

Chapter 6

Survey of Spread Spectrum Based Audio Watermarking Schemes

This chapter presents the survey of spread spectrum based audio watermarking schemes in the literature.

6.1 BASIC DIRECT SEQUENCE SPREAD SPECTRUM

Cox et al. (1997) proposed a secure robust watermarking approach for multimedia based on spread spectrum technology. Although their system was originally proposed for watermarking images the basic idea also applies to audio watermarking.

The watermarking procedure proceeds as follows:

From host signal, a sequence of values $x = \{x_i\}$ is extracted, which is used for inserting secret message $m = \{m_i\}$. The watermarked sequence is denoted as $w' = \{w'_i\}$ and inserted back into the place of x to obtain a watermarked signal y . During

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transmission, possible distortion or attacks may affect y and the received signal is now denoted as \hat{y} , which may not be identical to y . Assume the host signal is available at the decoder side, a probably altered watermarked sequence $w^* = \{w_i^*\}$ is first extracted from the received signal \hat{y} . A possibly corrupted message m^* is extracted from w^* and compared to m for statistical significance. (Cox et al., 1997).

During watermark embedding, a scaling parameter α which controls the watermark strength is specified and used in the watermark embedding equation. Three embedding formulae used are

$$y = x + \alpha w \quad (6.1)$$

$$y = x(1 + \alpha w) \quad (6.2)$$

$$y = x(e^{\alpha w}) \quad (6.3)$$

Equation (6.2) is used in (Cox, 1997) with $\alpha = 0.1$.

The similarity between the extracted watermark and the embedded watermark is measured by

$$sim(m, m^*) = \frac{m \cdot m^*}{\sqrt{m^* \cdot m^*}} \quad (6.4)$$

Large values of $sim(m, m^*)$ are important and typically if $sim(m, m^*) > 6$, then a watermark is detected in the received signal.

6.2 TIME DOMAIN SPREAD SPECTRUM WATERMARKING SCHEME

Cvejic et al. (2004) proposed an alternative audio spread spectrum watermarking scheme in the time domain. The embedding part is illustrated in Figure 1.

Time domain masking properties of the HAS are used to maximize the amplitude of the watermark to be embedded, which increases robustness during detection, while still keeping the watermark imperceptible and maintaining high perceptual audio quality.

A frequency analysis block counts the signal zero-crossing-rate (ZCR) in the basic block interval and derives the high frequency spectral information. The power of the embedded watermark is proportional to the amount and strength of high frequency

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