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A Survey and Comparative Study on Video Watermarking Techniques with Reference to Mobile Devices

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ABSTRACT
During the last few years' mobile devices like smart phone and tablet witnessed a random growth in terms of hardware and software. The increased growth of apps, sharing data, videos, images through internet need security and intellectual property right. Developing a watermarking technique for data protection and authentication on shared data in mobile internet within the limited memory and significant battery consumption is one of the current challenging fields. In this paper we have performed a survey on available video watermarking techniques and a feasibility study on video watermarking techniques for mobile devices. Also the comparative study on features of watermarking with different video watermarking algorithm is performed.

Keywords **-** DCT, DFT, DWT, LSB, Mobile Devices, SVD

I. INTRODUCTION

Due to the advancement in technology, digital document data like videos, images, text messages are shared easily using mobile devices and can be copied without owner's permission. This leads to a new challenge of protecting the multimedia data. Watermarking is a technique of embedding copyright information into the host data to protect the intellectual right and the originality of data. Video watermarking technique is an extension of watermarking concept. The collection of consecutive still images is considered as digital video and the amount of watermark data inserted in video is called as payload. Video watermarking provide few attacks like frame dropping, frame swapping which applicable only to video and to be addressed to achieve the security in watermarking. In this paper section II discuss about Video watermarking, section III is the survey on video watermarking, section IV is the survey on video watermarking on mobile devices, section V is the Comparative analysis and conclusion is given in section VI.

II. VIDEO WATERMARKING

2.1 General Properties of Video Watermarking

The properties we discus here plays a very important role in video watermarking process.

2.1.1 Imperceptibility

The embedded watermark should not change, effect or damage the quality of original data. A watermark should be imperceptible that human cannot find the difference between the original and the watermarked data [1].

2.1.2 Robustness

When a video is shared usually there will be some distortion. The watermark should be robust against all innocent and malicious attack. Even if the video changes copy right data should not get affect [3][5].

2.1.3 Capacity and Payload

The amount of data to be embedded in cover work is called Capacity. The number of watermark bits in host data is payload. The payload varies from one application to other[3][4].

2.1.4 Security

The Watermark and original data should be accessible only to the authorized user. The hackers and unknown user must be unable to extract the watermark and the original data should not effect by any attacks [1][3].

2.1.5 Computational Cost and Time Complexity

The cost to embed watermark into host data and to extract watermark should be reliable. It is very important to pick a suitable complexity watermarking algorithm to avoid high complexity problems like more software and hardware resources. Time taken by watermarking algorithm should be less to increase the efficiency [1].

2.2 Classification of Video Watermarking Attacks

The video watermarking technique mainly faces two type of attack

2.2.1 Innocent Attack

Innocent attack is unintentional and coincidence attack like smoothening and compressing image [8].

2.2.2 Malicious Attack

These are intentional attack like deleting and desynchronizing attack [8].

2.3 Classification of Video Watermarking Technique

Depending upon perception and insertion domain video watermarking classified as shown in Fig 1 [3][8].

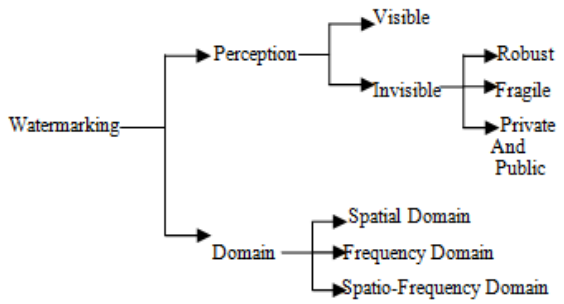

Fig.1. Classification of Video Watermarking

2.3.1 Spatial Domain Method

The spatial domain method, embed the watermark by modifying the pixel value of the host video [1][2]. Spatial domain method is faster compared to Frequency domain with simplicity and less computational complexity [3]. The method is less robust to geometric distortion and less resistant to noise, compression and low pass filtering [5].

- Least Significant Bit

A simplest watermarking technique, watermark is embedded by changing lower order bit of each pixel. The payload of LSB technique is very less and restricted [7].

- Correlation -Based Technique

It is a straight forward approach to embed watermark by adding pseudorandom noise pattern to luminance value of video pixel. The pseudorandom noise (MN) pattern i.e. A(y, z) is added to cover image B(y, z) the outcome is watermarked image B_A(y, z).Here (y, z) represent position of watermark.

$B_A(y, z) = B(y, z) + k^* A(y, z)$

k represent gain factor. The spatial method can provide better robustness and average payload if image is decomposed into blocks and multiple watermarks is embedded in blocks by optimal watermarking technique [5].

2.3.2 Frequency Domain Method

The watermark is embedded in frequency domain instead of spatial domain[1]. Watermark is spread out to entire image so it is more efficient, robust and secure compared spatial domain[5].

- Discrete Fourier Transform

In this approach, watermark is embedded only in first frame of group of pictures. The full DFT technique is applied to identify frame to be watermarked and magnitude of coefficient is calculated. This method is robust against linear/non linear filtering, sharpening and resist geometric transformation like scaling rotation and cropping [5].

2.3.3 Spatio-Frequency Domain Method

The watermark is embedded by changing coefficient of applied video transform.

- Singular Value Decomposition

SVD is a numerical watermarking technique, used to get diagonalized matrices. The watermark is embedded in singular value of original image. The length and coefficient of watermark effect watermarking technique [6].

SVD is mathematical tool to analyze matrices. A square matrices A of M x N size is decomposed into three matrices X,Y,Z such that $A=XYZ^T$. Z^T transpose of Z, X, Y are orthogonal matrix and z is square diagonal [7].

- Discrete courier Transform

It is a spread spectrum communication method in this; the data is represented in terms of frequency [4]. Embedding of watermark is done in first k highest magnitude of DCT coefficient of image. The result obtained after applying DCT coefficient will be an image of sum of varying magnitude and frequency. Horizontal frequencies vary from left to right and vertical frequencies top to bottom. Watermark in mid band gives better robustness and imperceptibility [1][5].

- Discrete Wavelet Transform

The transform in this technique is based on wavelets, with varying frequency with respect to duration. Multi-resolution decomposition of image and frames is possible in DWT. The wavelet is divided into 4 sub bands LL, LH, HL, HH. The first letter in sub band refers to frequency applied for rows and second letter refers to filter applied to columns [13].

Watermarking in each band provide different advantage, watermarking in LL provide resistance against compression, watermarking in LH, HL and HH robustness against noise and filters

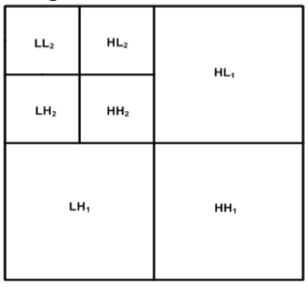

Fig.2. 2-levels DWT Scheme

The comparative analysis of different standard watermarking technique with respect to some important features of video watermarking technique is tabulated in Table 1. The terminologies used in the table are as follows: R: Robustness, IP: Imperceptibility, S: Security, P: payload, C: Computational Cost, T: Time Complexity, RE: Reliability.

Features	LSB	DFT	DCT	DWT	SVD
R	Less robust against geometric distortion	High robust against geometric distortion	High robust against filters	High robust against geometric distortion	High robust against geometric distortion
IP	Less compared to DFT,DCT, DWT,SVD	High	High	Better, Watermark length and key effect visual quality	Better, length of co-efficient effect visual quality
S	Less secure, usually depend on choice of key	High secure	Better, semi-private waterm arking	Better, semi-Private watermarki ng	High, Private watermar king
P	Less, limited data can be added	average	High	High	High
C	Less	Reliable cost	Reliabl e cost	Very High	High
T	Less	High	High	Very High	High
RE	Better, for multiple watermarki ng	High	High	Very High	Very High

Table.1. Comparative analysis of Video Watermarking Techniques

III. SURVEY ON VIDEO WATERMARKING

In [8], wiem Trablesi et al. designed a new Watermarking technique aims at three important features of video watermarking like robustness, capacity and invisibility. After comparative study of existing watermarking system, spatial domain, frequency domain, Spatio-frequency domain they claimed Spatio-frequency is better.

In proposed system frames are extracted from given video. Moving object or background of moving object is taken as region of interest. SVD watermarking technique is applied. Video is reconstructed, mosaic image is extracted from reconstructed video, ROI is detected and second watermark is applied. This proposed method proved robust for several attacks with better invisibility and capacity.

In [9], Gui Feng et al. proposed new Zero Watermarking Technique based on intra prediction of DCT coefficient character for robustness and time stamp mechanism. The IPR database stores copy righted watermark.

H.264 video coding standard is used in this paper. The proposed method mainly focuses on luminance DC coefficients of 4x4 sub blocks in I frame. Binary Sequence is generated by formula (1)

$X_i = 1$ if DC>=0 (1)

$X_i = 0$ if DC<0

Generated binary sequence is encrypted and zero watermark is added. When the watermark video is received comparison is done with original watermark stored in IPR database so proposed system proved robust and helps in time stamp mechanism.

Mrs. Anita Jadhav et al. proposed a dynamic 3D DCT in [10] to overcome drawbacks of static 3D DCT which works well only for correlated videos. The Otsu Thresholding method is used for scene change detection and dynamic 3D DCT is applied for different length frames identified by scene change detection. Extracted RGB frames are converted into YCbCr frames. Watermark is applied in Y components and 3D IDCT operation is performed on watermarked videos. The conclusion is given that, the dynamic 3D DCT is more suitable only for high motion activity video to avoid distortion.

In [11], Jiali Bao et al. proposed robust watermarking method for ROI in H.264 scalable video coding. The frame is divided into 9 blocks by flexible macro block ordering. Moving object in frame is detected by Gaussian mixture model and water mark is embedded only in ROI. Each macro block is represented by Slice id. Different watermark is added in different ROI block by finding luminance part of DCT matrix. Arnold transformation is applied to improve robustness. The proposed provides high security for ROI and robustness for many malicious attacks.

Venugopala P S et al. proposed scene change based watermarking in [12]. The proposed method decompose watermark gray image into 8 multiple bit plane image, all frames of same scene is embedded with same single bit plane image. For different scene different bit plane image is embedded.

The frame of selected video is divided into 8X8 block size, with 7 triple group luminance value A to G. 1 bit watermark from gray scale bit plane image is added to selected luminance value of video frame by adjusting pixel value and it is concluded proposed scheme is robust against frame dropping and temporal shift attack and noise adding.

In [13], Hitesh Panchal et al. gave approach of watermarking for uncompressed video key frames. The original video is decomposed into frames by X^2 histogram matching method. The R G B component are extracted from selected frames and 4 level DWT is applied, R G B component of color video is taken as watermark and watermark is embedded in LH or HL sub band with secret key generation. It is concluded water mark is done in less time and method is robust against frame dropping and frame averaging attacks.

The comparative study of different proposed video watermarking technique with respect to some important features of video watermarking technique is showed in Table 2.

The Table 2 is represented with few terminologies. R: Robustness, IP: Imperceptibility, P: payload, T: Time Complexity.

IV. SURVEY ON VIDEO WATERMARKING ON MOBILE DEVICES

In [14], Arun Kejariwal et al have proposed an algorithm for watermark embedding, extraction and to protect copy right of the image with detailed study of energy and performance on mobile devices. The proposed system consist 3 components server, mobile and proxy server. Server handles client request and database, mobile acts as client and proxy server is best powerful server. Mobile device communicates with proxy server for security, message delivery and quality of service and proxy server communicate with server for raw data requested by the client. The experiment is carried out in Sharp Zarus PDA with intel 400MHz XScale. 11 image watermarking algorithms like Bruyundonckx, corvi, cox, durgad,

Survey Methods	Technique	R	IP	P	T
Multi-Signature robust video watermarking[8]	SVD	Good	Good	Good	Better
Zero watermarking[9]	DCT	Good	Good	Better	Better
Dynamic 3D DCT watermarking[10]	DCT	Good	Better	Better	Good, Only for High motion activity video
Robust SVC watermarking for ROI[11]	DCT	Good	Good	Good	Better
Scene change based video watermarking[12]	New approach	Good	Good	Good	Good
Watermarking on extracted key frames from compressed color video[13]	4 level DWT	Good	Good	Good	Poor

Table.2. Comparative Analysis of Proposed Video Watermarking Techniques Based on Survey

fridrich, kim, Koch, wang, xia, xie, zhu discussed in [15] are carried out for embedding, extraction and copy right protection of watermark and they concluded extraction require more energy than embedding.

Jin Li et al proposed a statistical model in [16]. This model improves encoding process of 3D DCT, the paper mainly aimed at getting zero quantized coefficients from 3D DCT by taking 8X8X8 pixel cube as input. The proposed system over comes the drawbacks of Baseline Encoding Method by avoiding redundant calculation of ZQDCT coefficient.

Laplacian distribution is applied to handle distribution of residual pixel and obtain ZQDCT by this redundant calculation is reduced, visual quality degradation improves, battery life time is increased and less time taken.

Daniela Stanescu et al. proposed a method to introduce stenography in mobile devices by using LSB watermarking method in [17]. Stenography is a process of hiding a secret text or image in a message. The proposed method is tested in three architecture ARM7 based micro controller, RISC Architecture and multi core processor, ISSAC. Three stenographic algorithms are used. First 2 bit LSB method, hiding most significant bit of secret message in least significant bit, second YUV method, RGB is converted to YUV format before applying LSB method and last KLT method, does not hide the values of color component of secret message in host message but hides the resulted parameter after KLC transform. All three algorithms are tested in every architecture and they concluded ISSAC processor is more suitable for stenography in Mobile using KLT algorithm.

Raffaele Pizzolante et al. developed a tool to embed visible and invisible watermark in mobile with Android OS in [18]. The data for watermarking is taken from the USB drive, SD card. The tool supports JPG, BMP and PNG files.

The visible Watermark algorithm, watermark text is converted to bitmap image and merged with bitmap image derived from host image in random position. The invisible watermark is developed using modified Langelaar DCT based algorithm. Seed is an ID which is used to embed and extract watermark and threshold to indicate robustness of embedded watermark. This tool improves copy right protection and execution time.

V. COMPARATIVE ANALYSIS OF WATERMARKING ON MOBILE DEVICES

The comparison of different proposed watermarking technique with respect to some important features of mobile device video watermarking is showed in Table 3.

The Table has few terminologies. R: Robustness, B: Battery life, E: Efficiency, ET: Execution Time, S: Security, BRD: Bruyundonckx, COR: corvi, DUR:

durgad, FRI: fridrich, KOC: Koch, WAN: wang, ZDCT: ZQDCT coefficient, LDCT: Langelaar DCT KLT: Karahunen-Loeve Transform, ALG: Proposed Algorithms and goodness is measured in terms of Good(G), Better(B), Poor(P).

Method	**ALG**	**R**	**B**	**E**	**ET**	**S**
LSB	BRD	G	G	G	G	P
	2-BIT LSB	P	B	P	G	P
	YUV	B	B	B	G	B
	KLT	G	G	G	G	G
DCT	COX	B	B	B	B	B
	FRI	G	P	P	P	G
	KOC	B	B	G	G	P
	ZDCT	B	B	P	P	G
	LDCT	G	G	B	B	G
DWT	COR	B	B	B	B	B
	DUR	B	B	B	B	B
	KIM	B	B	B	B	B
	XIA	B	B	B	B	B
	XIE	G	B	P	G	G
	ZHU	G	G	B	G	G

Table.3. Comparative Analysis of Proposed Watermarking Techniques Based on Mobile Devices.

VI. CONCLUSION

This paper has discussed different video watermarking technique and video watermarking on mobile devices that are proposed in the literature. The comparison analysis is performed under important video watermarking features like robustness, imperceptibility and capacity. It is observed Spatio- frequency method like DWT, SVD is better watermarking approach. The survey papers on watermarking on mobile devices is carried out for images and it is observed DWT is better approach and KLT LSB method is better for stenography in mobile devices. SVD and DFT watermarking method is not yet implemented on mobile devices. Ideas of image watermarking algorithms on mobile devices can extended for video watermarking, by dividing videos into frames.

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