The 7th International Symposium on Virtual Reality, Archaeology and Cultural Heritage
VAST (2006)
M. Ioannides, D. Arnold, F. Niccolucci, K. Mania (Editors)

Watermarking and Digital Rights Management - A Pilot DRM System Implementation and Technical Guidelines to Cultural Digitization Projects

D. K. Tsolis[1] S. N. Nikolopoulos[1] E. G. Karatzas[1] S. A. Sioutas[1] E. A. Hondrou[1] A. I. Mouriki[1] Ai. A. Georgiadou[1] and T. S. Papatheodorou[1]

Department of Computer Engineering and Informatics, University of Patras

Abstract

The issue addressed in this paper is at first a brief presentation of the Technical Guidelines for IPR protection and management applied to Greek cultural digitization projects. Secondly, the work focuses on the analysis and implementation of a typical Digital Rights Management System for organizations and projects aiming at the digitization and exploitation of cultural content. Both Technical Guidelines and the DRMS are setting a solid framework for providing answers to a crucial and complex issue, the issue of the protection and management of intellectual property rights for analog and digital content.

Categories and Subject Descriptors (according to ACM CCS): H.4.0 [Information Systems Applications]: General

1. Introduction

Greece has already recognized the great importance of digitization for Cultural Heritage. The salvation, the long term preservation and exploitation of cultural resources of any type are strongly related to digitization (a process that includes, the creation of digital surrogates, the structuring of the digital resources in repositories and the content management aiming at efficient exploitation through added value services). In addition, long term digital preservation of digital memory is considered an emerging technological and policy issue. Both issues of digitization and long term digital preservation are considered as the basis of promoting Greek Culture through the Internet, and through interactive and multimedia applications.

Nevertheless, before the process of digitization to take place, there is one issue, which is constantly emerging, setting barriers not only to digitization itself but also to further exploitation of the digital content through the Internet and E-commerce applications, the issue of copyright protection and management. Dealing with this issue, a wide range of activity has been initiated focusing on setting a functional legal framework, supporting organizations through Technical Guidelines and experimenting with rising technologies like the Digital Rights Management Systems. The results of these activities are presented through this paper, shedding light to an issue of worldwide interest. Based on the research activity carried out at the High Performance Information Systems Laboratory of the University of Patras, a pilot information system is also being presented, which supports a cultural organization to protect and manage rights for digital content through watermarking. The system was initially designed and implemented for the Hellenic Ministry of Culture. The objective is to propose the main features, functional and technical requirements and innovative subsystems of a typical Digital Rights Management System for cultural organizations and the results to be adopted by cultural public or private organizations. The system utilizes innovative watermarking algorithms, digital image libraries, interoperable e-licensing mechanisms, unique identification subsystems so as to support digital rights management and protection functions.

2. Technical Guidelines

The Technical Guidelines entitled "Practical guide-handbook for the protection and management of Intellectual Property Rights of digital cultural content and a digital

rights management system based on international metadata standards", was based on an extensive research study and a pilot implementation on relevant issues. The aim was to support cultural organizations to characterize content to be digitized, clear the intellectual property and relevant rights. In parallel, gives advice on who are the key players, what are the collective societies and clearing houses in Greece, when and how to get in contact with them so as to clear rights and comply to the current legislative framework.

In addition, the cultural organizations are introduced to the current technological solutions for copyright protection and management such as watermarking, encryption, metadata and Digital Rights Management systems in general. Systems, software and hardware solutions, commercial applications which are focusing on the copyright protection and management issue are being presented and analyzed. The Technical Guidelines are not aiming at evaluating the software and hardware solutions but are giving advice to the cultural organizations of how to choose a solution that fits their needs amongst the existing ones.

The Technical Guidelines main scope is to provide a direct and effective method of navigating through the subsequent issues of the problem. The issues are not exhaustively analyzed and described. At first the issues are briefly presented and then the reader is directed to more detailed sources of information (if desired). In this way organizations are able to follow a step by step approach for resolving their rights clearance issues and are at the same time supported by to-do lists and tips. The process results at a clear set of rights for the digitized content, with special terms of use for Internet and E-commerce applications with relevant electronic licenses produced between the cultural organizations and technological providers.

The first chapter of the Guidelines is a practical guide to national and international legislation. A clear view of the restrictions for the use of digitized content is being given to cultural organizations, especially for the content exploited through the Internet. Furthermore, the technological means and the functional requirements necessary to support cultural organizations to protect and manage the intellectual property rights of the digital content.

In the framework of the Guidelines, several flow diagrams for the process of clearing rights are being given, which when followed by the cultural organizations (assisted by certain choices), they manage to clear the rights of the digital content, to define all the details regarding the terms of use, restrictions of use and embed watermarks for the protection of the copyright.

At present time, there are more than 300 on-going digitization projects in Greece of about a total of 120 million Euros cost, which are developing the Greek digital cultural content, the services and accompanying tools and are obliged to conform to the aforementioned Technical Guidelines. The document is only in Greek and is distributed in electronic format by the Greek Information Society Secretariat. These projects are core digitization projects aiming mainly at digitizing, disseminating and promoting collections of various historical periods of Hellenic Culture. The collections that are being digitized are including various types of content, images, artefacts, sites, buildings, archives, music, cinema and movie libraries, etc. The use of Internet for the promotion of the digital content is a very important work package of the projects, as well as the dissemination of cultural objects in other languages (English, French, German, etc). The results of the projects will be the mass digitization and mass promotion of the Hellenic Cultural Content in a European and World wide level. In addition, the content industry in Greece is being supported and cultural organizations have an important opportunity to digitize and safeguard their collections and artefacts.

3. A Typical DRMS for Digitization and IPR Protection

In this section and based on research activity carried out at the High Performance Information Systems Laboratory of the University of Patras (http://www.hpclab.ceid.upatras.gr) [DT1], a pilot information system is being presented, which supports a cultural organization to protect and manage rights for digital content. The system was initially designed and implemented for the Hellenic Ministry of Culture and the results are partly used in the aforementioned Technical Guidelines. The work was not aiming at promoting an already implemented DRMS. The objective was to shed light on the main features, functional and technical requirements and subsystems of a typical Digital Rights Management System for cultural organizations and the results to be adopted to the Technical Guidelines.

3.1. What is Digital Rights Management?

The term Digital Rights Management (DRM) was introduced in the late 1990s [CSTB99]. When content is created (information), a control to a set of rights to that content is inherited to the owner - allowing browsing, editing, printing, executing, copying etc. Traditionally, those rights have accrued from three sources:

- Legal. Rights that someone acquires either automatically under law or by some legal procedure (such as applying for a patent).
- Transactional. Rights that someone gets or gives up by trading them, such as buying a book or selling a manuscript to a publisher.
- Implicit. Rights defined by the medium that the information is in.

The most important matter about DRM is that the first two sources of rights haven't changed much with the advent of technologies such as the Internet, cell phones and MP3 files. Various parties have called for a complete replacement of the Intellectual Property (IP) law without correspodence.

The legislators have responded to new technologies by creating Directives and Acts. Transactions have remained the same regardless of the fact that they can be performed over the Internet. What is different is the implicit nature of rights when applied to traditional media. The Internet has made these implicit rights explicit. This engenders problems as well as opportunities for content providers as well as consumers [NK02].

Digital Rights Management refers to digitally controlling and managing rights for analog or digital content. The need for control and management has increased now that digital network technologies have taken away the implicit control that content owners get with legacy media.

3.2. The Typical DRM System - an Overview

The DRMS's main objectives are [BR02]:

- To provide an appropriate information infrastructure, especially focusing on cultural digital content (digital images) and its special characteristics. The services implemented range from typical e-commerce applications (electronic catalogs and shopping kart) to advanced services such as searching for images based on the image content and unauthorized content use detection.
- To protect the copyright of the digital images though robust watermarking techniques. Multi-bit watermarks are embedded to the digital images which are commercially exploited and delivered to the buyers.
- To support the digital rights management process for the cultural content and for the transactions taking place.
- To provide an effective mechanism for tracking down improper use of digital images which are owned by the cultural organization.

The general system architecture and its main components are the following:

- The Digitization layer.
- The Digital Image Library.
- The copyright protection subsystem, which protects digital content with watermarking techniques and provides for digital rights management.
- The E-Commerce applications.

The following information includes a detailed presentation of the main features and characteristics of the subsystems which the typical DRMS consists of. These systems and applications are:

- **Unique identification system**. One of the key challenges in the move from physical to electronic distribution of content is the rapid evolution of a set of common technologies and procedures to identify and manage pieces of digital content. A widely implemented and well understood approach to naming digital objects is essential if we are to see the development of services that will enable content providers to grow and prosper in an era of increasingly sophisticated computer networking. The International DOI Foundation (IDF) [DOI] was established in 1998 to address this challenge, assuming a leadership role in the development of a framework of infrastructure, policies and procedures to support the identification needs of providers of intellectual property in the multinational, multi-community environment of the network. The IDF has developed, and continues to evolve, a fully implemented solution to this challenge: the DOI System, using the Digital Object Identifier (DOI), an "actionable identifier" for intellectual property on the Internet. The DOI is now widely implemented by hundreds of organisations through millions of identified objects. The implemented DRMS is utilizing the DOIs infrastructure for the unique identification of the elements of the digital content.
- **Digital image library**. The design and implementation of the Digital Image Library is required for further development of the DRMS. The Digital Image Library is consisting of the Digital Image Library and the Metadata sets which are described in detail. The efficient management of digital images is based on an advanced database system. The Digital Image Library is designed and developed in accordance with metadata sets described in the following paragraph. The metadata sets are incorporated through tables, fields, triggers and views in the Database. The need for adopting international metadata standards is profound, especially for applications aiming at cultural content exchange. The DIG 35 Specification "Metadata for Digital Images" [DIG35], holds a very important role in the selection of fields and tables, regarding the digital images metadata. This metadata standard is already being widely used in simple end-user devices and even to worldwide networks. The database structure has also a special focus on metadata for the Intellectual Property Rights management.
- **Copyright protection subsystem**. The copyright protection subsystem is an intermediate layer between the e-commerce applications and the digital image library. Its main function is to protect the copyright of the digital images stored and exploited by the DRMS. Using a simplified view of the subsystem, it is considered as a black box which takes the original digital images as an input and produces the watermarked images. The whole process is automated and whenever a new original image is stored to the digital library the watermarked surrogates are created which carry the copyright owner id and other information used for copy control, digital signature, unauthorized use tracking and transaction management.

  Watermarking Algorithm. Watermarking principles are mainly used whenever copyright protection of digital content is required and the cover-data is available to parties who are aware of the existence of the hidden data and may have an interest removing it [SK00]. In this framework the most popular and demanding application of watermarking is to give proof of ownership of digital data by embedding copyright statements.

For this kind of application the embedded information should be robust against manipulations that may attempt to remove it [PW02]. Many watermarking schemes show weaknesses in a number of attacks and specifically those causing desynchronization which is a very efficient tool against most marking techniques [CV03]. This leads to the suggestion that detection, rather than embedding, is the core problem of digital watermarking. According to the above the first most important step towards the implementation of the watermarking algorithm is the selection and evaluation of the watermarking method. The method chosen is mainly based on the further elaboration of the MCWG (The Multimedia Coding and Watermarking Group, http://www.mcwg.gr) watermarking tool, focusing on constructing a more efficient detection mechanism, resulting to a more robust watermarking technique. The core of the MCWG tool is a transform domain technique that is based on the use of the Subband DCT transform. The marking formula is the same well known multiplicative rule used in the large majority of the existing literature. The proposed watermarking method was tested particularly with digital images provided by the Hellenic Ministry of Culture and fine-tuned in accordance with the produced results. In addition, certain actions were taken for the further development of the method so as to incorporate multi-file support, monochrome and colour images and multidimensional digital images.

- **Effective licensing mechanisms**. The difference between purchasing and licensing is very important. Purchasing a copy of a work is the dominant transaction model of the copyright legislative framework for more than 200 years. The purchasing process, involves the exclusive transfer of ownership rights from the creator to the buyer. The copyright directive allows, for certain goods, the buyer to loan, rent or resell the purchased copy. Licensing, on the other hand, consists of a restricted transfer of rights for the work for certain uses under defined and declared terms and conditions. The licenses are expressed through contracts between the interested parties. The contract includes a wide range of terms and conditions. Licensing is widely used also for information previously embedded in cultural heritage objects. Although, certain license types might have advantages, their use as an information distribution model, provokes scepticism, especially pertaining to the restriction of public access to digital content of high educational value. Licensing negotiations tend to be time consuming. The adoption of an e-licensing mechanism for the typical DRMS is necessary and is implemented through technological standards which facilitate interoperable and direct licensing modes. The license produced by the DRMS is coded in XrML (eXtensible Rights Markup Language). Whenever an element of the digital content is being transacted (distributed, purchased, etc.) a digital license is being produced by the DRMS and distributed to the interested parties.
- **E-commerce applications**. The last layer of the DRM system's architecture is the one that provides all the e-commerce applications and services. These applications aim at establishing new standards in the field of e-commerce mainly in the digital cultural content sector. The most important components are:

  Definition of a standardized pricing policy specifically for the digital images of the Cultural Heritage.

  Flexible on-line license agreement which defines restrictions of use and rights for personal use.

  Design and implementation of an on-line shop based on the Digital Image Library with an advanced on-line catalog.

  Methods of secure commercial transactions using watermarking technologies.

  The standardized pricing policy for digital images purchased through the web is promoting a flexible user license agreement ("signed" on-line). The users that adhere to the terms of the license have the right to reproduce a digital image, to use the digital image in web sites, CD-ROMs, to edit the image and create original works, but do not have the exclusive rights to resell the digital image or indirectly gain profit based on the digital image.

3.3. Case Study: Hellenic Ministry of Culture

The aforementioned DRMS was experimentaly installed to the Hellenic Ministry of Culture. The system is being used by personnel of three authoritative agencies of the Ministry. In everyday use the system supports:

- The distributed insertion and management of surrogates in the selected organizations.
- Automated and imperceptible embedment of watermarks for the copyright protection of the digital content.
- The insertion of twenty high quality digital images per day and per organization.
- Once a month and when the Ministry's network is not overloaded, these digital images are safely transferred through the network to the central database server.
- Low quality, watermarked copies are automatically presented through the Ministry's Web Site.

The above scenario is based on the assumption that a trained user in every organization will be using the system five hours per day.

4. Conclusions

The Technical Guidelines was based on an extensive research study and a pilot implementation on relevant issues. The aim is to support cultural organizations to clear rights, to comply with the current legislative framework and protect and manage the copyright of digital content.

A typical DRMS is an integrated information system able to carry out numerous functions on behalf of cultural organizations, pertaining to the protection and management of

digital cultural content, and its copyright. The DRMS provides:

- Services for creation, management and long term preservation of cultural content.
- Digital management of rights and the copyright of the content.
- Copyright proof and protection of the digital content through technical means (e.g. watermarking).
- E-Licensing mechanism for direct and effective licensing for digital content.
- Added value services for the end user (e.g. e-commerce applications).

The technologies used include digitization, digital libraries, digital object identification, metadata, encryption, watermarking, XrML, e-commerce applications and services etc. The effective combination, customization and integration of these technologies into an information system support the effective protection and management of the copyright of the digital cultural content.

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