

Chapter 76

Optimization in Digital Watermarking Techniques

Santi P. Maity

Bengal Engineering and Science University, India

Claude Delpha

Laboratoire des Signaux et Systèmes, France & Université Paris-SUD XI, France

ABSTRACT

Digital watermarking (DWM) becomes a multidisciplinary research area involving theory of communications, signal processing, multimedia coding, information theory, cryptography, computer science and game theory etc. This chapter looks digital watermarking as an optimization problem from different combination of these areas. The goal is to resolve the conflicting requirements of different parameters and properties of digital watermarking. The chapter also presents a review of recent advances in the state-of-the-art algorithms for optimized watermarking techniques. Optimized watermarking methods are then discussed from the rigorous mathematical analysis to theoretical derivations of algorithms with the aid of soft computing techniques. The design and implementation of optimized watermarking methods for the image, video and sound signals are discussed in the context of various diverse applications. Finally, the scope of future research in this area is highlighted.

INTRODUCTION

The widespread use of Internet and wireless networks, the blooming growth in consumer electronic devices and the advancement in digital techniques to achieve high compression rate, altogether make it possible nowadays to acquire

multimedia streams easily. Hence, the owner as well as the users of multimedia data is under real threat due to the growing concern of copyright infringement, illegal distribution, unauthorized tampering and security in communication (Cox, 2001; Wu, 2003). Digital watermarking and information hiding that deal with an acceptable embedding of an auxiliary data in the digital media become a potential solution to the class of

DOI: 10.4018/978-1-4666-2136-7.ch076

problems over the last decade. Several diverse disciplines, namely communication, signal processing, information theory, computer science to very large scale integration (VLSI) technology for real time implementation make it an attractive research field. Digital watermarking (DWM) promises to meet plurality of applications varying from the conventional applications to the several new and promising applications like quality of service (QoS) assessment in future generation wireless communication, data indexing, medical transcription, lured application etc (Eggers, 2002). Nature, the best teacher of us, encourages learning the analogy of the biological systems to handle the challenges in the algorithm and application for information hiding too (Pan, 2009). In this chapter, the terms watermarking, data hiding and information hiding have been used interchangeably and indicate the same meaning while the term stego is used mostly to emphasize statistical non-detectability in data hiding.

Development of digital watermarking algorithm experiences a trade-off relationship to meet several essential properties. These properties, to cite some, include: the quality of the multimedia content containing the hidden data called imperceptibility, the security of the hidden data in term of statistically non-detection, the number of bits that can be embedded with the limits of acceptable quality called capacity, and the robustness indicating the capability to withstand the intentional or unintentional signal processing operations, called attacks. Interestingly, the properties have their own limitations, and they might have conflict to one another (Pan, 2004). For instance, hiding more information with a given decoding reliability degrades perceptual quality of the digital content to a great extent or maintains perceptual quality at the cost of robustness. The primary goal of watermarking is to develop efficient embedding strategy so that watermark fits the cover signal as maximally as possible. It is also required that the watermark symbol is expected to be detected/decoded reliably from various possible degraded versions of the watermarked signal.

Mathematical theory of digital communication in general and the information theory in particular was used in digital watermarking system design to evaluate the ultimate limits of the performance achievable by any watermarking scheme subject to very general constraints, such as maximum allowed embedding and attacking distortions. Some interesting but surprising results are obtained by looking at digital watermarking from an information theoretic perspective. One such result is the independence of watermark detection/decoding reliability with/without the presence of host signal during decoding. Another benefit obtained by looking at digital watermarking from an information theoretic perspective is that such an analysis provides a number of hints on optimal attacking and decoding/detection strategies (Barni, 2004).

Soft-computing, a sub-branch of computer science is rich with many optimization tools. In digital watermarking, genetic algorithms (GAs) may be used to design several optimized algorithms for better trade-off in imperceptibility, robustness and security. Artificial neural networks (ANN) may be used to design robust watermarking for images to take advantages of relatively easy algorithmic specification, pattern matching and classification while designing optimized algorithms. The feasibility of support vector machine (SVM) may be explored to determine automatically where the significant blocks are and to what extent the intensities of the block pixels can be modified (Pan, 2004). Chaotic dynamic system may be used to generate sequences with spectrum properties such as lowpass or highpass characteristics in order to design optimized watermarking with respect to certain types of attacks (Feng, 2006). The soft computing techniques clubbed with wavelets such as probabilistic neural network and wavelets, spiking neural network and wavelets, GA and wavelets are also used extensively for better optimization in data hiding problems (Pan, 2009).

Although knowledge of different diverse disciplines have been applied in watermarking research, major emphasis is focused everywhere to resolve

35 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/optimization-digital-watermarking-techniques/71043

Related Content

Ethical Principles, Challenges, and Methodological Issues in Cross-Cultural Research: Implementations, Examples, and Recommendations

Sukran Kilic (2024). *Methodologies and Ethics for Social Sciences Research* (pp. 138-158).

www.irma-international.org/chapter/ethical-principles-challenges-and-methodological-issues-in-cross-cultural-research/337054

Counsellors' Phenomenological Experiences of Working with Children or Young People who have been Cyberbullied: Using Thematic Analysis of Semi Structured Interviews

Catherine Knibbs, Stephen Gossand Kate Anthony (2017). *International Journal of Technoethics* (pp. 68-86).

www.irma-international.org/article/counsellors-phenomenological-experiences-of-working-with-children-or-young-people-who-have-been-cyberbullied/178534

Voice of the Coast: A Review on Ethical Issues of Scientists Who Engage in the Sri Lankan Fishing Community

Dunima Kaushini Dharmasiri (2024). *Reviving and Re-Writing Ethics in Social Research For Commoning the Community* (pp. 174-188).

www.irma-international.org/chapter/voice-of-the-coast/341293

Are Persuasive Technologies Really Able to Communicate?: Some Remarks to the Application of Discourse Ethics

Christian Linder (2014). *International Journal of Technoethics* (pp. 44-58).

www.irma-international.org/article/are-persuasive-technologies-really-able-to-communicate/108854

Q-R Code Combined with Designed Mark

Jun Sasaki, Hiroaki Shimomukaiand Yutaka Funyu (2008). *Intellectual Property Protection for Multimedia Information Technology* (pp. 206-218).

www.irma-international.org/chapter/code-combined-designed-mark/24100