Chapter V
Watermarking and Authentication in JPEG2000

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ABSTRACT

This chapter introduces JPEG 2000 as an application field for image authentication and the new technology of digital image watermarking. The new compression format has many unexplored characteristics that both the watermarking and the authentication communities should carefully take into account. Thus, a brief introduction to the standard is given at the beginning, discussing its structure, features, novelties, and capabilities. Following that introduction, watermarking techniques are presented, at first into the wavelet domain (the DWT is part of the JPEG2000 core), and then into the JPEG 2000 pipeline. The effects of the various standards' parameters in this process are carefully investigated. Then, authentication mechanisms of JPEG 2000 images are described and we peek into JPSEC, part-8 of JPEG 2000 that deals with issues of watermarking and authentication.

INTRODUCTION

Since the mid 1980s, ITU (International Telecommunications Union) and ISO (International Organization for Standardization) have joined efforts in order to establish a new standard for efficient compression of grayscale and still color images. The result of this process has been named “JPEG” (Joint Photographic Experts Group) and has been established as international standard IS 10918-1 in 1991. Very soon, the JPEG image format (jpg) has became the most commonly used format. New features were soon added. However, some of them required costly licensing, while some of the more than 40 available options, were mutually exclusive. Thus, only basic functionalities were adopted from most
users. To correct the mistakes of the past, to take account of new trends (e.g. wavelets) and to adapt to the increased needs and requirements of modern multimedia and Internet applications, a new standard was required. Under these circumstances, almost a decade later, JPEG2000 emerged (“JPEG 2000”, 2007). The new standard provided a unified coding system for different types of still images (bilevel, gray scale, color, multicomponent) with different characteristics (natural, medical, remote sensing etc.) allowing different imaging models (client/server, real time transmission, image library archival etc.). The system performs superior to older standards by achieving great compression ratios while retaining image quality at the same time. Part I of the standard (ISO/IEC 15444-1, 2007) can be used on a royalty and fee-free basis. All these lead to the conclusion that it is only a matter of time before JPEG2000 will become widely accepted.

Watermarking and authentication for digital images are also new technologies, descendants of the last decade. The main reason for their introduction was the fact that digital images are quite easy to duplicate, forge or misuse. One of the most important applications of watermarking is the protection of the images’ copyright while authentication aims to the verification of the content, investigate if an image is tampered or not and if it is, to identify the locations that these alterations have occurred. Both technologies need in order to succeed, the inclusion of side-information into the original image. That is obviously the reason why lossy compression schemes often cause to them great problems. Part of the watermarking or authentication information may be discarded along with insignificant (presumed) parts of the original image’s content, as a side effect in order to achieve better compression. Very few techniques have been proposed to cope with this problem and this is the motivation behind this chapter.

This chapter is organized in four parts. The first one, is a short presentation of the JPEG2000 structure, features, novelties introduced and capabilities. Following that introduction, the second part describes watermarking, at first into the wavelet domain (the DWT is part of the JPEG2000 core) and then right into the JPEG2000 pipeline. The effects of the various standard’s parameters are also described in this part. In the third part the authentication mechanisms of JPEG 2000 images are described along with parameters that affect the watermarking process as image capacity and quality. The last part is the shortest and describes in brief JPSEC, part-8 of JPEG2000 that deals with such cases.

**JPEG2000: AN OVERVIEW OF THE STANDARD**

The new standard has come to serve a wide variety of applications like the Internet, mobile communications, medical imagery, remote sensing, color facsimile, printing and scanning, digital photography, e-commerce, digital libraries and many more. Of course, each of these areas imposes certain requirements that the new standard should fulfil in the best possible way. So the implementation of JPEG2000 provides the following:

- **Superior low bit-rate performance:** The new standard performs superior according to its predecessors for very low bit-rates. It is now possible to compress grayscale images with high detail, under 0.2 bpp. Of course Internet and mobile communications, as well as network applications greatly benefit from this feature.

- **Continuous-tone and bilevel compression:** Various kinds of images are supported by the new compression system. The algorithm is capable of compressing images of various dynamic ranges (e.g. from 1 to 16 bpp for each color component). This turns beneficial for a variety of applications
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