

A Review on Improved Audio Watermarking Methods

Rupali Nayyar¹, Randhir Singh², Ritika³

M.Tech. Student, Department of ECE, S.S.C.E.T, Badhani, Pathankot, India

Associate Professor (HOD), Department of ECE, S.S.C.E.T, Badhani, Pathankot, India

Assistant Professor, Department of ECE, S.S.C.E.T, Badhani, Pathankot, India

Abstract – Audio/Sound watermarking is becoming popular technique in electronic picture running because it's capacity to protect the audios by injecting watermarks in them. In that report, different formulas are mentioned that has tried to simply help the robustness and imperceptibility attributes of a good watermarking algorithm by considerably improving the visible quality of the watermarked picture and being sturdy against common signal running procedures and attacks. Various types of numerous episodes is likewise regarded to judge the effectiveness of the many technique include DCT, DWT, SVD, FFT, Arnold transform.

Key Words: Watermarking Scheme, FFT, Arnold transform, SVD strategy.

1. INTRODUCTION

From a standard viewpoint a watermark assures a url relating to the organic knowledge and equivalent information. This url could offer different purposes. Thus the different types of watermarks are categorized as:

Crucial watermarks can be utilized as confirmation and content consistency systems in a number of ways. This signifies that the watermark is just a guaranteed url understandable only by certified people who have the information concerning the secret.

Community watermarks behave as an knowledge company with the watermark understandable by everybody. These public watermarks may not be detectable or removable by a next party. This requirement could be reduced if these watermarks become knowledge links. In accordance with the purpose and the sort of watermark, watermarking practices should get certain indicate, security and standard properties.

1.1 DESIRED FEATURES OF AUDIO WATERMARKING ALGORITHMS:

Signal processing properties: The watermark should really be perhaps not perceivable by an observer. The watermark should really be successful against intentional or predicted manipulations, e.g. pressure, collection, resampling, requantisation, collection, hiking, etc.

Security properties: The watermarking process should be determined by an important to ensure protection, maybe not on the algorithm's secrecy. The algorithm should really be published. The watermark should really be statistically undetectable. The algorithm needs to have a mathematical formulation. The development process should really be symmetric or asymmetric (in the sense of men and women crucial cryptographic algorithms), based on the application. Robustness against problems, which use numerous watermarked copies, also referred to as collusion attacks.

General properties: The algorithm should allow real-time processing. The algorithm must certainly be variable to different degrees of robustness, quality and different amount of data. The algorithm should truly be tunable to different presses. The algorithm should support numerous watermarks.

1.2 AUDIO WATERMARKING AND APPLICATIONS:

Copyright protection: The copyright manager will be authenticated by the information of the trick vital to understand the trick watermark.

Monitoring: Embedding a key watermark allow the tracing of illegal burning.

Fingerprinting: In point-to-point circulation situations factual statements about authenticated people could possibly be stuck as essential watermarks correct prior to the protected supply of the data.

Indication of content manipulation: The sign of material adjustment (tamper-proofing) from the approved state could possibly be found by way of a community or fragile watermark.

Information carrier: A public watermark embedded into the data stream can become a link to external databases storing information about the copyright and license conditions.

2. WATERMARKING TECHNIQUES

Various watermarking methods are available. But, these methods are generally found in sound watermarking.

2.1 Discrete Cosine Transform: The DCT switches or turns an indication from spatial domain in to a frequency domain. DCT is real-valued and presents a better

approximation of an indication with many coefficients. This method decreases how big the standard equations by discarding higher size DCT coefficients. Important architectural data is within the paid down size DCT coefficients. Thus, breaking up the high-frequency DCT coefficient and utilising the light advancement in the low-size DCT coefficient, it will purchase and cover the side data from satellite images. The improved picture is reconstructed by hiring inverse DCT and it is behave to be sharper with exemplary contrast. DCT is widely present in data force practices such as for instance for instance JPEG and MPEG. The important advantages of DCT include its large energy compaction houses and accessibility to quickly calculations for the computation of transform. The power compaction home of the DCT effects in modify coefficients with only many coefficients having rates, hence which makes it adequate for watermarking.

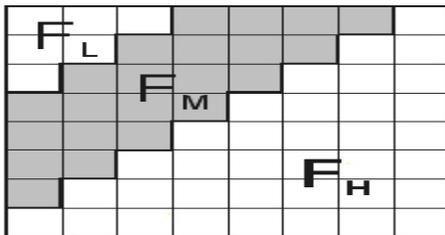


Fig -1: Discrete Cosine Transform Regions.

Two-dimensional discrete cosine transformation and its inverse transform are defined as:

$$C(u,v) = \alpha(u)\alpha(v)$$

$$\sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right] \tag{1}$$

$$f(x,y) =$$

$$\sum_{u=0}^{N-1} \sum_{v=0}^{N-1} \alpha(u)\alpha(v)c(u,v) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right] \tag{2}$$

Where, $u, v = 0, 1, 2, \dots, N-1$

$x, y = 0, 1, 2, \dots, N-1$

$\alpha(u)$ is defined as follows:

$$\alpha(u) = \sqrt{1/N} \quad u=0;$$

$$\alpha(u) = \sqrt{2/N} \quad u=1, 2, \dots, N-1$$

2.2 Discrete Wavelet Transform: The DWT is just something of filters. You are certain to get two filters involved, one could be the “wavelet filter”, and one other can be the “running filter”. The wavelet filter is just a big get filter, as the running filter is just a reduced get filter. After using a 1-level DWT on a photo, we’ve the approximation sub-band LL, the outside sub-band LH, the right sub-band HL, and the diagonal sub-band HH. Furthermore, if we hope to use a 2-level DWT on the photograph, we just use however still another 1-level DWT

on the approximation sub-band LL. Following using a 2-period DWT, we also provide the approximation sub-band LL2, the outside sub-band LH2, the right sub-band HL2, and the diagonal sub-band HH2 of the approximation sub-band LL other than sub-bands LH, HL, HH. DWT is preferred, since it offers equally a simultaneous spatial localization and a quantity deliver of the watermark within the sponsor picture. The hierarchical house of the DWT presents the chance of considering an indication at numerous claims and orientations.

2.3 Singular Value Decomposition: SVD is really a powerful mathematical evaluation instrument used to analyze matrices. The Single Price Decomposition of image I of measurement Michael x Deborah is bought by the function:

$$I = USV$$

$$(3)$$

Wherever U is column-orthogonal matrix of measurement Michael x Michael, S can be diagonal matrix with good or zero aspects of measurement Michael x Deborah and transpose of Deborah x Deborah orthogonal matrix V. The diagonal articles of matrix S are called the simple prices of I. The articles of U matrix are called remaining simple vector and the articles of the matrix V are called the right simple vector of I. Therefore, each simple value shows the luminance of image level and the corresponding amount of simple vector shows the geometry of the image layer. In SVD based image watermarking, several techniques are possible. A regular method is always to utilize SVD to the complete protect image and adjust every one of the simple prices to upload the watermark. The important home of SVD based watermarking is that the huge of the improved simple prices of image can transform by really little costs for several kinds of attacks.

2.4 Fast Fourier Transform: Fourier examination turns a sign from their special domain to a representation in the size domain and vice versa. A FFT quickly computes such transformations by factorizing the DFT matrix directly into an item of short (mostly zero) factors. Therefore, it grabs to lessen the trouble of examine the DFT from, which arises if one just applies this is of DFT, to where's the data size. An FFT is really a strategy to compute the identical affect faster: examine the DFT of N facets in the counting way, using the classification, requires $O(N^2)$ arithmetical procedures, while an FFT can compute the identical DFT in only $O(N \log N)$ procedures. FFTs are of price to an extensive choice of programs; from digital indicate handling and resolving imperfect differential equations to formulations for fast multiplication of big integers. An FFT computes the DFT and provides the identical affect as reviewing the DFT classification straight away; probably the most crucial

huge difference is that the FFT is much faster. (In the current presence of round-off issue, several FFT formulations may also be far more unique than reviewing the DFT classification straight away.

2.5 Arnold Transformation: Image scrambling finds modify of the photograph, which rearranges the spatial place of the pixels relating to some axioms, and makes photograph distortion for the target of security. If the modify axioms and ideas were not given, the initial photograph cannot be reconstructed. Regular methods for scrambling contain Arnold modify, Amazing modify, Fractal Hilbert fold, Conway sport and Graycode modify an such like .

Arnold modify is placed on fight watermarking image. This can be a modify proposed by Arnold in his ergodic theory called cat-face transformation. Think photograph pixel coordinates are x and $ymca$, $x, ymca$ Elizabeth $0,1,... N-1$ (N may be the get of photograph array)

3. LITERATURE SURVEY

Swanson et al. (1998) [1] provided a information embedding algorithm that has the ability to handle the get a handle on dilemmas i.e., the problem of deadlock. The deadlock has been repaired by mcdougal by using pseudo-random turbine which uses two keys—one that is dependent upon mcdougal and various is dependent upon the signal. The mixed watermark process has been used. First watermark stuck wants the original apply for the detection while another watermark is separate of the original watermark. To check the robustness of the algorithm, various symptoms like numerous watermarks, resampling, sound etc., have now been applied.

Wei FOO et al. (2001) [2] provided an flexible algorithm for sound watermarking which employs fit hiding method. The algorithm has been separate into two parts—encoder style and decoder design. In the encoder section, segmentation is performed on the original sound signal. And it mask computation and fit hiding is performed and watermark information coupled with kernel variables are caught to the sound signal. The parts are organized and watermark reviewing is performed to acquire the information when it comes to the watermark place and eventually subsequent recombining the parts, watermark sound indicate is obtained. In the decoder style area of the algorithm, first the sound segmentation is performed on the watermarked sound signal. Various symptoms were produced to try the robustness of the process applied and it's been designed the robustness against choice is less.

Seok et al. (2002) [3] has stated the fundamental wants necessary for sound watermarking algorithm. An algorithm using Main Routine Spread Collection (DSSS) has been discussed. That algorithm requires advantage of

the masking capability of HAS. That removal is blind strategy which uses brightening procedure. Robustness of watermarked sound is analyzed using episodes like combine down, amplitude and information compression.

Cvejic et al. (2003) [4] offered a algorithm in 2003 which is also on the cornerstone of the wavelet domain. Audio indicate is inputted in to the filter to acquire the wavelet coefficients. Concurrently, it's handed down for masking examination as properly to ascertain where in actuality the embedding of the watermark may be done. A key essential turbine is employed to produce a pseudo-random routine to arbitrarily pick a sub-band. Following embedding has been performed inverse DWT is completed to acquire the watermarked audio signal.

Sriyingyong et al. (2006) [5] provided an algorithm which uses DWT alongside Adaptive Tabu Search (ATS). ATS keeps records of all measures beginning research to solution. It even has capacity of doing backtracking. Binary image is progressed into 1-D matrix and then encrypted. Noise shows is decomposed. Applying Db4 and approximation subband thus acquired is segmented. After calculating normal, each little bit of watermark is stuck with the sound signal. Calculation of embedding strength is performed using ATS and by the conclusion Inverse DWT is applied. In the detection algorithm, 5 stages DWT has been used and from rough approximation coefficient suggest cost is calculated.

Ketcham et al. (2007) [6] put forward a genetic algorithm which uses Discrete Wavelet Transform. It is just a blind watermarking algorithm. In the embedding area of the algorithm, the 2-D binary picture is converted to the 1-D antipodal routine which can be ergo secured using a random sequence. After the decomposition of the insight sound in to 5 levels, the team of the coarsest approximation sub-band is segmented in to k-segments. Eventually, the IDWT is performed to obtain the watermarked sound signal. To boost the robustness of the algorithm more, GA has been used on binary picture as well. In the recognition algorithm, similar measures are performed. The performance is evaluated combined with robustness of the algorithm utilizing the episodes like random sound, selection, cropping. That algorithm shows fair robustness. An versatile sound watermarking algorithm using DWT and SVD has been given.

Yan yang et al. (2009) [7] provided a story music watermarking algorithm. That Algorithm uses DCT transform. The electric music suggests following subjection is improved applying DCT transform. Concurrently, binary picture is compensated down dimensionally and shifted through pseudo-random compositor. The likeness between the recovered and the specific picture is compared and along with that numerous symptoms like selection, Additive bright Gaussian sound

are put on check the robustness of the algorithm. That blind music watermarking strategy presented because respective paper is stable against all the attacks.

Nikmehr et al. (2010) [8] in the pipeline a technique of sound watermarking which engages equally DWT and DCT. The pieces produced as a result of the segmentation of the initial sound signal more are split in to two sections. The synchronization areas are embedded in to DWT coefficients of the original part while the watermark areas are embedded in to the DCT coefficients of the next part The DCT coefficients are produced following doing DWT on the next section. That algorithm shows an excellent resistance to the attacks.

Singhal et al. (2011) [9] proposed an algorithm which engages multilevel wavelet decomposition alongside DCT and SVD methodology. Multi-level haar wavelet decomposition is applied following framing the first music signal. After rearranging the approximation coefficient, DCT-SVD is applied and watermark is embedded. After applying the inverse DCT-SVD, watermarked music signal is obtained. In the extraction technique, both watermarked and unique music signs are compared to acquire the watermark image. That algorithm puts the intruder in the situation about the amount on that your wavelet decomposition has been done.

Elshazly et al. (2012) [10] in the pipeline an algorithm which uses DWT alongside recommend quantization. Following transforming the segmented sound show using DWT and picking the reduced power coefficients, recommend optimization is used on it. In the healing process, the watermarked sound show is segmented and turned using DWT and following applying the recommend quantization with this show, watermarked image is recovered, reshaped and decrypted to obtain the first watermark. That algorithm is very stable against frequent symptoms like paid off shift filter, compression, replicate, resampling etc.

Ghobadi et al. (2013) [11] provided an algorithm which employs LSB method. It is just a blind sound watermarking approach tamper recognition and elimination technique.

Originally, sound history is changed in to the vector which is then normalized and changed into matrix form. Following calculating the suggest of each column independently, it's caught by using LSB method. And then Opposite of the aforementioned mentioned method is performed.

Mursrat Ali (2014) [12] applied differential development (DE) algorithm to balance the tradeoff between robustness and imperceptibility by exploring numerous running factors in picture watermarking.

Jing - Ming Guo (2014) [13] the need of trademark security and rightful possession become really urgent in the quickly growing Web environment. The watermarking offers a convenient way to full cover up certain information.

Pranab Kumar et al. (2015) [14] proposes a blind singular price decomposition (SVD) based sound watermarking scheme applying entropy and log-polar transformation (LPT) for trademark security of sound signal. In this scheme, originally the initial sound indicate is segmented into nonoverlapping frames and discrete cosine transform (DCT) is placed on each frame. Low volume DCT coefficients are divided into subscription band and entropy of each subscription band is calculated. Watermark information is embedded in to the Cartesian components of the biggest singular price acquired from the DCT subscription band with best entropy price of each frame by quantization. Simulation results suggest that the concealed watermark information is effective against different attacks. The contrast examination reveals that this scheme has large information payload and gives superior efficiency compared to the state-of-the-art watermarking schemes reported recently.

4. COMPARISON TABLE

The below table (Table - 1) showing the comparative study on various research carried out by number of engineers, with their fruitful outcomes, limitations and applications.

Table - 1: A comparative review on various research reports published by numerous authors

Name of author	Title of the paper	Technique	Benefits	Limitations
M. D. Swanson	Robust audio watermarking using perceptual masking	Perceptual Masking	Guarantee that the embedded watermark is inaudible and robust.	the deadlock problem
S.W. FOO	An Adaptive Audio Watermarking System	Adaptive Audio Watermarking System	method is robust to common signal processing operations of noise addition, re-sampling, cropping, filtering and MPEG coding.	the problems of audible echoes
Seok, Jongwon	A novel audio watermarking algorithm for copyright protection of digital audio	A Novel audio watermarking algorithm	This algorithm to protect against unauthorized copying of digital audio.	But results are not effective.
N Cvejic	Robust audio watermarking in wavelet domain using frequency hopping and patchwork method	Audio watermarking method in wavelet domain	To enhance security, watermark is embedded in a randomly selected sub-band of the host audio according to a secret key.	computational complexity
N Sriyingyong	Wavelet-based audio watermarking using adaptive tabu search	Adaptive Tabu Search (ATS)	This is inaudible and robust to many digital signal processing, such as resamplig, cropping, low pass filter, additive noise and lossy compression (MP3).	Not give optimistic results
M. Ketcham	Intelligent audio watermarking using genetic algorithm in DWT domain	Genetic algorithms (GA) in the discrete wavelet transform	It is robust against watermarking attacks	Not give optimistic results
Yang, Yan	A Novel Audio Watermarking Algorithm for Copyright Protection Based on DCT Domain	additive audio watermarking algorithm based on DCT domain	AC DCT coefficients play different influence in robust and inaudibility.	computational complexity

Hooman Nikmehr	A New Approach to Audio Watermarking Using Discrete and Cosine Transforms	Audio Watermarking Using Discrete and Cosine Transforms	The noise introduced by the new scheme to the audio signal is imperceptible the watermarked audio signal is more robust against resampling, low-pass filtering, mp3, additive noise and requantizing attacks	Security is not enhanced.
Achintya Singhal	Audio watermarking using combination of multilevel wavelet decomposition, DCT and SVD	Audio watermarking using combination of multilevel wavelet decomposition, DCT and SVD	robustness and inaudibility	Results are not up to mark.
A. R Elshazly	Secure and robust high quality DWT domain audio watermarking algorithm with binary image	DWT domain audio watermarking algorithm	The algorithm has a good security because only the authorized can detect the copyright information embedded to the host audio signal.	computational complexity
Alireza Ghobadi	Blind audio watermarking for tamper detection based on LSB	Blind audio watermarking based on LSB	It preserves audio files from any tampering.	Audio incapability to hide data.
Mursrat Ali	A robust image watermarking technique using SVD and differential evolution in DCT domain	Image watermarking technique using SVD and differential evolution in DCT domain	The role of DE algorithm is to identify the best multiple scaling factors for embedding process in order to achieve the best performance in terms of robustness without compromising with the quality of the image.	Time consuming
Jing - Ming	False-positive-free SVD-based image watermarking	SVD-Based Image Watermarking	It achieves a high payload, and outperforms the former reliable SVD-based watermarking	The false positive problem of which an attacker can easily claim
Pranab Kumar	Blind SVD-based audio watermarking using entropy and log-polar transformation.	Blind SVD-based audio watermarking using entropy and log-polar transformation.	The hidden watermark data is robust against different attacks.	Results are not up to mark.

5. CONCLUSIONS

The existence of an invisible watermark has the capacity to turn out to be recognized employing the right watermark origin and diagnosis algorithm. With this investigating most of us minimize a few of our be concerned about inconspicuous watermarks. Arnold convert has transformed the watermark in such a way that it becomes worthless for the hackers or crackers. Different types of numerous episodes are often considered to gauge the effectiveness of the planned technique. The strategy was created in MATLAB software with the aid of picture running toolbox.

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