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Digital Audio Watermarking Survey and Analysis of Current Methods

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Abstract—Many competent watermarking algorithms have been counseled and requested for digital pictures and digital video, though, insufficient algorithms have been counseled for audio watermarking. This is due to the fact that, the human audio arrangement is distant extra convoluted and sensitive than the human discernible system. This undertaking will target at growing a robust and reliable method of audio watermarking. By quality of the new advancements in computer and telecommunication webs, multimedia files are produced, stored and distributed facilely across the globe. Though, the ownership and copyright of multimedia files are not normally protected. Digital watermarking has been counseled in present years as a way of protecting multimedia contents from intellectual piracy. This is attained by modifying the early content, by inserting a signature that can be removed, after vital, as a facts of ownership.

Index Terms—Digital Signal Processing, Watermarking Process, Audio Watermarks

I. AUDIO WATERMARKING

Digital audio watermarking involves the obscuring of data inside a digital audio file. Demands for this vision are numerous. Intellectual property protection is presently the main steering manipulation behind scutiny in this area. To combat online music piracy, a digital watermark could be added to all recording prior to discharge, signifying not merely the author of the work, but the user who has bought a legitimate copy. Newer working arrangements outfitted alongside digital entitlements association (DRM) multimedia will remove the watermark from audio files prior to frolicking them on the system. The DRM multimedia will safeguard that the user has paid for the song by contrasting the watermark to the tolerating bought licenses on the arrangement.

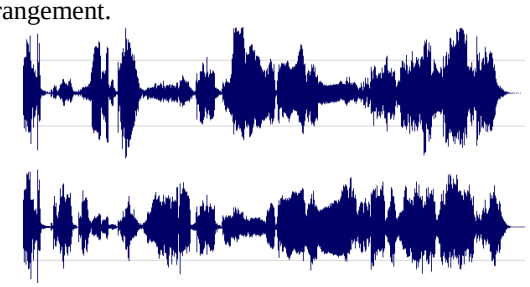

Figure 1 An Example of Digital Audio Watermark

Other non-rights related uses for watermarking vision encompass embedding auxiliary data that is related toa particular song, like lyrics, album data, or a puny web page, etc. Watermarking could be utilized in voice conferencing arrangements to indicate to others that party is presently speaking. A video appeal of this vision ought to encompass of embedding subtitles or closed captioning data as a watermark.

Properties of an Audio Watermark

A watermarking algorithm can be delineated by a number of properties. The comparative meaning of every single solitary property nevertheless depends on the demands of the application. The six vital properties are as follows.

Perceptual transparency

In all most every single solitary appeal, the watermark-embedding algorithm has to insert watermark data lacking changing the perceptual quality of the host audio signal. The fidelity of a watermarking algorithm is normally delineated as a perceptual similarity amid the main and watermarked audio sequence. Though, the quality of the watermarked audio might come to be contaminated, whichever intentionally by an antagonist or unintentionally across the transmission procedure, beforehand a person perceives it. In such a case, it is supplementary sensible to redefine the fidelity of a watermarking algorithm as a perceptual similarity amid the watermarked audio and the main host audio at the point at that they are provided to a client.

Watermark bit rate

Bit rate is of an embedded watermark is delineated as the number of bits of the watermark embedded in one consecutive of the host audio gesture and is given in bits every single consecutive (bps). The bps necessity of a watermark depends on the application. For example, a slight demands, such as duplicate domination, demand the insertion of a serial number or author ID, alongside the average bit rate of 0.5 bps. In a slight envisioned demands, like obscuring speech in audio, algorithms have to be able to embed watermarks alongside the bit rate that is a momentous fraction of the host audio bit rate, i.e. up to 150 kbps.

Robustness

The robustness of a watermarking algorithm is delineated as its skill to detect/ remove the watermark afterward area gesture processing manipulations. The set of gesture processing modifications to that a watermarking algorithm needs to be robust opposite is completely appeal dependent. For example, in wireless display monitoring, embedded watermark demand merely to tolerate distortions provoked by the transmission procedure, encompassing vibrant compression and low bypass filtering, because the watermark detection is finished undeviatingly from the display signal. On the supplementary hand, in a slight algorithms robustness is completely unwanted and those algorithms are labeled fragile audio watermarking algorithms.

Blind or informed watermark detection

In a slight demands, a detection algorithm might use the main host audio to remove watermark from the watermarked audio sequence (informed detection). It oftentimes considerably enhances the detector presentation, in that the main audio can be subtracted from the watermarked duplicate, growing in the watermark sequence alone. Though, if detection algorithm does not have admission to the main audio (blind detection) and this inability considerably cuts the number of data that can be hidden in the host signal. The finished procedure of embedding and removing of the watermark is modeled as a link channel whereas watermark is distorted due to the attendance of forceful interference and channel effects. A forceful interference is provoked by the attendance of the host audio, and channel aftermath correspond to gesture processing procedures.

Security

Watermark algorithm have to be safeguard in the sense that an antagonist have to not be able to notice the attendance of embedded data, permit alone remove the embedded data. The protection of watermark procedure is elucidated in the comparable method as the protection of encryption methods and it cannot be brokenunless the authorized user has admission to a hidden key that controls watermark embedding. An unauthorized user must to be incapable to remove the data in a reasonable number of era even if he knows that the host gesture encompasses a watermark and is acquainted alongside the precise watermark embedding algorithm. Protection necessities vary alongside appeal and the most stringent are in 8 cover link demands, and, in a slight cases, data is encrypted prior to embedding into host audio.

Computational complexity

The implementation of an audio watermarking arrangement is a monotonous task, and it depends on the firm appeal involved. The main subject from the technical point of contemplate is the computational intricacy of embedding and detection algorithms and the number of embedders and detectors utilized in the system. For example, in display monitoring, embedding and detection have to be finished in real era, as in copyright protection demands, era is not a critical factor for a functional implementation. One of the business subjects is the design of embedders and detectors, that can be demanded as hardware or multimedia plug-ins, is the difference in processing manipulation of disparate mechanisms (laptop, PDA, mobile phone, etc.).

II. AUDIO WATERMARKING APPLICATIONS

Embedding of Copyright Information:

During conception, copyright data in the form of a watermark can be anchored undeviatingly in the recording. This makes it probable to check at a afterward era whether a competitor, for example, has grabbed examples of music frolicked on a priceless instrument and utilized them in his product lacking permission. With the assistance of the watermark, it is additionally probable to furnish copyright verification in the event that a competitor claims he produced a given label.

Embedding of Recipient Information

It can additionally be expedient to use audio watermarking of promotional recordings endowed to wireless stations or the press or afterward music tracks or audio books are vended by an Internet shop. Here the trusted is to personalize every single solitary recording distributed. In such cases data is embedded as a watermark that can be utilized at a afterward era to monitor recipients. This can be the recipient's client number, for example. If these recordings are discovered afterward on the Internet, the embedded data can be utilized to understand the person to whom the recorded physical was chiefly distributed.

The supremacy of the watermarking method above the Digital Entitlements Association (DRM) method is that the main multimedia format is not adjusted by the watermark. To illuminate this, if a watermark is embedded in an MP3 file, the consequence is an MP3 file that can be frolicked on every single commercially-available MP3 player. It is

subsequently not vital for clients to buy different playback devices. Furthermore, the watermark stays in the recording even in the event of format conversion, even if the physical experiences analog conversion.

Embedding of Title Information

The audio watermarking method can in principle additionally be demanded for monitoring wireless broadcasts. To do this, every single solitary label that is to be monitored have to be endowed alongside a exceptional identifier in the form of a watermark. A computer afterward scans wireless strategies and investigates the gesture for watermarking. Even nevertheless the audio fingerprinting method is normally demanded to present this task there are cases in that the audio watermarking method propositions precise advantages. This is the case, for example, afterward specific television commercials are to be monitored that have varied video tracks but an identical audio trail.

III. RELATED WORK

Chi-Man Pun et al2013 [1] A robust feature points detector for invariant audio watermarking is proposed in this paper. The audio segments centering at the detected feature points are extracted for both watermark embedding and extraction. These feature points are invariant to various attacks and will not be changed much for maintaining high auditory quality. Besides, high robustness and inaudibility can be achieved by embedding the watermark into the approximation coefficients of Stationary Wavelet Transform (SWT) domain, which is shift invariant. The spread spectrum communication technique is adopted to embed the watermark. Experimental results show that the proposed Robust Audio Segments Extractor (RASE) and the watermarking scheme are not only robust against common audio signal processing, such as low-pass filtering, MP3 compression, echo addition, volume change, and normalization; and distortions introduced in Stir-mark benchmark for Audio; but also robust against synchronization geometric distortions simultaneously, such as resample time-scale modification (TSM) with scaling factors up to 50%. In general, the proposed scheme can well resist various attacks by the joint RASE and SWT approach, which performs much better comparing with the existing state-of-the art methods.

Arnold, M. et al, 2014 [2] Today, comparing audio watermarking systems remain a challenge due to the lack of publicly-available reference algorithms. In addition, robustness against acoustic path transmission is only occasionally evaluated. This jeopardizes the chances of digital watermarking to be adopted in the context of applications where such a feature is vital, e.g., second screen, audience measurement, and so on. In this paper, they introduce a rather simple audio watermarking algorithm, whose source code has been publicized for potential reuse by the watermarking community. They then complement this baseline system with three additional components, namely a psychoacoustic model, a resynchronization framework, and an improved correlation-based detector. Reported experimental results clearly demonstrate that the resulting high-fidelity audio watermarking system manages to survive the acoustic path.

Naskar, R. et al, 2013 [4] Reversible watermarking is a class of watermarking where they can recover the host (cover) signal losslessly along with distortion-free recovery of the watermark. The reversible watermarking algorithms proposed till date have been proposed for digital images. In this paper they propose a reversible watermarking scheme for audio signals. In general, reversible watermarking algorithms are computationally more expensive compared to their non-reversible counterparts. To reduce the run time latency of the proposed reversible audio watermarking scheme, a redundant watermark embedding technique is used which embeds the watermark without overflow checking of the watermarked audio sample values, but can reversibly retrieve the watermark utilizing the redundancy. The proposed technique also avoids the use of a location map for overflow checking, thus avoiding the need for multi pass, computation intensive data processing.

Baiying Lei et al, 2013 [5] In this paper, a robust audio watermarking scheme based on singular value decomposition (SVD) and differential evolution (DE) using dither modulation (DM) quantization algorithm is proposed. Two novel SVD-based algorithms, lifting wavelet transform (LWT)-discrete cosine transform (DCT)-SVD and discrete wavelet transform (DWT)-DCT-SVD, are developed for audio copyright protection. In their method, LWTDWT is first applied to decompose the host signal and obtain the corresponding approximate coefficients followed by DCT to take advantage of property. SVD is further performed to acquire the singular values and enhance the robustness of the scheme. The adaptive DM quantization is adopted to quantize the singular values and embed the watermark. To withstand desynchronization attacks, synchronization code is inserted using audio statistical characteristics. Furthermore, the conflicting problem of robustness and imperceptibility is effectively resolved by the DE optimization. Simulation results demonstrate that both the LWT-DCT-SVD and DWT-DCT-SVD methods not only have good imperceptibility performance, but also resist general signal processing, hybrid and desynchronization attacks. Compared with the previous DWT-DCT, support vector regression (SVR)-DWT-DCT and DWT-SVD methods, their method obtains more robustness against the selected attacks.

Yong Xiang et al, 2014 [6] This paper presents a patchwork-based audio watermarking method to resist de-synchronization attacks such as pitch-scaling, time-scaling, and jitter attacks. At the embedding stage, the watermarks are embedded into the host audio signal in the discrete cosine transform (DCT) domain. Then, a set of synchronization bits are implanted into the watermarked signal in the logarithmic DCT (LDCT) domain. At the decoding stage, they analyze the received audio signal in the LDCT domain to find the scaling factor imposed by an attack. Then, they modify the received signal to remove the scaling effect, together with the embedded synchronization bits. After that, watermarks are extracted from the modified signal. Simulation results show that at the embedding rate of 10 bps, the proposed method achieves 98.9% detection rate on average under the considered de-synchronization attacks. At the embedding rate of 16 bps, it can still obtain 94.7% detection rate on average. So, the proposed method is much more robust to de-

synchronization attacks than other patchwork watermarking methods. Compared with the audio watermarking methods designed for tackling de-synchronization attacks, their method has much higher embedding capacity.

Youssef, S.M. in 2013 [7] In this paper, a novel Hybrid Fuzzy Self-Adaptive digital Audio Watermarking scheme (HFSA-AW) is proposed based on local audio features. Firstly, the original audio signal is partitioned into audio frames. These audio frames are transformed into discrete wavelet transform (DWT) domain. A method for performing automatic segmentation based on features related to rhythm, timbre and harmony is presented. A proposed segmentation approach, combining audio signal characterization by statistical features and fuzzy clustering approach, is proposed. The local features of each audio frame are extracted respectively, and these features are used to train a fuzzy c-means clustering algorithm. Since fuzzy set theory is capable of performing complex nonlinear mappings between input and output spaces, it can effectively estimate the strength of a frame for each sub-band and ensure that the embedded watermark in the original audio is self-adaptive. A new watermark embedding scheme, based on fuzzy adaptive embedding strength, is used to embed watermark into the statistics average value of low frequency components. In order to evaluate the performance of the proposed audio watermarking method, subjective and objective quality tests including bit error rate (BER) and signal to noise ratio (SNR) are conducted. Experimental results show that the proposed scheme is inaudible and robust against common signal processing, including low-pass filtering, noise addition, and cropping.

Ghobadi, A. et al, 2013 [8] Recently, the attention of researchers has Audio because of the audio capability to hide data. There is some research to hide data in audio using watermarking technique. Some of them tried to use the watermark technique to protect the audio file of any tampering. The current research defined in this chapter issue by using cheap audio watermarking and preserves audio files from any tampering. It will discuss more on previous study on tamper detection. The method provides both embedding and extraction solutions.

Hong Zhao et al, 2013 [9] An audio recording is subject to a number of possible distortions and artifacts. Consider, for example, artifacts due to acoustic reverberation and background noise. The acoustic reverberation depends on the shape and the composition of the room, and it causes temporal and spectral smearing of the recorded sound. The background noise, on the other hand, depends on the secondary audio source activities present in the evidentiary recording. Extraction of acoustic cues from an audio recording is an important but challenging task. Temporal changes in the estimated reverberation and background noise can be used for dynamic acoustic environment identification (AEI), audio forensics, and ballistic settings. They describe a statistical technique based on spectral subtraction to estimate the amount of reverberation and nonlinear filtering based on particle filtering to estimate the background noise. The effectiveness of the proposed method is tested using a data set consisting of speech recordings of two human speakers (one male and one female) made in eight acoustic environments using four commercial grade microphones. Performance of the proposed method is evaluated for various experimental settings such as microphone independent, semi- and full-blind AEI, and robustness to MP3 compression. Performance of the proposed framework is also evaluated using Temporal Derivative-based Spectrum and Mel-Cepstrum (TDSM)-based features. Experimental results show that the proposed method improves AEI performance compared with the direct method (i.e., feature vector is extracted from the audio recording directly). In addition, experimental results also show that the proposed scheme is robust to MP3 compression attack.

Khaldi, K. et al, 2013 [10] In this paper a new adaptive audio watermarking algorithm based on Empirical Mode Decomposition (EMD) is introduced. 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. The data embedding rate of the proposed algorithm is 46.9-50.3 b/s. Relying on exhaustive simulations, they show the robustness of the hidden watermark for additive noise, MP3 compression, re-quantization, filtering, cropping and resampling. The comparison analysis shows that their method has better performance than watermarking schemes reported recently**.**

IV. CONCLUSION

Time-domain methods digital watermarking methods encompass the Least Momentous Bit substitution (LSB) and echo obscuring methods, amid countless others. LSB embeds the watermark data in the least momentous bits of the audio example benefits by overwriting the main bits. It seizes supremacy of the quantization error that normally derives from the task of digitizing the audio signal. On the supplementary hand, echo watermarking endeavors to embed data into the main discrete audio gesture by familiarizing a recapped edition of a constituent of the audio gesture alongside puny offset, main amplitude and plummet rate to make it imperceptible. In finish, time-domain audio watermarking is reasonably facile to apply, and needs insufficient computing resources, nevertheless, it is nevertheless, fragile opposite gesture processing aggressions such as compression and filtering. In upcoming we ought to like to apply a robust audio watermarking scheme below frequency domain. Frequency span audio watermarking methods retain human perceptual properties and frequency masking characteristics of the human auditory arrangement for competent watermarking. In these methods, the era and amplitude of the change span coefficients are adjusted in a precise method to grasp the wanted watermark data.

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