International Journal of Innovative Computing, Information and Control
Volume **4**, Number **11**, November **2008**
ICIC International ©2008 ISSN 1349-4198
pp. 3027–3036

DCT-BASED ZERO REPLACEMENT REVERSIBLE IMAGE WATERMARKING APPROACH

Chien-Chang Chen and De-Sheng Kao

Department of Computer Science
Hsuan Chuang University
Hsinchu 300, Taiwan
cchen34@hcu.edu.tw

Received August 2007; revised December 2007

Abstract. *Reversible watermarking recovers an original image from a watermarked image by extracting the embedded watermarks. This work presents a reversible image watermarking approach that works on quantized DCT coefficients, implying that the original quantized image can be recovered perfectly after watermark extraction. The concept of zero replacement reversible watermarking is presented. Two parameters adjustment rules, ZRE and ZRX, are first proposed to embed and extract one bit to DCT coefficients, respectively. Additionally, the CA rule is presented to prevent confusion during embedding and extraction. Watermark embedding and extracting algorithms based on these three rules are then proposed. Experimental results indicate that the quality of watermarked image is very good, and that the proposed approach can also identify maliciously attacked regions efficiently. The proposed approach is also compared with other watermarking methods, demonstrating that the proposed approach works well.*
Keywords: Reversible watermarking, DCT, Quantization

1. **Introduction.** Digital images are easy to transmit, modify and reproduce. Therefore, protecting an important image from malicious attack or unauthorized usage is of priority concern. Watermarking has recently become a popular solution to this image authentication problem for protecting important images [4], and can be further extended to video [13].

Watermarking involves embedding user information into an image. However, such watermarking is always irreversible, i.e. the original image cannot be recovered after watermark extraction. Some applications, such as medical or military images, need to recover the original image from a watermarked image. Therefore, reversible watermarking approaches have been presented.

Studies on reversible watermarking approaches are briefly reviewed below. Most reversible watermarking approaches operate on the spatial domain. Alattar [1] embedded watermarks by difference integer transformation. Celik *et al.* [2] first compressed the remainder of an image, then embedded reversible watermarks into the saved space of the remainder. Tian [11] presented a technique to embed one watermark bit into the LSB of difference between two pixels. The new calculated difference is then added to these two selected pixels as embedding steps. Ni *et al.* [10] presented a histogram-based reversible watermarking approach. A watermark bit 1 is embedded by adding the peak-pixel value in histogram, while embedding a 0 involves no modification. Vleeschouwer *et al.* [12] used a circular histogram to solve the reversible watermarking problem. They transferred the histogram to a circle, then shifted the histogram clockwise or counterclockwise by embedding a watermark bit. Li [9] presented an image-independent reversible watermarking