A SECURE HEVC VIDEO WATERMARKING SCHEME FOR AUTHENTICATION AND COPYRIGHT PURPOSES

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I hereby declare that the work in this thesis is my own except for quotation and summaries which has been duly acknowledged.

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I would like to dedicate this thesis work to

My beloved parents,

My lovely wife,

My beloved children,

My brother

With thanks for all the years of

Caring, love and support.

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ABSTRACT

High-Efficiency Video Coding (HEVC) becomes one of the widely deployed standards for multimedia applications. However, HEVC streams can be easily tampered by any third party, which negatively affects the authentication and copyright protection. Existing watermarking schemes used for copyright purpose are not able to protect the copyright information, especially if the hosting video encountered some intentional and/or unintentional attacks, such as recompression attack, lossy channel attacks, signal processing attacks, frame deletion attack, and image processing attacks. In addition, existing watermarking schemes used for authentication purpose are mostly suffering from the inability to detect recompression attack, especially if it uses the same quantisation parameters as the original compression. Further, existing watermarking schemes are suffering from the inability to locate tampering in videos. Moreover, some of those schemes could allow unauthorized access over an insecure channel, which is considered a serious security issue. In order to solve these issues, two HEVC video watermarking schemes are proposed; (1) a zero-fragile watermarking scheme based on sensitive watermarking zone and (2) a robust watermarking based on invariant watermarking zone. Additionally, the error correction code and cryptography techniques are applied to the watermark information to increase robustness and security over insecure channels. The first proposed scheme shows enough sensitivity to successfully detect video tampering, distinguish between intentional and unintentional attacks, and differentiate between first and second video compression at different bitrate, with accuracy improvement up to 42% compared to the-state-of-the-art schemes. Moreover, the second proposed scheme shows significant improvement; up to 8.23% of robustness against recompression attack, 95% against channel noise attacks, and 5.37% against frame deletion attack compared to the state-of-the-art schemes. Additionally, both proposed schemes are capable to maintain high visual quality, minimum bitrate increase, and high embedding capacity. Furthermore, both proposed schemes can localise tampering and prevent unauthorized access to watermarked information even over insecure channels.

ABSTRAK

Pengekodan Pengekodan Video Berkecekapan Tinggi (HEVC) menjadi salah satu standard yang banyak digunakan untuk aplikasi multimedia. Walau bagaimanapun, aliran HEVC dengan mudah dapat diganggu oleh pihak ketiga, yang memberi kesan negatif terhadap pengesahan dan perlindungan hak cipta. Skema tanda aras yang digunakan untuk tujuan hak cipta tidak dapat melindungi maklumat hak cipta, terutamanya jika video hosting mengalami serangan yang dirancang dan / atau tidak dirancang, seperti serangan kompresi, serangan saluran yang hilang, serangan pemprosesan isyarat, serangan penghapusan bingkai, dan pemprosesan serangan gambar. Di samping itu, skema tanda aras yang digunakan untuk tujuan pengesahan, kebanyakannya tidak mampu untuk mengesan serangan kompresi, terutamanya jika menggunakan parameter kuantisasi yang sama dengan pemampatan asal. Selanjutnya, skema penandaan aras juga tidak berupaya untuk mencari gangguan dalam video. Tambahan lagi, beberapa skema tersebut dapat membenarkan akses tanpa izin melalui saluran yang tidak selamat, yang dianggap sebagai masalah keselamatan yang serius. Untuk menyelesaikan semua masalah ini, dua skema tanda aras video HEVC dicadangkan; (1) skema penanda aras rapuh sifar berdasarkan zon tanda aras sensitif dan (2) penandaan aras yang kukuh berdasarkan zon tanda aras tidak berubah. Selain itu, kod pembetulan ralat dan teknik kriptografi diterapkan pada maklumat tanda aras untuk meningkatkan ketahanan dan keselamatan terhadap saluran yang tidak selamat. Skema pertama yang dicadangkan berjaya menunjukkan kepekaan yang tinggi bagi mengesan gangguan video, membezakan antara serangan yang disengajakan dan yang tidak disengajakan, dan membezakan antara pemampatan video pertama dan kedua pada kadar bit yang berbeza, dengan peningkatan ketepatan sehingga 42% berbanding dengan skema yang canggih. Seterusnya, skema cadangan kedua menunjukkan peningkatan yang ketara; sehingga 8.23% ketahanan terhadap serangan mampatan, 95% terhadap serangan kebisingan saluran,dan 5.37% terhadap serangan penghapusan bingkai berbanding dengan skema canggih. Justeru, kedua-dua skema yang dicadangkan ini mampu mengekalkan kualiti visual yang tinggi, peningkatan kadar bit

minimum, dan kapasiti penyematan yang tinggi. Tambahan lagi, kedua-dua skema yang dicadangkan dapat melokalisasikan gangguan dan sekaligus mencegah akses yang tidak sah ke maklumat bertanda aras walaupun melalui saluran yang tidak selamat.

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LIST OF ALGORITHMS

LIST OF ABBREVIATIONS

ADIFFi,j	-	Average Difference Between Coefficients Pair (i,j)
AEC	-	Average Embedding Capacity
AMP	-	Asymmetric Motion Partition
AMV	-	Average Motion Vector
AWGN	-	Additive White Gaussian Noise
BCH	-	Bose, Chaudhuri, Hocquenghem
BCH-R	-	Bose, Chaudhuri, Hocquenghem-Repetition
BER	-	Bit Error Rate
BIR	-	Bitrate Increase Ratio
BMP	-	Bitmap
CABAC	-	Context Adaptive Binary Arithmetic Coding
CAVLC	-	Context Adaptive Variable Length Coded
CIF	-	Common Interchange Format
DAR	-	Detection Accuracy Rate
DCT	-	Discrete Cosine Transform
DFT	-	Discrete Fourier Transform
DST	-	Discrete Sine Transform
DWT	-	Discrete Wavelet Transform
ECC	-	Error Correction Code
ECR	-	Embedding Capacity Ratio
EWM	-	Embedded Watermarking Message
$\overline{\text{EWM}}$	-	Recovered EWM
GOP	-	Group of Pictures
HD	-	High Definition
HEVC	-	High Efficiency Video Coding i.e., h.265
HF	-	Hash Function
HFZW	-	Hash Function Zero Watermarking

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