IMAGE WATERMARKING IN THE TIME-FREQUENCY DOMAIN

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ABSTRACT

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With the fast development of the internet and multimedia tools in the past decade, the access and the unauthorized reproduction of digital data has become easier and widespread. The ease of access to digital data brings with itself the challenge of content protection. One way to address this problem is through digital watermarking, which has become an important tool in copyright protection applications. The watermarking algorithms proposed so far, focus on time or frequency domain representations of the image. There have been only a few attempts to utilize the joint time-frequency (spatial-spectral) characteristics of an image for watermarking. These time-frequency domain watermarking attempts were mainly focused on detecting the watermark rather than extracting it and did not provide a theoretical framework for the performance analysis of the watermarking algorithms.

In this dissertation, we introduce three new image watermarking schemes in the joint time-frequency domain to address these issues in image watermarking. The first two methods embed the watermark in the time-frequency domain of the image using Wigner distribution. Two different methods for embedding the watermark in the Wigner distribution are introduced; the Time-Wigner method where the watermark is embedded directly into the Wigner distribution of the image, and the Wigner-Wigner method where the Wigner distribution of the watermark is embedded in the Wigner distribution of the image. The performance of the embedding algorithms and the corresponding watermark detectors are analyzed. It is shown that embedding in the time-frequency domain is equivalent to a non-linear embedding function in the
spatial domain. The third watermarking approach in the time-frequency domain uses the local autocorrelation function of the image. The local autocorrelation function for a subset of pixels chosen from the image is computed and the watermark is embedded in the selected locations of the autocorrelation function. A blind detection algorithm is derived and its performance is quantified by deriving the probability of error. The proposed algorithm is shown to be transparent and robust under attacks. A comparison of the proposed methods with a discrete wavelet transform (DWT) domain based or/and spread spectrum (SS) methods is illustrated through simulations. The detailed analysis of the proposed time-frequency watermarking algorithms shows that looking at this joint domain improves watermarking capacity and robustness compared to existing methods.