ISSN : 2455-9679
SJIF Impact Factor : 6.008

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INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"A STUDY ON OUTLINE AUDIO WATERMARKING TECHNIQUES DIGITAL AUDIO WATERMARKING"

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ABSTRACT

There is a need of an effective watermarking technique for copyright protection and authentication of intellectual Property. In this work we propose a digital watermarking technique which makes use of simultaneous frequency masking to hide the watermark information into host. The algorithm is based on Psychoacoustic Auditory Model and Spread Spectrum theory. It generates a watermark signal using spread spectrum theory and embeds it into the signal by measuring the masking threshold using Modified Psychoacoustic Auditory model and using dct transform. Since the watermark is shaped to lie below the masking threshold, the difference between the original and the watermarked copy is imperceptible. Recovery of the watermark is performed without the knowledge of the original signal. The software system is implemented using MATLAB and the characteristics studied.

***Keyword**: watermarking technique, MATLAB, Psychoacoustic, Spectrum theory*

I. INTRODUCTION

With the spread of digital technology, enormous amounts of information can be accessed, in the appearance of images, text and audio [6]. Audio compression technologies like MPEG-2 Audio Layer III (MP3) or Advanced Audio Coding (AAC) enables the transfer of audio information with a slight amount of data, compared to the uncompressed raw data. Nevertheless, these technologies also provide opportunities for people to spread illegal copies of protected works over the Internet [20]. Therefore, several methods of protecting copyright ownership have been developed. Watermarking, belonging to the field of Data Hiding [6], is a technology embedding "data into digital media for the purpose of identification, annotation and copyright" [4]. First developed for the use in digital images , several Watermarking techniques for digital audio data have been proposed afterwards (e.g. [4, 6]). In contrast to the field of cryptography, the protected audio content itself is not encrypted and the receiver of a watermarked audio signal may not know or even perceive the presence of hidden information . Starting with the first developed algorithms in the 1990s (e.g. [10]), audio watermarking has gained in importance to date. Matt Montag, an employee of the internet audio streaming service Spotify, pointed out with an online listening test1 conducted at his homepage, that the music corporation Universal Music Group (UMG) utilizes audio watermarking in works of their artists, with audible artifacts to some extent, on his employer Spotify and also e.g. on the online music store iTunes or inside broadcasts of UMG songs over FM radio2 . Moreover, classical music enthusiasts on the audio internet forum Hydrogenaudio3 noticed watermark artifacts inside lossless audiofiles by UMG, purchased in an online music store for lossless audio. Examples like these underline, that audio watermarking is a topic with high relevancy in today's digital world. As many researchers in this topic have exhibited, algorithms in audio watermarking should meet the following requirements:

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1. Imperceptibility, respectively minimal perceptibility, of the embedded signal by the human auditory system (HAS) while preserving the perceptional audio quality of the host signal [4, 6, 30, 32, 5, 1].
2. Embedding of the watermark directly into the audio data and not in the audio header or wrapper, respectively [6, 4].
3. Robustness against any form of audio data manipulation or processing with the intend of removing or corrupting the embedded watermark signal, e.g. lossy audio data compression, addition of noise, filtering Beyond that, several papers suggest that the watermark data should inhere the ability of being self-clocking [6, 4, 1] or support the addition of multiple watermarks [6] for enhanced robustness and also include error correction coding to ensure data accuracy [4]. All the referred algorithms in this paper are based on the embedding of the binary states "one" or "zero" (watermark bits). Algorithms in audio watermarking can either be dependent on the original signal (non-blind) or independent (blind) for watermark detection [11]. This paper considers different types of audio watermarking techniques and shows their different approaches in integrating watermark data directly into the audio data. Moreover, the techniques are evaluated in terms of robustness and suitability for different types of audio signals. Since most watermarking techniques hide their information in the time domain of the host signal [21], several techniques of that category are discussed in this paper. The presented audio watermarking techniques are classified into the three categories spread spectrum, echo hiding and low frequency based watermarking. The selection of these categories is based on the number of publications covering the particular watermarking approach and the number of outside references towards these papers, underlining their scientific relevancy. Also the presented watermarking method should inhere a minimum amount of robustness against signal manipulation attempts, hence the often referenced low-bit coding watermarking method [4], where information is embedded by altering the least significant bit of an audio sample, is not covered. Other audio watermarking techniques include phase coding [4], modified patchwork algorithm, cepstrum domain [19] and histogram based watermarking. Due to the limited page space, they could not be discussed here in detail. The scientifically first presented and commonly used [19] method, spread spectrum watermarking, is presented first, followed by the echo hiding approach, low frequency watermarking and topics of current watermarking research.

II. CURRENT RESEARCH

Previously proposed audio watermarking techniques have still been a subject in current research. Based on the number of publications, the topic of echo watermarking has gained in importance in the last four years. Xiang et al. presented a dual-channel time spread echo method for additional robustness [34]. It is based on the previously presented time spread echo method by Ko et al. [18] and is enhanced with two time spread echo kernels. In contrast to [18], the PN sequences used for the echo kernels can contain any real value and not merely the two values -1 and +1. In addition, the applied PN sequence can inhere the characteristics of colored noise and not merely white noise.

III. OVERVIEW OF THE MATLAB

MATLAB is a modern high-level technical computing type language. The MATLAB integrates graphical representation, programming in an easy-to-use environment where problems, computation, and solutions are expressed in familiar mathematical notation and for numeric computation, algorithm enhancement, data analysis, and visualization MATLAB is the interactive environment. Using the MATLAB product, you can resolve technical computing problems more faster than with conventional programming languages, such as FORTRAN and C, C++.MATLAB in a broader collection of applications, includes signal and image processing, computational biology, communications, control design, financial modeling ,analysis and test and measurement. MATLAB became a standard tool for accommodating technical computing and simulink became an interactive tool for modeling the dynamic systems, simulating, and analyzing. Simulink tool box offers a set of tools which can be used to construct complex systems from a library of built-in blocks. Add-on toolboxes have the collection of special-purpose MATLAB functions; accessible separately extended the MATLAB location to solve specific classes of problems in these functional areas. MATLAB software presents a number of features for documenting and distributing your work. You can assimilate your MATLAB code with extra languages and applications.

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SJIF Impact Factor : 6.008

IV. RESULTS

IMAGE TO BE HIDDEN

Original fish image is used in audio watermarking. Fish image to hide in host audio signal so that no one cannot detect when it transmitted.

Figure 4.1: Fish Image

DETECTED / EXTRACTED FISH IMAGE

This is Extracted fish image that is extracted from audio signal using detection technique.

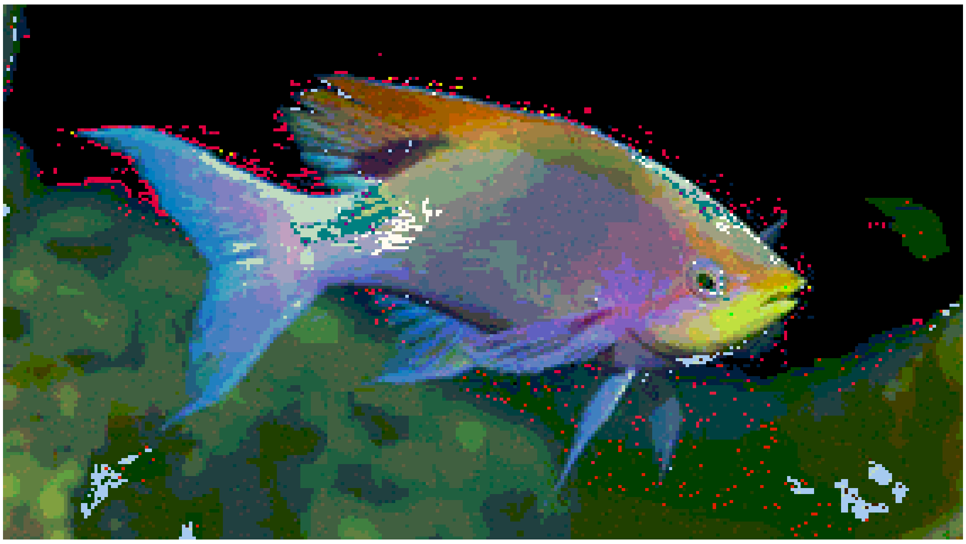

Figure 4.2: Detected Fish Image from Watermarked Audio

COMPONENT SPECTRUM COMPARISON OF AUDIO

AMPLITUDE SPECTRUM OF THE UN-WATERMARKED AUDIO

This is the amplitude spectrum of host audio signal with respect to frequency where no image hidden it.

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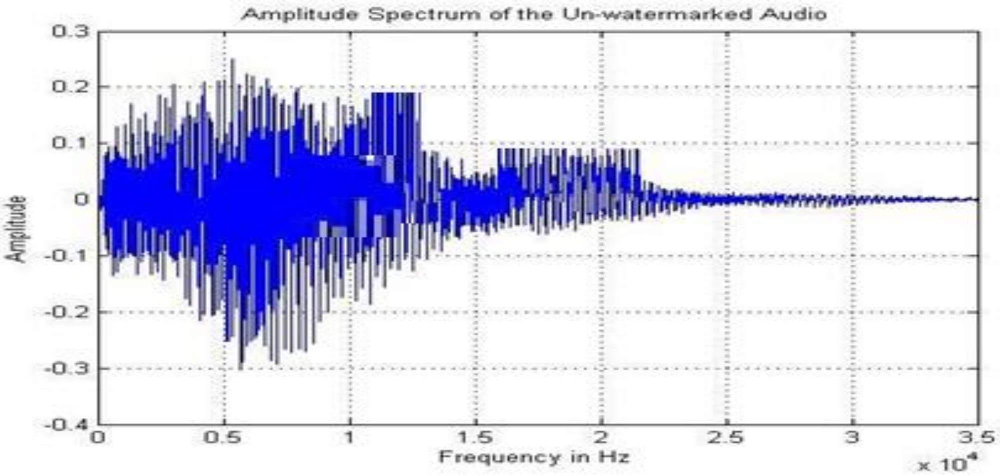

Figure 4.3: Un-watermarked Host Audio

AMPLITUDE SPECTRUM OF THE WATERMARKED AUDIO

This is the amplitude spectrum of the watermarked audio signal where fish image embedded between 0 kHz to 25 kHz.

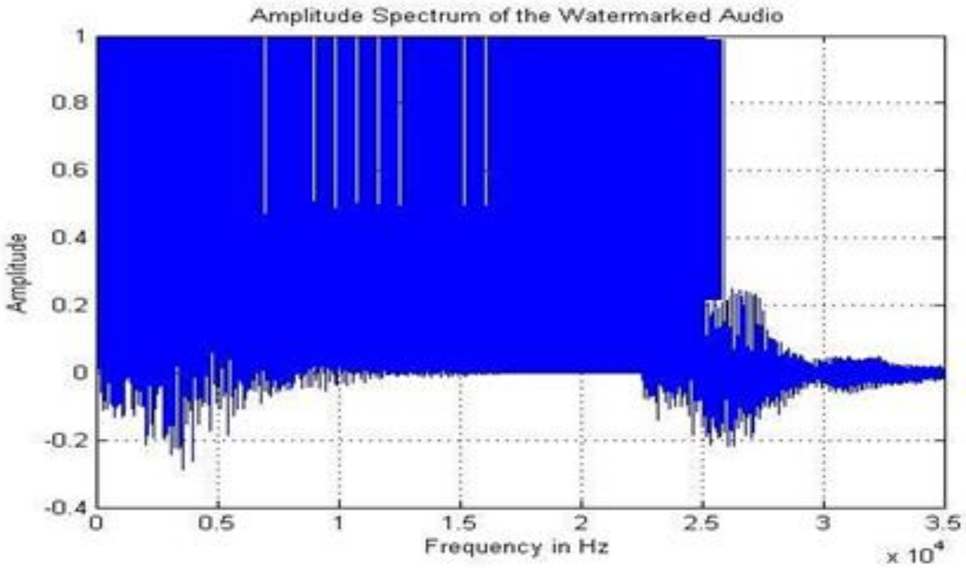

Figure 4.4: Watermarked Audio

MEAN SQUARED ERROR (MSE)

Mean Squared Error (MSE) is one of the earliest tests that were performed to test if two pictures are similar. The simulation result is given below.

MSE: 0.76

PEAK SIGNAL TO NOISE RATIO (PSNR)

Peak signal to noise ratio is calculated between the original fish image power & detected /extracted fish image. The simulation result is given below.

PSNR: 49.4657214 Db

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V. Results comparison

Table 4.1 Results Comparison

Images	PSNR			MSE		
	LSB	*DCT*	*DWT*	*LSB*	*DCT*	*DWT*
Jet [1]	46.78015	47.7632	46.6309	0.5525	0.3420	1.4912
Baboon[1]	47.6214	48.2192	46.7262	0.4734	0.3230	1.4610
Fish	---------	49.4657214	---------	---------	0.76	---------

VI. Conclusion

In this work, another watermarking dependent on Frequency Masking plan is introduced. This technique utilizes the time area sign and procedures it in recurrence space, while time space highlights of the transporter stays same, so nobody can distinguish the concealed information into it. The calculation depends on Psychoacoustic Auditory Model and Spread Spectrum hypothesis. It produces a watermark signal utilizing spread range hypothesis and implants it into the sign by estimating the veiling limit utilizing Modified Psychoacoustic Auditory model. Since the watermark is formed to lie underneath the veiling edge, the distinction between the first and the watermarked duplicate is subtle. Recuperation of the watermark is performed without the information on the first sign. The watermarks are implanted into non covering DCT coefficients of the sound sign which are haphazardly chosen and difficult to distinguish even with the visually impaired location. The sound watermarking is generally new and has wide extension for research. For future, another calculation will recommended that taking highlights of Human Auditory System and the sign handling speculations. Proposed calculation depends on DCT area while thinking about the more dynamic parts of the sign.

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