

Digital Audio Watermarking With Discrete Wavelet Transform Using Fibonacci Numbers

P. Mohan Kumar¹, Dr. M. Sailaja²

M. Tech scholar, Dept. of E.C.E, Jawaharlal Nehru Technological University Kakinada, U.C.E.K, Kakinada, India¹

Professor, Dept. of E.C.E, Jawaharlal Nehru Technological University Kakinada, U.C.E.K, Kakinada, India²

ABSTRACT: There are many techniques existing for watermarking. Among all of the known techniques Fibonacci is the advanced technique for digital audio watermarking. In previous paper, we can observe that Fast Fourier Transform is used for embedding data and extracting them into bit extracting manner by changing the magnitudes of the Fast Fourier Transform spectrum. In this paper, discrete wavelet transform is used for watermarking. By using discrete wavelet transform we get better resolutions when compared to the previous techniques. The main advantage of using Fibonacci numbers is that it is possible to change the frequency samples adaptively. This paper focuses mainly on reducing the number of bits that are used for embedding and extracting. The results show that the method has high capacity and without any distortions in the audio signal and also provides robustness to the common digital audio signal processing.

KEYWORDS: Audio watermarking, Fibonacci numbers, digital multimedia security.

I. INTRODUCTION

In these days, with the rapid development in the various communication techniques, transferring of digital contents is become more and more usual. And it is also easier to create an illegal copy and distribution of digital contents. The watermarking technique is used for more security purpose. By using watermarking process, a watermark is hidden or embedded watermark into media. After that the embedded data can be detected or extracted from the marked signal for various applications. And also follow some basic properties for applying the watermarking.

Audio watermarking must satisfy the following basic properties:

1. Imperceptibility: The quality of audio should not be reduced after adding watermarking. Because, the audio should be retained after adding watermarking.
2. Security: Watermarking signals should not reveal any clues or data about the watermark bits in them. And the security of the watermarking procedure is depends only on secret keys, they do not depends on the secrecy of the watermarking algorithm.
3. Robustness: The strength is to extract a watermark from a watermarked signal after some of the various signal processing or malicious attacks.
4. Payload: The data can be embedded into the audio signal without losing imperceptibility. The data payload refers to the number of watermarked data bits that are embedded with a host signal per unit time for audio signals. And these are measured in bits per second.

The algorithm used in this paper is, first we can select some part of frequency of the DWT spectrum for embedding the secret bits. The selected frequency band is divided into short frames and a secret bit is to be embedded to the each frame. For digital watermarking there is only "0" and "1" are available. So, for secret bit "1", DWT samples in the frame can be changed to the closest Fibonacci number with odd index. For secret bit "0", DWT samples in the frame can be changed to the closest Fibonacci number with even index.

In frequency domain techniques wavelet transform is one of the best technique. It is often used due to its reduced computational burden and it has been the Chosen transform for the proposed method. And it is also used to improve the resolution of the digital audio signal after adding the watermarks. By adding the watermarks to the signals we can get the resulting transform coefficients and then apply extracting to the watermarked signal. By using the methods based on the transforms gives better quality and robustness against the common attacks.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor & UGC Approved Journal)

Website: www.ijirset.com

Vol. 6, Issue 9, September 2017

II. RELATED WORK

A. Fibonacci numbers:

The numbers 1,1,2,3,5,8,13,21,34,55,89,144,....., known as Fibonacci numbers. These have been named in the nineteenth century by French mathematician Edouard Lucas after Leonard Fibonacci of Pisa. For digital audio watermarking this is the first time to use the Fibonacci numbers.

The equation to generate the Fibonacci numbers is given below:

$$F_n = \begin{cases} 0, & \text{if } n < 0, \\ 1, & \text{if } n = 1, \\ F_{n-1} + F_{n-2}, & \text{if } n > 1. \end{cases}$$

One of the very interesting feature about the Fibonacci numbers we used in this paper, is the ratio between the two consecutive Fibonacci numbers in the sequence. Fibonacci numbers can also be generated by using the golden ratio also. And the value of golden ratio can be noted as

$$\varphi = \frac{1 + \sqrt{5}}{2} = 1.6180339887\dots$$

and

$$\varphi = \frac{1 - \sqrt{5}}{2} = -0.6180339887\dots$$

Golden ratio is the ratio between the positive quantities. So, golden ratio must be positive. And the equation for Fibonacci numbers generation by using the golden ratio can be written as

$$F(n) = \frac{\varphi^n - (1 - \varphi)^n}{\sqrt{5}} = \frac{\varphi^n - (-\varphi)^{-n}}{\sqrt{5}}$$

B. Discrete Wavelet Transform:

By using discrete wavelet transform the key advantage is that it has over temporal resolutions than the Fourier Transforms. And also captures the both frequency and location information. In both frequency domain and time domain discrete wavelet transform has better approximations than compared to the Fourier transforms. In this paper, HAAR transform can be used for watermarking. This HAAR wavelet transform is to be considered to pair up the input values. The HAAR wavelet transform can be performed by using the mother function and scaling function. The HAAR wavelet's mother function can be described as the following equation:

$$\psi(t) = \begin{cases} 1 & 0 \leq t < \frac{1}{2}, \\ -1 & \frac{1}{2} \leq t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

And the scaling function of the HAAR transform can be described as:

$$\varphi(t) = \begin{cases} 1 & 0 \leq t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

Discrete wavelet transform is used for signal coding, to represent the discrete signals in the more redundant form. For one dimensional signal discrete wavelet transform can be written as:

$$W(j, k) = \sum_j \sum_k x(k) 2^{-j/2} \psi(2^{-j} n - k)$$

Where, $\psi(t)$ is a time function with finite energy.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor & UGC Approved Journal)

Website: www.ijirset.com

Vol. 6, Issue 9, September 2017

III. PROPOSED METHOD

The proposed method is used to improve the resolution and robustness of the watermarked signal. This method can be performed in four steps. First adjust the parameters to get the desired capacity, transparency and robustness. Now we can discuss the steps involved in this proposed method.

In first step, adjust the parameters according to get the desired transparency, robustness and capacity. We call this as tuning process. For this process the suggested system provides frequency band and frame size are the two parameters. The flowchart of tuning process is:

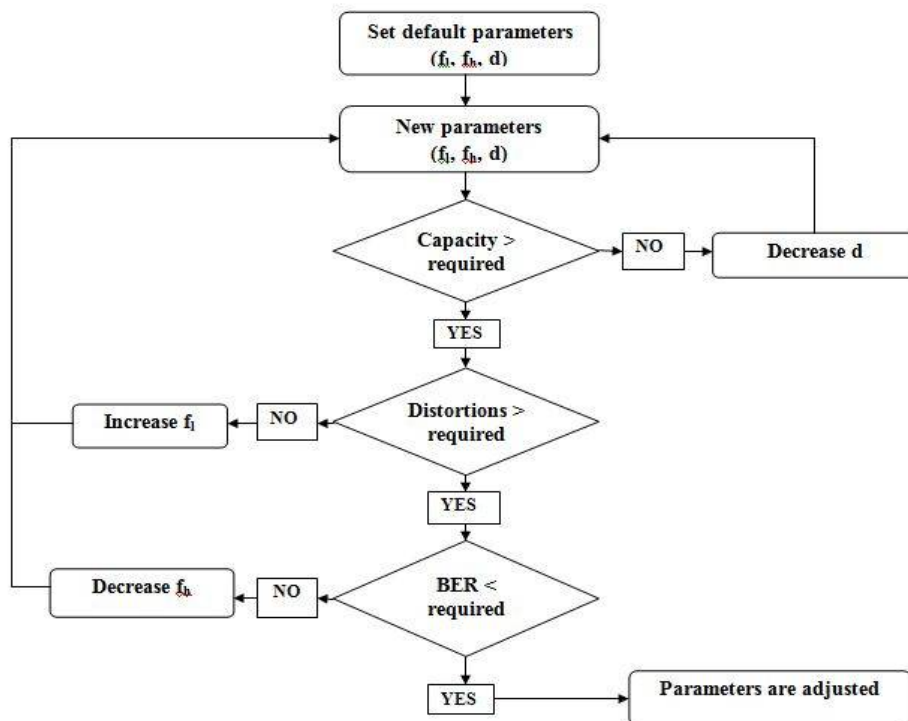


Fig 1: Flowchart for adjusting the parameters.

As we discussed above, set new parameters for frequency band (f_l , f_h) and frame size (d). First we can set default values for parameters. And then adjust the parameters as we required. To achieve the better robustness must increase the frame size, if the frame size is more then will get more robustness. The most of the MP3 signals cut-off frequencies are higher than 16kHz. So, set the higher frequency f_h , as 16kHz. And the lower frequency is note as default value 10kHz. Low frequency value is implies to the distortions and capacity. If the distortions are more, then increase the value of the low frequency f_l . The capacity of the signal is decreased when the frame size is increased. So, we keep the default value for the frame size is $d=5$. Finally, the parameters are to be adjusted according to the requirements.

In the next step, embed the secret bits to the wavelet coefficients of the audio signal. To compute the DWT coefficients apply discrete wavelet transform to the original audio signal. Divide the original signal into blocks of same length. Now these divided blocks in the selected frequency band are divided into the frame size d . For all the samples in the selected frame, find the largest Fibonacci number, the Fibonacci number for i^{th} sample, which is lower than the magnitude of the DWT sample. The original Fibonacci series is having two 1^{s} in starting of the series, but we consider only one for this algorithm. The flowchart algorithm for embedding the secret bits is shown in fig.2.

First divide the original file into blocks of particular length. Then divide the samples in the selected frequency band into the given frames of size d . For every frame select the largest Fibonacci number, the Fibonacci number for the particular sample which is lower than the magnitude of that particular wavelet sample. And the marked samples of the

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor & UGC Approved Journal)

Website: www.ijirset.com

Vol. 6, Issue 9, September 2017

signal are obtained by two conditions. They are, if the number of samples in the frame with modulo 2 is equal to the watermark bit then select the lowest Fibonacci number. If the number of frames in the frame with modulo 2 is not equal to the watermark bit then select the second lowest Fibonacci number from the selected series.

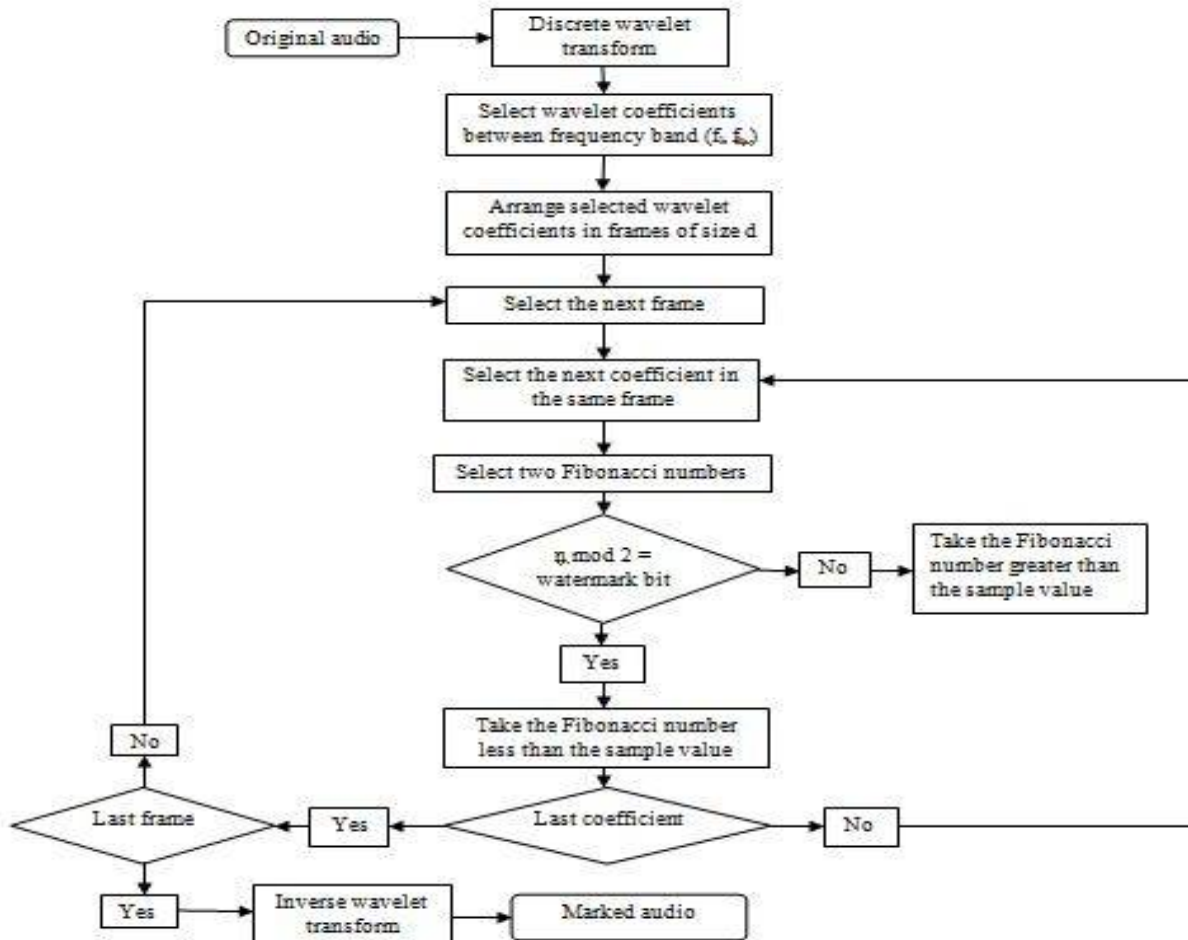


Fig.2: Flowchart for embedding the secret bits.

And finally apply inverse discrete wavelet transform to get the marked audio signal.

In this method, the original audio signal is not required for extracting process. And here the detector is blind. The parameters that are used for detection, the frame size and frequency band can be transmitted in a secured manner to the detector. The process for extracting is also same as embedding, but here marked audio signal is taken as input signal. to compute the DWT coefficients, apply discrete wavelet transform to the marked audio signal. Now divide these wavelet samples in the selected frequency band to the frames of the size d. For every DWT sample in the present frame, first find the closest Fibonacci number. If the DWT sample is in the same distance for the two Fibonacci numbers, then select the lowest Fibonacci number from that two numbers.

For detecting the secret bit in any frame, each sample in that frame is examined to check if it is a “0” or “1”. After evaluating all the samples in current frame, a secret bit can be extracted by using the number of “0” bits and number of “1” bits in the current frame based on the voting scheme. If the number of samples noted as “1” is equal to or greater than half the frame size, then the extracted bit is noted as “1”. Otherwise the extracting bit is noted as “0”. For example, the frame size taken as 5 and detect three “0” and two “1”, then the extracted bit is taken for that frame would be “0”.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor & UGC Approved Journal)

Website: www.ijirset.com

Vol. 6, Issue 9, September 2017

The parameters used in this method are the first level security for the system. Without knowing the frequency range and frame size an attackers will not be able to perform any actions such as erase, replace, extraction of embedded watermark. To increase the security there are many cryptography techniques are available, based on the requirements of the watermarking system select the related cryptography technique. To change the secret bit stream to another stream by using the pseudo random number generator. By using the pseudo random number generator it is more difficult to extract the secret information for attackers.

IV. SIMULATION RESULTS

In order to evaluate the performance of the proposed method, the experiments have been performed and presented for each and every sample of the frame in the audio signal separately. From fig.3, we can observe that the resolution from original signal to the watermarked signal is approximately same. Compared to the previous techniques, by using the discrete wavelet transform the resolution is more. It is also possible to increase the bit rate, by choosing the wider frequency band for embedding or by decreasing the frame size d .

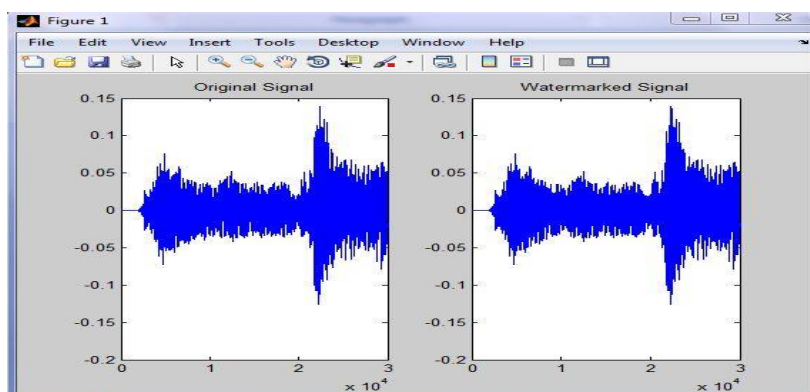


Fig.3: Watermarked audio signal.

Each watermarking technique has its own properties that to be different. Compared to other watermarking techniques, it is hard to establish a fair comparison of proposed scheme to other techniques. In fig.4, shows that the embedding message and extracted messages of the system. Compared to previous method, the number of bits used for embedding and extracting is less. When the usage of bits is less, the time taking for embedding or extracting the data is also less. So, the process will become faster.

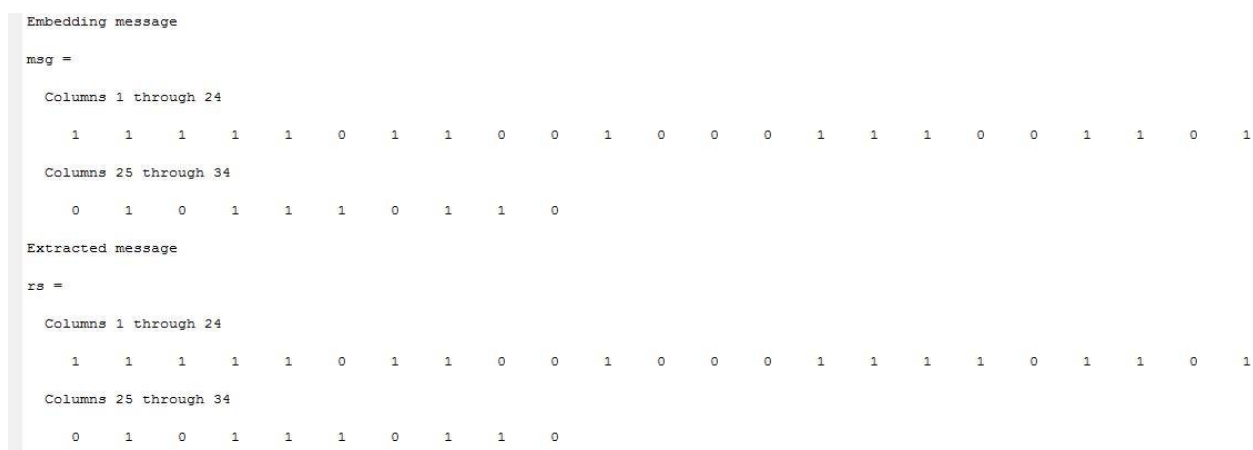


Fig.4: Embedding and Extracting messages.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor & UGC Approved Journal)

Website: www.ijirset.com

Vol. 6, Issue 9, September 2017

The most valuable achievement by this proposed technique, the robustness against the difficult attacks such as noises, echo and filtering. And the capacity is also high when compared to the previous methods. The proposed scheme, embed the much more information or data, and it gives less distortions in the watermarked signal at the same time.

V. CONCLUSION

In this paper a high capacity transparent watermarking technique is used for digital audio signal. And it is robust against the common audio signal processing attacks. We determine the robustness, capacity and the perceptual distortions in the system by using the parameters frequency band and the frame size. If the frame size is increased the better robustness can be achieved but the capacity can be decreased. The capacity and the transparency is depends on the frequency band. So, these two parameters are important for this technique. This work can be further extended for getting more resolution and the better robustness for the audio signal.

REFERENCES

1. M. Fallahpour and D. Megias, "DWT-based high capacity audio watermarking", IEICE transaction fundamental electronics, communication computer science, vol. E93-A, No. 01, pp. 331-335, January 2010.
2. M. Fallahpour and D. Megias, "High capacity audio watermarking using the high frequency band of the wavelet domain", in multimedia tools and applications. New York, NY, USA: Springer, 2011, vol. 52, pp. 485-498.
3. S. T. Chen, G. D. Wu and H. N. Huang, "wavelet domain audio watermarking scheme using optimisation-based quantisation", IET signal processing, vol. 4, No. 6, pp. 720-727, 2010.
4. N. K. Kalantari, M. A. Akhaee, M. Ahadi and H. Amindavar, "Robust multiplicative patchwork method for audio watermarking", IEEE transaction audio, speech, lang. Processing, vol. 17, No. 6, PP. 1133-1141, August 2009.
5. S. T. Chen, H. N. Huang, C. J. Chen and G. D. Wu, "Energy-proportion based scheme for audio watermarking", IET signal processing, vol. 4, No. 5, pp. 576-587, 2010.
6. G. E. Bergum, Ed. *Et. Al.*, Applications of Fibonacci numbers. New York, NY, USA: Springer, 1991, vol. 4.
7. H. J. Kim, "Audio watermarking techniques", in proc. Pacific rim workshop Digital steganography, pp. 1-17, 2005.
8. M. Mansour and A. Tewfik, "Data embedding in audio using time-scale modification", IEEE transaction speech audio processing, vol. 13, No. 3, pp. 432-440, May 2005.
9. X. Y. Wang and H. Zhao, "A novel synchronization invariant audio watermarking scheme based on DWT and DCT", IEEE transaction signal processing, vol. 54, No. 12, pp. 4835-48.