ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

A SECURE METHOD OF OPTIMIZED LOW COMPLEXITY VIDEO WATERMARKING

K. Swaraja, Y. Madhaveelatha and V. S. K. Reddy
Department of E.C.E, J. N.T. University, Hyderabad, GRIET, Hyderabad, India.

ABSTRACT

In recent existence numerous video watermarking schemes have been anticipated, but the majority of them are functional to uncompressed video. At this point we propose a blind digital compressed video watermarking scheme for H.264 compressed domain to condense the number of computations.Due to its characteristics of high compressibility, it can acquire immense quality at minor bit rate, and this is the reason why many applications conform H.264 Codec. The planned method elites the macro block performing the Differential Evaluation algorithm further based on the fore determined threshold and the coefficient rarefied for watermark embedding is deployed on the parity of the coefficients after transformation and quantization. The proposed method impede the bit rate increase within a decent end point by selecting appropriate non-zero quantized AC residuals for embedding the watermark. Experimental results flaunt that there is more acceptable control towards bit rate augment and at the same time perceptual quality can be kept in existence even after undergoing different attacks.

Keywords: DCT analysis, parity, differential evaluation, P-frames, Bit-rate variation, H.264.

1. INTRODUCTION

In this day and era digital multimedia data are stockpiled further conveniently and also the information is more effortlessly emulated without deformity. Due to the exponential growth of internet besides getting the benefits of internet such as new ways of propagating and sharing digital video, the world also faces threats of copyright defiance, privacy and plagiarism plight. Digital video watermarking has gathered significant interest of research because of the illegal redistribution and unauthorized use of digital multimedia and it can be a promising solution in digital right management system. Until recently the primary tool available to protect the content owner's right has been encryption and it is mainly concerned with secure communication but not copyright protection. Thus digital watermarks came into existence to tackle this tough issue. The conflicting parameters in designing digital watermarking scheme include imperceptibility, robustness and payload. The basic concept of video watermarking is the insertion of watermark in the original data, this watermarking process should not tamper the audio visual quality which means that watermarking must have imperceptibility. Even though watermark signal has undergone some attacks such as frame deleting, frame inserting, noise, cropping, frame swapping etc the watermark should still exist in the host signal and can be detected then that type of watermarking is said to have robustness. Data payload represents the amount of information which is inserted into the original content, thus bit rate must always be controlled. Most of the video watermarking techniques are either in the spatial domain [1], [2] or in the transform domain [3], [4]. If the watermark is hidden in the transform domain the result is more pleasant to the human visual system than in the spatial domain. Therefore transform domain is more recurrently used for watermarking data. By enrooting a method for video watermarking scheme, scheduled the pre-selected frames and also be capable to guarantee the safety of the embedded watermark based on the discrete cosine transform (DCT), if the method is tough then the watermark from the video that has most likely been attacked or spoiled can be procured aptly, thus to meet this in the proposed work we are making use of differential evaluation algorithm for embedding the watermark based on the parity of the last non zero AC coefficient after transformation and quantization of a 4x4 luma block of P-frame. The rest of this paper is organized as follows. In Section 2 the related work are addressed. Section 3 describes the DE based optimized watermarking scheme. Section 4 presents the proposed video watermarking scheme in inter frames. Simulation results are demonstrated in section 5. Finally, section 6 presents the Conclusion.

2. RELATED WORK

A split of coefficients must be preferred to entrench the watermark to attain up to standard eminence in H.264 compressed domain. The detector possibly will not locate the equivalent subset which might guide to subsequent failure and also desynchronization in detecting watermark due to alteration after re-encoding or enforced attacks. Nonblind- interleaving is practiced in which, the real video is used for selecting specific position of the watermark data [5] in turn to surmount this difficulty, although the extent of application in this approach is restricted. In the blind interleaving, security concern is the foremost problem and is susceptible to spot the inserted position of watermark data [6], [7] by attackers. For that reason, scheming a blind, robust, and protected process is actually enviable and relevant. In CAVLC the final nonzero and nontrailing ac coefficient is used to put the watermark data [7] and cannot endure next to watermarking attacks as the security concern is not well thought-out. Based on motion vectors (MV) there are a

VOL. 10, NO. 4, MARCH 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

few watermarking algorithms [8-12] and such methods are usually delicate as the motion vectors are susceptible to signal processing attacks. The inserted watermark can be identified and confirmed by the way of moderately translating intra/inter prediction type[13] on or after syntactic elements of the bit stream in blind video watermarking and delicateness is guaranteed by opting the final nonzero quantized ac co-efficients. The genetic algorithm [14] is a replica of machine learning which draw from its performance commencing a metaphor of the method of progression in environment. The projected work introduced a novel unsighted interleaving/detecting watermarking algorithm in the compressed domain to steer clear of earlier shortcoming and afford further competent H.264 compression domain watermarking, by exploiting the syntactic elements of the video stream, thus the differential evaluation strategy is employed to optimize the gain of embedding algorithm and also augment the undetectability, so that protection is greater than before.

A. H.264 Encoding

H.264 is a block-based compression standard in the vein of its antecedent, each frame in the video is alienated into a set of slices and every slice once more comprise a set of macroblocks, all macroblocks include 16x16 luma samples, 8x8 Cb and Cr chroma samples, to eliminate spatial and temporal redundancy Pel samples in a macroblock are vastly compacted.

Each macroblock is another time alienated into sub-blocks enclosing one 4x4 Luma and two 2x2 Chroma sub-blocks (Cb and Cr) as represented in Figure-1. All the Pels are transformed in each sub-block, further expected and entropy coded for compression.

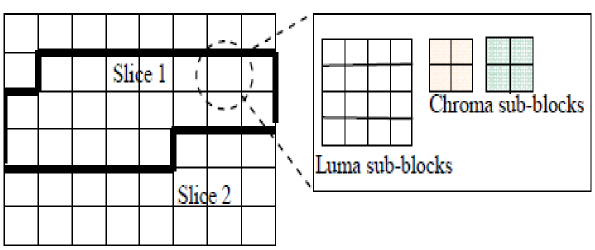

Figure-1. H.264 Encoded frame.

A macroblock is moreover intra-predicted or inter-predicted. In intra-prediction approach, pels of a sub-block are expected using macroblocks contained in the alike frame. In inter-prediction approach, pels of a sub-block are expected using block based motion compensation from one or more previously encoded frames [15]. A frame comprise of three forms of slices: I, P and B. I-slice hold merely intra-prediction macroblocks, inter and/or intra prediction macroblocks are included in P and B slices. Proposed method inserts the watermark data in quantized luminance co-efficients of P-slice

Macroblocks. The best macroblock for embedding is chosen based on a DE progression strategy which suggest protection against fine watermarking attacks. Every macroblock include 16x16 luminance samples, further 16x16 samples are alienated into 4x4 sub-blocks. Thus all sub-blocks enclose single DC coefficient along with 15 AC coefficients, as depicted in Figure-2. Pre arranged luma samples of a sub-block are put out in zig-zag search.

DC	AC1	AC2	AC3
AC4	AC5	AC6	AC7
AC8	AC9	AC10	AC11
AC12	AC13	AC14	AC15

Figure-2. 4x4 sub-block of a Macro Block.

B. Relavance bounded by Texture and AC Coefficients

Taking into concern the allocation of frequency, all coefficients in the DCT block, commencing top-left to bottom-right, can be alienated into four groups: DC coefficient, low frequency coefficients, medium frequency coefficients and high frequency coefficients. Allotment of frequency for DCT coefficients is depicted in Figure-4.

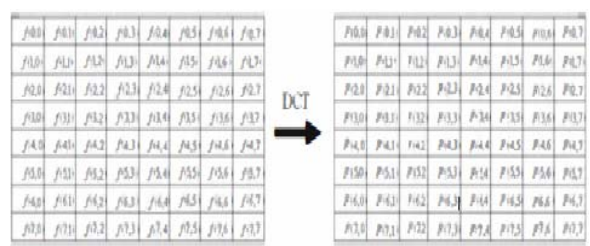

Figure-3. DCT block from Frame block.

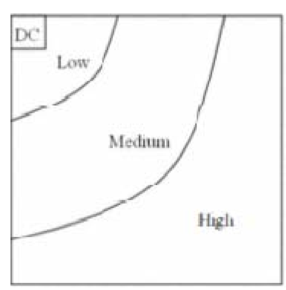

Figure-4. Frequency distribution of DCT coefficients.

It is feasible to acquire texture information by evaluating medium and high frequency coefficients of DCT block as the texture keep up a correspondence to Medium and High frequency coefficients of DCT block. Medium and High frequency include many non-zero coefficients, all AC coefficients are considered as medium or high frequency coefficients except for F(0,1) and F(1,O).Depending on numeral of non-zero medium or

VOL. 10, NO. 4, MARCH 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

high frequency coefficients the 8x8 real image blocks are alienated into plain, modest and composite texture blocks.

3. DIFFERENTIAL EVALUATION (DE) BASED OPTIMIZED WATERMARKING SCHEME

Storn and Price [16] bring in a trouble-free, rapid and tough progression algorithm denoted as DE, the genetic algorithm also includes this evolutionary algorithm. The algorithm generate preliminary population of P entity Mi,G, i = 1,. . ., P, dimension D is chosen for each entity, index i insinuate ith result of the population at generation G. DE comprise of chiefly three activities as interpreted below.

Mutation: perturbed entity Si,G is created subsequent to each destination entity Mi,G then, by arbitrarily selecting three diverse entity (Mx1, Mx2, Mx3) the mutation practice is initiated from the recent population that must also be unusual compared to the destination entity Mi,G (i.e., $x1 \neq x2 \neq x3 \neq i$).
The weighted difference of two of the vectors is added to the third vector after scaling by a factor F [0, 1].

$$S_{i,G+1} = M_{x1,G} + F(M_{x2,G} - M_{x3,G}) \qquad (1)$$

Where, i span over numeral of persons, Si, G+1 is called the donor vector.

Crossover: flourishing solutions are included from the prior generations by means of recombination which is called as crossover. Entity of the destination vector, Mi,G, and the entity of the donor vector, Si,G+1 are used to develop the check vector Ci,G+1, the elements of check vector depends on a crossover probability $Cp \in [0,1]$.
Check vector generation is

$$C_{j,i,G} = \begin{cases} S_{j,i,G} & \text{if } r_j \leq Cp \quad \forall\, j = k \\ M_{j,i,G} & \text{otherwise} \end{cases} \qquad (2)$$

Where $k \in \{1,. . ., D\}$

Selection: The destination vector Mi,G is correlated with the trial vector Ci,G+1 and the one with the minimum function value is acknowledged to the subsequent generation

$$M_{i,G+1} = \begin{cases} C_{i,G} & \text{if } f(C_{i,G}) \leq f(M_{i,G}) \\ M_{i,G} & \text{otherwise} \end{cases} \qquad (3)$$

Mutation, crossover and selection prolong until some stopping condition is attained.

4. THE PROPOSED SCHEME

A. Watermark embedding

The major tasks of using DE in the watermarking approach are: preventing any video degradation, improving the video quality of the watermarked video, and securing the watermark strength after an attacking procedure. DE has been used extensively as a multi-objective function to find the most suitable blocks in the DCT Frame. Based on the characteristics of the video sequences and the size of the watermark to be embedded first, it searches for the best blocks for the embedding positions next, we choose an appropriate threshold such that after inserting the watermark the video sequence should maintain imperceptibility. The assortment of the threshold diverge from 0 to 15; the threshold rise and fall for dissimilar video sequences based on the content of video sequences. If the site of the final nonzero quantized AC coefficient is no less than the threshold then the watermark can be inserted.

Content based threshold assortment for watermark embedding process, comprise the following most important steps.

Step1. First we search the location of the last nonzero point in the inverse Zig-Zag Scan for all the quantified 4x4 luma block, till the first nonzero point is found.

Step2. If the value 'Kp' of the nonzero point is no less than the threshold then the watermark 'Wm' is embedded to that location by modifying the value 'Kp'.

Step3.
If Wm=1
#
#

$$Kp = \begin{cases} Kp & \text{if } Kp\%2 \text{ is } 1 \\ Kp + 1 & \text{if } Kp\%2 = 0, Kp > 0 \\ Kp - 1 & \text{if } KP\%2 = 0, Kp < 0 \end{cases} \qquad (4)$$

If Wm=0
#

$$Kp = \begin{cases} Kp & \text{if } Kp\%2 \text{ is } 0 \\ Kp + 1 & \text{if } Kp\%2 = 1, Kp > 0 \\ Kp - 1 & \text{if } KP\%2 = 1, Kp < 0 \end{cases} \qquad (5)$$

If the embedded bit is '1' the value is odd number, if the embedded bit is '0', the value is even.

B. Watermark extraction

This scheme do not necessitate the Original video stream for allusion, may well extract the watermark promptly and apparently, and the aspect is depicted as follow.

VOL. 10, NO. 4, MARCH 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

Step1.First we will search the location of the last nonzero Coefficient and judge whether it is no less than the threshold.

Step2.If the location of the nonzero Coefficient is odd then the watermark bit '1' is extracted and if the location of nonzero Coefficient is even then the watermark bit '0' is extracted.

$$Wm = \begin{cases} 1, & if\ Kp\%2 = 1 \\ 0, & if\ Kp\%2 = 0 \end{cases} \quad (9)$$

5. SIMULATION RESULTS

For simulation purpose three dissimilar standard video sequences are employed to assess reasonably the watermarking methods.

A. Outcome on the Quality, Payload and Bit-rate of the Video

To estimate the imperceptibility of the projected idea, a succession of checks have been performed and in each video sequence we are using only P-frames and then in each P-frame we are embedding only in 4x4 luminance block within the 16x16 macro block based on the parity of the non-zero AC coefficients of the 4x4 block, in this the selection of the block is done by optimized Differential Evaluation method which is efficient for global search method and consequently this algorithm preserve fine PSNR along with less bit rate variation and more payload capacity when compared with [17].

The original watermark image and watermarked videos are shown in Figure-5 and Figure-6. In the testing, noticeable artifacts are not found in all of the test video sequences. More to the point subjective inspection is usually taken to evaluate the perceptual quality all the way through PSNR (Peak Signal to Noise Ratio). Table-1. Exemplify the bit rate variation, PSNR and the payload capacity of the proposed optimized algorithm with [17].

Figure-5. Watermark image.

Figure-6. Three different video watermarked sequences.

We are interleaving dissimilar watermark bits into the above mentioned three dissimilar video sequences and contrasting the Payload, Bit rate variation and the PSNR with [17] and the simulation results are shown in Table-1.

Table-1. Comparison of the proposed technique with [17].

Sequence	Payload(bits)		Bit rate variation(%)		PSNR variation(db)	
	Paper	[17]	Paper	[17]	Paper	[17]
Calendar	25340	18415	0.73	1.73	-0.04	-0.03
Mobile	30400	20360	0.68	2.15	-0.06	-0.04
Carphone	25328	15320	1.81	2.78	-0.03	-0.02

When the interleaved 4x4 block is sited in the smooth region there will be further augment in bit rate, as the nonzero quantized AC residuals compete with the texture areas and if we insert the watermark in the smooth region there will be extra zero quantized AC residuals where abundance of spare information is required for amending Kp from 0 to 1. As a result the sequences with smooth region in the simulation cannot be banned from raise in bit rate but in this paper as the differential evaluation strategy chooses only the texture region for inserting the watermark in P-frames which made it feasible for preserving PSNR and at the same time the bit rate raise is prohibited and payload capability is augmented when contrasted with [17]. The imperceptibility of the projected scheme is assessed by contrasting watermarked video with the original video. There are minute variation among the watermarked and the original video, so the algorithm convene the human perceptual constraint. More to the point personal scrutiny, PSNR (Peak Signal to Noise Ratio) is frequently in use to approximate the personal quality. Figure-7 shows the PSNR similarity among the original and the watermarked videos Calendar, Mobile, Carphone. The graph present a plan regarding PSNR of the interleaved frames are somewhat unusual on or after the original frames, thus reveal the watermark bring in slight control to the video.

VOL. 10, NO. 4, MARCH 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

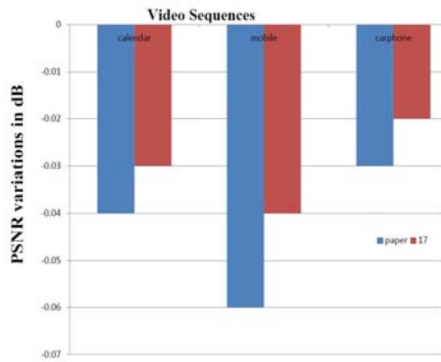

Figure-7. PSNR variation of proposed method with [17].

B. Robustness testing

Even after different types of attacks such as Salt and Pepper Noise, Gaussian filtering and Average filtering the projected method is competent to extort the watermark image, lacking any degradation because of the secured optimized DE algorithm which is confirmed in Table-2. Three different videos after attacks is depicted in Figure-8 and the extracted watermark even after these attacks is depicted in Figure-9. The Original and Watermarked video after different types of attacks is depicted in Figure-10.

Table-2. Robustness against three type of attacks (salt and pepper noise density=0.001, gaussian filter [3x3] sigma=0.3 and averaging filter, r=0.5).

Sequence	Salt &Pepper		Gaussian		Avgfiltering	
	Paper	[17]	Paper	[17]	Paper	[17]
Calendar	86%	75%	83%	79%	84%	72%
Mobile	88%	76%	89%	81%	86%	74%
Carphone	74%	68%	76%	64%	78%	69%

Figure-8. (a)Salt&pepper noise; (b) Gaussian noise; (c) Avg Filtering.

Figure-9. Extracted watermark image.

Figure-10. (a)Original video; (b) Watermarked video after attacks.

6. CONCLUSIONS

A secure low complex digital video watermarking technique interleave the watermark in the compressed domain of H.264 video. Watermark embedding utilizes the differential evaluation algorithm to find the most suitable blocks and the threshold selection is based on the parity of the nonzero-AC Coefficients of P-frame. In this paper as we are embedding the watermark in P-frames based on differential evaluation algorithm thus the PSNR is maintained when compared with [17] along with this the proposed scheme is also admirable in requisites of bit rate raise and payload capability. Simulation consequences describe the enhanced concert over accessible implementations with GA, and hence additional research effort could spotlight on mounting some innovative algorithms associated to differential evaluation. Upcoming research possibly will strive to relate the differential evaluation optimization algorithm with bacterial foraging-based methods to decline the computational outlay and time all through global optimization.

REFERENCES

[1] W. Bender., D Gruhl., N Morinoto. and A Lu, Technique for data hiding. IBM Systems Journal. 1996, Vol.35, Nos 3-4, pp. 313-335.

[2] Faben A. P. Petitcolas., Ross J Anderson. and Markus G Kuhn. Information hiding a survey. Proc. IEEE, 1999, pp.385-403.

[3] N. Nikolaidis. and I Pitas. Robust image watermarking in the spatial domain. Signal Processing, 1998, pp. 385-403.

[4] Mitchell D Swanson., Mei Kobayashi. and Ahmed H Tewfik. Multimedia data embedding and watermarking technologies. Proc. IEEE, 1998, pp.1064-1087.

[5] M. Noorkami. and R. M. Mersereau. A framework for robust watermarking of H.264-encoded video with controllable detection performance. IEEE Trans. Inf. Forensics Security, vol. 2, no. 1, Mar. 2007,pp.14-23.

[6] D. Xu, R. Wang. and J. Wang. Blind digital watermarking of low bit rate advanced H.264/AVC compressed video. Digital Watermarking. 2009,pp.96 109.

[7] T. Lihua., Z. Nanning., X. Jianru. and X. Tao. A CAVLC-based blind watermarking method for H.264/AVC compressed video. in IEEE Asia-Pacific Services Computing Conf, APSCC 2008, pp.1295-1299.

[8] P. Wang., Z. D. Zheng. and J Ying. A Novel Video Watermark Technique in Motion Vectors. 2008 International Conference on Audio, Language and Image Processing (ICALIP). 2008, pp.1555- 1559.

[9] H. A. Aly. Data Hiding in Motion Vectors of Compressed Video Based on Their Associated Prediction Error IEEE Transactions on Information Forensics and Security. 2011, pp.14-18.

[10] G. Feng., G. Z. Wu., Motion Vector and Mode Selection Based Fragile Video Watermarking Algorithm. IEEE International Conference on Anti-Counterfeiting, Security and Identification ASID. 2011. pp.73-76.

[11] T. Y. Kuo. Y. C. Lo. Fragile video watermarking technique by motion field embedding with rate-distortion minimization. Journal of Communication and Computer. 2009, pp.16-22.

[12] R. D. Wang., Q. Li., H. L. Zhu. D. W. Xu. Fragile Watermarking Scheme Suitable for the Authentication of H.264/AVC Video Content. Journal of Information and Computational Science. 2012, pp.3693-3706.

[13]Shi Jinnhorng., Mahmoud., E. Farfours., PingzhiFan., Xian Wang., Tianruihi. and Jing-Mingguo. A. low cost fragile watermarking scheme in H.264/AVC compressed domain. Published in :Journal Multimedia Tools and Applications, Volume 72,Issue 3,October 2014, pp.2469-2495.

[14] A. Chaudhry., A. Jaffar., B. Sikandar. and J. Y. Kim. Genetic Swarm Based Robust Image Watermarking. Proceedings of the 7th International Conference on Ubiquitous Information Management and Communication. ICUIMC 2013, ISBN: 978-1-4503-1958-4.

[15] R. Storn., K. Price. Differential evolution- a simple and efficient heuristic for global optimization over continuous spaces. J. Global Optimiz.11 (4).1997, pp.341-359.

[16] H. 264. Advanced video coding for generic audiovisual services [online], Available: http://www.itu.int/rec/T-REC-H.264, April 2007.

[17] M. Noorkami. and R.M Mersereau. Digital Video Watermarking in P frames with controlled video bit-rate increase. IEEE Transactions on Information Forensics and Security. vol. 3, no.3, September 2008, pp.441-455.