MPEG-2 Video Compressed Watermarking

Mahak (Phd Scholar)
Department of Computer Science ,Kurukshetra University,Kurukshetra

***Abstract*— Video watermarking is an important method of protecting the intellectual property copyright of the video media. In this paper a video watermarking based on MPEG-2 video compression is proposed. MPEG video compression is used in many current and emerging products. These applications benefit from video compression in the fact that they may require less storage space for archived video information, less bandwidth for the transmission of the video information from one point to another or a combination of both. First starting with MPEG-2 compressed video standard and then the algorithm principle of video watermarking is given, after video streams are partly decoded, the watermarking information modulated by m sequence is embedded into the direct current coefficients of chroma DCT of video I frame or P frame.**

Keywords*— MPEG-2, watermarking. *Spread Spectrum, DCT,* Compressed Domain, *Embedding

I. INTRODUCTION

MPEG (Moving Picture Experts Group) was started in 1988 as a working group within ISO/IEC with the aim of defining standards for digital compression of audio-visual signals. MPEG video compression is used in many current and emerging products. It is at the heart of digital television set-top boxes, DSS, HDTV decoders, DVD players, video conferencing, Internet video, and other applications. These applications benefit from video compression in the fact that they may require less storage space for archived video information, less bandwidth for the transmission of the video information from one point to another or a combination of both.

MPEG-2 is a video coding standard created by the Moving Picture Experts Group (MPEG) and finalized in 1994. Now, in 2005, it is the standard format used for satellite TV, digital cable TV, DVD movies, and HDTV. In addition, MPEG-2 is a commonly used format to distribute video files on the internet. MPEG-2 is an evolution of MPEG-1, an earlier MPEG coding standard finalized in 1991. In fact, MPEG-2 is a superset of the MPEG-1 standards.

The MPEG-2 bit stream is basically just a series of coded frames one after the other. There are headers and time stamps to help decoders align audio and scrub through the bit stream.

Dependent on the applications requirements we may envisage "lossless" and "lossy" coding of the video data. The aim of "lossless" coding is to reduce image or video data for storage and transmission while retaining the quality of the original images - the decoded image quality is required to be identical to the image quality prior to encoding. In contrast the aim of "lossy" coding techniques - and this is relevant to the applications envisioned by MPEG- 1 and MPEG-2 video standards - is to meet a given target bit-rate for storage and transmission.

Important applications comprise transmission of video over communications channels with constrained or low bandwidth and the efficient storage of video. In these applications high video compression is achieved by degrading the video quality – the decoded image "objective" quality is reduced compared to the quality of the original images prior to encoding (i.e. taking the mean-squared-error between both the original and reconstructed images as an objective image quality criteria). The smaller the target bit-rate of the channel the higher the necessary compression of the video data and usually the more coding artifacts become visible. The ultimate aim of lossy coding techniques is to optimize image quality for a given target bit rate subject to "objective" or "subjective" optimization criteria. It should be noted that the degree of image degradation (both the objective degradation as well as the amount of visible artifacts) depends on the complexity of the image or video scene as much as on the sophistication of the compression technique for simple textures in images and low video activity a good image reconstruction with no visible artifacts may be achieved even with simple compression techniques.

II. MPEG VIDEO LAYERS

MPEG video is broken up into a hierarchy of layers to help with error handling, random search and editing, and synchronization, for example with an audio bit stream. From the top level, the first layer is known as the video sequence layer, and is any self-contained bit stream, for example a coded movie or advertisement. The second layer down is the group of pictures, which is composed of 1 or more groups of intra (I) frames and/or non-intra (P and/or B) pictures that will be defined later. Of course the third layer down is the picture layer itself, and the next layer beneath it is called the slice layer. Each slice is a contiguous sequence of raster ordered macroblocks, most often on a row basis in typical video applications, but not limited to this by the specification. Each slice consists of macroblocks, which are 16x16 arrays of luminance pixels, or picture data elements, with 2 8x8 arrays of associated chrominance pixels. The macroblocks can be further divided into distinct 8x8 blocks, for further processing such as transform coding. Each of these layers has its own unique 32 bit start code defined in the syntax to consist of 23 zero bits followed by a one, then followed by 8 bits for the actual start code. These start codes may have as many zero bits as desired preceding them.

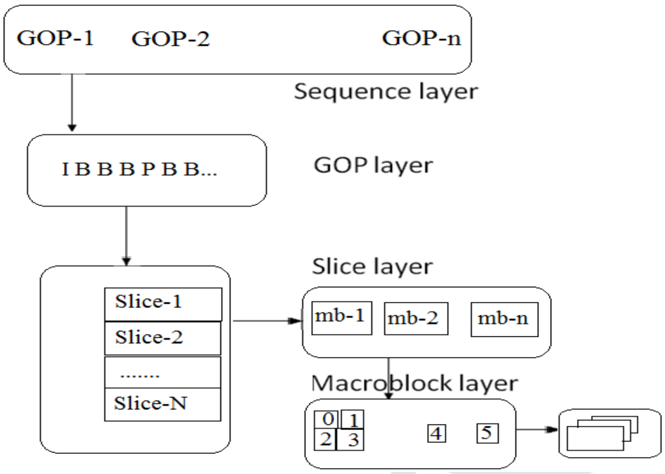

Fig.1 Video Layers

Three frame types are defined in MPEG-2 coding scheme:

1) *Intra-Frame Coding (I Frame):* It encodes independently not referring to any other frames. I frames provides prediction reference points for the coding sequence and the decoding process can be started from these points. The compression ratio of I picture is not high.
2) *Prediction Coding (P Frame):* Relative to the Intra-frame coding picture, it carries out prediction coding with motion compensation and it is usually used as the reference picture of successor prediction pictures. In addition, it has a higher coding efficiency.
3) *Bi-Directional Prediction Coding (B Frame):* It needs the forward and backward reference frames as its motion compensation and it has the highest compression degree. In addition, B picture is never used as the reference frame of prediction.

III. BIT RATE REDUCTION PRINCIPLES

A bit rate reduction system operates by removing redundant information from the signal at the coder prior to transmission and re-inserting it at the decoder. A coder and decoder pair is referred to as a 'codec'. In video signals, two distinct kinds of redundancy can be identified.

1) *Spatial and Temporal Redundancy*: Pixel values are not independent, but are correlated with their neighbours both within the same frame and across frames. So, to some extent, the value of a pixel is predictable given the values of neighbouring pixels.
2) *Psycho Visual Redundancy:* The human eye has a limited response to fine spatial detail, and is less sensitive to detail near object edges or around shot-changes. Consequently, controlled impairments introduced into the decoded picture by the bit rate reduction process should not be visible to a human observer.

Two key techniques employed in an MPEG codec are intra-frame Discrete Cosine Transform (DCT) coding and motion-compensated inter-frame prediction.

IV. VIDEO WATER MARKING PROCESS

In MPEG videos, because the direct coefficient-DC of chroma discrete cosine transform- DCT in I frame of video is a parameter which always exists in video streams and has a high robustness, the watermark information modulated by m sequence is embedded into the direct coefficients of chroma DCT of I frame or P frame, the watermark information is difficult to be removed when not influencing the video effect, and therefore, the robustness is enough.

A. *Watermarking Embedding*

1.) In this method, video bit-stream is first parsed syntactically and data related to header information, motion, texture are separated out in separate buffers. MPEG-2 Video Watermarking using Quantization Index Modulation 5 Header information and motion data are kept unchanged and simply added to the output bit-stream without any alteration. DCT data is computed by performing Huffman decoding and inverse quantisation.

2.) Consider a block of 8 x 8 samples originating from the frame of sequence for I- frame or from a prediction error signal for P- frame, respectively. The block is transformed with the DCT and then quantized. Suppose that each frame contains Nc chrominance or luminance 8 x 8 blocks. Assume f_i is the DC coefficients of each chrominance block. Watermark bits are embedded in these DC coefficients using QIM.

3.) QIM technique permits to embed one bit b $\in \{0; 1\}$ of the message into one DC coefficient. Consider the case when the sample with index i of the DC coefficient, is denoted by f_i. QIM uses two quantizers, Q_0 and Q_1. When the bit to embed is a 0, the used quantizer is Q_0 and when the bit to embed is a 1, the used quantizer is Q_1. Any quantizer Q is defined by a step Δ that defines Nc quantization cells equally spaced by $1/\Delta$. Quantizing a value f_i with Q(f), consists of substituting the value of f_i with the nearest quantization cell value f_i'.

4.) Altered DCT coefficients are then zig-zag scanned and run level encoded with VLC codeword. Modified codeword then added to the bit-streams to produce the new MPEG-2 video stream with embedded authentication information.

5.) The key problem here is that the direct coefficient-DC of chroma DCT is a parameter which is very sensitive to vision system and embedding watermarks into the direct coefficient of chroma DCT is equivalent to adding micro interferences to it. This interference must be lower than a perceptual threshold of human visual system. Therefore, the step size of QIM should be adjusted according to the size of direct coefficients to improve digital watermark detection rate and visual effect.

6.) To control the bit-rate, watermark embedding must abide to the constraint that the size of the whole video should not increase after watermarking. Hence quantization levels of QIM are adjusted to get the desired bit rate.

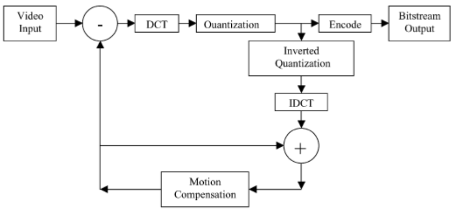

Fig.2 Watermark Embedding Process

B. *Watermarking Extraction*

The watermark is decoded from the extracted bitstream as shown in Fig. 3. The extracted bitstream is passed through the variable length decoder (VLD) and then given to zigzag de-sequencer. The position of DC coefficients is identified and accordingly watermark bits are generated from the quantization table. Parameter required for watermark extraction is only step size used in the quantization process. This is required for the generation of quantization table at the receiver. Extraction of watermark is as follows:

The watermark detector quantizes the received signal f(i)'' by the union of two quantizers $\{Q_0;Q_1\}$ and gets $f_0(i)$ and $f_1(i)$ respectively. The detector determines the index of the quantizer containing the reconstruction point which has minimum Euclidean distance to the received signal. This index corresponds to the received watermark information $\hat{b}$. In the case that encoder embedded one bit in each sample of the host signal, detection can be described as

$$\hat{b}_i = \arg_{b\in\{0,1\}} \min(f(i)'' - f_b(i))^2$$

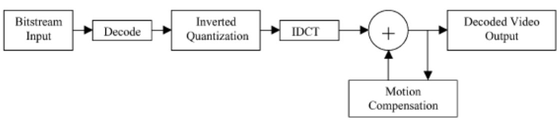

Fig.3 Watermark Extraction Process

QIM offers high watermark rates when the distortion introduced by attacks is small. QIM must be considered a symmetric watermarking technique, since encoder and decoder have to have the same knowledge, in particular the involved quantizer sets must be known.

V. Conclusions

Digital video watermarking is a new and merging area of research .it mainly deals with adding hidden message or copyright in digital video. In this paper, a new low complexity video watermarking for MPEG-2 compressed domain is proposed in which the embedding/extracting is performed using the syntactic elements of the compressed bit stream. The watermark information is embedded into the direct coefficients of chroma DCT on video I frame or P frame, this scheme doesn't need partly decoding so it greatly decreases the computational complexity and increases real-time performance.

References

[1] F. Hartung ; B. Girod,(1997) "Digital watermarking of MPEG-2 coded video in the bitstream domain", *in Proc. ICASSP97,*, vol. 4, pp. 2621-2624.

[2] T. Y. Chung; M.S Hong, Y.N Oh; D.H. Shin ; S.H. Park(1998), "Digital watermarking for copyright protection of MPEG-2 compressed video", *IEEE Transaction on Consumer Electronics*, vol. 44, pp. 895-901.

[3] F. Hartung ; B. Girod(1998), "*Watermarking of uncompressed and compressed video*", in Signal Processing, vol. 66, no. 5, pp. 283-301.

[4] G. Langelaar ; R. Lagendijk(2001), "Optimal differential energy watermarking of DCT encoded images and video*", IEEE Transactions Image Processing*, vol. 10, no. 1, pp. 148- 158.

[5] C.S. L;, J.R. Che;, L. H.Y.M, ; K.C. Fan(2002), "Realtime MPEG-2 video watermarking in the VLC domain", *in Proceedings 16th International Conference on Pattern Recognition*, vol. 2, pp. 552-555.

[6] J. Fridrich ; R. Du(2002), "*Lossless authentication of MPEG-2 video",* Proc. Int. Conf. Image Processing (ICIP), 2:893-896.

[7] Kutter M, Jordan F,;Ebrabimi T(1997). "*Proposal of a watermarking technique for hiding/ retrieving data in compressed and decompressed video*", Tech. Report M2281, ISO/IEC Document, JTCI/SC29/WG11, Stockholm: MPEG4Meeting, .

[8] Z. J. Zhu, G.Y;Jiang, M.Y(Aug 2002)u etc, "*New Algorithm for Video Watermark*", ICSP, vol.1, pp.760-763.

[9] Kyung-Won Kang, Kwang-Seok Moon, Gwang-Seok Jung, ; Jong-Nam Kim, "*An Efficient Video Watermarking Scheme Using Adaptive Threshold and Minimum Modification on Motion Vectors*", Lecture notes in computer science ISSN 0302-9743, vol. 3656, 2005, pp. 294-301.

[10] Biswas S, Das S R, Petriu E M, "An adaptive compressed MPEG-2 video watermarking scheme", *IEEE Transactions on Instrumentation and Measurement*, Vol. 54, No. 5, 2005, pp. 1853-1861.

[11] Peter Meerwald, Andreas Uhl(June 23-26),2008, "Blind motion-compensated video watermarking", *in Proceedings of the 2008 IEEE Conference on Multimedia and Expo, ICME '08*, pp. 357- 360.

[12] Maneli Noorkami; Russell M. Mersereau (June 03 ,2008), Fellow, IEEE "Digital Video Watermarking in P-Frames With Controlled Video Bit-Rate Increase", *IEEE Transactions on Information Forensic and Security*, Vol. 3.