



## Chapter XVI

# A Robust Watermarking Scheme Using Codes Based on the Redundant Residue Number System

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## Abstract

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*In this chapter, a watermarking scheme that utilizes error correction codes for added robustness is proposed. A literature survey covering various aspects of the watermarking scheme, such as the arithmetic redundant residue number system, and concepts related to digital watermarking is given. The requirements of a robust watermarking scheme are also described. In addition, descriptions and experimental results of the proposed watermarking scheme are provided to demonstrate the functionality of the scheme. The authors hope that with the completion of this chapter, the reader will have a better understanding of ideas related to digital watermarking as well as the arithmetic redundant number system.*

## Introduction

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Companies and people alike have benefited greatly from the usage of computers in their work and daily lives. Gone are the days when interested parties would have to scour libraries and archives for references to information that they require. Today, all of these and more are accessible with the click of a mouse. The Internet has proven itself to be a limitless source of information, ranging from texts, images, sounds, and videos. Everyone can now obtain the resources that they need and use it at their pleasure, at almost no cost. Everyone is an expert, sometimes to the chagrin of real experts of the subject matter.

However, as an unforeseen consequence of this, people are ignorant to copyright issues often associated with materials obtained via the Internet. Often times, people choose to continue their activities with full knowledge that copyright laws are being violated by their actions. Solving this ever-growing problem requires a multi-prong approach ranging from passing new regulatory laws, enforcing fines on copyright violators and developing technologies that can be used in managing digital media.

One of the more promising technologies that can be used to curtail the illegal use of copyrighted materials is digital watermarking. An exciting and fast-growing field in digital watermarking focuses on the challenges involved in securing digital images. In general, a watermarking scheme attempts to hide a mark within an image that can be used for a variety of purposes such as copyright protection (Barni, Bartolini, Cappellini, & Piva, 1997; Craver, Memon, Yeo, & Yeung, 1998), fingerprinting for traitor tracking (Boneh & Shaw, 1998), copy protection and image authentication (Celik, Sharma, Saber, & Tekalp, 2002; Kundur & Hatzinakos, 1999).

## Definitions and Histories

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### Arithmetic Redundant Residue Codes

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The Chinese remainder theorem (CRT) owes its namesake to a Chinese mathematician by the name of Sun Zi, who has been credited for its initial conceptualization. The theorem first appeared in the book called *Sun Zi Suanjing* or simply Sun's Arithmetical Manual (Ding, Pei, & Salomaa, 1996, p. 2). The CRT has its many uses ranging from fields such as cryptography, computing, and coding theory.

In the field of cryptography, Shamir (1979), and later improved by Asmuth and Bloom (1983), proposed a scheme of distributing a common secret among a group of participants. Each participant has only a partial piece of the secret that cannot be used to derive the whole secret. According to Stinson (1995, p. 326), some subset of participants must cooperate to reconstitute the secret. On the other hand, for the field of computing, Asmuth and Blakley (1982) suggested a technique where a large computer file is split into several parts and stored in a few computers. The loss of a fixed number of parts not

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