ABSTRACT

In this chapter, we present an overview of our time frequency (TF) based audio watermarking methods. First, a motivation on the necessity of data authentication, and an introduction in digital rights management (DRM) to protect digital multimedia contents are presented. TF techniques provide flexible means to analyze nonstationary audio signals. We have explained the joint TF domain for watermark representation, and have employed pattern recognition schemes for watermark detection. In this chapter, we introduce two watermarking methods; embedding nonlinear and linear TF signatures as watermarking signatures. Robustness of the proposed methods against common signal manipulations is also studied in this chapter.

INTRODUCTION

The electronic distribution of multimedia (EDM) through the Internet offers many advantages to content sellers as well as consumers. Due to the digital representation, sellers face reduced cost of manufacturing, transportation, storage, and display. They can reach a larger number of users when compared to distributing by compact disc (CD) or digital versatile disk (DVD). Consumers, apart from the reduced cost, enjoy numerous benefits. They can have access to large collection...
of multimedia files, and can purchase and enjoy multimedia content instantly. Obtaining music online also enables consumers to have more control over what they listen to. They can buy individual singles rather than the whole album. By ordering these songs together, consumers can create their own listening experiences and bypass the context in which artists envisaged their work that would be listened to when purchased.

Despite these potential advantages, both the music and the movie industries are reluctant to distribute multimedia content through Internet. One of the reasons is that these industries are afraid of change. But these industries will eventually accept that EDM will be a significant distribution channel in the future. So the main obstacle in the implementation of EDM is piracy. While there are many advantages associated with digital media and digital media distribution, clear disadvantages are present. Prior to digital technologies, content was created, displayed, and stored in analog means. The advent of personal video recorder in the 1980s presented an opportunity to view video at home; but also provided an opportunity to make an illegal copy. However, when a copy is made from a recorded content, the new copy is inferior in quality to the original one. Any further copies made from that copy are very much reduced in quality to be of any commercial use. This discouraged people from copying and prevented piracy efforts from reaching alarming proportions. The new digital technologies represent multimedia content in digital format (1s and 0s). These bits can be efficiently stored in an optical or magnetic media. Since digital recording is a process where by each bit in the source stream is read and copied to the new medium, an exact replica of the content is obtained. The digital copies can be created with low cost equipment such as a CD recorder.

Though the digital representation helped to make identical copies easily, the full resolution multimedia files comprise large amounts of data. Transferring or storing them took a large amount of bandwidth. In the beginning of the 1990s, several compression technologies were developed and new standards such as motion picture experts group (MPEG) for video and MPEG 1 Layer - 3 (MP3) for audio reduced the size of the multimedia files by an order of magnitude. This coupled with the reduction in the cost of storage media allowed computer users to have thousands of songs or movies stored in their computers. Towards the end of the 1990s, the increasing availability of high-speed Internet provided an easy and cheap way of distributing movies and songs. The development of peer-to-peer (P2P) networks (BitTorrent, 2006; eDonkey, 2006; Kazaa, 2006) to exchange files helped Internet users to have an easy way to search and exchange multimedia files effortlessly on the Internet. The illegal sharing of multimedia content incurred severe losses to the copyright holders. According to the Recording Industry Association of America (RIAA), the volume of sold audio CDs dropped by 5% in 2001 (RIAA, 2001) and by 11% in the first half of 2002 (Valenti, 2002). Motion Picture Association of America (MPAA) estimates that the movie industry annually looses US$3 billion through physical piracy (Valenti, 2002). This figure does not include Internet piracy. Hence developing digital rights management (DRM) to protect digital multimedia content is a crucial problem for which immediate solutions are needed.

**DIGITAL RIGHTS MANAGEMENT**

DRM is a collection of commercial, legal, and technical measures that enable technically enforced licensing of digital information. DRM makes it possible for content distributors to distribute valuable content electronically, without destroying the copyright holders’ revenue stream. Though DRM can be designed to protect any digital information, in this chapter, the focus is restricted only on the technologies that are designed to protect multimedia content. DRM ensures that access to protected content (such as video or audio) is