

Video Watermarking using Discrete Wavelet Transformation

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Abstract - The Development of computer networks enhance the development of the information technology in different areas. Many a times, this digital data can be easily used to copied, manipulated and distributed in an illegal way [6]. Therefore, copy right protection, intellectual protection and material right protection for authors, owners, buyers and distributors becomes necessary and the authenticity of content or matter are crucial factors to solving problem. In order to secure and maintain the authenticity and integrity of multimedia documents, digital watermarking is a viable solution. This paper describes the application of Discrete Wavelet Transform (DWT). The video frames are first decomposed using DWT and then the watermark image is embedded in the low frequency wavelet [8].

Keywords- Data Leakage, confidential data, DWT, video, watermarking.

1. INTRODUCTION

In recent years, the fabulous growth of the internet technology and the expansion of powerful computing devices have not only boosted the multimedia electronic commerce up but also incited artists to share and promote their work online [5]. This implied a massive presence on the web of digital multimedia data such as audio, image, video, documents etc.

The use of digital video applications such as video-conferencing, digital television, digital cinema, distance learning, videophone, and video-on-demand has grown very rapidly over the last few years [3]. Today it is much easier for the digital data owners to transfer multimedia data over the internet, and hence the data could be perfectly duplicated and rapidly redistributed on a large scale.

However, with the spread-out and ease of use of powerful multimedia dedicated processing tools, these data can be downloaded, easily modified, illicitly appropriated, and then largely redistributed or commercialized on the Internet [7]. Protecting intellectual property rights of owners has then become a major concern. A solution to this problem is provided by digital watermarking.

Digital watermarking has now become one of the important techniques to secure digital media files in the domains of data authentication and copyright protection. A watermark is typically a digital data embedded in multimedia objects such that the watermark can be detected or extracted at later times in order to make an assertion about the object [5]. The idea behind digital watermarking is to embed information imperceptibly and robustly in the host data. In general, the watermark contains information about the origin, ownership, destination, copy control, transaction etc. Another set of applications of digital watermarking include transaction tracking, copy control, authentication, legacy system enhancement and database linking etc.

Digital Watermarking is one of the appealing methods to protect the copyright and unauthorized access to the content. Such type of watermarking can be applied to images, audio, videos etc. These watermarks should not alter the quality of content and it should be robust to the various attacks and distortion. Lot of work has been done on image watermarking and few have been done on video.

2. VIDEO WATERMARKING TECHNIQUES

There are many digital watermarking schemes that have been proposed for still images and videos. Most of them operate on uncompressed videos, while others work by embedding watermark directly into compressed videos. Video watermarking poses a number of issues which were not present in image watermarking. Due to inherent redundancy between video frames, video signals are highly vulnerable to attacks such as frame averaging, frame dropping, frame swapping and statistical analysis. Video watermarking approaches are classified into two categories based on the method of hiding watermark bits in the host video. Spatial domain watermarking, embedding and detection of watermark are performed by directly manipulating the pixel intensity values of the video frame. And, Frequency domain techniques, on the other hand, alter spatial pixel values of the host video according to a pre-determined

transform and are more robust than spatial domain techniques since they disperse the watermark in the spatial domain of the video frame, thus, making it difficult to extract the watermark through malicious attacks like cropping, scaling, rotations and geometrical attacks. Commonly used transform domain techniques are Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelet Transform (DWT).

3. DISCRETE WAVELET TRANSFORMATION

DWT has been utilized in digital image watermarking more often thanks to its excellent spatial localization and multi-resolution characteristics, which are almost like the theoretical models of the human sensory system [9]. The DWT splits the signal into two parts, i.e., high and low frequency parts. The high frequency part contains information about the fringe components, while the low frequency part is split again into high and low frequency parts. The former is usually used for watermarking since the human eye is less sensitive to changes in edges.

2-D discrete wavelet transform (DWT) decomposes an image or a video frame into sub-images, 3 details and 1 approximation. In general, it(2-D DWT) is an application of the 1-D DWT applied in both the horizontal and the vertical directions. This helps in separating the frequency band of frame (or image) into a lower resolution approximation sub-band (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components.

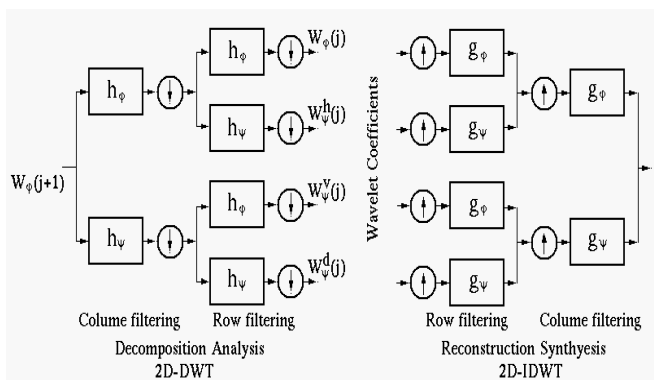


Fig-1: 3 level filter bank

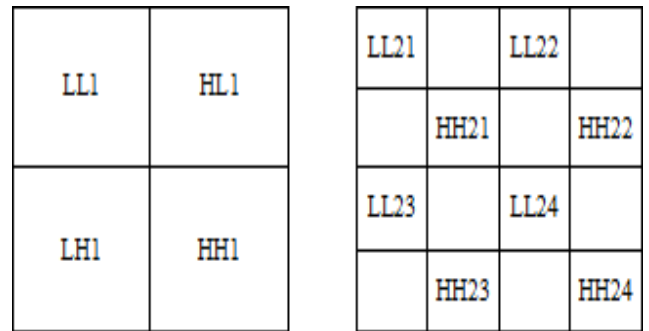


Fig-2: DWT sub-bands in (a) level 1, (b) level 2

4. HAAR WAVELET

In mathematics, the Haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. Wavelet analysis is similar to Fourier analysis in that it allows a target function over an interval to be represented in terms of an orthonormal basis [10].

The Haar sequence was proposed by Alfréd Haar in 1909. He used these functions to give an example of an orthonormal system for the space of square-integrable functions on the unit interval [0, 1]. Haar is referred as the special case of the Daubechies wavelet, and is sometimes known as Db1.

The Haar wavelet is conceptually simple, memory efficient, exactly reversible without the fringe effects characteristic of other wavelets and computationally cheap. The Haar transform does not have overlapping windows, and reflects only changes between adjacent pixel pairs [12]. It uses two scaling and wavelet function coefficients, and calculates pair wise averages and differences.

In the face off Haar wavelet, Daubechies wavelet families are more complex, and generally have a higher computational overhead. Contrary to our initial expectations, in some works, the Haar wavelet performs better than Daubechies wavelets.

5. RGB TO YUV CONVERSION

RGB formats are usually straightforward: red, green, and blue with a given pixel size. The most common is RGB24, allowing 8 bits and a value of 0-255 per color component. RGB frame grabbing is best if your image processing and/or storage requirements involve it. RGB captures are often saved directly as a bitmap by adding

an easy header. Windows XP GDI (Graphic Display Interface) and Linux GUIs work with and display RGB bitmap.

The problem with RGB, however, is that it's not the simplest mapping for representing visual perception. YUV color-spaces are a more efficient coding and reduce the bandwidth quite RGB capture can. Most video cards, therefore, render directly using YUV or luminance/chrominance images. The most important component for YUV capture is usually the luminance, or Y component. For this reason, Y should have the highest sampling rate, or the same rate as the other components. Generally, 4:4:4 YUV format (equal sample per component) is a waste of bandwidth because the chrominance can be adequately sampled at half the sample rate of the luminance without the eye being able to notice the difference. YUV 4:2:2 and 4:2:0 formats are generally used with the preference on 4:2:2. 4:2:2 means the chrominance components are sampled horizontally at half the rate of the luminance. 4:2:0 means the Cb (blue chrominance) and Cr (red chrominance) components are sub-sampled at a factor of 2 in the vertical horizontal directions.

Capturing to YUV (or YCrCb), besides being more efficient, is best when the images are to be rendered by a standard video display directly. Additionally, some image compression algorithms, like JPEG, directly support YUV, so there is no need for RGB conversion. In the YCrCb model, 0x80 is the black level for Cr and Cb, and 0x10 is the black level for Y.

6. PROPOSED SYSTEM

For embedding and extracting the watermark we are using DWT. Discrete Wavelet Transformation embeds data into the specific bands (LL and HH) in the wavelet domain. The algorithm uses the LL and HH bands to add the watermark where the motion in these bands does not affect the quality of extracted watermark if the video is subjected to different types of malicious attacks [4]. The proposed system consists of two steps, the first converts the RGB frames into YUV frames and embeds the watermark in the frames (the frames are still in YUV format), third extracts the watermark image which is now black and white when displayed as output.

A. Watermark Embedding Procedure Algorithm

Step 1: Video is divided into frames and each RGB frame is converted into YUV frame [1].

Step 2: 2-DWT is applied on the frames.

Step 3: RGB watermark image is converted into a vector $P = \{p_1, p_2 \dots p_{32 \times 32}\}$ of zeros and ones.

Step 4: This vector P is again divided into n parts. Afterwards, each part is embedded into each of the corresponding LL and HH sub bands. The watermark's pixels are embedded with strength x into the maximum coefficient M_i of each PC block Y_i . The embedding equation is:

$$M_i = M_i + xW \tag{1}$$

x = watermark embedding strength

Step 5: Inverse DWT is applied to obtain the watermarked luminance component of the frame. Finally watermarked frame is reconstructed and watermarked video is obtained [1].

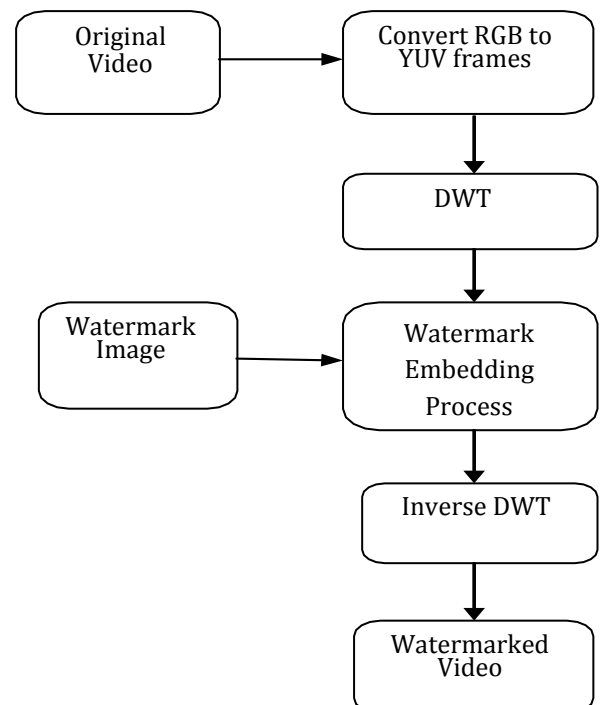


Fig-3: Watermark Embedding Process

B. Watermark Extracting Procedure Algorithm

Step 1: Watermarked video is converted into frames and Each RGB frame is converted to YUV format.

Step 2: 2-D DWT is applied. LL and HH sub-bands are divided into nxn non-overlapping blocks.

Step 3: Following equation is used to extract watermark.

$$W = \frac{M_i^1 - M_i}{x}$$

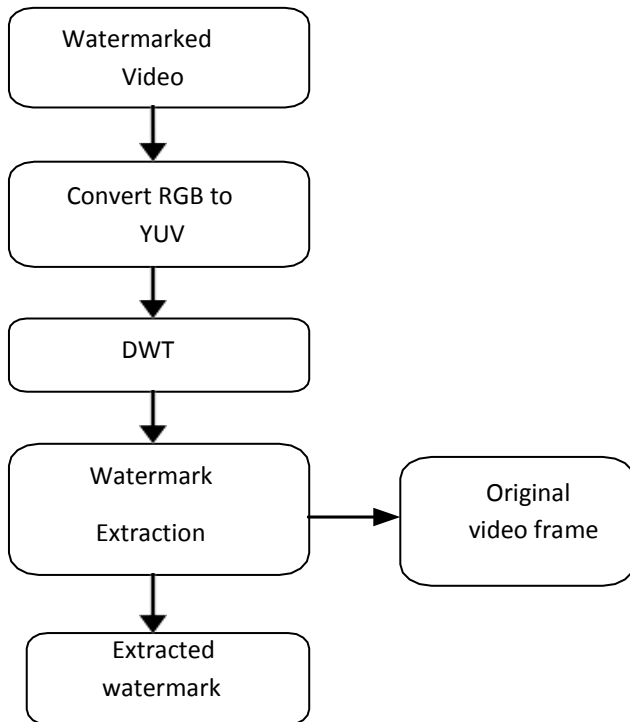


Fig-4: Watermark Extraction Process

7. CONCLUSIONS

Current methods for video watermarking are extension from image watermarking and there is scope for more innovations. As more and more low-bit rate compression standards for video are emerging, and with the progress of wireless technology, a lot of challenges are now thrown to video watermarking.

In future, use of machine-learning techniques is expected for judicious selection of suitable locations for watermark embedding. In general, the selection of suitable coefficients based on machine learning approaches may result in an improvement on the imperceptibility. Thus, the watermarking techniques can be implemented by using any of the intelligent approaches, like Genetic Programming (GP), Genetic Algorithms (GA), or Artificial Neural Networks (ANN).

Along with more and more maturing of digital watermark technology, the copyright authentication system based on digital watermark technology has more

and more functions for general domains, including digital library, electronic commerce, video-on-demand, remote education and training, digital camera and scanner. As a new thing of digital information security domain, digital watermark technology will be more and more useful. Therefore, it is believed that digital watermark technology might have long range development in the days to come and in addition have great commercial potential.

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