ABSTRACT

In the past decade, the business community has embraced the capabilities of the Internet for a multitude of services that involve access to data and information. Of particular concern to these businesses have been the protection and authentication of digital data as it is distributed electronically. This paper proposes a novel approach that combines the reactive rule-based scheme of an active database management system (ADBMS) with the technology of digital watermarking to automatically protect digital data. The ADBMS technology facilitates the establishment of Event-Condition-Action (ECA) rules that define the actions to be triggered by events under certain conditions. These actions consist of the generation of unique watermarks and the tagging of digital data with unique signatures. Watermarking is a technology that embeds, within the digital data's context, information identifying its owner and/or creator. The integration of these two technologies is a powerful mechanism for protecting digital data in a consistent and formal manner with applications in e-business in establishing and authenticating the ownership of images, audio, video, and other digital materials.

Keywords: active database, watermarking, copyright protection, digital fingerprinting

INTRODUCTION

The Internet has emerged as one of the most profound social, technical, and business phenomena in the history of mankind. It has transformed business (e.g., e-commerce), altered the way individuals communicate (e.g., e-mail), and enabled organizations and individuals access to a wide spectrum and wealth of easily accessible digital data. In e-business, a significant amount of digital data in the form of images, audio, and video continues to be developed and made available to a vast audience. These digital items are referred to as objects. As this trend continues to grow, restrictions on an object’s use, authenticity, and ownership are highly desirable, and in some cases, necessary for many companies. Through the use of digital watermarking technology, companies can embed in an object a distinctive signature that uniquely identifies them. The embedded digital watermark can identify an
object’s owner and/or fingerprint the object and link it to a requestor. Additionally, an object’s authenticity is verifiable by utilizing the digital watermark to detect any possible object tampering or alteration. Digital watermarking offers a way for the company to distinctively sign an object, indisputably verifying its ownership and the potential to identify violators, through the embedding of identifiable markings within the object. For example, when a company makes an object available on its Web site, Internet users can download the object to their local machines. These Web clients can use the object in any way they desire including claiming ownership, altering its content, and/or passing the object to others. However, with digital watermarking, the company still would be able to claim ownership, verify the object’s content, and determine a violator, since the object contains their identifiable markings.

Numerous areas of e-business have embraced database technology to organize and manage many of these objects. These passive databases function as large object repositories, which render efficient access and management of these objects. Passive databases can be extended using rules and related procedures, which will execute once an object is stored, manipulated, or retrieved, in order to watermark it in a dynamic and unique manner. These active databases respond to object manipulations in ways that enforce established business policies and procedures. The combination of these two technologies, active database and digital watermarking, enables the implementation of an Active Watermarking System (AWS) to protect, track, and authenticate digital data. The proposed AWS (Pons and Aljifri, 2002) automatically watermarks objects that are stored in the database in order to identify the object’s owner. When the object is retrieved, it is also watermarked with the requestor’s identity to track its release. In addition, the AWS extracts embedded watermarks from an object to authenticate its content and/or to determine the object’s owner and/or the object requestor. Organizations and individuals that embrace e-business can greatly benefit from this type of data protection.

The protection of intellectual digital property has gained significant attention in recent years with the 1996 World Intellectual Property Organization (WIPO, 1996a) conference that revised the Berne Convention for the Protection of Literary and Artistic Works to include digital dissemination and use of literary and artistic properties. Provisions of the resulting WIPO Copyright Treaty include several important issues related to future expansion of the use of watermarking techniques. The ideal electronic copyright management system has been described by the writers to include several vital capabilities, including the detection, prevention, and tracking of a number of performed operational functions like opening, printing, copying, or modifying of copyrighted properties (WIPO, 1996b; Burns, 1996; Stefik, 1996, 1997; Smith and Webber, 1995). The AWS supports many of these vital capabilities in a consistent and effective manner through the application of active rules.

The remainder of this paper is organized as follows. The next two sections respectively review the technologies of active database and digital watermarking. Then, we discuss the functionality and objectives of the AWS, and follow up with a section that focuses on AWS implementation issues. Next, the performance of the AWS under various loads is discussed. Finally, we present future enhancements to the AWS and concluding remarks.
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