital media is under question, the embedded information is decoded to identify copyright owner. The decoding process can extract the watermark from the watermarked media (watermark extraction) or can detect the existence of watermark in it (watermark detection). The embedding or encoding process can be viewed as a function or mapping that maps the input X (original media), W (watermark) and/or K (key) to output X' (watermarked media).

Mathematically it can be expressed as

$X' = E(X,W,[K])$ (1)

where $E(.)$ denotes the embedding process and [.] represents optional argument. Similarly the decoding or extraction process $D(.)$ can be expressed formally as

$W' = D(X'', [X], [K])$ (2)

and the detection process $d(.)$ can be expressed as $\{Yes\ or\ No\} = d(X'',[X],W,[K])$ (3)

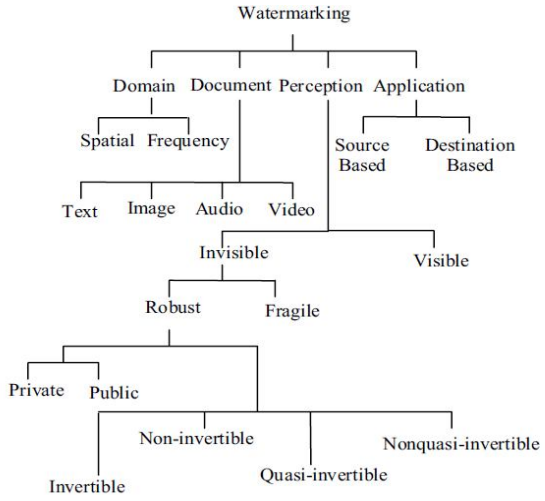

Fig.1 Different types of watermarking methodologies.

2.2 Video watermarking techniques:

Apparently any image watermarking technique can be extended to watermark videos, but in reality video watermarking techniques need to meet other challenges than that in image watermarking schemes such

as large volume of inherently redundant data between frames, the unbalance between the motion and motionless regions, real-time requirements in the video broadcasting etc. Watermarked video sequences are very

much susceptible to pirate attacks such as frame averaging, frame swapping, statistical analysis, digital-analog (AD/DA) conversion, and lossy compressions. Video watermarking applications can be grouped as security related like Copy control [18], fingerprinting, ownership identification, authentication, taper resistance etc. or value added applications like legacy system enhancement, database linking [1], video tagging, digital video broadcast monitoring, Media Bridge etc.

Apart from robustness, reliability, imperceptibility, practicality, video watermarking algorithms should also address issues such as localized detection, real time algorithm complexity, synchronization recovery, effects of floating point representation, power dissipation etc . According to the working domain, video watermarking techniques are classified in pixel domain and transform domain techniques. In pixel domain the watermark is embedded in the source video by simple addition or bit replacement of selected pixel positions. The main advantages of using pixel domain techniques are that they are conceptually simple to understand and the time complexity of these techniques are low which favours real time implementations. But these techniques generally lacks in providing adequate robustness and imperceptibility requirements.

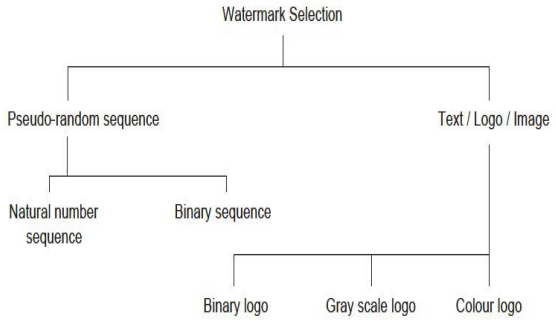

Fig. 2 Different types of watermark

3 SURVEY ON VIDEO WATERMARKING:

C.V. Serdean, M.A. Ambroze, M. Tomlinson and J.G.Wade, have combined the advantages of both Fourier-Mellin Transform (FMT) image registration techniques and the watermarking in the DWT domain in order to undo geometric attacks. They have also described a high capacity blind video watermarking system invariant to geometrical attacks such as shift, rotation, scaling and cropping. A spatial domain reference watermark is used to obtain invariance to geometric attacks by employing image registration techniques to determine and invert the attacks in their Paper,.[16] Maher El'arbi, M. Ben Amar, C. Nicolas, H. have described a method to embed different parts of a single watermark into different shots of a video under the wavelet domain. A multi-resolution motion estimation algorithm (MRME) has been adopted to allocate the watermark to coefficients containing motion. Other transformations have also been explored for watermarking such as principal component analysis (PCA). It has the advantage of high energy concentration and complete de-correlation which it is suitable for data hiding. PCA has been used in different ways in image and video watermarking methods in their paper, [18]. Thai Duy Hien, Yen-Wei Chen, Zensho Nakao, have proposed a method for selecting a set of coefficients in each PCA subblock to cast the watermark. They have also described that PCA has been used to obtain a reference of the cover image. The watermark is embedded according to the difference of the original and its reference image, in their research paper, "[19]. Xiangui Kang, WenjunZeng, and Jiwu Huang have presented a new approach that incorporates multi-band (M-band) wavelet transformation and PCA. In this case, for the typical spread spectrum (SS) watermarking system, blind retrieval is performed via cross-correlation between the marked video and the secret pseudo-noise (PN) sequence used to spread the watermark at the embedding stage in their paper. [23]. Yang Gaobo; Sun Xingming; Wang Xiaojing have explained the watermark is scrambled and embedded into the mid frequency DWT coefficients of each frame of the video. The quality of the scheme is enhanced by using a genetic algorithm. The main watermark, which carries multi-bit data, is inserted in the DWT domain and capacity is maximised by embedding based on a HVS model. The complete system is regarded as a noisy communications channel and so is protected by turbo coding in their paper. [27] Jiande Sun, Ju Liu, and Hua Yan, have described a video watermarking scheme to resist the temporal de-synchronization by using shot segmentation and two-dimensional PCA in their paper.[19].

4 Comparison:-

Video watermarking approaches can be classified into two main categories based on the method of hiding watermark bits in the host video. The two categories are: Spatial domain watermarking where embedding and detection of watermark are performed by directly manipulating the pixel intensity values of the video frame. Transform domain techniques, on the other hand, alter spatial pixel values of the host video according to a pre-determined transform and are more robust than spatial domain techniques since they disperse the watermark in the spatial domain of the video frame making it difficult to remove the watermark through malicious attacks like cropping, scaling, rotations and geometrical attacks.

Different digital video watermarking algorithms have been proposed. Some techniques embed watermark in the spatial domain by modifying the pixel values in each frame but these methods are not robust to attacks and common signal distortions. In contrast, other techniques are more robust to distortions when they add the watermark in the frequency domain. In these types of schemes, the watermark is embedded by modifying the transform coefficients of the frames of the video sequence. The most commonly used transforms are the Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelet Transform (DWT). Several researches concentrated on using DWT because of its multiresolution characteristics, it provides both spatial and frequency domain characteristics so it is compatible with the Human Visual System (HVS).

The recent trend is to combine the DWT with other algorithms to increase robustness and invisibility. 'Serdean' [16] has combined the advantages of both Fourier-Mellin Transform (FMT) image registration techniques and the watermarking in the DWT domain in order to undo geometric attacks. 'Elarbi' [18] has proposed a digital video watermarking scheme based on multiresolution motion estimation and artificial neural network. In 'Gaobo' [27] the watermark is scrambled and embedded into the mid frequency DWT coefficients of each frame of the video. The quality of the scheme is enhanced by using a genetic algorithm. Afterwards, Elarbi [18] has described a method to embed different parts of a single watermark into different shots of a video under the wavelet domain. Other transformations have also been explored for watermarking such as principal component analysis (PCA).

PCA is a linear transformation that chooses a new coordinate system for the data set. It has the advantage of high energy concentration and complete de-correlation which it is suitable for data hiding. PCA has been used in different ways in image and video watermarking methods. 'Hien' [24] has proposed a method for selecting a set of coefficients in each PCA sub-block to cast the watermark. In 'Yavuz'[8] PCA has been used to obtain a reference of the cover image. The watermark is embedded according to the difference of the original and its reference image.

5 Performance analysis:-

Performance of the different video watermarking schemes can be analyzed by the different Properties or the parameters of the watermarking scheme which are as explained below.

5.1 Performance Parameters :-

Imperceptibility: The watermark should not noticeably distort or degrade the host data in order to preserve the quality of the marked document.

Robustness: To measure robustness the watermark must be reliably detectable against signal processing schemes including data compression.

Fragility: These kinds of watermark are embedded in host data in such a way that they do not survive in the case of any modification even copying.

Tamper-resistance: The tamper-resistance property is focused on the intentional attacks in contrast to robustness.

False positive rate: The Probability of identifying an unwatermarked piece of data as containing a watermark by a detector is called the false positive rate.

Data payload: The amount of information present in watermarked media is called data payload.

Normalized correlation : The key component of the images detection is the normalized correlation.

PSNR: peak signal to noise ratio. It should be as high as possible.

Performance Parameters ⇨ / Watermarking Techniques ⇩	R	I	F	PSNR	NC	TC
FMT	A	G	A	P	P	A

DCT	G	A	P	P	A	A
DFT	A	G	A	A	P	A
DWT	G	G	A	G	G	A
PCA	G	G	G	G	G	G
GOF	G	A	G	A	G	P
PW	A	A	G	A	G	P
SS	A	A	G	G	A	A
TDC	G	G	A	A	A	G

Table 1 Performance analysis of different video watermarking techniques.

FMT - Fourier-Mellin Transform, DCT - Discrete Cosine Transform, DFT - Discrete Fourier Transform, DWT - Discrete Wavelet Transform , PCA - Principal Component Analysis, PW- Perceptual watermarking, GOF- group of frames & SS- Spread spectrum. P- Poor, A- Acceptable, G- Good.

6 Conclusion:-

We have reached the conclusion that Robustness to geometric attack, Imperceptibility, PSNR & NC are the most important requirements for a watermarking system, The performance analysis shown in this paper for different watermarking techniques considering different Parameters. From the literature survey the performance is analyzed accordingly Poor, Acceptable and Good. By observing this paper one can say the DWT and PCA techniques have superior performance as compared to other techniques.

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