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A Robust Coding Watermarking Algorithm based on H.264/AVC Compression Technique

1st Jinyu Lu
College of Engineering,
Bohai University
Jinzhou, 121000, China
156241142@qq.com

2nd Xianghua Tian
College of Engineering,
Bohai University
Jinzhou, 121000, China
1580352420@qq.com

***Abstract*—To coding watermarking solve based robustness insufficiency of video watermarking based on H264/AVC caused by only embedding 1 bit watermark in one coefficient of macro block,this paper put forward a new energy- differential video coding watermarking algorithm based on textural features by considering the properties of H.264 compression standard. The proposed algorithm firstly performs the 4×4 integer DCT on the current frame aming at identifying whether it is the texture block or not. Then the watermarking is embedded by adopting the way of differential energy for selecting the appropriate coefficients adaptively. The experimental result shows that the proposed algorithm has little impact on the video quality and bit-rate, moreover, its robustness can effectively resist the common attacks such as the gauss noise, low pass filter and re-coded performed on the video watermarking.**

Keywords—H.264/AVC, Differential Energy, Robust Watermarking, Fragile Watermarking, Semi fragile Watermarking

I. INTRODUCTION

With digital and internet developing for unprecedented speed, it is changing the outlook of the digital mulitmedia industry. Meanwhile digital and internet bring the convenient to people, it was also suffered the obsession of piracy and malicious tampering. Digital multimedia copyright protection and content authentication have become an important problem to be solved. According to statistics released by the State Administration of radio, film and televison, the Chinese films have grossed more than ¥45.712 billion. China has become the world’s second largest film market. However the digital content has been very easy to be copied and distributed, so this is a ubiquitous phenomenon that digital content and products protected are spreaded at radom; The legtimate rights and interests of the original works owner of digital media products have been infringed, and the phenomenon of priacy has become a serious social problem. Experience shows that means of technology and legal could protect digital copyright.

II. RESEARCH STATUS

Image watermarking always has been the focus of the study, but in recent years, with the development of video compression technology, many scholars focus on the research of video watermarking. At present, the research of video watermarking is mainly focused on MPEG, JPEG and H.264/AVC compression technology. In the last 15 years, the research based on H.264/AVC increase year after year. Many scholars have a large number of research results on H.264/AVC robust video watermarking algorithm, H.264/AVC fragile video watermarking and H.264/AVC semi-frgile video watermarking. Qiu[1] proposed dual watermarking scheme, in order to achieve the dual purpose of copyright protection and content authentication, which simultaneously embedded robust watermarking and fragile watemarking in the video, robust watermarking is embedded in the DCT transform domain coefficients of I frame, fragile watermarking is embedded in the motion vectors in the P frame. Zhang [2] proposed the robust video watermarking scheme based on H.264/AVC, firstly, it compressed the gray watermarking image, secondly, it spread spectrum for the two value sequence which is just compressed, finally, the watermarking information is embedded in a diagonal coefficient of the DCT domain. Noorkami[3-5] proposed that watermarking is embedded in the I macro block AC coefficients with

4×4 intra prediction mode. Firstly, it generated a public key according to the characteristics of the 16 DC coefficients of the I macro block, then combined with the private key provided by embedded person determine the position of watermarking embedded in the I macro block.

The robustness of the proposed watermarking algorithm has the disadvantages of poor imperceptibility and robustness. The proposed watermarking algorithms are not considered the human visual characteristics, which are not always embedded in the human eye insensitive position. These algorithms could achieve the purpose of embedding watermarking by changing a quantized DCT coefficient, and great improved compression performance. Due to most of the pixels in the residual frame are small, most of the DCT coefficients are converted to zero after the residual frame is transformed and quantized by DCT transform. If the 1 bit watermark was embedded in the 1fixed position coefficients in the macro block, the robustness and invisibility of the watermark would be poor. Langelaar,et al.[6-8] proposed a differential energy watermarking DEW scheme based on MPEG or JPEG compression technique.In the algorithm, the partial DCT high frequency coefficients are discarded, so that the difference between the coefficients of the 2 adjacent regions can be embedded into the watermark, this algorithm is robustness, but not suitable for H.264/AVC compression technique. Zhang [9-12] proposed a robust video watermarking scheme based on H.264/AVC compression technique. The scheme uses the DCT transform differential energy as a robust watermark embedded in the I frame, it has strong robustness, but watermark extracted would have errors.

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III. WATERMARK EMBEDDED AND EXTRACTED

Aiming at the shortcomings of the above algorithms [1,2,3,4,5,6,7], this paper propose a robust coding watermarking algorithm based on H.264/AVC compression technique. Point at poor robustness, this paper presented that coded watermarking is embedded into differential energy in the video I frame H.264/AVC compression technique; Point at HVS human visual system charateristic, the DCT macro block was divided into texture block and non-texture block, and the DCT macro block coefficients are changed by texture block or non-texture block, so that this paper achieved the invisibility of the watermark, and watermark can be extracted accurately after the attack.

In the embedding watermark process, firstly I frame is divided into several teams of macro blocks ,each team consisted of A and B macro blocks, secondly the watermark is encoded by BCH, each bit information of the encoded watermark is embedded into the macroblock.Depending on the change of the 4×4 DCT intermediate frequency and high frequency coefficients of A and B macro blocks to produce energy difference, if the embedded watermark is 1, the energy difference of the two macro blocks is forced to be greater than zero, if the embedded watermark is zero, the energy difference of the two macro blocks is forced to be less than zero. In order to avoid the obvious distortion of the video quality, one of A and B blocks is judged whether is a texture block or not, if it is a texture block, then the coefficient of the intermediate frequency is set 1 and the last high frequency coefficient is set 1, if it is not a texture block, then the last high frequency coefficient is set zero; another of A and B blocks is judged whether is a texture block or not, if it is, then the intermediate and the last high frequency is set 1, if it is not, the last high frequency is set zero.

A. Embedded Watermark Steps

Step 1,The I frame image is divided into several teams of A and B macro blocks, each which is consisted of 16 groups 4×4 DCT coefficients. For example, image pixel are 352×288, the number of macro blocks is 198(352×288/2(16×4×4)=198). Each team contain 1bit information;

Step 2, Judge texture blocks;

Step 3, Watermark encoded by BCH (127,64);

Step 4, The encoded watermark sequence is embedded into the macro block groups from the first bit. When the watermark information is 1and macro block of A is texture block , the amplitude of two DCT coefficients are forced to increase one, which one DCT coefficient is the fifth intermediate frequency cofficients, another DCT coefficient is the last high frequency cofficients, through Zigzag for DCT coefficients. When the watermark information is 1 and macro block of A is non-texture block, the amplitude of two DCT coefficients are forced to zero, homologously. This operation can produce energy difference. When the watermark information is zero, it is exchange of A and B on the above.

B. Extracted Watermark Steps

The watermark extraction is carried out in the H.264/AVC decompression,

Step 1, To reconstruct the pixel value of the decompressed macro block;

Step 2, The pixel value of the current reconstruction block is carried out by 4×4 integer DCT transform, to determine whether the block is a texture block or not;

Step 3, To calculate the DCT coefficient differential energy D of adjacent macro blocks;

Step 4, To extract the watermark according to D value, if D>0, then information is 1, if D<0, then information is zero;

Step 5. To encode by BCH (127, 64) according to the information sequence value above the results.

IV. EXPERIMENT RESULTS

This paper used H.264/AVC reference software model JM12.4, and CIF (352×288) sequence of Forman, Stefan, Coastguard, and ContainerShip. Frame rate of each sequence is 15 frame/s, the number of frame is 30, bit rate is 768kbit/s, and coding sequency according to *IPPPP*⋯, every 15 frames encoding a I frame, then watermark is embedded into each I frame.

Fig. 1 and Fig. 2 are the 1st frame of Forman sequence before and after the watermark embedded. Judging from the subjective, the frame quality has not declined.

Figure 1: Forman the 1st frame host image

Figure 2: Forman the 1st frame embedded watermark image

In this paper, four sequences are used to observe the effectiveness of the proposed algorithm. The results show that this algorithm is effectiveness.

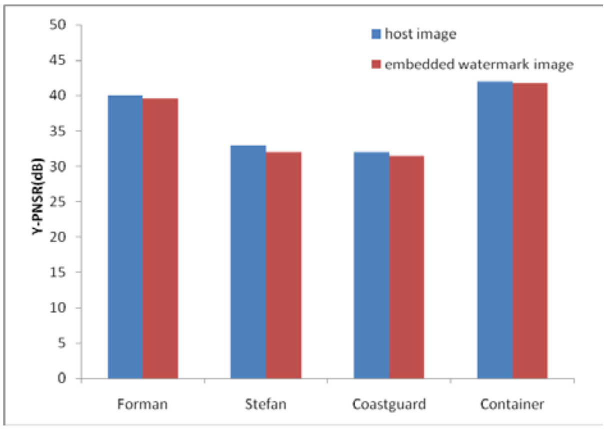

Figure 3: comparison PSNR 768kbit/s rate

TABLE I THE ROBUSTNESS OF FOUR EEQUENCES ATTACKS

Cylce Tests	Bit Rate Change	Gaussian Nosie	Contrast Enhancement
foreman	**0.8156**	**0.8752**	**0.9487**
Stefan	**0.8308**	**0.8967**	**0.9599**
Coastguard	**0.8460**	**0.8469**	**0.9828**
Container	**0.7576**	**0.8865**	**0.9721**
Cylce Tests	**Low Pass Filtering**	**Cutting**	**Rotate**
foreman	**0.8743**	**0.9179**	**0.8618**
Stefan	**0.8564**	**0.9221**	**0.8922**
Coastguard	**0.9548**	**0.9536**	**0.9150**
Container	**0.8304**	**0.9442**	**0.8147**

TABLE II THE EFFECT OF EMBEDDING WATERMARK ON THE CARRIER

Algorithm	Change of PNSR	Rate Variation	Changes in the Volume of Compressed Data
This paper	**0.45**	**0.21**	**0.084**
Document[7]	**0.46**	**0.37**	**0.091**
Document[1]	**0.43**	**0.25**	**0.057**
Document[2]	**0.93**	**1.33**	**0.152**

The results shows that this proposed algorithm can effectively resist all kinds of common signal processing attacks, because the sim of four sequences through many kinds of attacks is all above 0.75, as shown in the table I.

Compared with the proposed algorithms [1, 2, 3, 4, 5, 6, 7], the proposed algorithm can improve the robustness, when the watermark is slightly higher, as shown in the table II.

This algorithm is considered fully the human visual characteristics, and take advantage of the differential energy to embed the watermark, so this algorithm can increase robustness under the premise invisibility.

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