Chapter 16
Digital Image Watermarking Based on Fractal Image Coding

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ABSTRACT
This chapter proposes a watermarking technique using Ridgelet and Discrete Wavelet Transform (DWT) techniques. A wavelet transform is the wavelet function representation. A wavelet is a mathematical function which divides a continuous time signal into different scale components, where each scale components is assigned with a frequency range. Wavelets represent objects with point singularities, while ridgelets represents objects with line singularities. The Ridgelet transform Technique is a multi-scale representation for functions on continuous spaces that are smooth away from discontinuities along lines. The proposed technique applies Ridgelet transform on the cover image to obtain ridgelet coefficients. These coefficients are transformed by using 2-level DWT to get low frequency sub-bands – LL1 and LL2. The mutual similarities between LL1 and LL2 sub-bands are considered for embedding watermark. The obtained watermarked image has better quality when compared to a few exiting methods.

INTRODUCTION
The Berne Convention, is an international agreement governing copyright was first accepted by all Berne union member countries in Berne, Switzerland, in 1886 and modified at Paris in 1971 (Fitzgerald Brian et. al., 2011). The countries have realized the importance of intellectual property rights (IPR) after the establishment of the World Trade Organization (WTO) in 1995 (Hannibal Travis, 2008; Barbara Fox and Brian A. LaMacchia, 2003; Channapragada R. S. G. Rao et. al., 2014a). The advent of Wi-Fi technology has resulted in enormous increase in opportunities for creation and distribution of digital content. To protect the rights of creators of digital content and intended recipients while distributing over internet, the content is digitally watermarked so as to check the authenticity or copyright protection of the content. Digital watermarking has become an active and important area of research and development.

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Digital watermarking is a proven and existing technology that has been deployed in a broad range of applications like, E-commerce, Counterfeit deterrence, Broadcast monitoring, Forensic, digital Rights management, Copy prevention, Content filtering and classification (I.J. Cox et. al., 2002; Christine I. Podilchuk and Edward J. Delp, 2001). A digital watermark is defined as secret/authentication information embedded in a noise-tolerant signal such as audio or image data. Digital Watermarking is the technique of inserting authentication content in a carrier signal (Ingemar J. Cox., 2008; I.J. Cox et. al., 2002). The digital signature embedded as a watermark should retain its integrity within the content even after various manipulation attacks. The embedded signature can easily be extracted using suitable techniques. A watermark can be unique to one image or common to multiple images. A watermarking life cycle, shown in Figure 1, is divided into three distinct steps, Watermark Insertion/Embedding, Image Manipulation/Attacks, and Watermark Extraction/Detection (I.J. Cox et. al., 2002; Vidyasagar M. Potdar et al., 2005). In Watermark Insertion, an algorithm inserts the watermark into the cover image and produces a watermarked image. The watermarked image is stored in hard disk, shared or transmitted on Internet. If any user on Internet downloads this image and displays in his web site by making modifications without owner’s permission then the image is said to be manipulated or attacked. These manipulations may distract watermark or may even remove the same. In the Watermark Extraction or Detection process, an algorithm is applied to the attacked image to extract the watermark from attacked watermarked image for proving the authentication (M. Kutter & F.A.P. Petitcolas, 1999).

There are many watermark techniques in terms of their characteristic, application areas and purposes. They have different insertion and extraction methods (I.J. Cox et. al., 2002; Christine I. Podilchuk and Edward J. Delp, 2001; R.S.G. Rao Channapragada et al., 2012a). Digital watermarking methods can be classified based on working domain, type of document, human perception or application area as shown in Figure 2.

The watermarking techniques can be categorized to Time and Spatial domain and Transform domain based on the algorithms applied. Enhancement of the input signal through filtering is the most acceptable processing approach in the time or space domain (I.J. Cox et. al., 2002; Christine I. Podilchuk and Edward J. Delp, 2001). To analyze the signal properties the frequency domain analysis is used. This allows studying the spectrum to determine which frequencies are present in the input signal and which are missing. Signals are converted from time or space domain to the frequency domain the transform techniques like Fourier Transform (FT), Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Discrete Hadamard Transform (DHT), Walsh Hadamard Transform (WHT), Discrete Cosine Transform (DCT) etc. (M. Barni et. al., 1998; X. Kang et. al. 2008; R.S.G. Rao Channapragada et. al.,

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**Figure 1. Digital watermarking life cycle**
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