Chapter III

Audio Watermarking: Properties, Techniques and Evaluation

Andrés Garay Acevedo, Georgetown University, USA

ABSTRACT

The recent explosion of the Internet as a collaborative medium has opened the door for people who want to share their work. Nonetheless, the advantages of such an open medium can pose very serious problems for authors who do not want their works to be distributed without their consent. As new methods for copyright protection are devised, expectations around them are formed and sometimes improvable claims are made. This chapter covers one such technology: audio watermarking. First, the field is introduced, and its properties and applications are discussed. Then, the most common techniques for audio watermarking are reviewed, and the framework is set for the objective measurement of such techniques. The last part of the chapter proposes a novel test and a set of metrics for thorough benchmarking of audio watermarking schemes. The development of such a benchmark constitutes a first step towards the standardization of the requirements and properties that such systems should display.

INTRODUCTION

The recent explosion of the Internet as a collaborative medium has opened the door for people who want to share their work. Nonetheless, the advantages of such an open medium can pose very serious problems for authors who do not want their works to be distributed without their consent. The digital nature of the...
information that traverses through modern networks calls for new and improved methods for copyright protection.

In particular, the music industry is facing several challenges (as well as opportunities) as it tries to adapt its business to the new medium. Content protection is a key factor towards a comprehensive information commerce infrastructure (Yeung, 1998), and the industry expects new technologies will help them protect against the misappropriation of musical content.

One such technology, digital watermarking, has recently brought a tide of publicity and controversy. It is an emerging discipline, derived from an older science: steganography, or the hiding of a secret message within a seemingly innocuous cover message. In fact, some authors treat watermarking and steganography as equal concepts, differentiated only by their final purpose (Johnson, Duric, & Jajodia, 2001).

As techniques for digital watermarking are developed, claims about their performance are made public. However, different metrics are typically used to measure performance, making it difficult to compare both techniques and claims. Indeed, there are no standard metrics for measuring the performance of watermarks for digital audio. Robustness does not correspond to the same criteria among developers (Kutter & Petitcolas, 1999). Such metrics are needed before we can expect to see a commercial application of audio watermarking products with a provable performance.

The objective of this chapter is to propose a methodology, including performance metrics, for evaluating and comparing the performance of digital audio watermarking schemes. In order to do this, it is necessary first to provide a clear definition of what constitutes a watermark and a watermarking system in the context of digital audio. This is the topic of the second section, which will prove valuable later in the chapter, as it sets a framework for the development of the proposed test.

After a clear definition of a digital watermark has been presented, a set of key properties and applications of digital watermarks can be defined and discussed. This is done in the third section, along with a classification of audio watermarking schemes according to the properties presented. The importance of these properties will be reflected on the proposed tests, discussed later in the chapter. The survey of different applications of watermarking techniques gives a practical view of how the technology can be used in a commercial and legal environment. The specific application of the watermarking scheme will also determine the actual test to be performed to the system.

The fourth section presents a survey of specific audio watermarking techniques developed. Five general approaches are described: amplitude modification, dither watermarking, echo watermarking, phase distortion, and spread spectrum watermarking. Specific implementations of watermarking algorithms (i.e., test subjects) will be evaluated in terms of these categories.
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