Approaches for Copyright Protection of Compressed and Uncompressed Video Data using Enhanced Watermarking Techniques

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CERTIFICATE

This is to certify that the thesis entitled **"Approaches for Copyright Protection of Compressed and Uncompressed Video Data using Enhanced Watermarking Techniques"** submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for the award of the degree of **Doctor of Philosophy in Computer Science**, is a record of original research work done by **T. Jayamalar**, during the period of her study in the Department of Computer Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship or similar title to any candidate of any University or Institute.

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DECLARATION

I hereby declare that the matter embodied in the thesis entitled **"Approaches for Copyright Protection of Compressed and Uncompressed Video Data using Enhanced Watermarking Techniques"** is the result of investigations carried out by me in the Department of Computer Science, Avinashilingam Institute for Home Science andHigher Education for Women, Coimbatore, under the supervision andguidance of **Dr.(Mrs.)V.Radha**, Professor, Department of Computer Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, and it has not been submitted for the award of any Degree / Diploma / Associateship / Fellowship or similar title to any University or Institute.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
4SS	4 Step Search
ANN	Artificial Neural Network
ARPS	Adaptive Rood Pattern Search
CAR	Confidentiality, Availability and Reliability
CPTWG	Copy Protection Technical Working Group
DCT	Discrete Cosine Transformation
DCT-SVD	DCT-SVD Combined with Clustering Based Watermarking Algorithm
DEW	Differential Energy Watermarks
DFT	Discrete Fourier Transformation
DMB	Digital Media Broadcasting
DMV	Differential Motion Vectors
DRM	Digital Rights Management
DS	Diamond Search
DVD	Digital Video Disc
DWPT	Discrete Wavelet Packet Transformation
DWPT-SVD	DWPT-SVD Combined with Clustering Based Watermarking Algorithm
DWT	Discrete Wavelet Transformation
EARPS	Enhanced Adaptive Rood Pattern Search
ER	Embed Region
ES	Exhaustive Search
EST	Early Search Termination
FAX	Facsimile
FFT	Fast Fourier Transformation
FPBA	Feature Point Based Algorithm

GEO	Geometric
GOP	Group of Pictures
HDTV	High Definition Television
HIS	Hue Intensity Saturation
HVS	Human Visual System
ICA	Independent Component Analysis
IDCT	Inverse Discrete Cosine Transformation
IDWPT	Inverse Discrete Wavelet Packet Transformation
ILMAF-C	Identification of Low Motion Activity Frames Algorithm for compressed domain
ILMAF-UC	Identification of Low Motion Activity Frames Algorithm for Uncompressed domain
IP	Intellectual Property
IPTV	Internet Protocol Television
ISC	Initial Search Center
ISO	International Standards Organization
IT	Information Technology
JAWS	Just Another Watermarking System
JND	Just Noticeable Difference
JPEG	Joint Photographic Experts Group
LCRs	Local Circular Regions
LPF	Low Pass Filtering
LSB	Least Significant Bit
MBD	Minimum Block Distortion
M-JPEG	Moving Joint Photographic Experts Group
MPEG	Moving Picture Experts Group
MPEG-2	Moving Picture Experts Group-2
MPEG-4	Moving Picture Experts Group-4
MPEG-7	Moving Picture Experts Group-7
MSE	Mean Square Error
MTWM	Multithreshold Wavelet Method
MV	Motion Vector

NC	Normalized correlation
NTSS	New Three Step Search
OR	Other Region
PCA	Principal Component Analysis
PN	Pseudo Number
PSNR	Peak Signal to Noise Ratio
QIM	Quantized Index Modulation
RDWT	Redundant Discrete Wavelet Transformation
RGB	Red Green Blue
RMSE	Root Mean Square Error
SAD	Sum of Absolute Difference
SDMI	Secure Digital Music Initiative
SES	Simple and Effective Search
SSS	Secret Sharing Scheme
SVD	Singular Value Decomposition
TSS	Three-Step Search
URP	Unit-size RoodPattern
VC	Visual Cryptography
VLC	Variable Length Code
VOD	Video On Demand
VSSS	Visual Secret Sharing Scheme
WGDBS	Enhanced Wavelet Packet based watermarking algorithm based on Geometric Warping with HVS based criteria using neural network combined with Dynamic Block Selection Algorithm
WGSBS	Enhanced Wavelet Packet based watermarking algorithm based on Geometric Warping with HVS based criteria using neural network combined with Static Block Selection Algorithm
WPT	Wavelet Packet Transformation
WSQ	Wavelet-packet Scalar Quantization
XOR	Exclusive-OR

ABSTRACT

In the current era of communication medium, the usage of digital video has increased tremendously. In response to this increase, the importance of using property rights protection system for content protection has become a vital element of communication. Digital watermarking describes methods and technologies that hide information, which can be used as copyright control mechanism. In this research, watermarking methods, as a mechanism for content protection of video are proposed.

The copyright information is created as a nested watermark using wavelet transformation and visual cryptography. The study proposes techniques that embed the copyright data before compression (raw video data) or after compression. The MPEG video standard is used for compressed videos. Before embedding, in order to increase the robustness of the algorithms, a frame selection and region selection algorithm is used. This algorithm identifies optimal frames and regions within these frames that produce minimal distortion in the watermarked video.

Two techniques are proposed to watermark videos in uncompressed form. Both the techniques are built on wavelet packet coefficients based on geometric warping and Human Visual System. To increase the robustness geometric warping with block selection method is used. Two types of algorithms are used, namely, static and dynamic block selection during watermark embedding. The extraction of watermark consists of performing the embedding process in reverse order.

For watermarking compressed videos, three techniques are proposed. The techniques are based on Discrete Cosine Transformation, Discrete Wavelet Transformation and Feature based algorithm. The algorithms, in order to increase robustness and security use the SVD and dynamic block selection algorithms.

The research work, thus proposes a total of five algorithms, two for watermarking uncompressed videos and three for watermarking compressed videos. Several experiments were conducted to evaluate the proposed algorithms in terms of

payload, transparency, robustness and complexity using Peak Signal to Noise Ratio, Normalized Coefficients and speed of algorithms respectively. Robustness was tested using 13 attacks, namely frame averaging attack, frame dropping attack, frame swapping attack, cropping attack, rotation attack, collusion attack, impulsive noise attack, Gaussian noise attack, sharpening attack, blur attack, brighten attack, JPEG compression attack and MPEG compression attack.

Experimental results showed that all the proposed algorithms are robust and introduce minimum distortion in the watermarked domain. In particular, while considering uncompressed domain, the WGDBS (Enhanced Wavelet Packet based watermarking algorithm based on Geometric Warping with HVS based criteria using neural network combined with Dynamic Block Selection Algorithm) algorithm presents maximum efficiency in terms of capacity, transparency, imperceptibiloity, security and speed. With compressed domain, the DWPT-SVD watermarking algorithm performed well in terms of the selected five characteristics, namely, capacity, transparency, imperceptibility, security and complexity. Thus, from the results, it can be concluded that the WGDBS and DWPT-SVD algorithms are efficient in copyright protection and are comparable with the standard quality required for the recent applications like internet and Digital Rights Management applications.