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A new wavelet based logo-watermarking scheme

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Abstract

A new wavelet based logo-watermarking scheme for copyright protection of digital image is presented. Instead of using a noise type Gaussian sequence, a visually meaningful gray scale logo is used as watermark. Watermark embedding process is carried out by transforming both the image and logo in wavelet domain. To embed the watermark robustly and imperceptibly, watermark bits are added to the significant coefficients of each subband selected by considering the human visual system (HVS) characteristics. A scheme is developed for reliable extraction of watermark from distorted images. From the experimental results it can be observed that proposed method is robust to wide variety of attacks. Comparison with the existing methods shows the superiority of the proposed method.

Keywords: Watermarking; Logo; Wavelet transform; HVS characteristics

1. Introduction

With the increasing use of Internet and effortless copying, tampering and distribution of digital data, copyright protection for multimedia data has become an important issue. Digital watermarking emerged as a tool for protecting the multimedia data from copyright infringement. In digital watermarking an imperceptible signal "mark" is embedded into the host image, which uniquely identifies the ownership. After embedding the watermark, there should be no perceptual degradation. These watermarks should not be removable by unauthorized person and should be robust against intentional and unintentional attacks. Different watermarking techniques have already been published in the literature. Overviews on watermarking techniques can be found in (Langelaar et al., 2000).

Watermarking techniques can be broadly classified into two categories: such as spatial domain methods and transform domain methods. Spatial domain methods are less complex as no transform

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is used, but are not robust against attacks. Transform domain watermarking techniques are more robust in comparison to spatial domain methods. This is due to the fact that when image is inverse wavelet transformed watermark is distributed irregularly over the image, making the attacker difficult to read or modify. Among the transform domain watermarking techniques discrete wavelet transform (DWT) based watermarking techniques are gaining more popularity because of superior modeling of HVS. A detail survey on wavelet based watermarking techniques can be found in (Meerwald and Uhl, 2001).

Another advantage of the wavelet domain-watermarking algorithms is that security can be improved by selecting a key dependent wavelet transform as implemented in (Wang et al., 2002). They used randomly generated orthonormal filter bank as a major part of the private key. Besides selecting the filter bank randomly, to improve the private control over the watermark, middle frequency subbands are also selected based on the private key. Similarly, Dietl et al. (2003) proposed to use wavelet filter parameterization as a secret transform domain to improve the security of the watermarking method. To take the advantage of localization and multiresolution property of the wavelet transform Zhang et al. (2003) and Wang and Lin (2004) proposed wavelet tree based watermarking algorithms. Dawei et al. (2004) proposed a new type of technique in which wavelet transform applies locally, based on chaotic logistic map, and embeds the watermark. This method shows good robustness to geometric attacks like cropping and rotation but is sensitive to common signal processing attacks like lowpass filtering and image sharpening.

As pointed out by Braudaway (1997) and Zeng and Lei (1999), by embedding visually meaningful marks like logo or seal, it can be easy for convincing non-technical arbitrators by showing the extracted logo or seal than presenting a numerical value detected using statistical watermark detection techniques. Another advantage of using logo as watermark is that HVS characteristics can be exploited in recognizing noisy visual mark since HVS filters out random noise for better recognition of meaningful pattern.

Many researchers have investigated watermarking methods by embedding binary logos. Ohnishi and Matsui (1996) showed a method for embedding seal in wavelet transform domain. In order to make the method robust to JPEG compression they quantized the wavelet coefficients depending on the quality factor before embedding watermark. A method of embedding logos in DCT domain was proposed by Hsu and Wu (1996). First they permuted the seal using pseudo-random number traversing method and added this to the middle frequency coefficient of the 8×8 DCT coefficient block. Later they (Hsu and Wu, 1998) proposed a method in which both the image and binary logo are hierarchically wavelet decomposed and detail bands of the logo are added to corresponding bands of the image.

Kim et al. (1999) proposed a method for embedding binary logos in the Fourier domain. Before embedding the logo into the host data, they modulated the logo by adding pseudo-noise generated with a secret key. Zeng and Lei (1999) embedded binary logos by segmenting the image into small blocks and embedding one bit for each block. For improving the detector performance they exploited spatial correlation of the logo by embedding adjacent logo bits in adjacent image blocks and incorporating them in extraction procedure.

All the methods discussed above refer to binary watermark embedding only. But in many practical applications logos are grayscale images and these methods cannot be directly used for embedding them. Some authors like Niu et al. (2000) have embedded gray scale logos by converting them into bit planes. But by converting the grayscale logos into bit planes, these methods are not exploiting the perceptual characteristics of the logos and the host data in embedding the watermark. As pointed out by Kundur and Hatzinakos (2004) use of grayscale logo as watermark facilitates the embedding of arbitrary commercial logos and increases the quality of and overall number of possible logos identifiable by human observers. Kundur and Hatzinakos (2004) proposed a multiresolution fusion based watermarking method for embedding grayscale logos into wavelet-transformed images. For watermarking,