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Video Watermarking

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Abstract- Three different watermarking methods for video sequences compressed according to the H.264 video coding standard have been designed and implemented. Two of them represent frequency domain methods while the third belongs to spatial domain methods. Embedding in frequency domain is applied to transform coefficients obtained directly from the compressed video stream. The spatial domain watermark is transformed to frequency domain before embedding. Further, a generic watermarking framework has been designed and implemented in order to provide a simple interface for easy implementation of particular watermarking methods. The proposed methods have undergone several simulation tests in order to check up and compare their robustness against various attacks. The test set comprises recompression, scaling, cropping, denoising, noising, blurring, sharpening, multiple watermark embedding and collusion attack. The spatial domain watermarking method is preferred to frequency domain methods with respect to robustness and perceptibility.

Index Terms- Watermarking, Compressed video, H.264, Frequency domain, Spatial domain

I. Introduction

Nowadays, digital multimedia content (audio or video) can be copied and stored easily and without loss in fidelity. Therefore, it is important to use some kind of property rights protection system.

The majority of content providers follow wishes of production companies and use copy protection system called Digital Rights Management (DRM). A DRM protected content is encrypted during the transmission and the storage at recipient's side and thus protected from copying. But during playing it is fully decrypted. Besides recipients must have a player capable to play DRM encrypted content, the main disadvantage of DRM is that once the content is decrypted, it can be easily copied using widely available utilities.

Disadvantages of DRM can be eliminated by using another protection system, watermarking. Watermarking can be considered to be a part of information hiding science called steganography. Steganographic systems permanently embed hidden information into a cover content so that it is not noticeable. Thus, when anybody copies such content, hidden information is copied as well.

Three aspects of information hiding systems contend with each other: capacity, security and robustness. Capacity refers to amount of information that can be hidden, security to ability of anybody to detect hidden information, and robustness to the resistance to modifications of the cover content before hidden information is destroyed. Watermarking prefers robustness, i.e. it should be impossible to remove the watermark without severe quality degradation of the cover content, while steganography demands high security and capacity, i.e. hidden information is usually fragile and can be destroyed by even trivial modifications.

II. Existing Work or Literature Survey

In case of images, watermarking techniques are classifiedbased on two working domains. Spatial Domain in whichpixels of one or two randomly selected subsets of an imageare modified based on perceptual analysis of the originalimage and Frequency Domain in which values of certainfrequencies change.

Spatial domain:A watermarking method based on the spatial domainscatters information to be embedded to make theinformation more secure so that it is very difficult to detect.It uses minor change of the value of pixels. This approachhas an advantage which is it is strong for cropping andtranslation.Various approaches for spatial domain techniques havebeen proposed so far which are checksum techniques, two-dimensional spatial watermark, spread spectrum approachare some of them.

Checksum Technique In this approach, a watermark is formed from the
checksum value of the seven most significant bits of allpixels. A checksum is the modulo-2 addition of a sequenceof fixed-length binary words which is a type of hashfunction. This technique randomly chooses the locations ofthe pixels that are to contain one bit of

the checksum. Thepixel locations of the checksum together with the checksumvalue form the watermark which must be kept secret. Toverify the watermark, the checksum of a test image isobtained and compared to the watermark.

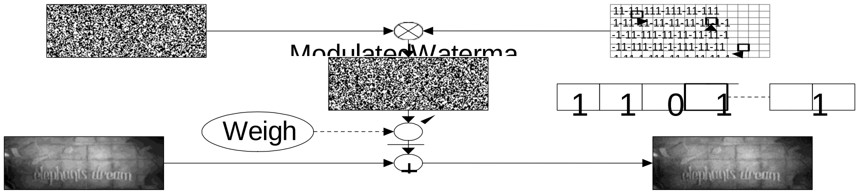
III. PROPOSED WORK

Considering one picture of the sequence, encoders may select between intraand inter coding for blocks of the picture. Intra coding is usually selected forpictures just after a scene cut while inter coding for fluently following pictures.Scene-cut pictures typically miss any statistical dependence on previous pictures,thus there is no reason to use inter coding. Fluently following pictures can beimagined as e.g. a static scene without any camera movement, thus suchfollowing pictures are very similar and inter coding is the best choice.In practice, encoders try both ways and choose the one that have betterbit-rate to distortion ratio.

A picture is partitioned into 16×16 blocks of pixel color samples calledmacroblocks (MB). Then, the prediction process is invoked. Intra codedmacroblocks can use intra prediction only while inter coded ones can use bothintra and inter prediction. The subtraction of original samples and predictedsamples is called prediction residual.

The inter prediction process may partition macroblocks into 2 16×8 or 8×16or 4 8×8 blocks and 8×8 blocks can be further partitioned into 2 8×4 or 4×8 or 44×4 sub-blocks. For each block, the most similar block of the same size and shapeis found in the reference pictures and its samples are used as predicted samples.
The identifier of the reference picture and the relative position of correspondingblocks are encoded into so called motion vector.
The residual is partitioned into 16 4×4 or 4 8×8 blocks, depending on chosen16frequency transform. The choice is made per macroblock. Further, these blocksare transformed to remove spatial correlation inside the blocks.

Basically, the H.264 standard provides 4×4 block transform only but it hasbeen extended to 8×8 blocks. The transform is a very close integer approximationto 2D-DCT transform with pretty much the same features and qualities.Then, the transform coefficients are quantized (Q), i.e. divided byquantization factors and rounded. This irreversible process typically discards lessimportant visual information while remaining a close approximation to theoriginal samples. After the quantization, many of the transform coefficients arezero or have low amplitude, thus can be encoded with a small amount of data.



The decoding process is reversal process to encoding resulting in visualvideo data,Incoming slices are decoded, using the same entropy coding as in theencoding process, up to intra prediction modes or motion vectors and quantizedtransform coefficients. Macroblock by macroblock, block by block, the quantized transformcoefficients are scaled to the former range, i.e. multiplied by dequantizationfactors, and transformed by inverse frequency transform. Hereby, the predictionresidual is obtained.

Iv.RESULTS AND DISCUSSION

Proposed watermarking methods have been exposed to several tests in orderto check up and compare their qualities and robustness. The test results aresummarized.

Perceptibilityexpressesamountofdistortioncausedbywatermarkembedding.

Uniquenessofthewatermarkmeansthatthedetectorshouldreturnsignificantly higher probability in case of copy ID which has been embedded thanincaseofothercopyIDs.

Timeconsumptionofboththeembeddingandthedetection pipelines. The time has been measured by standard Unix utility calledtime;theuser-spacetimehasbeenconsidered

Robustness test scripts simulate real attacks applied either intentionally orunintentionally to watermarked video sequences. In the simulations, they havebeen executed on pre-filtered watermarked sequences – the sequences have beenremuxed in order to contain (besides parameter sets) intra coded slices onlybecausethewatermarkisembeddedintointracodedslices only.

ThescalingtestscalesdownthewatermarkedvideosequencestothespecifiedresolutionusingMPlayerbicubic“scale”filter.

In the cropping test, the tested video sequences are cropped to the resolutiongiven by the cropping factor

Denoising is an attack especially against noise watermarking method. Itconsists in removing noise from the video sequence which could cause noisewatermark removal.

		Block					Coefficient					Noise				
	#C	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ED	3	1.00	1.00	1.00	1.00	1.00	0.92	0.91	0.91	0.90	0.90	0.65	0.92	0.96	0.97	0.97
	5	0.87	0.87	0.87	0.87	0.87	0.67	0.67	0.66	0.66	0.65	0.47	0.72	0.77	0.78	0.78
	10	0.51	0.51	0.51	0.51	0.51	0.40	0.39	0.39	0.38	0.38	0.27	0.43	0.47	0.48	0.48
FB	3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.70	1.00	1.00	1.00	1.00
	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.59	1.00	1.00	1.00	1.00
	10	0.96	0.96	0.96	0.96	0.96	0.87	0.87	0.86	0.86	0.85	0.41	0.87	0.89	0.89	0.89
KH	3	0.99	0.99	0.99	0.99	0.99	0.85	0.84	0.84	0.83	0.83	0.76	0.93	0.95	0.95	0.96
	5	0.90	0.90	0.90	0.90	0.90	0.69	0.68	0.68	0.67	0.66	0.56	0.74	0.78	0.79	0.79
	10	0.47	0.47	0.47	0.47	0.47	0.33	0.34	0.33	0.32	0.32	0.35	0.44	0.46	0.47	0.47
PW	3	0.72	0.72	0.72	0.72	0.72	0.51	0.51	0.51	0.51	0.51	0.24	0.43	0.50	0.52	0.51
	5	0.48	0.48	0.48	0.48	0.48	0.31	0.32	0.32	0.31	0.31	0.19	0.30	0.35	0.37	0.38
	10	0.30	0.30	0.30	0.30	0.30	0.17	0.18	0.18	0.18	0.18	0.16	0.20	0.23	0.23	0.23
R	3	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.97	0.96	0.96	0.77	0.93	0.96	0.97	0.98
	5	0.93	0.93	0.93	0.93	0.93	0.77	0.77	0.77	0.77	0.77	0.61	0.75	0.79	0.82	0.84
	10	0.62	0.62	0.62	0.62	0.62	0.44	0.44	0.44	0.44	0.44	0.38	0.46	0.49	0.50	0.49
SM	3	1.00	1.00	1.00	1.00	1.00	0.89	0.89	0.89	0.88	0.88	0.50	0.86	0.94	0.96	0.96
	5	0.91	0.91	0.91	0.91	0.91	0.64	0.64	0.64	0.64	0.63	0.37	0.64	0.72	0.75	0.76
	10	0.62	0.62	0.62	0.62	0.62	0.32	0.32	0.32	0.32	0.32	0.22	0.37	0.42	0.44	0.45
W	3	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.23	0.95	1.00	1.00	1.00
	5	0.89	0.89	0.89	0.89	0.89	0.77	0.76	0.76	0.75	0.74	0.17	0.77	0.86	0.89	0.90
	10	0.72	0.72	0.72	0.72	0.72	0.51	0.50	0.49	0.48	0.46	0.16	0.46	0.54	0.55	0.57

V.CONCLUSION

Watermarking is a copy protection system that allows tracking back illegally produced copies of the protected multimedia content. Compared with other copy protection systems like Digital Rights Management, the main advantage of watermarking is that the watermark is embedded permanently in visual data of the content but at the cost of slight loss in fidelity.

In this thesis, three different watermarking methods have been designed and implemented. Block and coefficient methods belong to watermarking techniques in frequency domain while pseudo-random noise method represents watermarking in spatial domain. Frequency domain techniques modify the coefficients obtained by the application of some frequency transform to visual data of the content. Spatial domain techniques apply the watermark directly to visual data of the content.

A generic watermarking framework has been designed and implemented as a plugin for an existing open source multimedia streaming library. The framework provides the interface for easy implementation of particular watermarking methods in both frequency and spatial domain.

The watermark embedding process is performed on a compressed video stream. The H.264 video coding standard has been chosen as the particular video compression technique. The standard uses a kind of the frequency transform mentioned above, thus frequency domain watermarking is implemented using coefficients of the compressed stream. The spatial domain watermark is transformed to frequency domain using the transform before embedding.

The watermarking methods have been compared with each other in terms of their perceptibility and robustness. The methods have been exposed to several simulation tests checking up their resistance to various types of attacks.

All the methods are more or less resistant to simple attacks such as 50 recompression and noising, and to some removal attacks such as denoising and collusion by averaging.

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