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Efficient Robust Audio Watermarking using Empirical Mode Decomposition

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***Abstract-* With the increasing usage of digital multimedia, the protection of intellectual property rights problem has become a very important issue. Watermarking has become a technology of choice for a broad range of multimedia copyright protection applications. Watermarks have also been used to embed format-independent data in audio/video signals in a way that is robust in functioning. In this paper a new adaptive audio watermarking algorithm based on Empirical Mode Decomposition (EMD) is introduced. This proposed technique aims at improving robustness, amend estimation/removal attacks, improving watermark imperceptiveness, and establishing convert communication over audio channel. The paper also brings to view works done by various on digital audio watermarking.**

Key Words- Audio Watermarking, robustness, synchronization code, frames.

I. INTRODUCTION

Digital audio watermarking has received a great deal of attention in the literature to provide efficient solutions for copyright protection of digital media by embedding a watermark in the original audio signal. Digital watermarking has to embed pieces of information into a digital media for protecting it against copyright infringements and other unauthorized applications. These signals are extracted by detection mechanisms and decoded. Main requirements of digital audio watermarking are imperceptibility, robustness and data capacity [1][2].More precisely, the watermark must be inaudible within the host audio data to maintain audio quality and robust to signal distortions applied to the host data. Finally, the watermark must be easy to extract to prove ownership5. Different watermarking techniques of varying complexities have been proposed like Patchwork based Digital Audio Watermarking, Spread Spectrum Watermarking, and Modified Phase Coding Audio Watermarking.

A. Patchwork Method.

It presents a novel patchwork-based embedding and decoding scheme for digital audio watermarking. At them bedding stage, an audio segment is divided into two sub segments and the discrete cosine transform (DCT) coefficients of the sub segments are computed. The DCT coefficients related to a specified frequency region are then partitioned into a number of frame pairs. The DCT frame pairs suitable for watermark embedding are chosen by a selection criterion and watermarks are embedded into the selected DCT frame pairs by modifying their coefficients, controlled by a secret key [4]. At the decoding stage, the secret key is utilized to extract watermarks from the watermarked DCT frame pairs. It usually has multiple applications of this algorithm don't interfere with each other, because patches made using different keys are almost orthogonal. One of the issue is the resynchronization attacks.

B. Spread-spectrum watermarking

Spread-spectrum watermarking scheme is an example of the correlation method which embeds pseudorandom sequence and detects watermark by calculating correlation between pseudo-random noise sequence and watermarked audio signal. Spread spectrum techniques for watermarking borrow most of the theory from the communications community[4]. The main idea is to embed a narrow-band signal (the watermark) into a wide-band channel (the audio file). The characteristics of both audio signal and watermark seem to suit the model perfectly. Spread spectrum techniques allow the frequency bands to be matched before embedding the message [5].

The Spread Spectrum method, signals may be heavily polluted by other unlicensed systems. These other competing signals appear as noise to the desired signal and may degrade signal integrity and range.

C. Phase coding watermarking

A phase coding method is used to embed any watermark data type (text, image, audio) in audio signals. The basic idea is to segment the audio signal and transforming it using the Discrete Fourier Transformation (DFT) and then embedding the watermark in the initial phase coefficients for every four segments [6]. The watermark can be extracted semi-blindly. Performance of the proposed watermarking methods was tested by using normalized correlation (NC) and bit error rates (BER) to measure the robustness, and signal to noise ratio (SNR) to evaluate the imperceptibility of our proposed methods.. Adaptive quantization could be applied on the phase coefficients to decrease the distortion or noise of the watermarked audio. A high watermark bitrates cannot be embedded in modified phase coding method.

II. EMPERICAL MODE DECOMPOSITION

A new signal decomposition method referred to as Empirical Mode Decomposition (EMD) has been introduced for analyzing non-stationary signals derived or not from linear systems in totally adaptive way .The audio signal is divided into frames and each one is decomposed adaptively, by EMD, into intrinsic oscillatory components called Intrinsic Mode Functions (IMFs). The watermark and the synchronization codes are embedded into the extrema of the last IMF, a low frequency mode stable under different attacks and preserving audio perceptual quality of the host signal[3] [7]. The data embedding rate of the proposed algorithm is 46.9–50.3 b/s. A major benefit of EMD relies on no priori choice of filters or basis functions. Compared to classical kernel based approaches, EMD is fully data-driven method that recursively breaks down any signal into a reduced number of zero-mean with symmetric envelopes AM-FM components called Intrinsic Mode Functions (IMFs).

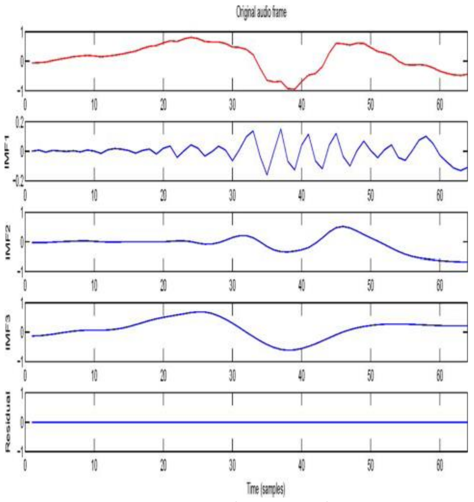

Fig 1. Decomposition of an audio frame by emd.

III. SYSTEM IMPLEMENTATION

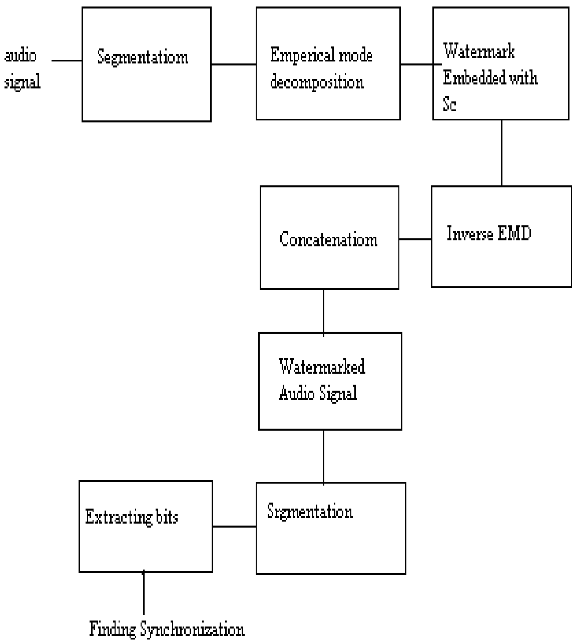

Fig.2 .block diagram.

The idea of this watermarking method is to hide into the original audio signal a watermark together with a Synchronized Code (SC) in the time domain. The input signal is first segmented into frames and EMD is conducted on every frame to extract the associated IMFs. Then a binary data sequence consisted of SCs and informative watermark bits are embedded in the extrema of a set of consecutive last IMFs. A bit (0 or 1) is inserted per extreme.

Each audio signal is divided into frames of size 64 samples.EMD is conducted on every frame to extract the associated IMFs.

Watermark is embedded in last frame of IMFs with synchronization code.

Now inverse EMD applied for recovering watermark.

Step 1: Split original audio signal into frames.
Step 2: Decompose each frame into IMFs.
Step 3: Embed times the binary sequence into extreme of the last IMF.
Step 4: Reconstruct the frame using modified technique.
Step5: Concatenate the watermarked frames to retrieve the watermarked signal.

Synchronization Code locates the embedding position of the hidden watermark bits in the host signal i.e. SC is used. This code is unaffected by cropping and shifting attacks. SCs are combined with watermark bits to form a binary sequence denoted by the bit of watermark & then embedding is performed. For watermark extraction, host signal is spitted into frames and EMD is performed on each one as in embedding. With the position of SC determined, we can then extract the hidden information bit, which follows the SC.

Sync-code	Watermark bits	Sync-code

Fig. 3. Data structure.

WATERMARK EXTRACTION

For watermark extraction, host signal is splitted into frames and EMD is performed on each one as in embedding. We extract binary data by embedding in the last EMFs of sequence. We then search for SCs in the extracted data. This procedure is repeated by shifting the selected segment one sample at time until a SC is found. With the position of SC determined, we can then extract the hidden information bits, which follow the SC.

Parameters	**Patch work**	**Spread Spectrum**	**Phase coding**	**Emd**
Complexity	highest	High	Less	Less
Efficient	moderate	High	Less	Highly
Robust	less	High	highest	Highest
Security	Low	High	lowest	Highest
Perceptuality	noisy	Less noise	Noisy	Less noise

Table 1. Comparison between four methods

IV. CONCLUSION.

In this paper a new adaptive watermarking scheme based on the EMD is proposed. Data bits of the synchronized watermark are embedded in the extrema of the last IMF of the audio signal based on QIM. Extensive simulations over different audio signals indicate that the proposed watermarking scheme has greater robustness against common attacks than recently proposed algorithms. This method shows better efficiency and has precise security property when analyzed with different methods

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