Chapter 5
From Watermarking to In-Band Enrichment: Theoretical and Applicative Trends

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ABSTRACT

Fostered by the emerging Knowledge Society, the enriched media is nowadays a very challenging research topic, be it considered either from academic or from industrial perspectives. In its largest acceptation, enriched media refers to all possible associations established between some original data (video, audio, 3D, ...) and some metadata (textual, audio, video, executable codes, ...). Such a new content may be further exploited for various applications, like interactive HDTV, computer games, or data mining, for instance. This chapter is meant to bring into evidence the role watermarking techniques may play in this new applicative field. Following the watermarking philosophy, the in-band enrichment supposed that the enrichment data are inserted into the very data to be enriched. Thus, three main advantages are ensured: backward compatibility, format coherence, and virtually no network overhead. The discussion is structured on both theoretical aspects (the accurate evaluation of the watermarking capacity in several real-life scenarios) and on applications developed under the framework of the R&D contracts conducted at the ARTEMIS Department, Institut TELECOM.

1. INTRODUCTION

The video enrichment requires some additional (meta)data, of any type and with any syntax, to be associated with an original video content. Although very simple, this principle proves itself very powerful in practice: content customisation (digital television, e-commerce), interactivity (games, e-learning), adaptation (intelligent broadcasting), indexing/data mining, property right assessment are just some examples of value added services it supports.

The enriched video scientific, technical and economic supports are granted by the efforts of the leading industrial players, of active SMEs, of main state institutions and of research laboratories. For
instance, Ericsson mentioned the new services associated to the enriched video as an important component of its latest success story (Ericsson 2009). At the CeBIT 2008, the products presented by Thomson included enriched video functionality (Thomson 2009). IBM took the enriched video challenge as an opportunity to grant to the disabled persons non-discriminatory access to digital content (IBM 2009). The Louvre Museum in Paris showed a special interest in the new multimedia services: the already obsolete audio guides are replaced by true multimedia companions with tactile screens (Louvre 2009). The SMEs are also part of the core efforts in enriched multimedia (Wipo 2009), (Fre 2009), (Pay 2009), mainly with the large number of patents: their reaction capacity allows them to step into new roles in a continuously evolving market.

The convergence between in-band enrichment and watermarking has been brought into evidence by academic research activities (Barron, Chen & Wornell 2003), (Mitrea, Duta, Zaharia & Prêteux 2006), (IRISA 2009): following the new in-band enriched multimedia concept, Figure 1, the additional data are no longer conveyed through a supplementary channel, but inserted into the visual content itself. The insertion should not perceptibly alter the visual quality of the original content. Moreover, this information must be recovered even after severe alterations of the enriched video, be they the consequence of transmission errors, malicious attacks, or application related operations.

When compared to the traditional solutions, the in-band enrichment features three main advantages: virtually no-cost concerning the terminal and video representation format, a complete backward compatibility guaranteeing the co-existence of successive service generations, and virtually no network overhead. Additionally, note that the in-band enrichment may fully benefit from the theoretical watermarking framework.

Following a study devoted to the capacity of video watermarking (Mitrea & Prêteux 2009), this chapter is meant to be a guide for a user interested in deploying such solutions. In Section 2, the watermarking-inherited theoretical framework for in-band enrichment is sketched. Section 3 is devoted to the capacity evaluation for watermarking purposes. The related applicative instantiations are detailed and illustrated with reference values in Section 4. Note that this approach is deliberately left open: should the user be interested in some new applications, he/she can further decline the general framework so as to match his/her own purpose and to find his/her context-dependent theoretical limits. Section 5 brings more light on the impact of the difference between the real-life watermarking and its theoretical models. Section 6 discusses and demonstrates the effectiveness of the results for four enrich media content applications while Section 7 concludes the paper and opens the perspectives for future work.

2. BACKGROUND

Under the watermarking framework (Cox, Miller & Bloom 2003), (Arnold, Schmucker & Wolthusen 2003), (Davoine & Pateux 2004) the mark is to be transparently (imperceptibly) and persistently (robustly) associated with the media content, Figure 2. Note that while in “traditional” watermarking applications the mark is exploited for intellectual property assessment, in in-band