HIGH CAPACITY ROBUST AUDIO WATERMARKING SCHEME BASED ON FFT AND LINEAR REGRESSION

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ABSTRACT. This paper proposes a novel high capacity audio watermarking algorithm to embed data and extract them in a bit-exact manner by changing some of the magnitudes of the FFT spectrum. The key idea is to divide the FFT spectrum into short frames and change the magnitudes of the selected FFT samples using linear regression and the average of the samples of each frame. Using the average of FFT magnitudes leads to improved robustness, since this variable is more invariant against manipulations compared with the magnitudes of single samples. In addition, linear regression helps to minimize the alterations of FFT samples, which results in better transparency. Apart from very remarkable capacity, transparency and robustness, this scheme provides three parameters which facilitate the regulation of these properties. The experimental results show that the method has a high capacity (0.5 to 2.3 kbps), without significant perceptual distortion (ODG is about –1) and provides robustness against common audio signal processing such as echo, added noise, filtering and MPEG compression (MP3).

Keywords: Audio watermarking, Multimedia security

1. Introduction. The growth of the Internet, sudden production of low-cost and reliable storage devices, digital media production and editing technologies have led to widespread forgeries of digital documents and unauthorized sharing of digital data. As a result, the music industry alone claims multi-billion illegal music downloads on the Internet every year. Thus, it is vital to develop robust technologies to protect copyrighted digital media from illegal sharing and tampering.

Considering the embedding domain, audio watermarking techniques can be classified into time domain and frequency domain methods. In frequency domain watermarking [1-9,14-16], after taking one of the usual transforms such as the Discrete/Fast Fourier Transform (DFT/FFT) [4-6,17], the Modified Discrete Cosine Transform (MDCT) or the Wavelet Transform (WT) from the signal [7,9,14-16], the hidden bits are embedded into the resulting transform coefficients.

In addition to wavelet transform, [14] uses optimization for quantization, [15] takes advantage of the patchwork embedding method, and normalized energy is used in [16].


In frequency domain schemes, the Fourier transform (FT) is very popular. Among different Fourier transform, the Fast Fourier transform (FFT) is often used due to its