MAJOR PROJECT REPORT

ON

A BLIND AUDIO WATER MARKING USING ERROR CORRECTING CODES

Submitted for the Partial Fulfillment of the Degree

MASTER OF TECHNOLOGY

IN

SIGNAL PROCESSING AND DIGITAL DESIGN

BY

BHAGYALAKSHMI NARAYANAPURAM
2K15/SPD/06

Under the Guidance of

Dr. JEEBANANDA PANDA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
DELHI TECHNOLOGICAL UNIVERSITY, DELHI-110042
(SESSION 2015-2017)

CERTIFICATE

This is to certify that the thesis entitled "A BLIND AUDIO WATERMARKING USING ERROR CORRECTING CODES" is being submitted by BHAGYALAKSHMI NARAYANAPURAM, 2K15/SPD/06 for partial fulfillment of the degree "Master of Technology" in "Signal Processing and Digital Design" from Delhi Technological University. This work carried out by BHAGYALAKSHMI NARAYANAPURAM under my guidance and supervision. The matter contained in this thesis has not been submitted elsewhere for award of any other degree.

Dr. Jeebananda Panda
Associate Professor
Deptt. of E&C Engg.
Delhi Technological
University
Delhi-110042

ACKNOWLEDGEMENT

I would like to express my heartily gratitude and thanks to my project guide Dr. Jeebananda Panda, Associate Professor in Department of Electronics and Communication Engineering, Delhi Technological University, for continuous inspiration, encouragement and guidance in every stage of preparation of this thesis work.

I am also extremely thankful to Dr. S. Indu, Head of the Department of Electronics and Communication Engineering, Delhi Technological University, for the support provided by her during the entire duration of degree course and especially in this thesis.

I would like to thank my batch mates for their support throughout the entire duration of the degree.

Bhagyalakshmi
Narayanapuram
2K15/SPD/06
Department of Electronics and Communication Engineering
Delhi Technological University

ABSTRACT

Currently over the millions of digital audio files such as digital songs are copied illegally during file-sharing over the networks. It has resulted as the loss of revenue for music and broadcasting industries. The traditional protection schemes are no longer useful to protect copyright and ownership of multimedia objects. These challenges have prompted significant research in digital audio watermarking for protection and authentication. It helps to prevent forgery and impersonation of audio signal. In this paper, a novel audio watermarking based algorithm is proposed using Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT). Furthermore, the Arnold transform and error correction technique are utilized to improve the performance of proposed algorithm. The performance is measured using Bit Error Rate (BER), Peak Sound to Noise Ratio (PSNR) and Structural Similarity Index (SSIM) between the extracted watermark and original watermark. The experimental results show excellent resilience against typical signal processing attacks compared to the previous algorithm. The performance is improved in terms of BER for 0-3.9%, PSNR higher than 62-db and Structural Similarity Index (SSIM) from 0.99 to 1.

TABLE OF CONTENTS

List of Figures

List of Tables

1 INTRODUCTION

In past few years We have seen , multimedia information problem becomes more important and many others who are owners for that data, trying to take care about protection of their relevant or information from any illegal threat duplication. To maintain the original data availability , serious precautions are necessary should be done. But after times, industries have to come up with some good techniques or procedures to give protection the intellectual property of such data of creators, distributors or simple owners. For the development of Digital information protection schemes so much attention is required for this it is an interesting challenge. So many approaches are available in this Digital world to protect visual data, probably Watermarking is most interested one in those approaches.

1.1 MOTIVATION

A Watermark is on a Digital signal ,the information hidden within it . It has unified into data to the host signal with in it, and no header file or additional conversions to data are reguires. with in base signal it is framed for enduring perminently. What have happened with encryption , here the host data is not restricted to the access.

Digital Watermarking:

Watermarking, that identifies the copyright file's information(author, rights, etc..) embedded into a Digital image by the pattern of bits, audio or video. This name comes from rarely Watermark of visible, whichsignifies the letterhead of manu facture.

Andrew Tirkel & Charles Osborne has given the term Digital Watermarking in 1992.

For original content , Watermarking in Digital form provides protection of copyright, provide source tracking, Broad cost monitoring for Telivision related information .

1.2 Research objective

multimedia security plays important role in now a days. for strong need of Audio copyright protection a robust Audio Watermarking scheme hass necessary. To built a ineradicable, robust and invisible audio Watermarking technique an investigion and survey has done **o**n multimedia Watermarking techniques issues and multimedia security.

A Discrete Wavelet Transformations (DWT) related audio Watermarking Schedule with Arnold scrambling and Cyclic codes is proposed. In this Watermarking sceme initially for decomposition of audio signal, Haar proposed wavelet transform will be used with primary level decomposition by using Discrete Wavelet Transform.. In this work the Watermark will be embedded to the lower frequency band to provide better robustness.. To overcome this draw back Discrete cosine transform (DCT) was presented for Er improvement of DWT drawback of BEr, Unlike DWT, DCT will perform lower Bit error rate. For various attacks DCT provides 'admirable robustness' . Here for image Watermarking DWT-DCTe will u. The decomposition of host image by using discrete wavelet transform is held upto 3-levels. of selected DWT sub bands for coefficient blocks computed the DCT transform. it will result effective Watermarking will be embedded For these sub bands binary Watermarking,.

we use Scrambling to sensitive data removal. an effected and efficient technique will be used to scramble the data here encryption based is Arnold Transform. The problem in the signal like to improve the robustness, distribution of errors, in the Digital Watermarking, to change the distribution of errors Arnold Transform will be helps. this technique has utilized Before embedding to jumble the binary Watermark. Error Correcting Codes is used For the Audio Watermarking , significantly to improve the algorithm performance in addition to the Arnold transform , by using ECC.

1.3 Report Overview

We review issues related to different multimedia security and Watermarking techniques in the next chapter. Audio watermaking literature review In 3rd chapter different image, has shown.

2. Background

Watermarking plays important role in multimedia security. let u**s see**

Figure 2: Picture demonstrating an INR 100 note having Watermark at its left side which is impressively obvious when note hold under light

Hold 100 rupees note upto ligt and observe what has been seen there. otherwise see the company offer letter on a light and observe what is looking there**.** The picture of Mahatma Gandhi or our company's logo will be seen according to our observation respectively. This mainly proves the 'authenticity' or 'ownership' known as Watermarking. Today most paper Watermark have two properties as Visible and Invisible . To begin with, the Watermark is escaped see amid ordinary utilize, just getting to be noticeably unmistakable thus of an exceptional review prepare (for this situation, holding the bill up to the light) Second, the Watermark passes on data about the test in which it is disguised (for this situation, the Watermark displays the validness of the bill).

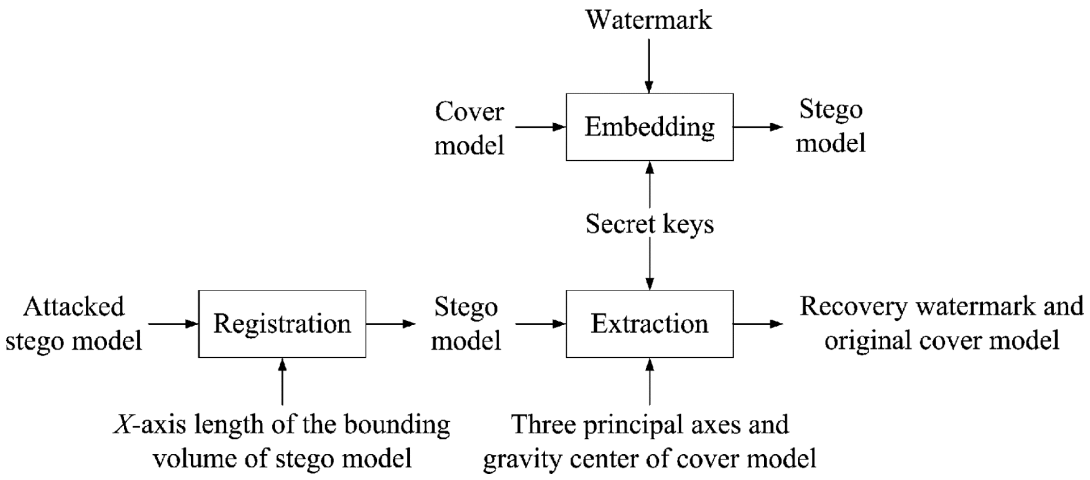


Figure2: Watermarking process

Parts of Watermark presenting/disclosure structure has appeared at Figure .The inserted information can be perceived in, or ousted from, a natural media fragment in an application.

2.1 Multimedia Security

Web, today, gives a condition where tricks can point of fact re-transmit sight and sound information on a wide scale range. Security has wound up being a champion among the most essential and testing issues for .

The security of media objectives were essentially indistinctly equivalent to standard information business systems:

- these tow needs to each other supplier of the fabric if the customer confirm at the top of an office
- substance must have honest/ real (in other words) that it has honestly / really been the substance is unchanged and spread around by the provider that.
- The respectability and genuineness fundamentals ought to be on moreover on the assention the substance and. The ability defer that substance provider should Has a customer customer must be able has acknowledged a few terms, while the to demonstrate that specific set rights have been obtained.

- Customer safety can also critical. On occasion,substances to understand may attractive has the ability that no one, even the substance provider the identity in customer

  Now a days there has a plenty of quantities &procedures to analyst on the particular one, cryptography is also one of that, Watermarking with computerized, and convention conveyance will be secure. Distinctive procedures down various experimental territory.

2.2 Cryptography

cryptography is the content which proprietors swing to primary innovation . Cryptography is presumably the most well-known technique for securing advanced substance. It is unquestionably one of the best created as a science. The substance is scrambled preceding conveyance, and a decoding key is given just to the individuals who have acquired genuine duplicates of the substance. The encoded record has made open through the Internet, however fitting key without would be trivial to privateer..

2 sorts of cryptosystems were there: symmetric and uneven. a message to scramble/unscramble, a comparable key (riddle key) and disproportionate first cryptosystems use and cryptosystems will useby one key overall public key to encode a message and a substitute key (the private key) to unravel it. Lopsided cryptosystems are also called open key cryptosystems.

sender to the recipient securely and in a deliberately outlined way? If you could send the puzzle key securely, at that point, on a fundamental level, you wouldn't require the symmetric cryptosystem regardless - in light of the way that you would simply use that protected channel to send your message. Frequently, trusted dispatches are used as a response for this issue. Another, all the more convincing and time tested course of action is an open key cryptosystem, for example,RSA, which is utilized as a bit of the prominent security contraption**.**

Take an example, there is to pass the information between two persions like Alice and Bob in secret manner, spy needs by Eve. Alice and Bob could be the military planes, they want todo a private talk either by online or in any other way.Eve is trying to catch their information but they cant overcome that problemof catching the signals, for this purpose they will use cryptography to overcome.

The process has been shown in figure. mechanized key has been exchange by both controversial , both know it that the information secrett. this key used by Alice to encode messages which she sends, and with a comparable key interpreting to changes primary messages by Bob. mixed messages are futile to Eve, who doesn't know the key, in this manner can't recreate the primary messages. With a better than average encryption figuring, this arrangement will work honorably, however exchanging the key while keeping it secret from Eve is an issue.

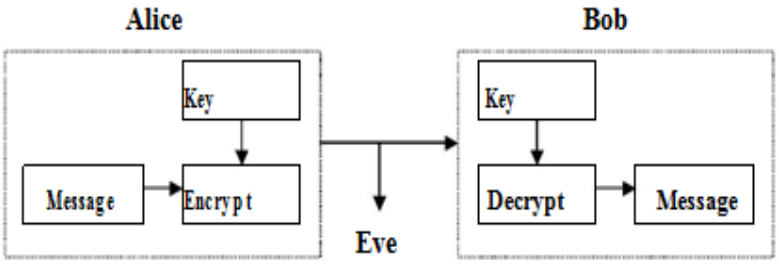


Figure 2.1

Unbalanced cryptosystems (open-key encryption, appear in Figure) are typical in view of the fact that they share the key in an open key for encryption and a secret key for unscrambling. It is unreasonable to choose the secret key of the general public key. In the overview, Bob produces a few keys and tells everyone (Eve) his open to unravel it. This arrangement authorizes Alice and Bob to get into the puzzle without meeting**.**

It's probably not possible key from the general open. Unfortunately, encryption can not help the author screen, how a certified customer handles the substance in the light of the interpretation. Private walkers can really buy the thing, use the unscrambling

key to get an unprotected fabric, a illegal copies. Any coon word, cryptography can cause dust in the journey, but once again unshaved, the fabric has no further insurance.

2.3 History of Watermarking

In spite of the fact that the specialty of papermaking was designed in China more than one thousand years prior, paper Watermarks did not show up until around 1282, in Italy. The imprints were made by adding slim wire examples to the paper molds. The paper would be marginally more slender where the wire was and consequently more straightforward. The significance and reason for the soonest Watermarks are unverifiable. They may have been utilized for down to earth capacities, For example, distinguish the forms on which sheets of paper are written, or as brands to recognize the paper manufacturer. Then they could speak again with magic characters, or perhaps just served as decoration. By the eighteenth century, a Watermark on paper made in Europe and America became more and more evident. They are used as trademarks.

To record the date the paper was made, to demonstrate dimensions of unique records. It was also time that Watermarks began to be used like anti-counterfeiting measures to the money and different archives. Watermark term seems to be set near the end of the eighteenth century and can be obtained from German expression, was sermarke (this may also be the German word English). The term is really a misunderstanding, as water was not particularly necessary for the formation of the seal. It is probably given on the grounds that the heads take on the influence of water on paper. Over time the term Watermark is set, counterfeiters have begun to create Watermarking strategies that are used to ensure paper money. False challenging progress in Watermark innovation. William Congreve, an Englishman, has strategy for making shadow Watermarks represented by embedded colored material in the middle of the newspaper in the middle of PAPER PROCESSING. The subsequent prints are more likely than difficult to produce, in view of the fact that the Bank of England itself refused to use it in view of the fact that it was too difficult to make it. A more useful innovation was constructed by another English man, William Henry

Smith. It had used the fine wire designs to replace substitutions, replaced by some kind of low relief form that are embedded in the paper form. The subsequent minor departure from the surface of the mold has made Watermarks with different shades of dark. This is the basic strategy today used for President Jackson's content on the $ 20 charge. 400 years later, at 1954, Emil Hembrooke of the muzak Corporation documented a patent for "Watermarking" melodic works. A recognizable proof code is embedded in music with irregular application of a tight step channel directed at 1 kHz. The indifference of vitality in this repetition has shown that the step channel is connected and that the nonattendance term has used to encode a spelling or dash. The recognizable evidence flag uses Morse code. It has hard to decide when advanced water brands first spoke. In 1979, Szepanski depicted a machine-distinguishing example that could be placed on archives for hostile to duplication purposes. After nine years, Holt has shown a technique to install a distinctive code in a sound flag. However, Komatsu and Minaga used the term 'automated Watermark' for the first time in 1988. Nevertheless, it was unlikely until the early 1990s that the term automated Watermarking has really come true. Around 1995, enthusiasm for computerized water brands began with fungi. In addition, some associations about this time began to consider Watermark innovation for consideration in different measures. Watermark Frames Technical Working Group Kopieerbeskermings (CPTWG) try to secure video in DVD circles. The Secure Digital Music Initiative (SDMI) Watermark made a central part of its framework to secure music. Two activities that are supported by the European Union, VIVA and Talisman, the Watermark deal with communication control. The International Organization for Standardization (ISO) appreciates innovation in relation to the planning of MPEG power standards. In the late 1990s, some organizations established to promote Watermarking articles. Various organizations increasingly in recent times, has made Watermark advances for a variety of benutings

2.4 Requirements for Watermarking algorithms:

- **Transparency:** The most central prerequisite for any Watermarking strategy might be with the end goal that it is straightforward to the end client. The Watermarked substance ought to be consumable at the expected client gadget without offering irritation to the client. Watermark just appears at the Watermark-locator gadget.

- **Security:** Watermark data should just be available to the approved gatherings. Just approved gatherings should have the capacity to adjust the Watermark content.

- **Ease of installing and recovery:** Ideally, Watermarking on advanced media ought to be conceivable to be performed "on the fly". The calculation requirement for the chose calculation ought to be least.

- **Robustness:** Watermarking must be sufficiently vigorous to withstand various types for flag handling operations, "assaults" or unapproved get to. Any endeavor, regardless of whether purposeful or not, that can possibly adjust the information substance is considered like an assault Heartiness among assault is a key necessity for Watermarking and the accomplishment of innovation for copyright security relies on upon this.

- **Impact on transfer speed**: Watermarking ought to be done so as to not build the data transfer capacity required for transmission. On the off chance that Watermarking turns into a weight for the accessible data transfer capacity, the technique will be rejected.

- **Interoperability**: Digitally content of Watermarked might at present to be interoperable with the goal that can be consistently gotten to through heterogeneous systems and can be played on different plays out gadgets that might be Watermark mindful or uninformed.

2.5 Importance of Digital Watermarking

Watermarking interest was no doubt because of the expansion in worry over copyright security of substance to the sudden increment . The Internet had moved toward becoming easy to use with the presentation of Marc Andreessen's Mosaic web program in 1993, it rapidly turned out to be certain that individuals needed to download music, imgs, Watermarks have used leg or suggested. These incorporate communicate observing, exchange following, verification (with direct similarity to our rs100 case), duplicate control, and gadget control.

AIMS

i. To decide have the capacity if a picture has been changed or not.
ii. The modification capacity any to find made any on the picture.
iii. To coordinate have to capacity confirmation the information with host picture as different information opposed as a document.
iv. The imperceptible information installed picture ordinary be under of conditions survey.
v. Watermarked permit to put lossy-pressure away in design validation.

2.6 Classification of Digital Watermarking

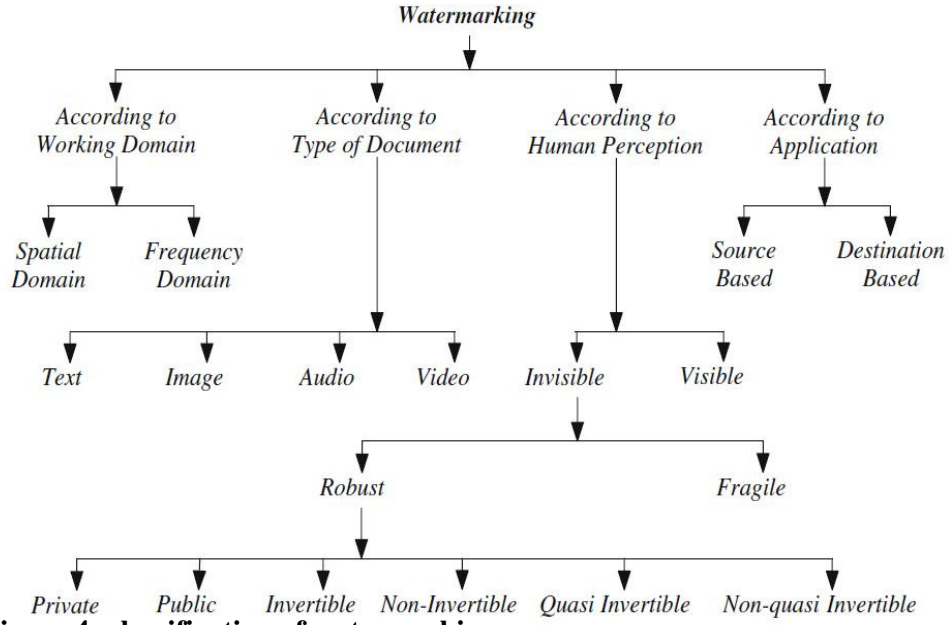


Figure 4: classification of watermarking

Visible Watermarking

only for images these Watermarks applicable will be happend. These logos were tailored picture, but it will shown right. As Watermarks can not be cut away, the middle part of the image. In addition, such Watermarks are guaranteed against such factual research.

Invisible Watermarking

Unprotected Watermarks are treated in the subject. It is possible by a recognized agency that it was recognizable.

- Robust Watermarking
    - Embedded unprotected Watermarks.
    - Resists image preparation or attack.
    - Use for copyright policy otherwise to confirm the holder.
- Fragile Watermarking

  These are Watermarks that effectively interrupted an attempt attack them. Sensitive for the pulverization Watermarks of information. In the figure, a case of sensitive Watermark until you talk to the first image, the the modified image was second and the third largest change.
- Watermarking with Semi Fragile
    - Sensitive to alteration.
    - Feature of both hearty and Fragile Watermark.
    - Provides information confirmation

Other than Watermark robustness, Watermark can likewise classified into obvious and undetectable sorts, noticeable Watermarks are discernible to a watcher. After that, Watermarking is not detected subtly and does not change the image. In our efforts, we are busy with invisible Watermarks because they have a wider range of applications as opposed to obvious Watermarks

2.7 Applications of Digital Watermarking

follow-up when the subject leaves the safe area of advanced and released to the customer. Advanced Watermark was used to develop the policy and gives the content owners the opportunity to ensure the rights and features of electronic equipment. Container of the brand. actual special needs of this application are as follows:

Digital Watermarking technology for authentication & sabotage proofing:

single-time ges of damaged car driven by the workshop to evaluate repair costs. Moving to advanced photos will save a lot of time and money for this type of procedure. Nevertheless the computerized images are adapted to exaggerate damage, or even done from the beginning, because the change of the automated image is much less demanding with the ability to achieve any power-driven photo equipment. can also recognize that part of the change from the custom image itself. Through a joint investigation with remarkable Japanese insurance agencies, we establish the specialized ability to innovate for the above-mentioned mechanical applications.

The special requirements for this application are as follows:

• Invisible to general customers.

• Applies to packaged print design (with most advanced cameras JPEG perfect organization).

• Sensitive to dust control, pressure and so on.

2.8 DISTORIONS AND ATTACKS

We need to recognize two "purposes" or "reasons" for against a Watermark to an assault picture:

• Hostile or malevolent assaults, which are an endeavor to debilitate, evacuate or change the Watermark, and

• Temporary attack can occur during normal display preparation and not tampering with watermark. Print loose image considered be the most known form of abuse if a watermark. A wide variety of attacks have been portrayed in writing. removable

- Geometrical attacks
- Cryptographic attacks
- Protocol attack

2.8.1 Removal attacks

Attacks of abstraction aimed at harness watermark abstract. If someone tries to abstract water market out of the data, there is an abstraction attack. Exercise (simple) attacks try to determine and evacuate the watermark. Occasionally, the risk of someone trying to attack. most widely used . The attack is fertile if the watermark can no longer be recognized, but the image is more consistent and can be used for a specific reason. Many such attack operations have been proposed:

- **Lossy picture pressure (JPEG, JPEG 2000)**
- **Gaussian commotion for Addition**
- **Denoising**
- **Filtering**
- **Median obscuring and separating**
- **Signal improvement (honing, differentiate upgrade)**

Geometrical attacks

These attacks are not aimed at removing the watermark, but try to either destroy it or disable its detection. They attempt to break the correlation detection between the extracted and the original watermark sequence, where the image is subjected to translation, rotation, scaling and/or cropping. This can be accomplished by "shuffing" the pixels. The values of corresponding pixels in the attacked and the original image are the same. However, their location has changed. These attacks can be subdivided into attacks applying general affine transformations and attacks based on projective transformation. Cropping is a very common attack since in many cases the attacker is interested in a small portion of the watermarked object, such as parts of a certain picture or frames of video sequence. With this in mind, in order to survive, the watermark needs to be spread over the dimensions where this attack takes place.

Mosaic attack. This point is emphasized by a "presentation" attack, which is of quite general applicability and which possesses the initially remarkable property that a marked image can be unmarked and yet still rendered pixel for pixel in exactly the same way as the marked image by a standard browser. The attack was motivated by a fielded automatic system for copyright piracy detection, consisting of a watermarking scheme plus a web crawler that downloads pictures from the net and checks whether they contain a watermark. It consists of chopping an image up into a number of smaller sub images, which are embedded in a suitable sequence in a web page. Common web browsers render juxtaposed sub images stuck together, so they appear identical to the original image, which is shown in Fig. 3. This attack appears to be quite general; all marking schemes require the marked image to have some minimal size (one cannot hide a meaningful mark in just one pixel). Thus by splitting an image into sufficiently small pieces, the mark detector will be confused. The best that one can hope for is that the minimal size could be quite small and the method might therefore not be very practical.

Cryptographic attacks

Cryptographic attacks aim at cracking the security methods in watermarking schemes and thus finding a way to remove the embedded watermark information or to embed misleading watermarks. One such technique is brute-force search for the embedded secret information. Practically, application of these attacks is restricted due to their high computational complexity. They cover, for example, direct attacks to find the secret key or attacks called collusion attacks. Cryptographic attacks are very similar to the attacks used in cryptography. There are the brute force attacks, which aim at finding secret information through an exhaustive search. Since many watermarking schemes use a secret key, it is very important to use keys with a secure length. Another attack in this category is so-called Oracle attack which can be used to create a non-watermarked image when a watermark detector device is available.

Protocol attacks

Protocol attacks neither aim at destroying the embedded information nor at disabling the detection of the embedded information (deactivation of the watermark). Rather, they take advantage of semantic deficits of the watermark's implementation. The protocol attacks aim at attracting the concept of the watermarking application. The first protocol attack was proposed by Craveret al. They introduced the framework of invertible watermark and showed that for copyright protection applications watermarks need to be non-invertible. The idea of inversion consists of the fact that an attacker who has a copy of the stego-data can claim that the data contains also the attacker's watermark by subtracting his own watermark. This can create a

situation of ambiguity with respect to the real ownership of the data. The requirement of non-invertability on the watermarking technology implies that it should not be possible to extract a watermark from non-watermarked image. As a solution to this problem, the authors proposed to make watermarks signal-dependent by using a one-way function. Consequently, a watermark must not be invertible or to be copied. A copy attack, for example, would aim at copying a watermark from one image into another without knowledge of the secret key. It also belongs to the group of the protocol attacks. In this case, the goal is not to destroy the watermark or impair its detection, but to estimate a watermark from watermarked data and copy it to some other data, called target data .

3. AUDIO WATERMARKING

This Watermarkng known technique for reducing data through signals of audio.. So far, different literary studies have been discussed in the literature by looking at different applications and developmental positions. Perceptual characteristics of the human hearing system (IS) using different audio sequences via a broadcast signal. All watermark technology, but is at risk: High robustness is equipped with a high watermark data rate of perceptual parameter openness is not considered to be well-established. In addition, a cheerful domain covers coverage and given quarantine relate to data disregarded techniques considered for the design of the road to a data representation unjustified.

Audio Watermarking Techniques:

Generally, many healthy its performance in terms of cordiality and incomprehensibility. A scientific exposition has also been introduced that leads to the power of power.

Spread-range innovation has been used in healthy watermarking which is initially offered . Another strategy in the light of the distribution innovation is a numerous resound method that replaces a significant reverberate in the host flag with different echoes with different balances. The next technique is the positive and negative reform hiding plan .Each reverberate contains positive and negative echoes in adjacent areas. In the low repetition band, the response of positive and negative echo forms a smooth form that occurs through comparable reversed conditions of negative reverberate with that of a positive resound. When positive and negative echoes are applied, the nature of the host sound is not clearly written off by installing different echoes.

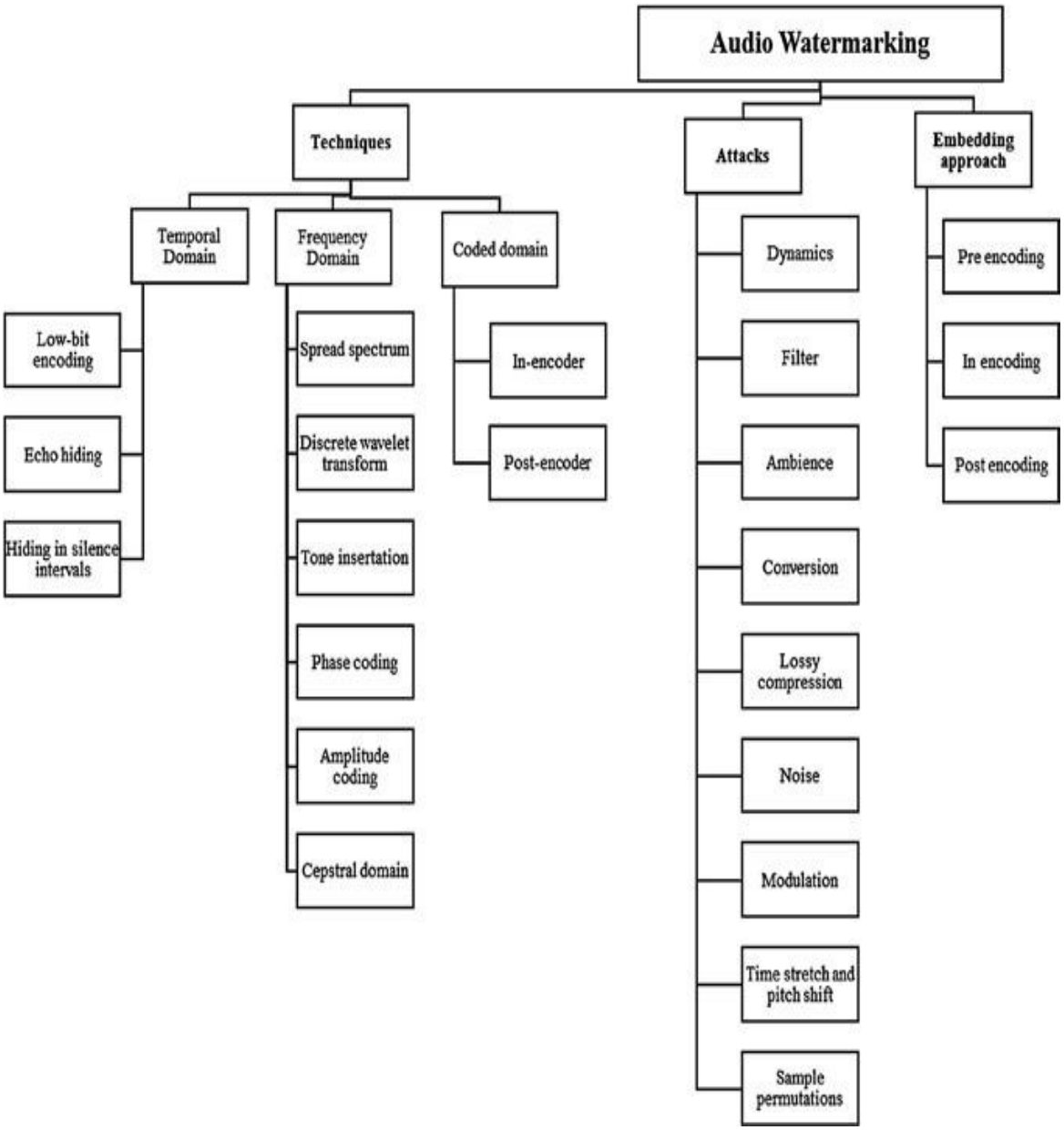


Figure 5: Audio Watermarking Techniques

Domain of Watermarking	Technique	DESCRIIPTION	Positive impacts	Drawbacks	Capacity (kbps)
Domain of Coded	modification of Code book	– For this purpose a code book. - Codebook parameters are changed to hide information	robustness is more	shrouded Low limit of information	2
	hiding of Bitstream	– Generate bitstream by encoding - LSB is connected to the bitstream - The data is hidden in a little stream - Bitstream usually sensitive to adaptation as the audio flag	robustness is more	of shrouded Low limit information	1.6
Transform domain	Magnitude Spectrum	- frequency domain utilized Instead of time domain -when it comparison wih TD, more resilient to noises in	commotion Stronger to amid expansion higher correspondences, rate of stowing information away	basic sound controls is Low vigor	20
	Tone insertion	– in cover signal it Embeds quiet tones - right extraction of information from watermark Information is provided as an explanation with known Frequencies and low power level - The information that conceals the border for tonnage integration The technology is low. - Some attacks can withstand tint integration Use technology, for example, low separation and bit-shortening; In all cases, attackers vary greatly Toner and focus the hidden information. - Safety can be controlled by the movement four or	covered up Indistinctness of Information	– transparency was Low –security Low	250bps

	Phase spectrum	- hidden information in a reference - replace the unique sound period with a flag referentiestadium -Phase fragments are equilibrated equilibrated to protect the relative phase between the fragments - Work as well as changes in phase parts are kept low. - Do they have a fine	Hearty against flag handling control and information recovery needs the unique flag	Low rate of information stowing away	333bps
	Spread spectrum	- Spreader hidden information in common room - information encoded stream coding Data that represents a significant part of the relapse Possible - removing the use of repetition data The inaccuracy of the information that has been removed – If impedance on a few – Frequencies is existed, the flag gathering is allowed	High robustness	Vulnerable to time Scale change	20bps
	Cepstral domain	- The data is displaced with cepstrale coefficients - The envelope information sections Frequencies are quiet by HAS - Here you get a high limit of hidden information - APF enhances the sound of the sound tag with watermark against expansion of shock, random intrusion, e-quantize and resampling.	robustly against flag handling operations	Perceptible flag twists and low robustness	54bps

	Wavelet	- The data is replaced by the wave train coefficients - Hide LSB information from wavelet coefficients - The subtlety of hidden information is low DWT - When the number of wave train coefficients is accessible, it is a valuable audience advantage in order to improve sound reversibility.	High rate of information stowing away	Inaccurate information extraction at the beneficiary	70 kbps
Temporal domain	Low-bit encoding	- The information relating to technology for closing - The least difficult technique for information about data structures, such as audio in image or image information in a report audio - replace the LSB plan every information inspection encapsulated - The low improve the higher deposit at the point where the extension and turn occur.	Easy to create also, high piece rate	Low security, delicate to assaults, simple to encroach	16 kbps
	Echo hiding	- Integration of information into a short reSound - Echo made by reverberation - Data storage can be accompanied by three parameters A reSound flag: start-up, delay (or new balance) and cost of dissolution. - Estimates of abundance and rotting rate must be placed below the nominal edge of the HAS - Two echo with different balances are used Implemented information: the double date "a" and Another talk double "zero"	Lossy information pressure is endured	Low security, low concealed information Capacity	50 bps

		date.			
	Silence intervals	- Provides information about hidden silence between two audio signals	Lossy information pressure is endured	Low concealed information limit	64 bps

Table 1: Different Audio watermarking Techinques with performances analysis

4. LITERATURE REVIEW

4.1 DWT

In Fourier research solved Discrete Fourier Transform (DFT), a sinusoidal signal premise of different frequencies. No data is lost on this change; As such, the flag can be fully restored for its first DFT (FFT) representation.

In the wavelet investigation is the discrete wavelet transform (DWT) weakens a flag of a series of general orthogonal wavelet base capabilities. These functions contrast starting sine work due to the spatially limited - the non-zero only a small part of the length of the flag. On the other hand increases wavelet and ontsyferde limited forms of a typical φ capacity, known as the mother wavelet. It may appear in the current situation in the summer time Fourier survey reversible, so that the first flag completely recovered the DST image.

Absolutely like DFT, daylight saving time, truthfully speaking, not only in a unitary transformation, but a series of transformations, each with an alternative arrangement of wavelet base. Two of the most famous is his Lette Wave and Daubechies set wolfette. For example, Figure 1 and 2, the general device 64, and Her-4 Daubechies wavelet capacity (for signals of length 64) separately. Here we will not discuss the subtle touches of how it is inferred, in any case, it is important that the corresponding essential characteristics:

1. Waveletkapasiteite spatially limited;

2. Wavelet expanded, interpreted and limited forms of a typical

Wavelet mother;

3. The wave train capabilities of the device frames orthogonal array of

Premise capacity.

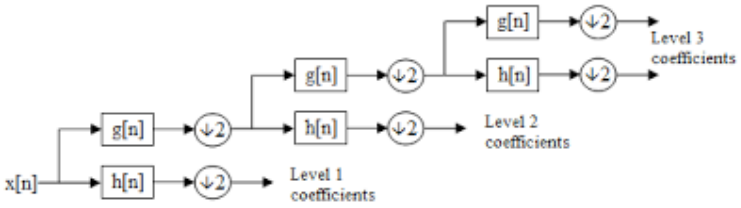


Figure 6: 1D- DWT

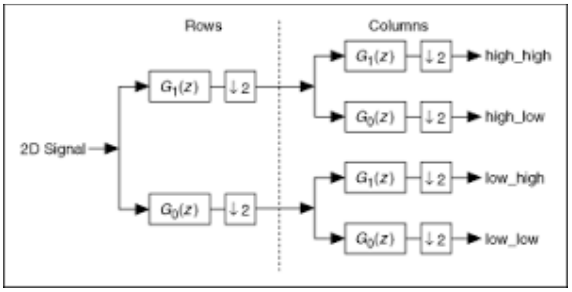


Figure 7: 2D DWT

Second waveform is a scan multi scale approach that overcome the disadvantage of determining the established discrete Fourier change (DFT). The change wave is useful to break down the general data and further details of an indicator. DWT is a progressive change and damages an indication of sound in a limited control of bands that can be used to reproduce the first sound. Since the capacity of data sets subsequent coefficients is smaller than the first sound, the coefficient sets are tested without data loss. recreation of the first flag of paraffin by testing, separation, and the sum of the individual subgroups. Through the application of the DWT the audio 2-D channels in each measurement. Channels separate the audio data in the four coefficient sets of multidetermination not covered, a sound estimate drop lower (LL) and detail segments flat (HT), vertical (LH) and inclind (HH). The DWT coefficients speak coarse scale sub-orchestra LL while the sets of coefficients LH, HL and HH coefficients of the DWT are nice format. The third level in the middle band coefficients are selected to achieve greater impact. The maximum amount of decay gives more prominent attacks against extreme security.

The (one-dimensional) DWT works on a genuine esteemed vector x of length 2n, n ∈ {2, 3, . . . }, and brings about a changed vector w of equivalent length. Figure 3(a)

and (b) outline the initial two stages of the DWT for a vector of length 16. In the first place, the vector x is separated with some discrete-time, low-pass channel (LPF) h of given length (in the Figures, we utilize length four for representation purposes) at interims of two, and the subsequent qualities are put away in the initial eight components of w. This progression is outlined in Figure 3(a). Second, the vector x is separated with some discrete-time, high-pass channel (HPF) g of given length (once more, for outline purposes, we utilize a channel of length four) at interims of two, and the subsequent high-pass qualities are put away in the last eight components of w. This progression is shown in Figure 3(b)

4.2 DCT

A limited grouping of informatiefocusen communicates by discrete cosine transform (DCT) a until then fully oscillating cosine capaciteiten at different frequencies. DCT is critical for various applications in science and the construction of loss of sound pressure (eg. MP3) and images (as JPEG ..) (where low recidiefsegmenten removable), to spookstrategieën for the numerical arrangement of halfwegverschillen. The use of cosine instead sinuscapaciteiten is the basis of pressure that the result (see below) less cosinuscapaciteiten expected a common flag will love, but in different circumstances to meet the cosine of a specific decision of the border since.

Specifically, a Fourier-related Changes a DCT such as the discrete Fourier Transform (DFT), but using only real numbers. The DCT is largely identified with Fourier series coefficients in an intermittent and symmetric improved system, whereas the TFT identified by coefficients of Fourier series in a properly developed temporal. DCT of identical to the TFT working length double majority with real information, even symmetry (since the Fourier change of a true and even real capacity and equal), but in some variants, data, and income moved significantly example. There are eight standard variants DCT, four normal.

DCT shift to make an image of a collection of numbers called coefficients. The value of a coefficient determined by the same volatility of arrangement of images in the

video situation. In the event that a large difference between the coefficient of a set, it can not be canceled without affecting the image quality.

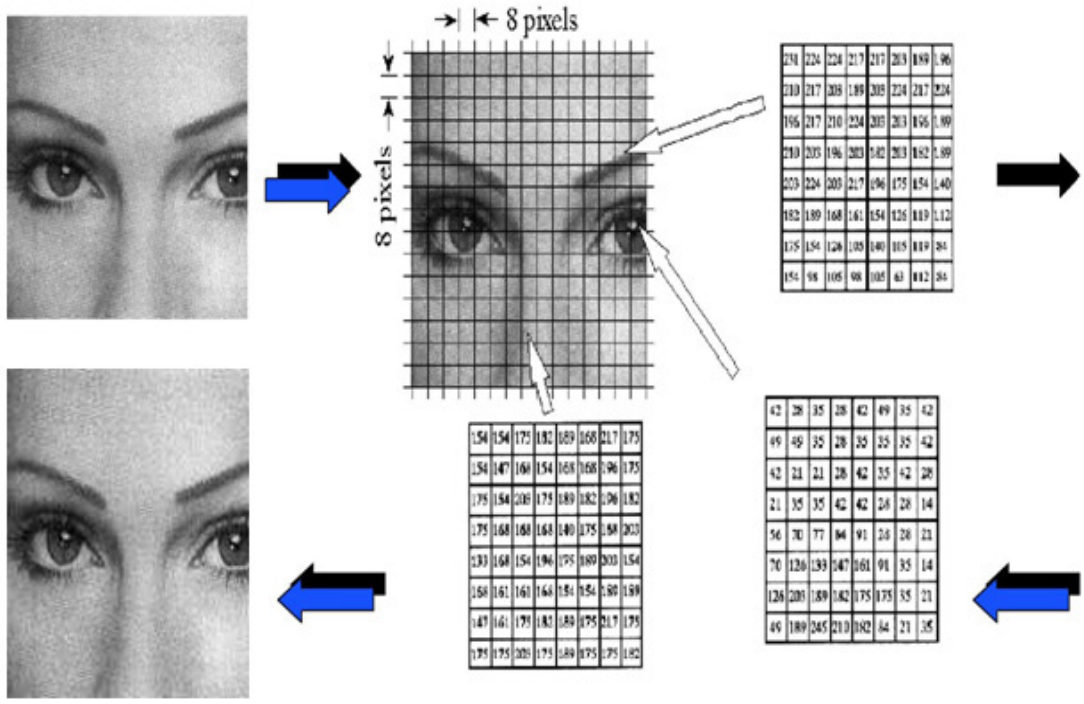
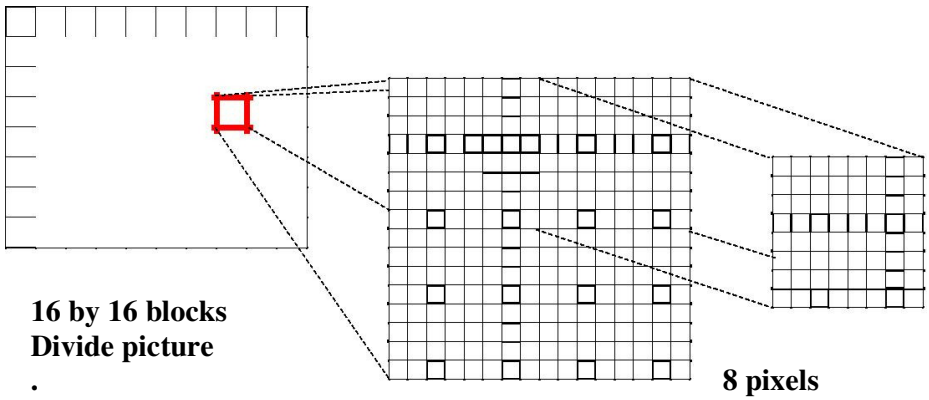


Figure 8: DCT conversion of an image



16 by 16 blocks
Divide picture
.

8 pixels
by 8 lines

DCT Equation of One-Dimensional

$$X_c(k) = (1/N) \sum_{n=0}^{N-1} x(n) \cos(k2\pi\, n/N),$$

where $k = 0, 1, 2, \ldots, N-1$

One-Dimensional IDCT Equation

$$x_c(k) = \sum_{n=0}^{N-1} c[u]\, X(n) \cos(k2\pi\, n/N)$$

where $k = 0, 1, 2, \ldots, N-1$

X_n is the DCT result, and

c[u] = 1 for u=0, and c[u] = 2 for u=1,2,3,...N-1

DCT Equation of Two-Dimwnsional

$$F[u,v] = 1/N^2 \sum_{m=0}^{N-1} \sum_{n=0}^{N-1} f[m,n] \cos\left[\frac{(2m+1)u\pi}{2N}\right] \cos\left[(2n+1)v\pi/2N\right]$$

where:

u, v = discrete frequency variables (0, 1, 2, …, N - 1),
f[m, n] = N by N image pixels(0, 1, 2, …, N - 1), and
F[u, v] = the DCT result

IDCT equation of Two-Dimentional

$$f[m,n] = \sum_{m=0}^{N-1} \sum_{n=0}^{N-1} c[u]c[v]F[u,v] \cos\left[\frac{(2m+1)u\square}{2N}\right] \cos\left[\frac{(2n+1)v\square}{2N}\right]$$

where:

u, v = discrete frequency variables (0, 1, 2, …, N - 1),
f[m, n] = N by N image pixels(0, 1, 2, …, N - 1), and
F[u, v] = the DCT result

Another lossless and lossy picture of change coding procedure comes about utilizing the DCT and DWT. abstaining and higher pressure proportion from sticking curios Discrete Cohesion Transform gives the, permits great confinement both in spatial and normality area. In light to DWT with expansive coefficients of MSE and PSNR values DCT is superiored and high pressure proportion. DWT keeping in mind The was utilizing Proposed system the end goal to get the high pressure procedure. great PSNR values the DWT utilized accomplished. de-noising of Picture where the components of commotion are found high recurrence. superb apparatus in picture preparing Wavelet speaks to an to expand the outcome in quality and Performance.

Here, The more mainstream piece based DCT change is which fragments in the non-covering a sound pieces and after to each piece that DCT is connected. It gives three yield recurrence subbands: high recurrence sub- ƅand, mid-recurrence sub- ƅand and low recurrence sub ƅand.

The watermark setting Central repeating subband essentially implanted provides sound quality indicator host. That's because of the two realities. The first fact is that much of the vitality of the flag in the low-frequency subgroup of the most essential parts of the sound is noticeable so that there is less room for any torsion therein the Sub bands The second reality is that high repeat segments that evacuated sound by pressure, what's more, shock attack.

4.3 Arnold Scramƅling Algorİthm:

Arnold calculation component of coding simplicity is also periodicity, so it uses, in general, to provide an additional level of security through computerized Watermarkİng. Arnold The change is excellent as it changes the feline face and it is reasonable that the flag size N × N. It is characterized as a condition

$$\begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

(x, y) and (ẋ, ẏ) {0, 1, 2, … ..N-1}, where(ẋ, ẏ) are the directions of mixed Watermark , (x, y) and is the directions of unique Watermark. N is the width or size of the prepared flag . Arnold Trans of a temporary nature. The deciphered flag based on encryption key

that can be used as many times it has been mixed an important mystery and characterizes.

4.4 Error correcting codes:

These are utilized to enhance information recuperation as a part of correspondence frameworks, particularly if the correspondence channel has inclined to clamor and obstruction. There are Cyclic codes, reed-Solomon codes, BCH, and Hamming code a few blunder revising codes like, The calculation of proposed incorporates cyclic codes as our blunder revising plan. in view of polynomials Cyclic codes limited fields are direct codes over. These are an imperative class of mistake codes and less demanding as far as usage.

Give about a final field n Ⓒ as linear code chance to be a. Ⓒ known and a cyclic code for each code word is characterized by Ⓒ.

Ⓒ = $(c_0, c_1, c_2, \dots\dots, c_{n-1})$. Next word $(c_{n-1}, c_0, c_1, c_2, \dots\dots, c_{n-2})$ will be right move of parts gotten by a cyclic. as polynomial. Consequently Cyclic codes are generally exhibited, the code word C spoken to as

Ⓒ **(x) =** $c_0 + c_1 x + c_2 x^2 + \cdots \dots + c_{n-1} x^{n-1}$

Because the double discourse is c0, c1, ..., cn-1 1 or 0 cyclic codes have some additional required additional codes. They depend on the Galois fields and are very valuable for error checking because of their fundamental properties. The structure is clearly identified with the Galois field, as a result of which the coding and interpretation calculations for 2-bit (3.2) encoder code with code length 1 and code length of the bit 3.

5. BLIND AUDIO WATERMARKING ALGORITHM

In proposed scheme, DWT decomposition for 3rd level is performed for selected sub-band frequency blocks DCT is applied on the host audio signal. here for Watermarking the content we will use binary image like Watermark, it is further encode with cyclic codes further scrambled by using Arnold transform. For Arnold transform , Watermark key will be used. Arnold transform explains the how many number of iteration has held for scrambling.

After that 2 ucorrelated pseudo random sequences generated , the Watermark bits can be embed to selected mid-band frequencies these sequences will decide of DCT blocks ,.

5.1 EMBEDDING WATERMARKING:

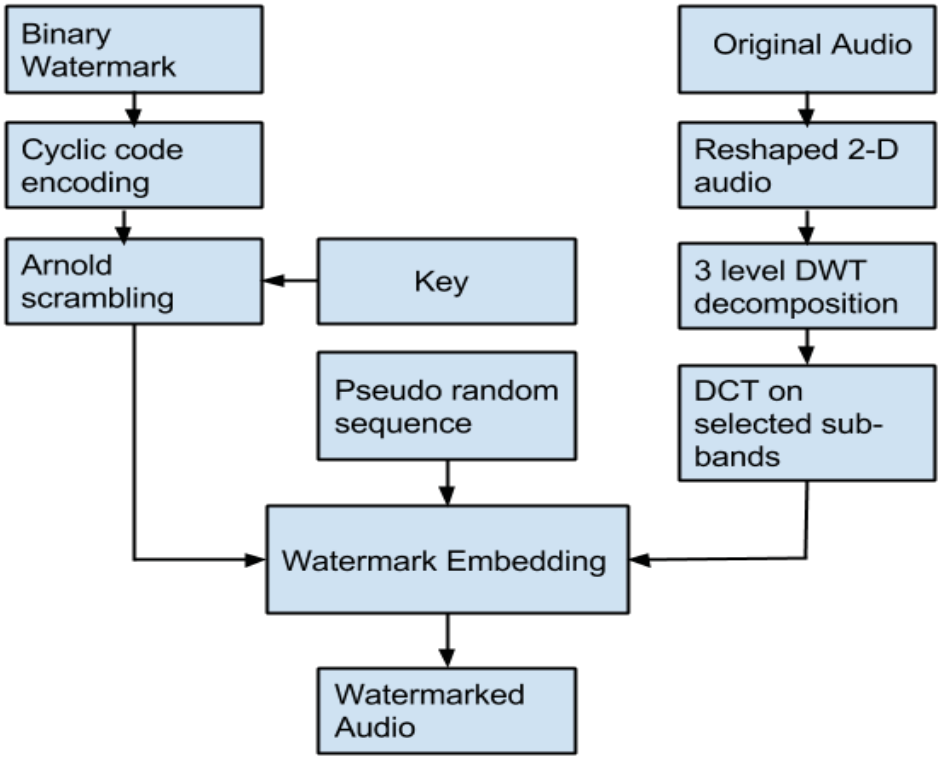


Figure 9: Embedding algorithm of Watermark

Fig. Show the algorithm of embed watermarks. The first host signal will of size M x M reformatted as a 2-D matrix. as a watermark the binary image is set, of the dimension N x N which is a rectangular matrix (where N = M / 32). Next, follow the steps in the suggested algorithm.

Step-1: to decompose the host audio signal On the M x M square matrix ee apply DWT of given host audio into sub-bands [L, H, V, D].

Step-2: for further processing V waveb and H means and (mid bands) has been selected. There is a trade mark between robustness against imperceptibility and the second level DWT chosen (through its wavelet) in these two subbands for [V1, V2, V3, V4] and [H1, H2, H3, H4] .

Step-3: select [H2, H3] lineage and [V2, V3]. DWT then allows with third blocks level of wavelet both degradation as shown in Figure . Then, D2, C2,B2and A2 bands are selected, and divided each band is into blocks of N / 4 x N / 4. to the selected mid band areas of the coefficients apply In each discreet cosine transform blocktrans.

Step-4: using watermark key , generate 2 uncertain pausdo random order (PN_1 & PN_2). The number of mid-band coefficients number of mid-band coefficients should be equal to the number of mid-band coefficients.

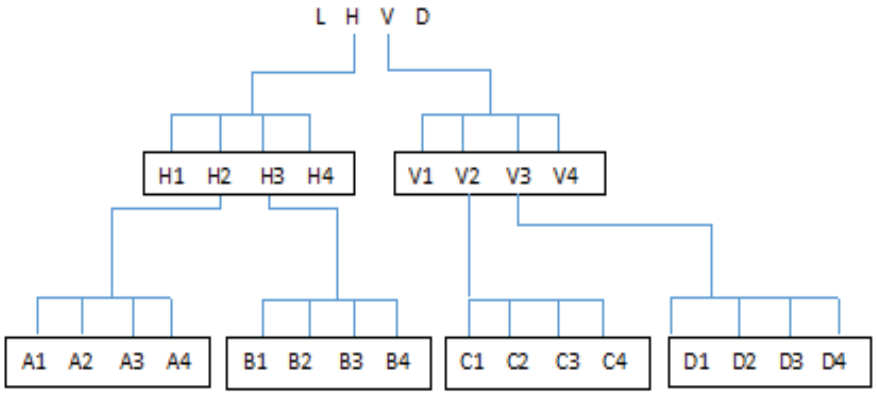


Figure 10: DWT decomposition tree

Step-5: Binary matrix watermark is reformed as X = μ * 2 matrix of size N x N, this will be coded with cyclic codes So that, where μ is a satisfying N x N= μ *2 constant

Step-6: X = 2* μ matrix, by Cyclic encoding will be done with the recovery of cyclic codes , improved data due to its structural property.

Step-7: By presenting more number of parity bits , perform with A(3,2) with cyclic encoding wi 2nd level of will over X2=X(:,2:3) and X1=X(:,1:2) to get a better level of security .

Step-8: column [c1 c2 c3] as specified reorder the matrix X1 with the to X11 by column [c1 c2] using and colum**n** [c2 c3] using X12. for X2 do same process so that it will form X22and X21.

Step-9: We will get Z1 with X11 and X12 Horizontally Concatenated Similarly, to form Z2 , X21 and X22 Vertically concatenate to get dimension 2N x 2N of matrix Z is used Z1 and Z2.

Step-10:By using secured and secret Watermark key, the matrix Z will be scrambled..

Step-11: The Scrambled watermark bits of matrix Z will **e**mbed to the audio by using following rule:

Z having the dimension of 2N x 2N. So, k _ (1,2N x 2N) , where k is index of matrix Z.

if Z(k)=0

Mid_coeff = Mid_coeff + P*N*_1

If Z(k)==1

Mid_coeff = Mid_coeff+ P*N*_2

end

Step-12: Here, apply inverse DCT and DWT to get the Watermarked Audio.

5.2 Watermark Extraction

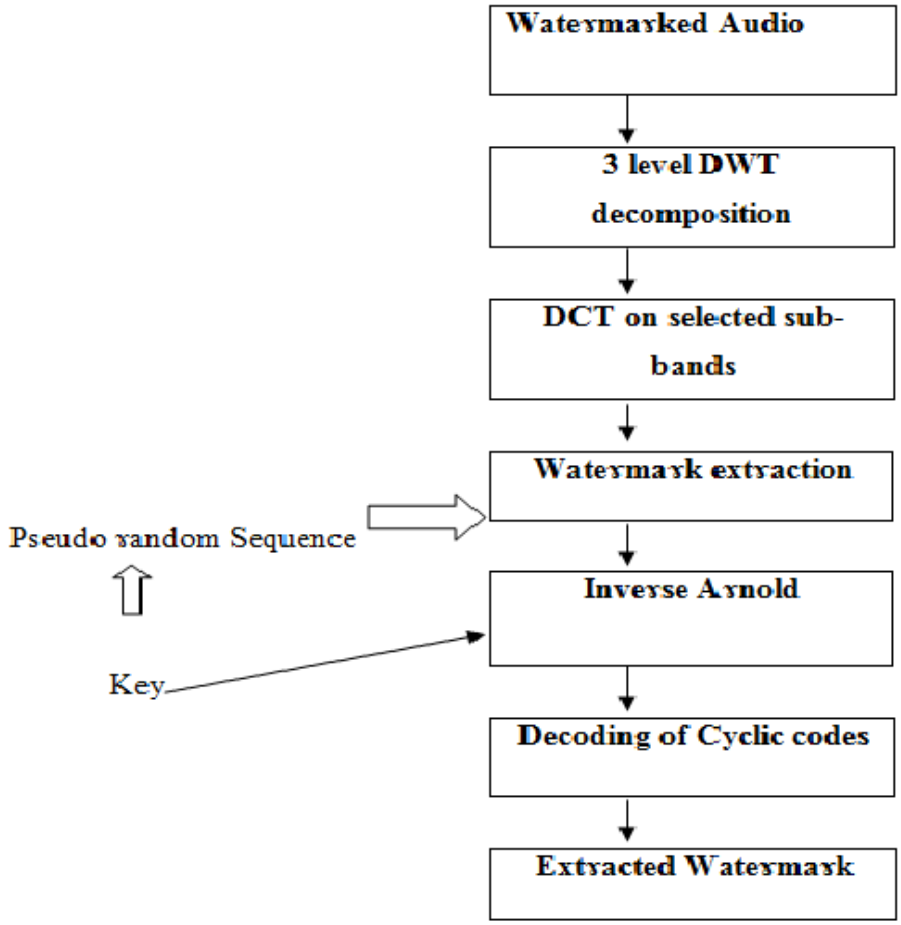


Figure 11: Extraction Algorithm of Watermark

Step-1: at the embedding algo reorder as M x M matrix of the Watermarked audio then Apply DWT3rd level decomposition of exactly done.

Step-2: For mid-band coefficients Generate 2 uncorrelated pseudo random sequence with similar length in DCT block as number.

3: For selected mid-band coefficients apply DCT for each and every blocks.

Step-4: According to following rule Watermark bits will be extracted:

if correlation(mid_coeff and PN_1)> correlation(mid_coeff and PN_2)

Z(k)=0

if correlation(mid_coeff and PN_2)• correlation(mid_coeff and PN_1) Z(k)=1,

where Z is extracted Watermark bit matrix.

Step-5 : of matrix Z ,obtain dimentions 2N x 2N and by using inverse Arnold key , pass this matrix .

Step-6 reorder the matrix Z by satisfying matrix W= 4* μ.

Step-7 : Above matrix divide From middle Horizontally occur the to form matrices

W2= 4* μ/2& W1=4* μ/2 .

Step-8: W1 and W2 Here will be separated Vertically to get matrix with each size having μ/2*2 of W11, W12, W21 and W22.

Step-9 : To form X2Concatenate W11 and W12 Horizontally to form the condition as X 1 (4*μ/2).

Step-10 : 3 or 2 column will Eliminate from the matrix X1 & X2. Their dimension will be 3*.(μ/2)

Step-11 : On X1 and X2 , Cyclic decoding will apply with size of A(3,2) respectively to get X1'and X2'. after that X1's 2nd column or X2' s 1st column will be removed.

Step-12: X1'and X2' Concatenated Horizontally for forming matrix X.

6 IMPLIMENTATION ALGORITHM OF BLIND AUDIO WATER MARKING

Looney , Pop, Classical, Jazz, and music structures will be considered as unique sound flag. Every music flag is tried in .wav configuration length of size 512 x 512. The paired picture of size 16 x 16 will be chosen for Watermark and is appeared at Fig...

For this situation, quantity of cycles for Arnold scrambling , we have taken as 7 it was similar length of the pseudo arbitrary arrangement. Accordingly, add up to 7 coefficients are chosen for Watermark installing for every 4 x 4 size of sub-band of DCT.

The parameters measured under execution of the proposed technique is assessed by, for example, Peak Sound to commotion proportion (PSNR) , Bit Error rate (BER), and SSIM- Structural similitude record . for calculation of gauge strength, SSIM and BEr were utilized here in the recovered Watermark to confirm the contortion PSNr will be useful. Transmission in advanced, the bit Error rate (BER) is figuredthe execution gauge & of bit mistakes per unit time , it relies upon quantity. bit Error proportion (BEr additionally) separated was the quantity aggregate to bit mistakes by no. of a particular exchanged bits amid to interim. BEr as follows .

$$\mathbf{BER\%} = \frac{\boldsymbol{BER}}{\text{No.of bits to be sent}} * \mathbf{100}$$

Crest Signal-to-Noise ratio (PSNR) was great estimation to pictures then nature of any given 2 pictures. It utilized for ascertain nature of the unique Watermark (paired picture) and also removed Watermark .

PSNR is given by

$$\mathbf{PSNR(dB) = \ -10\ log_{10}\frac{MSE}{S^2}}$$

here S is maximum pixel value.

The audio signal quality is performed in terms of Signal to Noise ratio (SNR) is defined follows $\mathbf{SNR(dB) = \frac{P_{signal}}{P_{noise}}}$

$\boldsymbol{P_{signal}}$ is the power of signal and $\boldsymbol{P_{noise}}$ in noise power.

Table II . parameters were figured between unique Watermark and removed Watermark for different assaults.

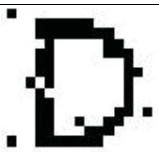
AUDIO TYPES	EXTRACTED WATERMARK	BIT ERROR RATE (%)	PSNR(dB)	SSIM
LOONEY		3.9	62.2132	0.9991
JAZZ		0	Inf	1
POP		3.9	62.2130	0.9990
CLASSICAL		0	Inf	1

TABLE II- DIFFERENT AUDIO SIGNALS TEST RESULTS AND CORRESPONDING EXTRACTED WATERMARK

power expecting for input flag 0 dBW includes SNR per test AWGN as 10dB. . By utilizing normal channel had finished Separating here numerator like My filter as characterized balanced exchange capacity was made . It is the matrix of rows where

size of square lattice number have equivalent to columns of info, 512 for this situation. it entirety standardized Lastly .when sound lattice set as zero Cropping will be done where some particular length of.

Lmax=5*L/11 & Lmin = L/11 has been utilized as adjusted values for this situation. 1-Lmin as more given, Lmax-end set to zero. According to capacity of MATLAB by utilizing inbuilt resamples, resampling has finished. Fs_1/Fs_0 unique times ,Host matrix will be resampled at examining rate where original testing rate(Fs)= Fs_0 and round(Fs/9)= Fs_1. with Fs _0/ Fs _1 unique times resampled testing rate occur. Encourage postured condition was given as

If length(Resampled Audio)<L

Resampled Audio(end+L)=0

If length(Resampled Audio)<L

Resampled Audio = Resampled Audio(1:L)

512 x 512 was dimention & L is unique Audio length which is for our situation . By utilizing inbuilt MATLAB work, requantization has been finished where host sound flag put information away at it's new composed wave record. Fs has specimen rate of information it is also 8 piece as new levels has used. in Table III-VI calculation of Proposed by using Arnold and cyclic codes scrambling changes been contrasted and Arnold scrambling & ECC without using DWT-DCT had calculated.

Audio Signal	Attacks	Praposed Algorithm	DWT-DCT based Method
LOONEY	AWGN	0.13	0.61
	Filtering	0.35	1.32
	Cropping	0.16	0.53
	Resampling	0.45	1.99
	Requantization	0.03	0.27
JAZZ	AWGN	0.00	0.00
	Filtering	0.25	0.59
	Cropping	0.14	0.42
	Resampling	0.17	0.93
	Requantization	0.00	0.00
POP	AWGN	0.08	0.30
	Filtering	0.35	1.26
	Cropping	0.16	0.49
	Resampling	0.46	2.00

	Requantization	0.03	0.14
CLASSICAL	AWGN	0.01	0.01
	Filtering	0.26	0.92
	Cropping	0.14	0.44
	Resampling	0.44	1.89
	Requantization	0.00	0.00

TABLE III - COMPARISION OF NORMALIZED BER PERFORMANCE WITH PROPOSED ALOGORITHM AND RELATED WORK

Audio Signal	Attacks	Praposed Algorithm	DWT-DCT based Method
LOONEY	AWGN	0.9963	0.9957
	Filtering	0.9901	0.9854
	Cropping	0.9949	0.9910
	Resampling	0.9769	0.9978
	Requantization	0.9991	0.9979
JAZZ	AWGN	1.0000	1.0000
	Filtering	0.9925	0.9922
	Cropping	0.9951	0.9940
	Resampling	0.9942	0.9994
	Requantization	1.0000	1.0000
POP	AWGN	0.9977	0.9977
	Filtering	0.9891	0.9859
	Cropping	0.9946	0.9940
	Resampling	0.9798	0.9736
	Requantization	0.9990	0.9988
CLASSICAL	AWGN	0.9997	0.9999
	Filtering	0.9917	0.9892
	Cropping	0.9950	0.9938
	Resampling	0.9769	0.9756
	Requantization	1.0000	1.0000

TABLE IV - COMPArISION OF SSIM PERFORMANCE WITH PROPOSED ALOGORITHMAND RELATED W0RK

Audio Signal	Praposed Algorithm(dB)	DWT-DCT based Method
CLASSICAL	0.30009	0.2802
JAZZ	3.1821	3.0332
POP	0.0205	0.0192
LOONEY	0.0117	0.0106

TABLE V - SNR COMPARISON BETWEEN ORIGINAL AUDIO AND WATERMARKED AUDIO Signal

Audio Signal	Praposed Algorithm(dB)	DWT-DCT based Method
CLASSICAL	0.00042	0.000431
JAZZ	0.001068	0.001068
POP	0.000102	0.000102
LOONEY	0.000038	0.34259

TABLE VI - BER COMPARISON BETWEEN ORIGINAL AUDIO AND WATERMARKED AUDIO SIGNAL

The above last two tables says demonstrates after inserting Watermark the assessment execution how it will be present in unique signal of audio in terms of mutilation. if SNR value will be higher then it estimates execution as better. BEroutput should be low. Here we have BER gotten has practically equivalent to 0 it outcomhas great e and at under diffent attacks od distortions, in Table III satisfactory BEr has been characterized. between the extricated Watermark picture and unique picture SSIM was about 1 which tells separated Watermark is practically as same as first taken picture. the calculation of DWT-DCT for proposed SNR execution utilizes the cyclic code more, enhances the execution Arnold scrambling system . By doing this way of manner, will provides the better outcomes of Watermarking by existing plans of examination . The execution of the calculation uncovers that the proposed calculation is valuable to have duplicate insurance furthermore, proprietorship confirmation application.

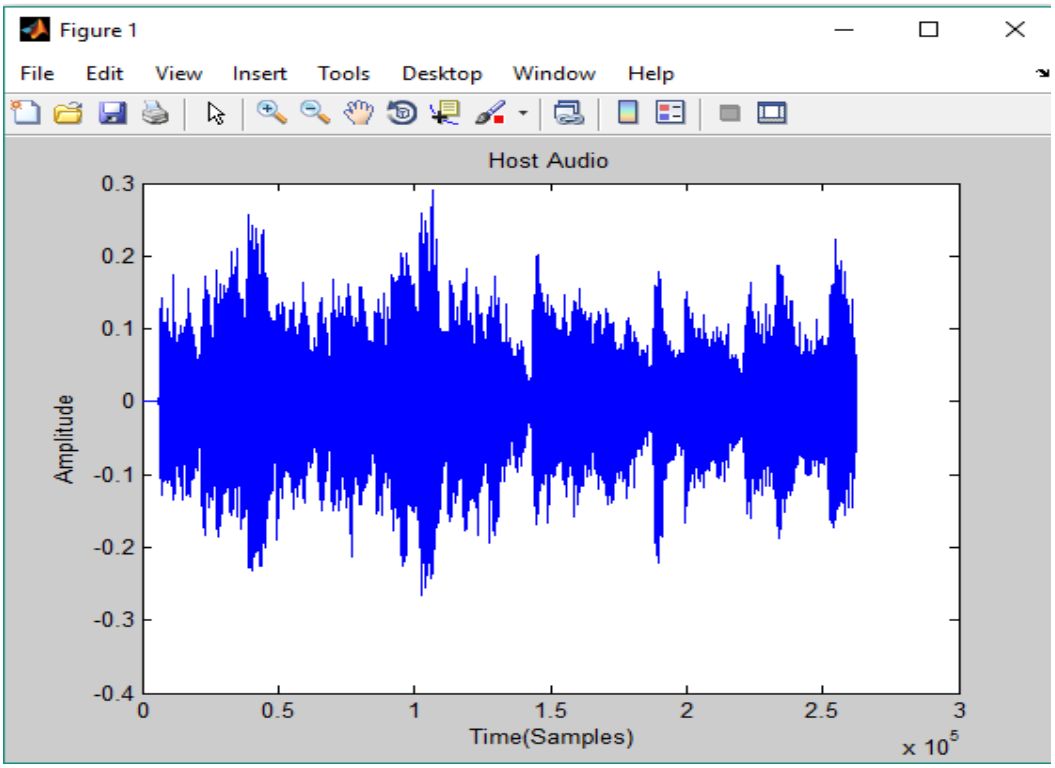


Figure 13: Host Audio Signal

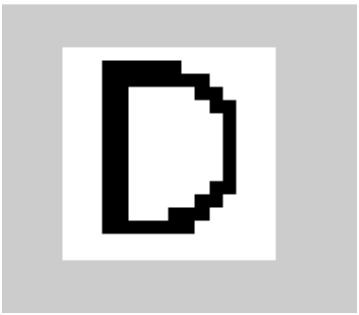


Figure 14: Embeeding watermark image

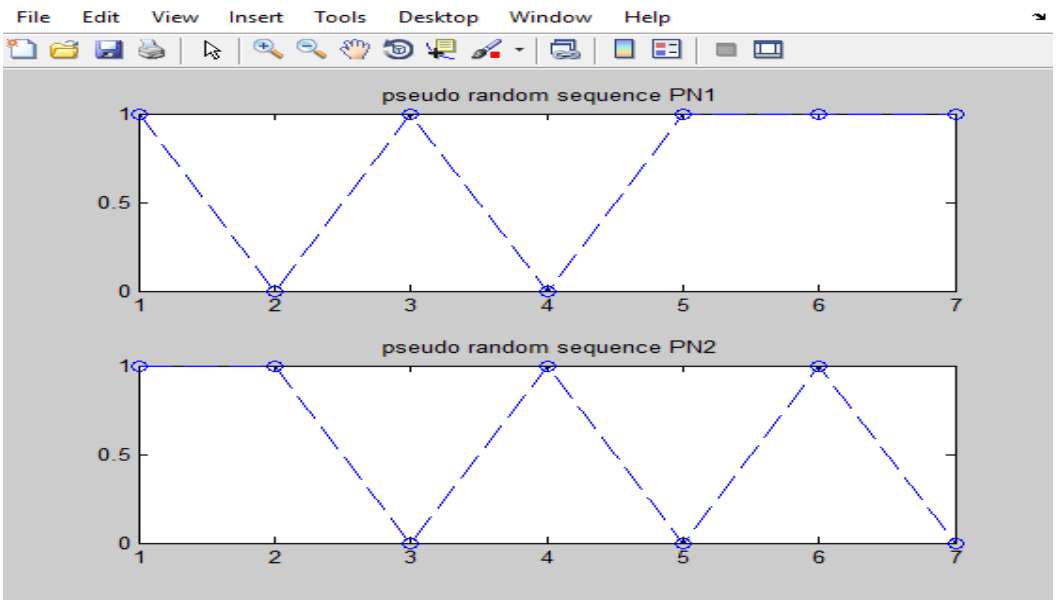


Figure 15: Generated Pseudo Random Sequences

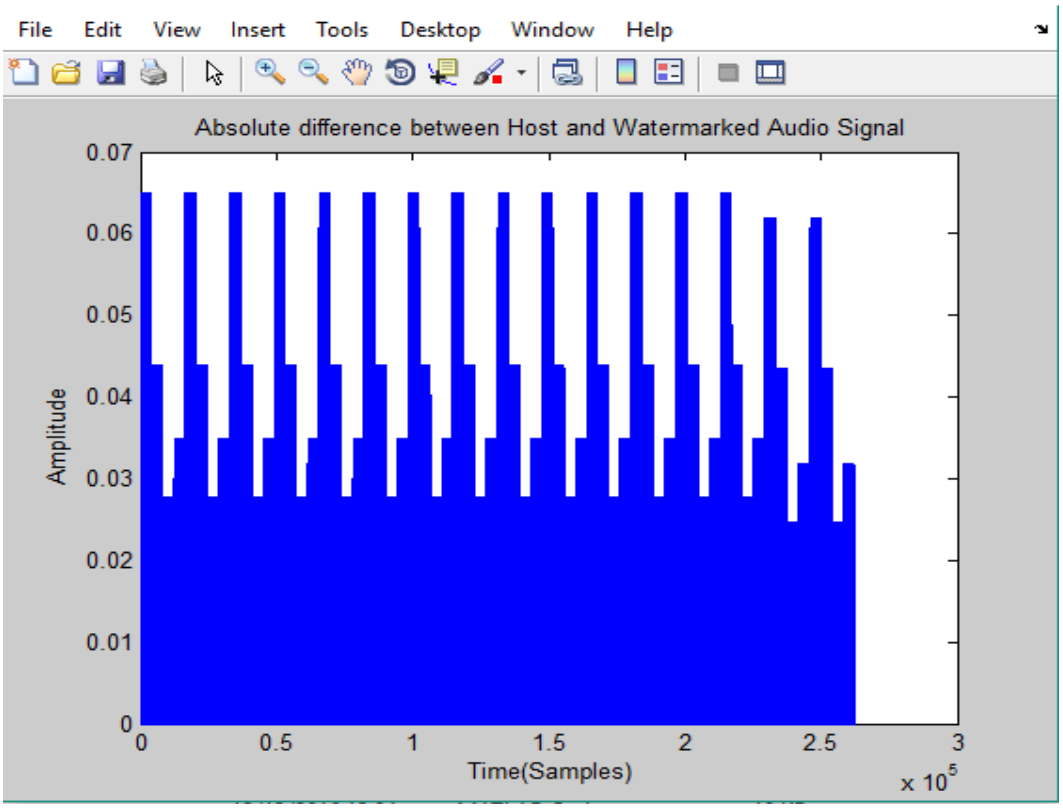


Figure 16: Absolute difference between Host and watermarked Audio signal

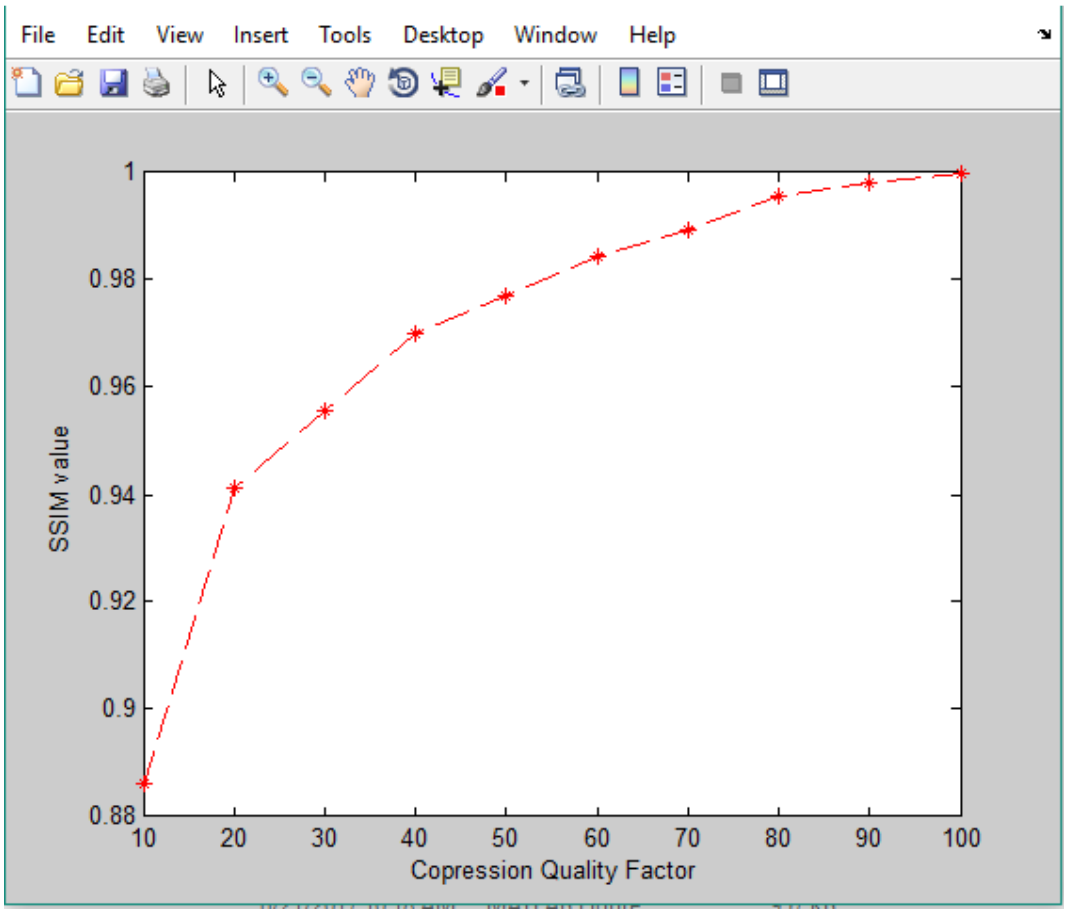


Figure 17: performance Graph between Copression Quality factor and SSIM value

REFERENCES

[1] Arnold, M., Chen, X. M., Baum, P., Gries, U., & Doerr, G. (2014). A phase-based audio watermarking system robust to acoustic path propagation. Information Forensics and Security, IEEE Transactions on, 9(3),411-425.

[2] Joshi, A. M., Mishra, V., & Patrikar, R. M. (2015). FPGA prototyping of video watermarking for ownership verification based on H. 264/AVC. Multimedia Tools and Applications, 1-24.

[3] Joshi, A., Mishra, V., & Patrikar, R. M. Real Time Implementation of Digital Watermarking Algorithm for Image and Video Application.

[4] Olanrewaju, R. F., & Khalifa, O. (2012, July). Digital audio watermarking; echniques and applications. In Computer and Communication Engineering (ICCCE), 2012 International Conference on (pp. 830-835). IEEE.

[5] Yee, H. H., & Wei, F. S. (2009, January). Audio watermarking with error-correcting code. In TENCON 2009-2009 IEEE Region 10 Conference (pp. 1-5). IEEE.

[6] Wu, S., Huang, J., Huang, D., & Shi, Y. Q. (2005). Efficiently selfsynchronized audio watermarking for assured audio data transmission. Broadcasting, IEEE Transactions on, 51(1), 69-76.

[7] Foo, S. W., & Dong, Q. (2010). A normalization-based robust image watermarking scheme using SVD and DCT. Acad. Sci. Eng. Technol, 6(1), 205-210.

[8] Vijaya K. Ahire and Vivek Kshirsagar, "Robust watermarking scheme based on Discrete wavelet transform (DWT) and Discrete Cosine Transform (DCT) for copyright protection of digital images". IJCSNS International Journal of Computer Science and Network Security, VOL.11 No.8, August 2011.

[9] Jiansheng, M., Sukang, L., & Xiaomei, T. (2009, May). A digital watermarking algorithm based on DCT and DWT. In International Symposium on Web Information Systems and Applications (WISA'09) (pp. 104-107).

[10] Abdul, W., Carré, P., & Gaborit, P. (2013). Error correcting codes for robust color wavelet watermarking. EURASIP Journal on Information Security, 2013(1), 1-17.

[11] Ren, K., & Li, H. (2011, August). Large capacity digital audio watermarking algorithm based on DWT and DCT. In Mechatronic Science, Electric Engineering and Computer (MEC), 2011 International Conference on (pp. 1765-1768). IEEE.

[12] Joshi, A. M., Mishra, V., & Patrikar, R. M. (2015). Design of real-time video watermarking based on Integer DCT for H. 264 encoder. International Journal of Electronics, 102(1), 141-155.

[13] Kang, H., & Iwamura, K. (2014, June). Watermarking based on the difference of discrete cosine transform coefficients and an error-correctingcode. In Proceedings of the 1st international workshop on Information hiding and its criteria for evaluation (pp. 9-17). ACM.

[14] Papakostas, G. A., Tsougenis, E. D., & Koulouriotis, D. E. (2014). Moment-based local image watermarking via genetic optimization. *Applied Mathematics and Computation*, *227*, 222-236.

[15] Joshi, A. M., & Darji, A. (2009, October). Efficient dual domain watermarking scheme for secure images. In Advances in Recent Technologies in Communication and Computing, 2009. ARTCom'09. International Conference on (pp. 909-914). IEEE.

[16] Mohammad Ali Nematollahi, Chalee Vorakulpipat, Hamurabi Gamboa Rosales. "Chapter 2 Audio Watermarking", Springer Nature, 2017.

[17] DCT BASED BLIND AUDIO WATERMARKING SCHEME Charfeddine Maha, Elarbi Maher, Koubaa Mohamed and Ben Amar Chokri REGIM, Research Group on Intelligent Machines, University of Sfax National School of Engineers (ENIS), BP 1173, Sfax, 3038, Tunisia.

[18] P. Bassia and I. Pitas, robust audio watermarking in the time domain, IEEE transactions on Multimedia, Vol. 3, Issue: 2, pp. 232 –241, 2001.

[19] Jiwu Huang, Yong Wang, Yun Q. Shi, 2002, A Blind AudioWatermarking Algorithm With Self-Synchronization, IEEE International Symposium on Circuits and Systems, ISCAS 2002, Vol. 3, pp. 627 – 630.

[20] Ching-Tang Hsieh, Pei-Ying Tsou, Blind Cepstrum Domain Audio Watermarking Based On Time Energy Features, 14th International Conference on Digital Signal Processing, DSP 2002, vol.2, pp. 705 – 708.

[21] Zheng Liu and Akira Inoue, IEEE Transactions On Circuits And Systems For Video Technology, Audio Watermarking Techniques Using Sinusoidal Patterns Based on Pseudorandom Sequences, Vol. 13, NO. 8, pp. 801 - 812, August 2003

[22] Foo Say Wei, Xue Feng and Li Mengyuan, A Blind Audio Watermarking Scheme Using Peak Point Extraction, IEEE International Symposium on Circuits and Systems, ISCAS 2005, Vol. 5, pp. 4409 – 4412.

[23] Shaoquan Wu, Jiwu Huang, Daren Huang, and Yun Q. Shi, Efficiently Self-Synchronized Audio Watermarking for Assured Audio Data Transmission, IEEE Transactions On Broadcasting, VOL. 51, NO. 1, pp. 69 – 76, 2005.

[24] Xiang-Yang Wang and Hong Zhao, A Novel Synchronization Invariant Audio Watermarking Scheme Based on DWT and DCT, IEEE Transactions on Signal Processing, Vol. 54, No. 12, 4835 - 4840, December 2006.

[25] Li Zhang, Li-Min Chen, Gong-Bin Qian, Self-Synchronization Adaptive Blind Audio Watermarking, 12th International MultiMedia Modelling Conference Proceedings, 2006, Beijing, ISBN 1- 4244-0028-7.

[26] Zhao Xu, Ke Wang and Xiao-hua Qiao, Digital Audio Watermarking Algorithm Based On Quantizing Coefficients, Proceedings of the 2006 International Conference on Intelligent Information Hiding and Multimedia Signal Processing , IIH-MSP'06, ISBN: 0-7695- 2745-0, pp. 41 – 46.

[27] Da-Wen Xu, Rang-Ding Wang, Ji-Long Bao, A Blind Audio Watermarking Algorithm Based on Convolutional Code, 8th International Conference on Signal Processing, 2006, Beijing, Vol. 4

[28] Xiangyang Wang, Wei Qi, and Panpan Niu, A New Adaptive Digital Audio Watermarking Based on Support Vector Regression, IEEE Transactions On Audio, Speech, And Language Processing, Vol. 15, No. 8, pp. 2270 - 2277, November 2007.

[29] Hai-yan Liu , Xue-feng Zheng, Ying Wang, Dwt –Based Audio Watermarking Resistant To Desynchronization, Seventh International Conference on Computer and Information Technology, pp. 745 – 748.

[30] Charfeddine Maha, Elarbi Maher and Ben Amar Chokri, A blind audio watermarking scheme based on Neural Network and Psychoacoustic Model with Error correcting code in Wavelet Domain, 3rd International Symposium on Communications, Control and Signal Processing, ISCCSP 2008, pp. 1138 – 1143.

[31] Vivekananda Bhat K, Indranil Sengupta, and Abhijit Das, Audio Watermarking Based on BCH Coding using CT and DWT, International Conference on Information Technology, ICIT '08, pp. 49 – 50.

[32] Yongqi Wang, Yang Yang, A Synchronous Audio Watermarking Algorithm Based on Chaotic Encryption in DCT Domain, 2008 International Symposium on Information Science and Engieering, ISISE'08, Vol. 2, pp. 371 – 374.

[33] Xiang-Yang Wang, Pan-Pan Niu, Hong-Ying Yang, A robust digital audio watermarking based on statistics characteristics, Pattern IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.3, No.2, April 2013 295 Recognition, Volume 42, Issue 11, Pages 3057–3064, November 2009.

[34] Mingquan Fan, Hongxia Wang, Chaos-based discrete fractional Sine transform domain audio watermarking scheme, Computers and Electrical Engineering, Volume 35, Issue 3, May 2009, pp. 506– 516.

[35] Yong-Hong Chen, Jian-Cong Chen, A New Multiple Audio Watermarking Algorithm Applying Ds-Cdma, Proceedings of the Eighth International Conference on Machine Learning and Cybernetics, Baoding, 12-15 July 2009, Volume: 4 , pp. 2205 – 2210.

[36] Bingwei Chen and Jiying Zhao, An Adaptive and Secure Audio Watermarking Algorithm Robust to MP3 Compression, International Instrumentation and Measurement Technology Conference, Singapore, I2MTC 2009, pp. 629 – 632.

[37] Wei Cao, Yixin Yan, Shengming Li, Bit Replacement Audio Watermarking Using Stereo Signals, International Conference on New Trends in Information and Service Science, 2009, NISS '09 , pp. 603 – 606.
[38] Xiao-li Liu et. al., An Audio Watermarking Method of Resistance Statistics Attack Based on Psychoacoustic Model, Fifth International Conference on Information Assurance and Security 2009, Vol. 1, pp. 737 – 739.

[39] Hong Peng, Jun Wang, Weixing Wang, An Adaptive Audio Watermarking Method Based on Local Audio Feature and Support Vector Regression, 10th ACIS International Conference on Software Engineering, Artificial Intelligences, Networking and Parallel/Distributed Computing, 2009, pp. 381 – 384.

[40] Tingting Xu, Zhen Yang, Blind Audio Watermarking Scheme for Copyright Protection of Multi-User, International Conference on Multimedia Information Networking and Security, 2009, Vol. 2, pp. 159 – 162.

[41] Malay Kishore Dutta , Phalguni Gupta, Vinay K. Pathak, Blind Watermarking in Audio Signals using Biometric Features in Wavelet Domain, IEEE Region 10 Conference TENCON 2009, pp. 1 – 5.

[42] David Megias, Jordi Serra-Ruiz, Mehdi Fallahpour, Efficient selfsynchronised blind audio watermarking system based on time domain and FFT amplitude modification, Signal Processing, 2010, Volume 90, Issue 12, pp. 3078–3092.

[43] Vivekananda Bhat K, Indranil Sengupta, Abhijit Das, An adaptive audio watermarking based on the singular value decomposition in the wavelet domain, Digital Signal Processing, 2010, Vol. 20, Issue 6, pp. 1547–1558.

[44] Dongmei Wu, Shangguo Yang, Zuochen Wang, Wenhua Qin, BCH Code-Based Robust Audio Watermarking Algorithm in the DWT Domain, International Conference on Intelligent Computation Technology and Automation, 2010, Vol. 1, pp. 878 – 880.

[45] Liang Wang, Sabu Emmanuel, Mohan S. Kankanhalli, EMD And Psychoacoustic model Based Watermarking For Audio, Ieee International Conference On Multimedia And Expo (ICME), 2010, pp. 1427 – 1432.

[46] Yubao Bai, Sen Bai, Guibin Zhu, Chunyan You, Bowen Liu, A Blind Audio Watermarking Algorithm Based on FFT Coefficients Quantization, International Conference on Artificial Intelligence and Education (ICAIE), 2010, pp. 529 – 533.

[47] Wei-zhen Jiang, Fragile Audio Watermarking Algorithm Based on SVD and DWT, International Conference on Intelligent Computing and Integrated Systems (ICISS), 2010, pp. 83 – 86.

[48] Xiong-hua Huang, Wei-zhen Jiang, An Adaptive Fragile Audio Watermarking Based on MDFT, International Conference on Intelligent Computing and Integrated Systems (ICISS), 2010, pp. 91 – 94.

[49] Charfeddine Maha, Elarbi Maher, Koubaa Mohamed and Ben Amar Chokri, DCT Based Blind Audio Watermarking Scheme, International Conference on Signal Processing and Multimedia Applications (SIGMAP), Proceedings of the 2010, pp. 139 – 144.

[50] Jian Wangn, RonHealy,JoeTimoney, A robust audio watermarking scheme based on reduced singular value decomposition and distortion removal, Signal Processing, 2011, Vol. 91, Issue 8, pp. 1693–1708.

[51] Wang Xiang-yang, Niu Pan-pan, Lu Ming-yu, A robust digital audio watermarking scheme using wavelet moment invariance, The Journal of Systems and Software, 2011, Volume 84 Issue 8, pp. 1408-1421.

[52] Bai Ying Lei , Ing Yann Soon, Zhen Li, Blind and robust audio watermarking scheme based on SVD–DCT, Signal Processing, 2011, Volume 91, Issue 8, pp. 1973–1984.

[53] Yang Hong-ying, Wang Xiang-yang, Ma Tian-xia, A robust digital audio atermarking using higher-order statistics, International Journal of Electronics and Communications (AEÜ), vol. 65, Issue , pp. 560-568.

[54] Yanbin Zhao, Wanyi Yang, Di Chang, Wei Guo, A Robust Audio Sonic Watermarking Algorithm Oriented Air Channel, International Conference on Computational and Information Sciences(ICCIS), 2011, pp. 53 – 57.

[55] Baiying Lei, Ing Yann Soon, Feng Zhou, Zhen Li, Haijun Lei, A robust audio atermarking scheme based on lifting wavelet transform and singular value decomposition, Signal Processing, Volume 92, Issue 9, pp. 1985–2001.

[56] Xinkai Wang, Pengjun Wang, Peng Zhang, Shuzheng Xu, Huazhong Yang, A norm-space, adaptive, and blind audio watermarking algorithm by discrete wavelet ransform, Signal Processing, April 2013, Volume 93, Issue 4, pp. 913–922.

[57] Hwai-Tsu Hu* and Wan-Cyun Li, A Perceptually Adaptive and Retrievable QIM Scheme for Efficient Blind Audio Watermarking, International Conference on Information Science and Applications , 2012, pp. 1 – 5.

[58] Xinkai Wang, Pengjun Wang, Peng Zhang, Shuzheng Xu, Huazhong Yang, A blind audio watermarking algorithm by logarithmic quantization index modulation, Multimedia Tools and Applications, springer, 2012, Online ISSN:1573-7721.