National Conference on Emerging Trends in Computer, Electrical & Electronics (ETCEE-2015)
International Journal of Advance Engineering and Research Development (IJAERD)
e-ISSN: 2348 - 4470 , print-ISSN:2348-6406,Impact Factor:3.134

Comparative Performance Analysis of Audio Watermarking Techniques

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***Abstract*—Due to the massive growth in computer technology enormous amount of music files are shared in the internet. The storage devices of music files are also changed from cassette tapes to MP3 players, mobile phones, DVD players. In order to solve problems in searching the needed songs among mass audio information, digital audio watermarking is involved. This is due to the fact that, the human audio system is far more complex and sensitive than the human visual system.In this paper, The conceivable arrangement of above issue is distinctive Audio watermarking Techniques, in the same way as Discrete Fourier Transform system (DFT), Discrete Wavelet Transform strategy (DWT), Discrete Cosine Transform method (DCT), Singular Value Decomposition (SVD).**

***Keywords*-Audio Watermarking, DFT, DWT, DCT, LSB, SSA, SVD.**

I. INTRODUCTION

In present day system times, computerized media, for example, images, videos and audio signs, have been comprehensively transmitted Through Internet and additionally other transmission transporters and individuals can get this sort of data more effectively than before [1].

The Music business is searching for dependable answers for issues connected with the insurance and abuse of audio information. Limitation of access to the information is not sensible in applications where the client needs to get to the information with a specific end goal to appreciate it. New strategies like digital watermarking, and encryption among others have been proposed to address these needs [2].

Notwithstanding, human ear is substantially more touchy than other tactile engines. Along these lines, great audio watermarking plans are hard to outline. A considerable measure of late works has proposed answers for this issue of copyright encroachment. As of late, numerous watermarking systems have been proposed for audio signal. The audio watermarking techniques reported in literature can be grouped into spatial domain, time domain, spread-spectrum domain, frequency-transform domain, and ceprtum-domain techniques [3].

Existing audio watermarking systems exploit their relevant properties of the human auditory system (HAS). In particular, HAS is insensitive to small amplitude changes in the time domain and frequency domains, allowing the addition of weak noise signals(watermarks) to the host audio signal such that the changes are inaudible. Frequency-domain techniques, in particular, have been more effective than time-domain techniques since watermarks are added to selected regions in the transformed domain of the host audio signal, such that inaudibility an robustness are maintained [3].

Motivation II. Features of audio watermarking are clarified in area III. Audio watermarking methodology IV. Different techniques are recorded with their favourable circumstances and disservices are clarified in segment V performance Evaluation VI.

II. MOTIVATION

In all research there is some motivation behind it. In our paper/project motivation is, due contemporary technology, there are broadly available tools in order to reproduce and retransmit multimedia data. Todays most popular & host issue due to internet music like, MP3. Audio behind audio watermarking helps to protect audio data. That's why I select this project.

III. FEATURES OF AUDIO WATERMARKING

Here are a few criteria that need to be fulfilled for powerful application of watermarking innovation. These are robustness, Imperceptibility, security and so forth. They are talked about underneath.

A. Robustness

Robustness watermarking is fundamentally used to copyright data of the advanced works; the watermark is not destroyed after some assault regardless can be discovered to give certificate. Robustness to that the watermark inserted in information has the capacity of making due after an assortment of transforming operations and assaults [4].

B. Imperceptibility

Watermark can't be seen by human eye or not be heard by human ear, just be caught through uncommon transforming or devoted circuits. It can be identified by an approved organization just. Such watermarks are utilized for substance or creator validation and for locating unauthorized copier [4].

C. Watermark security

Watermark security alludes to the failure by unauthorized clients to have admittance to the watermarked audio signal.

IV. AUDIO WATERMARKING METHODOLOGY

The planned method is divided into two parts, watermark embedding and watermark extraction process.

A. Watermark Embedding Process

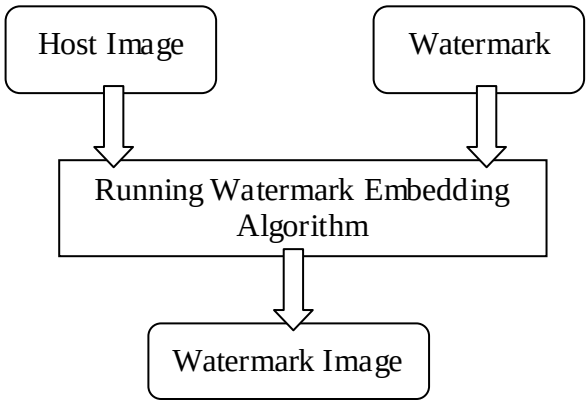

Fig. 1 Watermark embedding process

Figure 1 clarifies the watermark installing process in which have host image inserted with the watermark of any form of information, for example, image, content, and picture. Sometimes key also used with the watermark embedding which is not shown in the diagram [7].

B. Watermark detection and extraction process

Watermark detection and extraction process is utilized look at that whether the host image contains the installed watermark or the watermark can be extractable or not. In extraction process inputs are watermarked information and Output of extraction process is a watermark or believability esteem. The watermark detection and extraction procedure is as demonstrated in Figure 2 [7].

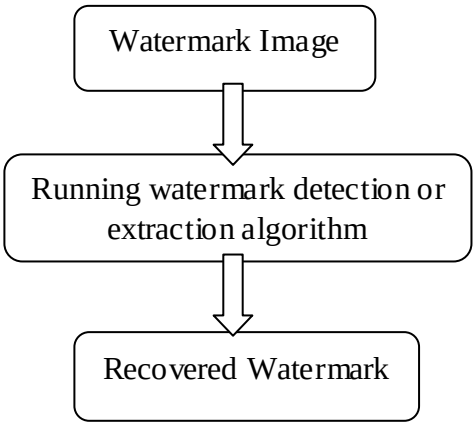

Fig 2 Watermark detection and extraction process

V. AUDIO WATERMARKING TECHNIQUES

Audio watermarking systems can be arranged in two sorts focused around domain. This is spatial domain and frequency domain. Definite depiction with focal points and detriments about these two methods are given below.

A. Spatial Domain Technique

In this system, the watermark is specifically connected to the host signal. Implanting and extraction is focused around straightforward operations.

The points of interest of the spatial area system are thoughtfully basic and have low computational unpredictability and less computational time and less computational expense. Be that as it may, they additionally a real disadvantage that robustness of spatial domain system is low and Fragile as compare with frequency domain technique [4].

There are two procedures generally prominent in spatial domain. They are:

- Least significant bit (LSB)
- SSM Modulation Based Technique

Least significant bit technique is the most prominent and basic strategy utilized. In this technique the watermark is inserted in the LSB of every pixel. It is the least complex strategy where the whole picture is utilized for inserting the watermark [5]. Subsequently making it conceivable to implant more diminutive protests as watermark and those excessively different times. Lower reckonings and straightforwardness are its favorable circumstances.

SSM Modulation Based Technique Spread-range procedures are strategies in which vitality created at one or more discrete frequencies is deliberately spread or circulated in time [4]. SSM based watermarking calculations insert data by straightly consolidating the host picture with a little pseudo noise signal that is modulated by the inserted watermark.

B. Frequency Domain Technique

Frequency domain techniques can further divided in main three parts.

- Discrete Fourier Transform technique (DFT)
- Discrete Wavelet Transform technique (DWT)
- Discrete Cosine Transform technique (DCT)
- Singular Value Decomposition (SVD)

1. Discrete Fourier Transform

In, the Fourier transform magnitude coefficients over the frequency range from 2.4 KHz to 6.4 KHz are replaced with the watermark sequence since human sensitivity declines compared to its peak around 1 KHz . Moreover, human ears are relatively insensitive to phase distortion, and especially lack the ability to perceive the absolute phase value, therefore in; the watermark is represented by the relative phase between selected coefficients and their neighbors. The problem with these watermarking schemes that they are less robust to signal processing and malicious attacks, such as audio compression [6].

2. Discrete Wavelet Transform

Wavelet Transform is an advanced method every now and again utilized as a part of computerized picture preparing, pressure, watermarking and so on. The Discrete Wavelet Transform (DWT) is as of now utilized as a part of a wide mixture of sign handling applications, for example, in audio and video compression, removal of noise in audio Here is an effective audio watermarking technique which gives advance level of security and increasing the impeccability and robustness of the watermark and which is multi-resolution decomposition.

The wavelet change gives the time-frequency representation of a given signal. The changes are focused around little waves, called wavelet, of fluctuating frequency and restricted length of time. The wavelet change decays the picture into three spatial directions (sub pictures or sub groups) horizontal, vertical and diagonal [7]. The groups are LL, LH, HL and HH.LL band contains low frequencies in horizontal and vertical both direction. HH band contains high frequencies in horizontal and vertical both direction. HL involves high frequencies in horizontal direction and low frequencies in vertical direction. LH contains low frequencies in horizontal direction and high frequencies in vertical direction [5].

Figure3 as shown below is a schematic diagram of four-level DWT decomposition. In the wavelet transform domain, high frequency parts represent detailed information of image's edge, contour and texture and so on. Embedding watermarking in these places cannot be easily detected a people are not easily conscious of it. But after processing or attacking, it has poor stability. Most energy of image is centralized in low frequency. Low frequency coefficients are nearly unchanged to common attack so that watermarking information embedded in low frequency coefficients has better robustness [8].

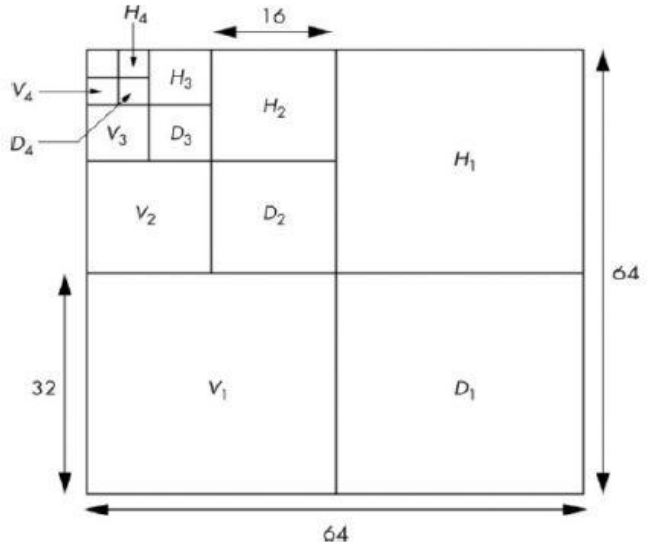

Fig 3 Four level DWT

DWT based technique for audio signals watermarking which has the least effect on the original signal. Reviewed by Ali Al-Haj in [6].

3. Discrete Cosine Transform

The discrete Cosine Transform is a technique for converting a signal into elementary frequency components [11].Such algorithm are strong against basic picture preparing operations like low pass filter, brightness and contrast adjustment, blurring and so on. Be that as it may, they are hard to actualize and are computationally more expensive. In the meantime they are feeble against geometric assaults like rotation, scaling, cropping and so forth. DCT the information is spoken to as frequency space instead of amplitude space. Applying DCT breaks the picture into low, center and high frequencies, consequently making the inserting into mid frequency band simple. The Two measurement DCT and inverse DCT comparisons for a picture of size M x N is given as follows in equation 1 and 2 [5].

$$F = \alpha(u)\alpha(v)\sum\sum f(x,y)\cos\left\{\frac{[(2x+1)u.\pi]}{2M}\right\}\cos\left\{\frac{[(2x+1)v.\pi]}{2N}\right\} \quad (1)$$

$$f = \sum\sum\alpha(u)\alpha(v)F(u,v)\cos\left\{\frac{[(2x+1)u.\pi]}{2M}\right\}\cos\left\{\frac{[(2x+1)v.\pi]}{2N}\right\} \quad (2)$$

Where,

$$\alpha(u) = \sqrt{1/M} \qquad for\ u = 0$$

$$\alpha(u) = \sqrt{\frac{2}{M}} \qquad for\ u = 1,2,3\ldots.,M-1$$

$$\alpha(v) = \sqrt{\frac{1}{M}} \qquad for\ v = 0$$

$$\alpha(v) = \sqrt{2/M} \qquad for\ v = 1,2,3,\ldots.,N-1$$

4. Singular Value Decomposition

Singular value decomposition is a linear algebra method used to diagonalizable matrices. It packs most of the signal energy into a few singular values. The singular values of the audio content remain unfluctuating even if some alterations are made in the audio file [2]. An arbitrary matrix A of size m*n can be depicting by its SVD in the form of:

A =U (V')

Here *V* and V are orthogonal m*m and n*n square matrices respectively having *V1, V 2,…..*, Vm and V1, V2,...,Vn column vectors and, S is an m*n diagonal matrix with non-negative elements. Diagonal terms S1, S2,... ,Sn of the matrix S are called singular values of A[2].SVD has so many properties like translation, scaling properties so that it can be used in watermarking applications [9].

Although all SVD-based watermarking algorithms are enough robust against the geometrical attacks such as cropping and rotation, they are less robust against some distortions like Gaussian noise, blurring and histogram equalization [10].

5. Favorable circumstances of DWT over DCT

Allows superior localization both in time and spatial frequency domain. Higher compression ratio which is relevant to human perceptions.Wavelet transform comprehends the HVS more nearly than the DCT. Wavelet coded picture is a multi-determination portrayal of picture. Thus a picture can be indicated at diverse levels of determination and can be successively transformed from low determination to high determination.

6. Detriments of DWT over DCT

Computational unpredictability of DWT is more contrasted with DCT. DWT just inserts the watermark bits in the low vitality bits. So there may be opportunities to discover the install watermark from the embedded signal.

7. Preferences of DFT over DWT and DCT

DFT is rotation, scaling and translation (RST) invariant. Henceforth it can be utilized to recoup from geometric bends, though the spatial domain, DCT and the DWT are not RST invariant and thus it is hard to overcome from geometric mutilations.

VI. PERFORMANCE EVALUATION

So as to assess the execution of the watermarked pictures, there are some quality measures, for example, SNR, PSNR, and so on…

SNR (Signal to Noise ratio) measures the sensitivity of the imaging. It measures the signal quality with respect to the foundation commotion [4]. It is figured by the recipe given below,

$$SNR_{dB} = 10\log_{10}(\frac{P_{signal}}{P_{noise}})$$

The PSNR (Peak signal to noise ration) is utilized to center of attention the debasement in the inserted image as for the host image [4]. It is computed by the recipe as given beneath,

$$PSNR=10\log_{10}(L*L/MSE)$$

VII. CONCLUSION

Here, in this paper different perspective for audio watermarking introduced like outline, peculiarities, and process methods. Separated from it a concise and similar examination of watermarking systems is introduced with their favorable circumstances and weaknesses which can help the new analysts in related regions. In future this methods can also be used for military purpose to send a secrete data and also it can be used for ownership protection. Digital audio watermarking based on DWT-SVD techniques. This was designed to improve watermark robustness after the audio is subjected to various audio attacks.

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