

A ROBUST VIDEO WATERMARKING USING SIMULATED BLOCK
BASED SPATIAL DOMAIN TECHNIQUE

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To my beloved husband
To my beloved father and mother
To my beloved sisters and brothers

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ABSTRACT

A digital watermark embeds an imperceptible signal into data such as audio, video and images, for different purposes including authentication and tamper detection. Tamper detection techniques for video watermarking play a major role of forensic evidence in court. The existing techniques for concealing information in the multimedia host are mostly based on spatial domain rather than frequency domain. The spatial domain techniques are not as robust as frequency domain techniques. In order to improve the robustness of spatial domain, a watermark can be embedded several times repeatedly. In order for spatial domain techniques to be more efficient, more payload is needed to embed additional information. The additional information would include the redundant watermarks to ensure the achievable robustness and more metadata of pixels to ensure achievable efficiency to detect more attacks. All these required additional information will degrade the imperceptibility. This research focuses on video watermarking, particularly with respect to Audio Video Interleaved (AVI) form of video file format. The block-wise method is used to determine which block exactly altered. A high imperceptible and efficient tamper detection watermarking technique is proposed which embeds in first and second Least Significant Bits (LSB). The proposed technique divides the video stream to 2*2 non-overlapping simulated blocks. Nine common attacks to video have been applied to the proposed technique. An imperceptible and efficient tamper detection technique with a novel method of video segmentation to comprise more pixels watermarked is proposed. Experimental results show the technique is able to detect the attacks with the average of Peak Signal-to-Noise Ratio (PSNR) as 47.87dB. The results illustrate the proposed technique improves imperceptibility and efficiency of tamper detection.

ABSTRAK

Tera air digital membenamkan isyarat tidak kelihatan ke dalam data seperti audio, video dan imej, untuk tujuan yang berbeza termasuk pengesanan dan pengesanan gangguan. Teknik pengesanan gangguan untuk tera air video memainkan peranan utama sebagai bukti forensik di mahkamah. Teknik sedia ada dalam penyembunyian maklumat hos multimedia adalah kebanyakannya berdasarkan domain *spatial* berbanding dengan domain frekuensi. Ketahanan teknik domain *spatial* tidak seteguh teknik domain frekuensi. Pendekatan yang paling biasa untuk menyembunyikan maklumat dalam multimedia adalah menggunakan domain *spatial*. Kemantapan dari segi keteguhan, teknik domain *spatial* adalah tidak setinggi berbanding dengan domain frekuensi. Dalam usaha meningkatkan keteguhan domain *spatial*, tera air boleh dibenamkan secara berulang kali. Bagi menjadikan teknik domain *spatial* lebih cekap, lebih muatan diperlukan untuk membenamkan maklumat tambahan. Maklumat sampingan termasuk tambahan tera air adalah dikehendaki untuk memastikan keteguhan dicapai dan bagi memastikan kecekapan boleh diperolehi serta mengesan lebih banyak serangan lebih metadata bagi piksel diperlukan. Semua maklumat tambahan yang dimasukkan ini akan mengurangkan kualiti video. Kajian ini memberi tumpuan kepada tera air video, terutamanya berkaitan dengan format Audio Video (AVI). Kaedah *block-wise* diguna bagi menentukan secara tepat blok yang diubah. Pengesanan gangguan dan ketinggian mutu dengan menggunakan tera air Bit Terkurang Bererti (LSB) pertama dan kedua adalah dicadangkan. Teknik yang dicadangkan akan membahagikan aliran video kepada 2*2 blok simulasi secara tidak bertindih. Sembilan serangan untuk video telah diuji kepada teknik yang dicadangkan. Hasil uji kaji menunjukkan teknik yang dicadangkan mampu mengesan serangan dengan purata Isyarat Puncak Kepada Nisbah Bunyi (PSNR) 47.87dB. Keputusan ini menunjukkan teknik tersebut berjaya menambah baik kualiti dan juga kecekapan pengesanan gangguan.

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LIST OF ABBREVIATIONS

AI	-	Artificial Intelligence
CD	-	Compact Disc
DVD	-	Digital Video Disc
DFT	-	Discrete Fourier Transform
DCT	-	Discrete Cosine Transform
DWT	-	Discrete Wavelet Transform
IDWT	-	Inverse Discrete Wavelet Transform
DVS	-	Digital Video Surveillance Systems
dB	-	Decibel
CCTV	-	Closed Circuit Television
HAS	-	Human Auditory System
HVS	-	Human Visual System
LSB	-	Least Significant Bit
MSB	-	Most Significant Bit
RIFF	-	Resource Interchange File Format
AVI	-	Audio Video Interleave
MPEG	-	Moving Picture Experts Group
JPEG	-	Joint Photographic Experts Group
RSA	-	Rivest, Shamir, & Adleman (Public Key Encryption Technology)
PCA	-	Principal Component Analysis
PSNR	-	Peak Signal-to-Noise Ratio
NC	-	Normalized Cross-Correlation
VW16E	-	Video Watermarking 16 End
VW16F	-	Video Watermarking 16 First
VW8F	-	Video Watermarking 8 First

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CHAPTER 1

INTRODUCTION

1.1 Overview

A digital watermark is a kind of indication, which is accommodated in the host medium such as digital image, audio, text, software or video. It can be commonly used for ownership protection. Watermarking is a technique of covering digital information in the carrier signal (host). The hidden data is not necessarily related to the content of the host (Chang, Wang, *et al.*, 2011; Junxiao *et al.*, 2011; Liu, 2012). Particularly for video files, in order to solve the problem of unlawful manipulation and dishonest distribution, video watermarking is applied (Liu *et al.*, 2009; Sinha *et al.*, 2011).

Digital Video play a major role of forensic evidence in court (Su *et al.*, 2008; Xu *et al.*, 2010). Hence the video files should be authenticable with ability to detect the tamper, thus a technique like watermarking is applied for the purpose. The watermark must not have any effect on visual information and must not reduce the ability for compromise on the video evidence. Therefore, high imperceptible watermark has responded to the mentioned necessity (Su *et al.*, 2008). Video tamper detection is the challenge of today's researchers in the field of multimedia security (Van Schyndel, 2010).

Although video watermarking has many properties, the main three properties are imperceptibility, robustness and payload or capacity which are closely related to each other for example when the robustness increases, imperceptibility would be decrease and vice versa (Agarwal *et al.*, 2012; Yu *et al.*, 2014). The correct balance

between these conflicting requirements of watermarking should be found for any application and techniques (Agarwal *et al.*, 2012; Ishtiaq *et al.*, 2009).

1.2 Background of the Problem

Nowadays cameras in many circumstance has been installed, even these cameras mounted on the streets for fights, drug deals and other improper activities in an environment. The police might see the crime as it was happening or use the video to help in any consequent investigation. Digital multimedia content can easily be duplicated and stored and even without losing fidelity. In Digital Video System (DVS) video file is very vital, because it can be used as a piece of evidence, on the other hand; manipulating the video file by many editing video software in the market is like a piece of cake, so easy and simple with low cost (Sinha *et al.*, 2011).

By growth of communication network, due to the characteristics of digital products such as easy to transform and easy to copy, digital tamper detection has been critical issues which need to be solved (Agarwal *et al.*, 2012). Techniques used for video watermarking tamper detection compared to digital image are stagnant (Agarwal *et al.*, 2012). Ascribable to the natural redundancy between the video frames, proposed techniques for image tamper detection are not appropriate for digital video watermarking which are not presented for attacks including frame dropping, frame inserting, frame shifting and etc. Beside these attacks, techniques are restricted in ability to detect the tamper areas (Sinha *et al.*, 2011).

The tamper detection technique has to be designed to ensure the verification of video content and preventing forgery. Researchers have proposed digital watermarking to verify integrity of content for digital video (Chimanna and Khot, 2013; Nithyanandam *et al.*, 2011; Xu *et al.*, 2010). A wide range of modifications in any domain could be utilized for watermarking techniques (Junxiao *et al.*, 2011) On the other hand video market is become more and more popular; the cameras' information results have a major role in safety of environment and people. In order not to change the concept of visual information, the embedded data should be

imperceptible and robust. Hence, in addition to robustness and imperceptibility the constraint of computational is imposed to video watermarking (Hasnaoui and Mitrea, 2012).

Video application requires a large quantity of sequences to be processed. Watermarking techniques can also be applied in the frequency domain. In these techniques higher imperceptibility can be obtained as well as better robustness. The disadvantage of frequency domain methods is that they are computationally expensive when compared with spatial. Spatial domain techniques are best suit for video watermarking than other watermarking domains. Watermark can also be embedded in the frequency domains (Chimanna and Khot, 2013). In transform domain, first the host is converted to the frequency domain then the watermark is added and then the inverse frequency transform is applied. One of the common transform methods is the Discrete Cosine Transform (DCT) which divides the image into low, middle and high frequency bands. In the aspect of imperceptibility the middle band is best chosen rather than two other frequency bands. If the watermark is embedded in high frequency band, the details of the edges and other information would be affected. On the other hand, when the watermark is embedded into the low frequency, the imperceptibility is influenced negatively. The DCT is not more efficient than spatial domain when it comes to transparency and also it has intensive computation relatively (Yu *et al.*, 2014). Another common transform method is Discrete Wavelet Transform (DWT) which decompose the image into four sub bands that are low resolution approximation (LL), horizontal (HL), vertical (LH) and diagonal (HH) of detail components. The edge and texture patterns are located in high resolution sub bands. The watermark cannot embed in LL because the smoother part of the image is in this part and also the watermark cannot embed in HH because major details of the image will be lost. That is why the HL and LH are normally selected for watermarking (Chimanna and Khot, 2013; Sinha *et al.*, 2011). The DWT also is not more efficient than spatial domain in aspect of transparency and also have more computation compared to DCT.

1.3 Statement of the Problem

The most common approach for concealing information in the video host is spatial domain. The robustness of spatial domain techniques is not as high as other techniques. In order to improve the robustness of spatial domain, a watermark can be embedded several times repeatedly. As a result, if a single copy of that watermark can survive after attacks, that can be retrieved and the techniques passes the robustness test. Moreover, although spatial domain technique is easy to implement, sometimes adding noise entirely demolish the watermark and could be noticeable for attacker by comparing the anticipated sample with the received signal (Agarwal *et al.*, 2012).

In order for spatial domain techniques to be as efficient as other techniques, more payload is needed to embed additional information. The additional information would include the redundant watermarks to ensure the achievable robustness and more metadata of pixels to ensure achievable efficiency to detect more attacks. All these required additional information will degrade the quality (imperceptibility).

1.4 Research Questions

During conducting this research we try to find a suitable answer for the following questions:

- (i) What are the recent tamper detection techniques for video watermarking in spatial domain?
- (ii) How to improve imperceptibility and efficiency of video tamper detection watermarking techniques in spatial domain?
- (iii) How efficiency is the proposed technique?

1.5 Research Objectives

The exact research targets are as follows:

- (i) To study and investigate recent tamper detection techniques for video watermarking in spatial domain

- (ii) To propose a video tamper detection watermarking technique in order to improve imperceptibility and efficiency
- (iii) To evaluate the efficiency of proposed technique

1.6 Scope of the Study

This research has been focused on following scopes;

- (i) Digital video watermarking
- (ii) Tamper detection on watermarked video
- (iii) Vowel less video
- (iv) Audio Video Interleave (AVI) files format.
- (v) Uncompressed data part of AVI (dB)
- (vi) Spatial domain techniques is used
- (vii) C # is used for programming
- (viii) Avihex is used for visually compare files and check AVI files
- (ix) VirtualDub is used for expanding and combining the video frames
- (x) Microsoft Windows Paint and Microsoft office picture manager is used for applying attacks
- (xi) Efficiency and robustness of nine attacks (Frame Insert, Frame Exchange, Frame Deletion, Crop, Rotate, and Reverse Rotate, Frame shift, Salt and Pepper and Superimpose attack)

1.7 Significance of the Study

The more watermarked pixels yield the more detectable pixels. Indeed, the techniques to be more efficient, more payload is needed to embed. The additional information would include the redundant watermarks to ensure the achievable robustness and more metadata of pixels to ensure achievable efficiency to detect more attacks. All these required additional information will degrade the imperceptibility (Agarwal *et al.*, 2012). The watermark should not affect on visual information. Therefore, the output of the research is an appropriate solution for

tamper detection. Furthermore, the vision difference between original video and watermarked video is not recognizable. Additionally the method has high security and is robust against various modifications such as frame cut, frame swapping and frame insertion and variety of geometric attacks (Sinha *et al.*, 2011).

1.8 Summary

This chapter focuses on the purpose and the need for this research to be done. Background of the problem, objectives, scope and significance of study is expressed in this chapter. In next chapters all the relevant information is covered as a reference to achieve the objectives of this research.

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