



Methods for Preserving Audiovisual Metadata

Cooperatively Utilizing Watermarks and Fingerprints

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1 Introduction

Despite the evolution of Web video standards and the emergence of various proprietary Web video platforms, effective measurement of audiovisual content on the Web remains elusive. Additionally, methods for enforcing content usage rights through mechanisms such as content filtering are often manually intensive and are, as a consequence, untimely and error prone. A major reason for this is that audiovisual metadata is frequently unavailable to key participants. This is particularly true on the Web.

While Digital Rights Management (DRM) systems can effectively measure content usage and enforce usage rights, the reality is that a significant amount of content on the Web is and will continue to be distributed absent of DRM systems *in the clear*. Furthermore, significant amounts of content is and will continue to be super-distributed via mechanisms that fail to maintain metadata integrity. For example, content is frequently captured in the analog domain and subsequently digitized in a manner that doesn't preserve key metadata information and associated usage rights. As a result, significant effort is expended by various parties including content owners to subsequently identify content on the Web, appropriately measure its usage, and enforce usage rules.

Digital watermarking and fingerprinting technologies have the potential to assist content owners, distributors, and consumers in solving these problems. Where critical metadata about audiovisual content is no longer directly associated with an audiovisual file, watermark and fingerprinting technologies can potentially be used to reconstruct it.

2. Watermarking and Fingerprinting Techniques

Digital watermarking technologies enable the embedding of a hidden message into an audiovisual file, represented by a string of bits. These bits can subsequently be retrieved and used to determine various characteristics of the file. To facilitate usage measurement, a unique ID analogous to a UPC code may be embedded. To assist in the enforcement of various usage rules, usage flags may be set to determine the context in which content may (or may not) be further distributed and/or rendered. Watermarks may also be applied forensically to mark when and where content transits various points in a distribution chain to aid in the tracking of content and the context in which it is consumed.

Digital fingerprinting technologies facilitate the identification of an audiovisual file by generating a unique fingerprint from reference content, generating a fingerprint from unknown content and comparing the two. In cases where the fingerprints match, a positive identification is made. In such a manner, fingerprints can be used to assist in the identification of content.

Watermarking and fingerprinting technologies promise to preserve certain metadata through either direct embedding in the audiovisual file or through content identification and a corresponding database query. If achievable, such metadata preservation would help enable various market opportunities for content monetization through the ability to accurately measure content consumption while assisting in ensuring appropriate contexts in which content is consumed.



3. Implementation Challenges and the Need for Cooperation

Watermarking technologies in particular have been implemented with varying degrees of success in contexts including motion picture distribution, digital audio recordings, and cable television Video on Demand (VOD) systems. However, broad based implementations that include multiple linked distribution chains including the Web represent challenges.

Limitations in watermarking technologies restrict the amount of data that can be reliably and imperceptibly embedded into audiovisual content. The embedding of unique content identifiers, basic usage rules, and forensic information necessitates a data payload that is likely at or beyond the limit of what current watermarking technologies can provide.

Early research suggests that it's unlikely that an indeterminate multiple of unique watermarks can reliably coexist in a single audiovisual file. If each participant in a file's creation and distribution chain embeds a unique watermark in an uncoordinated, *layered*, manner, it's unlikely that all layered watermarks applied to the file could be reliably retrieved. Moreover, if disparate data formats and structures are used by participants, it's quite likely that the effective payload capacity of watermarking technologies will be insufficient to meet the needs of all participants; even if watermarks were applied cooperatively to effectively maximize payload capacity.

For watermarking to be effective across an extended distribution chain that includes the Web, this scenario would likely require cooperation amongst participants to be workable. Otherwise, there is real risk that watermarks embedded at the latter stages of the chain would obliterate watermarks embedded in earlier stages, significantly reducing the value of said marks those participants.

Fingerprint technologies can assist in the identification of content, but not without limitations. One can learn what a piece of content is, but not directly derive any usage rules associated with the content or at all obtain any forensic information about where the content has been. Furthermore, to reliably identify a piece of content the *entire* file must be processed to ensure that closely similar, but not identical, pieces of content are reliably distinguished.

4. Conclusion

There are a number of stakeholders representing related but distinct industries involved in the creation, distribution, and presentation of audiovisual content to consumers. Each stakeholder has an interest in managing content in various off-line and on-line scenarios. While stakeholders may have incentive and existing momentum to act independently, the limitations of watermarking technology will require cooperation amongst stakeholders if it's to be effective for all stakeholders.

While DRM solutions will continue to provide an effective means of monitoring content usage and enforcing usage rights, there are contexts where fingerprint and watermarking technologies could be used to complement DRM in monetizing commercial content. However, limitations in the technology will necessitate cooperation amongst participants if it's to be broadly effective. In this context, there is a real opportunity for a collaborative industry discussion.