# Repositório ISCTE-IUL

# DIGIPIPE – A PIPELINE METHODOLOGY FOR DIGITAL IMAGE PRODUCTION AND PROTECTION

Carlos Serrão[1], Joaquim Marques[2]

[1]ISCTE, Av. Das Forças Armadas 1600-082 Lisboa, Portugal, carlos.serrao@iscte.pt
[2]IPCB, Av. Pedro Alvares Cabral Nº12 6000 Castelo Branco, Portugal, marques@ipcb.pt

**Abstract**: *Electronic trading of multimedia content faces today important challenges. One of the most important challenges refers to the lack of production methodologies with strong interactions with the current state of the art digital content protection tools. This paper proposes a methodology, especially useful in the field of still digital images that interconnects a digital image production pipeline with coherent protection mechanisms building a framework for a digital rights management solution.*

**Keywords**: *e-commerce, metadata, watermark, image bank, image format, digital rights management*

## 1    INTRODUCTION

The Electronic Commerce of digital contents is growing in terms of importance profiting from the interconnected and heterogeneous world that the Internet represents. Success examples appear from all corners of the world, and audio, video and images represent the most important types of media being traded through digital means today. Examples such as Corbis[1] and Photodisc[2] are extremely representative of the growing importance of this type of business. Also, popular media formats, like MP3 for audio and DivX for video are facilitating the electronic exchange of digital media. Additionally, new digital imaging formats are hitting the market, like JPEG 2000 that will help electronic trading of digital images over the Internet to be pushed forward. Other important example of digital content trading is music. Music web stores are flourishing in the WWW, in particular due to the advent of the MP3 music format, which facilitates music exchanges [1].

Still digital image trading can profit from e-commerce technologies since the customers (marketing agencies, newspapers, magazines, and others) can access directly the image bank and search for the appropriate image for their needs, negotiate, buy and acquire it electronically and without any way of physical interaction. Disintermediation is a key factor in this type of electronic business as well as the rapid and easier access to content [2].

To explore completely these new digital contents e-commerce trends it is necessary to defend the rights owners of these digital goods. Copyright is essential to people who wants to maintain the recognition (financial, scientific, artistic) from is work, providing the legal basis for

---

[1] http://www.corbis.com
[2] http://www.photodisc.com

protecting the value of the still pictures. The value of that copyright, however, depends upon the legal tools that the interested parties use to protect them. This is a crucial issue in the digital world, where technology makes unauthorized copying and distribution of digital images easier for users. Without a concise protection policy capable of enforcing the legitimate user's copyright, authors will not trust the digital images electronic supply chain, turning the overall process completely unviable. Protection and rights management associated with perceptible content value is the appropriate way to turn digital images trading business viable for all interested business players. This paper presents a digital imaging production methodology, based on Digital Rights Management solutions appropriate for the mass production of still digital images content for trading using electronic commerce solutions with content rights protection concerns.

## 2   THE DIGIPIPE METHODOLOGY

This paper presents a methodology proposal called DIGIPIPE – Digital Imaging production Pipeline. This methodology describes the process of producing still digital images (both by creating them from non-digital formats, or by acquiring them directly by digital format), and trades them in an Electronic Commerce Application using DRM solutions.

This methodology encompasses 12 well-defined steps, each one with their specificities: pre-selection, digitalization, selection, retouching, pre-cataloguing, tilling, registration, watermark insertion, CD-ROM production, and portal publication, cataloguing and trading. Each of these steps is defined in the next few sections.
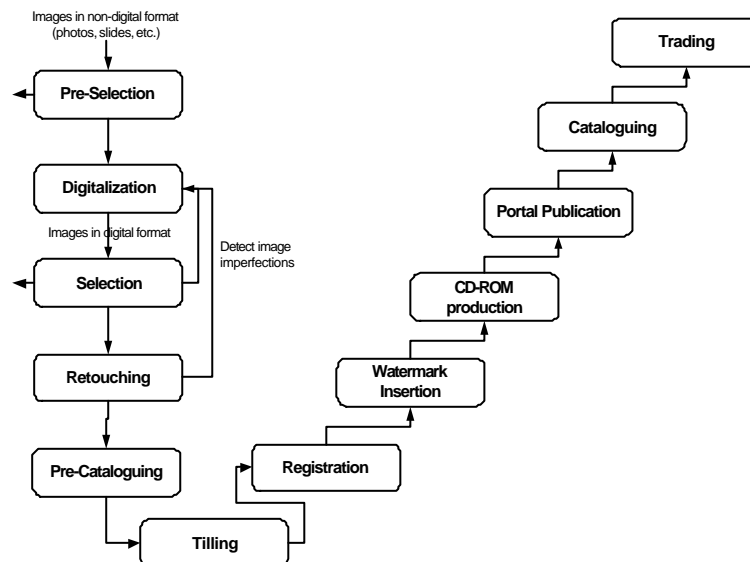


**Fig. 1** - The DIGIPIPE methodology overview

## 2.1   Pre-Selection, Digitalization and Selection

Pre-selection is the initial phase of the DIGIPIPE methodology and is the process responsible for a first image filtering process, evaluating if the images have or not quality enough to be digitized and afterwards published in electronic commerce site. This phase will only take place if the source of the images in non-digital. The author normally delivers the images in non-digital format (35mm, 6x9mm slides, paper or other formats) to the platform administrator and together they perform an interactive and exhaustive process of selecting the best quality images that will go into the next phase. Some of the choosing criteria, which are important in this phase, are: 1) Image technical quality: both the author and the administrator can reject images which are technically considered as being of bad quality; 2) Image type: if the author or the administrator consider that the image is not adequate for the purposes; 3) Image themes: if the image independently of it quality don't fit in any site themes could be rejected. Selected images go into the next phase of the methodology whilst the rejected images are returned to the author [3].

In the digitalization phase, a high-quality image scanner is used to produce high-quality digital images (images can be also directly acquired by the digital cameras). This scanner must be able to support multiple slide formats and must be able to produce high-resolution images (600 to 1200 dpi), normally resulting in a TIFF file of several tens of megabytes. The images (slides) must be perfectly cleaned in order to remove dust and scratches from the film. This could interfere in the final quality of the digitized images. The images selected in the previous phase of the methodology are then digitized by the operator resulting in a file, which is then saved to the hard disk (security copies are also performed using CD-ROM or DVD recorders) [4].

The selection phase is the final selective phase in this methodology and will be used to filter the digital images that will pass into the next phases of the proposed methodology. The digital images are then loaded from the hard drive and opened in an image editing software in a perfectly colour calibrated screen monitor. The administrator, through the digital image visual observation determines if the digital image is selected or rejected, based on the level of imperfections resulting from the digitalization phase. The author can, optionally, participate in this phase if necessary. The rejected images can return to the digitalization phase or definitely rejected and returned to the author.

## 2.2   Retouching, Pre-Cataloguing and Tilling

The retouching phase is used to correct minor visual imperfections detected in the digital image after performing a visual observation. This phase can occur at the same time then the previous one. Like in the previous phase, the digital images are loaded from their digital support and opened in an image editing software on a perfectly colour calibrated screen monitor. The administrator performs an accurate visual examination of the image and if necessary performs some retouch operations. These operations could include some of the following: cropping, colour balancing, colour correction and others. The images can be stored once again in the digital support or rejected if the retouching process results are not satisfactory. In this last case, the images must be digitized once again.

In the pre-cataloguing, some additional information about the image is collected and stored on a database. Although in this pre-cataloguing phase it is not mandatory the author's presence, in some cases it can be useful its collaboration. The images are loaded from digital support and

opened in an image editing software by the administrator. The administrator then fills a small electronic form containing some information about the image: Category and subcategory (which are compliant with a previously defined thesaurus); Initial description; Author name; Collection info. All this information is automatically filled on the database and is the first information about the image.

The process of tilling consists in the production of several different image sizes from the original image. This methodology proposes the usage of three different tiles: thumbnail, preview and original. Why is the tilling important? Tilling is particularly important due to the current bandwidth limitations of the Internet allowing a much faster browsing through the images. This methodology suggests the usage of three different image resolution levels, but more levels can be defined, and actually that depends on the business models that the administrator wants to implement: Thumbnail, used to perform a faster display of the image on web pages; Preview, used to capture details of a particular image; Original, the original image in its original size - the image that will be traded [6].

## 2.3    Registration and Watermark Insertion

The registration phase is one of the most important in this proposed methodology and constitutes an important DRM feature. During this phase, the digital object is uniquely registered and a unique identifier is issued – the license plate (LP). This LP will be used on all system to identify the image. The LP is an unique image identification and is composed of the following: 1) identifier of the type of the digital object (e.g. 11 means that this is a still digital image); 2) identifier of the registration authority: it is composed by the ISO country code and a number; 3) sequential number: indicating the number of registration within the registration authority[3].

The registration process works in the following way: a) original image is loaded from the digital support; b) a cryptographic hash function is computed from the image file data, using MD5 hash algorithm. The obtained hash value warrants the uniqueness of the image, since it probabilistically very low the possibility the two different images to have the same hash value; c) a new license plate number is assigned and attached to the hash value of the image; d) Both values are stored on the registration database; e) The pre-cataloguing phase data is loaded from the database and inserted as metadata inside the image file together with the license plate [6].

The watermarking insertion phase is also very important in any DRM solution. This is perhaps the most effective way to protect a digital image. During this phase two different types of watermarks will be used: visible watermarks to embed a visible logotype on the image preview level, and an invisible watermark that will be used to embed the information (license plate) on the original image. The original image is loaded from the digital support and using an invisible watermarking algorithm, the LP information is embedded in the image. The resulting image data is stored. The preview image is also loaded from the digital support and using a visible watermarking algorithm, an image logotype is stamped on the preview image. The resulting image is stored on the support. At this stage the original image is protected both with an invisible watermark which contains information about the registration authority and with the metadata which contains information about the image author [5].

---

[3] An example of such Registration Authority can be found at http://rcm.adetti.iscte.pt

**2.4    CD-ROM production, Cataloguing, E-Commerce site publication and Trading**

At this stage a CD-ROM catalogue containing the registered and watermarked images is produced and delivered to the author. This CD-ROM catalogue will be produced in HTML and will be visible using a normal web browser. It will contain all the three levels of image resolution and the pre-cataloguing information. This catalogue is sent to the author, transmitting the image protection phase of this methodology. If the author is not planning to trade the images over the Internet then the next phases of this methodology are unnecessary.

The Electronic Commerce Application will provide a mechanism for the author to add some information about himself and about the images published on the portal. Such information includes: Image title: a descriptive title of the image; Image detailed description: a detailed description of the image, describing as most as possible all the elements contained in the picture; Image category and subcategory: the category and subcategory where the image will be placed; Image collection and collection information: if the image belongs to a particular collection then this information and also information about the collection itself is taken in account; Image keywords: this is a set of keywords used to describe the image. This is important for searching purposes, therefore the process of keyword selection is crucial; Author information: general information about the image author; and other relevant information [4].

The E-Commerce site publication phase is where the author decides to trade the images and they are published in the WWW through the Electronic Commerce Application. This will organize the images in such a way that they will contain some value for the final user. Three types of organization are present in this platform: by author, by collection and by category. This provides the user an improved navigation experience and allows the user to choose the most appropriate image for their needs [5].

At the trading phase, the user is notified with a copyright notice. The images are then selected and sent by the delivery method choose to the user. The negotiation process involves several steps that are specified in the following topics: choose the image ?  choose the image usage type (generic usage, specific usage, specific usage conditions) ?  accepting the contract ? delivery address ?  payment method ?  delivery method.

After this interactive trading process is finished the image and a copy of the contract is sent to the user.


**3    CONCLUSION**

To enable electronic trading of digital content it is necessary to provide content protection and rights management in such a way that can enable trust between parties. This is the main goal of the proposed methodology. The schema of the protection possibilities are not forgotten and simultaneously implements various protection techniques that enable synergies and implements a higher trust level for copyright owners (copyright notice, registration, watermarking).These techniques are obviously insufficient without the existence of a system capable to support the management of content and associated rights. DIGIPIPE methodology enables this support and also a versatile and trusted way of doing digital contents electronic business.

## REFERENCES

[1] Digimarc C., Corbis , Digimarc bring active content solution to market , Sept. 2001 (http://digimarc.com/news/p r01-05.htm )

[2] DeBat, A. and A. Hoy, Copyright pirates: Web photos are under protection, Photo Marketing –Magazine, September 2001 (http://www.pmai.org/magazine/0901_copy.htm )

[3] CNBC, Getty Images, Inc.: SEC Filings, Dec 2000 Annual Report, http://news.moneycentral.msn.com/sec/business.asp?symbol=GETY )

[4] ITU-T Recommendation T.84 | ISO/IEC 10918-3

[5] Herrigel, A., Ruahnaid, A., et al., Secure copyright protection techniques for digital images, Information Hiding, 1998, http://citeseer.nj.nec.com/update/441322

[6] Guimarães, J; Serrão C.; Protecting Intellectual Property Rights trough Secure Interactive Contract Negotiation; May 1999; ECMAST99 –Madrid, Spain