Performance Evaluation of Novel Digital Audio Watermarking Technique designed for Copyright Protection Application

Ms. Anupama Barai [1], Ms. Sukanya Padave [2],
[1, 2] *Department of Electronics and Telecommunication*
K.C.C.E.M.S.R., Thane, India
[1] *anu4687@gmail.com*
[2] *padave.sukanya@gmail.com*

***Abstract*— Online distribution of digital media including images, audio, video and documents has proliferated rapidly in recent years due to large volume of the mobile phones. These files include diverse forms of multimedia such as music, video, text and image. However digital files can be easily copied distributed and altered leading to copyright infringement. Many people download and compress music from the internet creating exact copies of original data. It is this ease of reproducing that causes copyright violations. Copyright protection is the mechanism that prevents data usually digital data from being copied by some unauthorized means. Composers and distributors are more focused on implementing digital watermarking techniques to protect their material against illegal copying.**

In this paper a robust watermark system, using spread spectrum with perceptual masking designed for copyright protection application against attack is explained and compared with DCT and 1 D DWT.

Keywords—Copyright protection, Digital audio watermarking, Perceptual masking, Psychoacoustic Auditory Model, Spread Spectrum.

I. INTRODUCTION

Digital watermarking is the process that embeds copyright information as watermark into the multimedia object, so that the watermark can be extracted to make an assertion about the ownership [7]. The general schematic diagram of watermarking is shown in figure 2 a) and b).

Copyright Protection can implemented using Digital watermarking [3]. The need of Copyright Protection is explained in Figure 1. Digital watermarking is the process that embeds copyright information as watermark into the multimedia object, so that the watermark can be extracted to make an assertion about the ownership. Selection of Technique: as working on Audio Psychoacoustic Analysis is required for transparent embedding process. Spread Spectrum to enhance the robustness.

II. DIGITAL AUDIO WATERMARKING SYSTEM

There are many systems for watermarking [4], [5] and [6]. The proposed system comprised of two main steps: first, the watermark generation and embedding and second, the watermark recovery [1]. Following Figures 3 and 4 shows the proposed watermarking system.

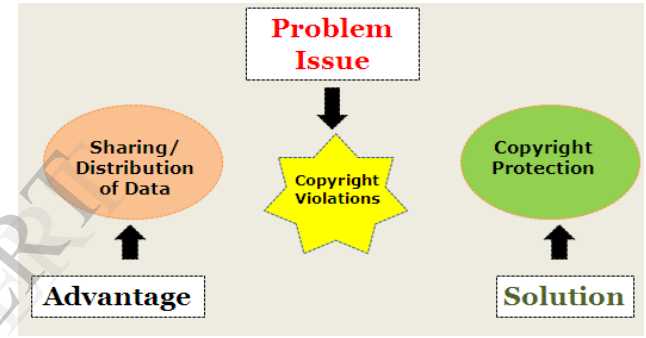

Figure. 1. Introduction.

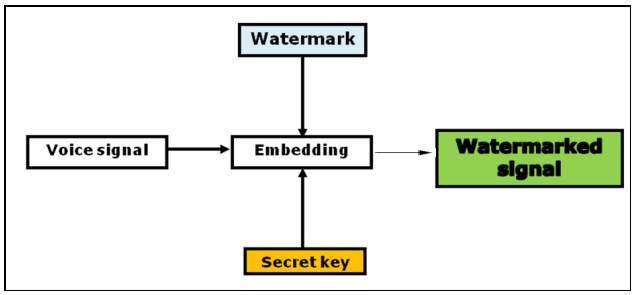

Figure. 2. a) General Schematic Watermarking System part I.

A. *Watermark Generation and Embedding*

The perceptual property of Human Auditory System is that components below threshold will be imperceptible [2], [8], [9]. In order to analyze the audio signal and compute the amount of masking effect, psychoacoustic model [12], [13] is developed accordingly. In audio watermarking, the noise produced should be inaudible to human ears; this is controlled by psychoacoustic model [10], [11]. In spread spectrum watermarking the watermark is added to the host like an additive noise. To prevent distortions being perceivable,

amplitude shaping by the minimum masking threshold from this model should be adopted.

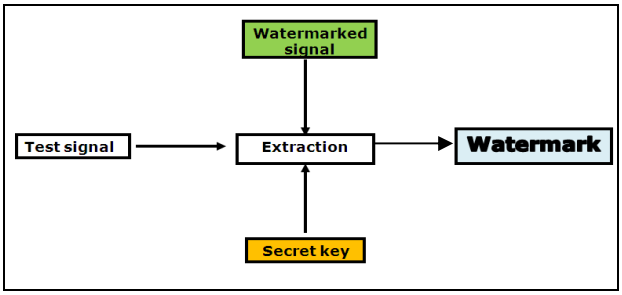

Figure. 2. b) General Schematic Watermarking System part II.

Spread spectrum is a means of transmission in which the signal occupies a bandwidth in excess of the minimum necessary to send the information; the band spread is accomplished by means of a code which is independent of the data, and a synchronized reception with the code at the receiver is used for de-spreading and subsequent data recovery.

The process of watermark embedding can be viewed as intention jamming of the watermark signal with the audio signal. In this case the signal (watermark) has much less power than the jammer (audio). It is one of the problems to be overcome at the receiver end. The following chapter expresses the process of watermark generation in spread spectrum terminology. The approach selected in this algorithm is the Direct Sequence Spreading. The system modulates input the data bit-stream with the help of Pseudorandom Number sequence and modulator signal which is usually a cosine function of time with some centre frequency. Figure 5 shows the generation of watermark technique [16].

The embedding procedure involves the following steps:

1. The final masking threshold information (as shown in figure 6 and 7) will be used to shape the watermark and embed it into the audio (Psychoacoustic Analysis). Shaping factor is very important for proper embedding.
2. Shaped Watermark is added in the audio file as an additive noise. Final output is the watermarked audio signal.

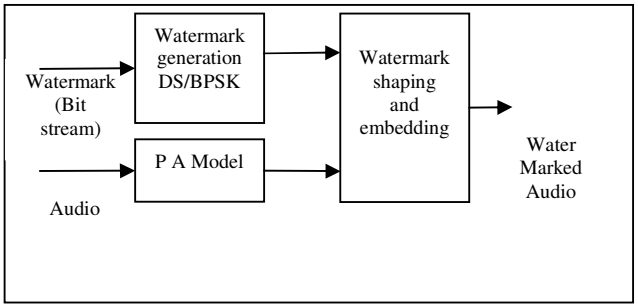

Fig. 3 Watermark generation and embedding

B. *Watermark Extraction*

While doing extraction again the psychoacoustic model is referred. Original and Watermarked signal are matched and watermark is extracted. Further Extracted Watermark and original is compared and quantified through correlation coefficient. Further performance evaluation is done against attacks namely Low pass filtering, noising, resampling, requantization and cropping.

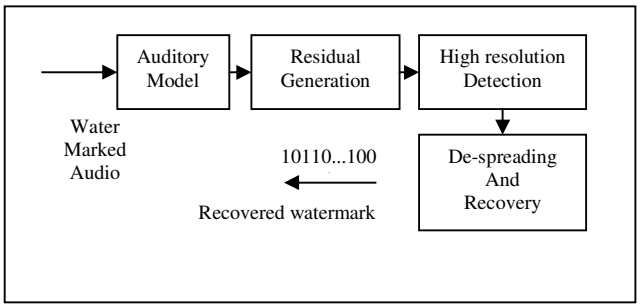

Figure. 4. Watermark Extraction

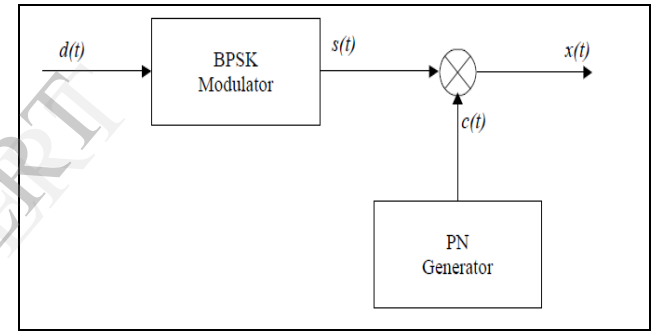

Figure. 5. Watermark Generation.

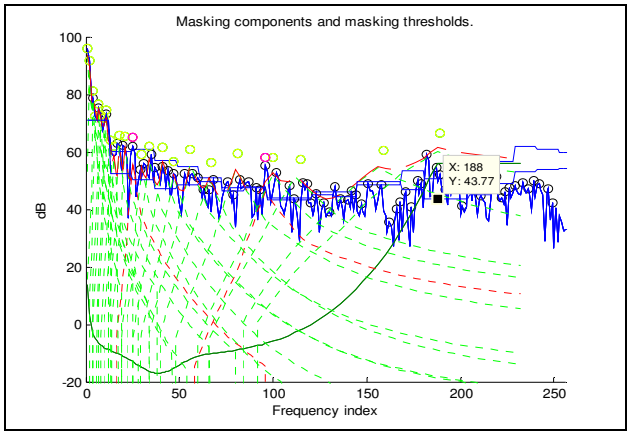

Figure.6. Masking Components and Masking Thresholds Using Psychoacoustic Analysis.

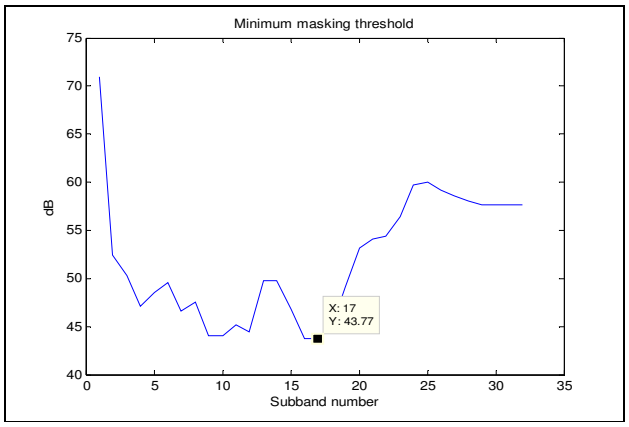

Figure. 7. Minimum Masking threshold Using Psychoacoustic Analysis.

III. OBSERVATIONS AND PERFORMANCE EVALUATION

Whenever the signal recorded in silence it will watermarked efficiently i.e. it will be less prone to attacks. Otherwise it is not getting properly analyzed as important part might be getting discarded under psychoacoustic analysis (if grouped under non-tonal component).

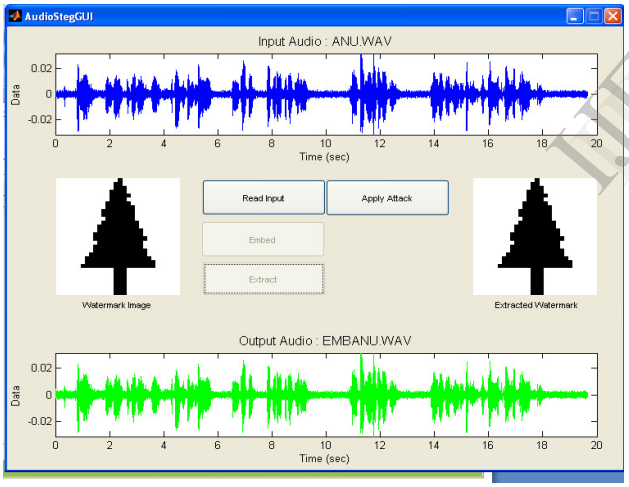

Figure. 8. System GUI

Also if signal has pauses in between then it is getting watermarked efficiently. The perceptual quality of the audio signal was retained. The watermarked signal survives to different attacks. Figure 8 shows the System GUI [14], [15]. Figure. 9 shows the watermarked audio output of different watermarking system compared. Figure.10 shows the extracted watermarks through different techniques. Figure 11 shows the extracted watermarks after different attacks with different techniques.

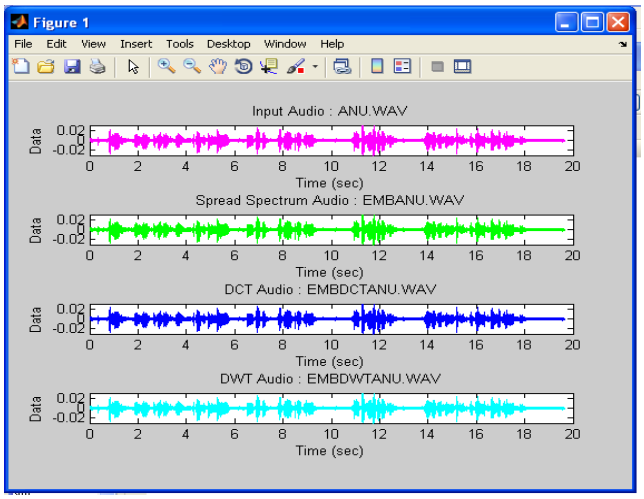

Figure. 9. Watermarked Audio output of different watermarking system.

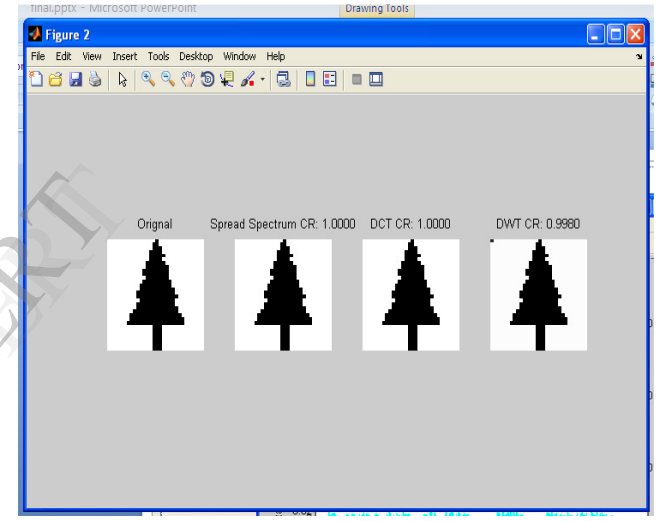

Figure. 10. Extracted Watermarks

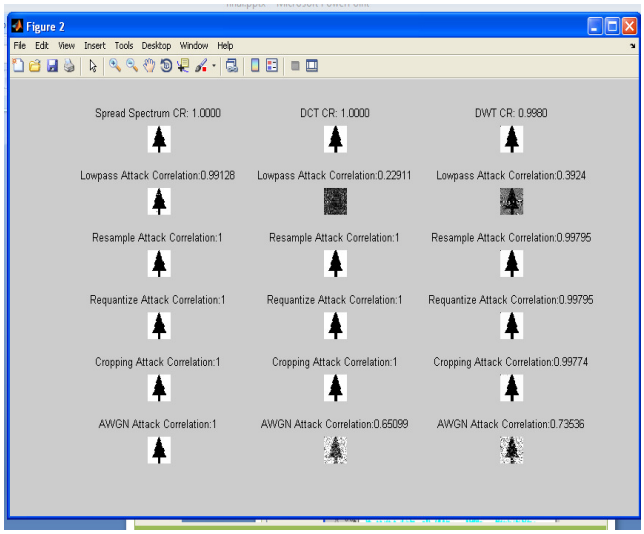

Figure. 11. Extracted Watermarks after different attacks with different techniques.

IV. CONCLUSION

1. The Psychoacoustic model for perceptual masking determination is important for transparent and efficient digital audio watermark embedding.
2. For a good and efficient watermarking system Robustness and Imperceptibility are two major factors.
3. The outcome depends on type of voice recorded under different conditions (silent or noisy surroundings).
4. The duration for recorded voice should be more than 5 seconds.
5. The robustness was checked on the basis of attacks: cropping, filtering, noising, resampling and requantization.
6. The Watermarking system is proved to be quite robust and imperceptible. The recovery of the watermark was around 99% or almost 100 % for various attacks except for LPF. LPF attack showed variations depending on the type of recorded voice. Retrieval of embedded watermark from the file is more efficiently done (almost 100%) through proposed system than DCT and DWT. In comparison to other techniques like DCT and DWT, the proposed technique showed better results especially for low pass filtering attack and AWGN attack.

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