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DWT BASED AUDIO WATERMARKING USING ENERGY COMPARISON

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***Abstract*-In this paper an audio zero watermark scheme based on energy relationship between adjacent audio sections has been proposed. Because of audio watermarking algorithms are not easy to develop. The human ear is far more sensitive than other human sensory organs like eyes. The host audio signal is divided into number of sections. One level Discrete Wavelet Transform is applied to each audio data blocks. Then the relational value array has been generated by comparing the energy of neighbored approximation coefficients. Watermark bits are XORed with the relational value array in order to produce the secret key during embedding process. In extraction scheme the watermark bits are extracted by the reverse process of embedding.**

Index Terms-Audio zero watermark, Discrete Wavelet Transform (DWT), Energy comparison.

I.INTRODUCTION

Watermarking is a technique through which the information is carried without degrading the quality of the original signal. Key is used to increase the security, which does not allow any unauthorized users to manipulate or extract data. Watermarking technology is now helpful in the attention of protecting copyrights for the images. There are two types of watermarks are present. They are visible and invisible or transparent watermarks, which cannot be perceived by the human sensory system. Based on the embedding domain, watermarking system can be classified as spatial domain and transform domain [6].

An audio watermarking is a technology to hide information in an audio file without the information to the listener and without affecting the quality of the audio signal [9],[12]. The spatial domain watermarking system can directly alters the main data elements in an image to hide the watermark data. The transform domain watermarking system alters the transforms of data elements to hide the watermark data. This has proved to be more robust than the spatial domain watermarking [8], [11]. Some complexities are present in the execution process. To overcome those problems a new audio signal decomposition method called Discrete Wavelet Transform (DWT) is used in our method [1]. One was derived from low frequency DWT coefficients, and the other was constructed from DWT coefficients of log-polar mapping of the host image [2].The audio embedded into watermark with the help of secret key and the watermarked image pass through the channel which several attacks like noise addition, re-sampling etc.,[4],[15] The same secret key after attacks in watermarked image to recover the original watermark image.

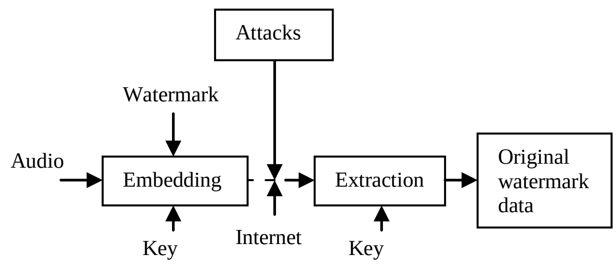


Fig 1.Watermark system model

Watermarking should be made in a way that they should provide the high robustness against various attacks such as the digital-to-analog and analog-to-digital conversions, noise addition, filtering, time scale modification, echo addition and sample rate conversion Watermarked signal should not lose the quality of the original signal [13]. It is called imperceptibility. Watermarking is employed on the original samples of the audio signal. Then for the transformation techniques, the discrete cosine transform and the discrete wavelet transform [3] etc., In transformation based approach the embedding is done on the samples of the host signal after they are transformed. Based on the application domain, the watermarks are classified into source based watermarks and destination-based watermarks. Source-based watermarks are desirable for authentication only. In destination based watermarks, each distributed copy gets a unique watermark identified by the particular buyer only [7],[14].

II. WATERMARK EMBEDDING

The embedding process involves several steps of operations. The steps are explained in detail as follows [10]. They are segmentation of an audio signal, DWT based time decomposition of the segmented frames of an audio signal. The block diagram of watermark embedding is shown in Figure 2.

Step 1: The audio signal gets divided into number of frames. The number of samples in each frame of a segmented audio signal is same for the purpose of watermark embedding.

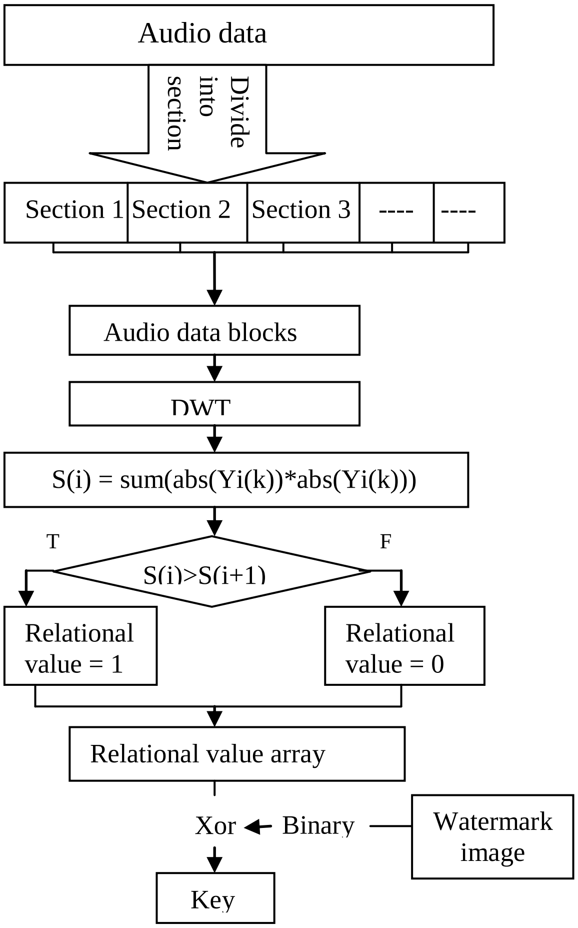


Fig 2.Flow chart for watermark embedding

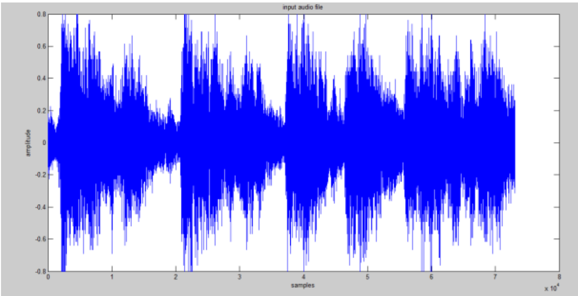


Fig 3.Host audio signal (1)

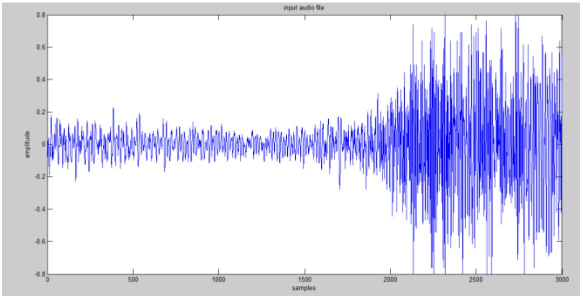


Fig 4.Host audio signal (2)

Step 2: Each sections are called audio data blocks. Each section has N samples.

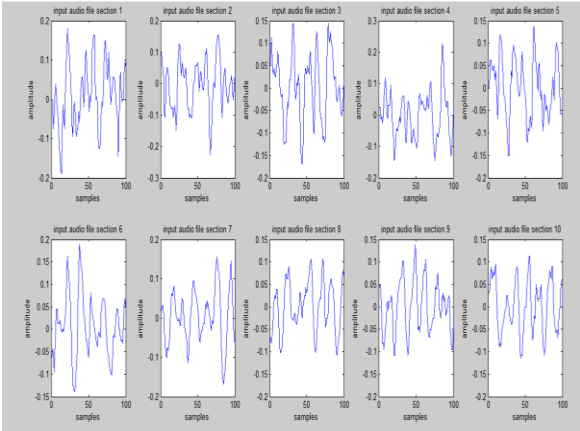


Fig 5.Segmented Frames

Step 3: One level Discrete Wavelet Transform (DWT) is applied into samples in each sections. The signal divided into approximation and detailed coefficients. Then the approximation coefficients of one level DWT is obtained.

Step 4: Energy will be calculated in approximation coefficients.

$$S(i) = sum(abs(Yi(k))*abs(Yi(k))) \quad (1)$$

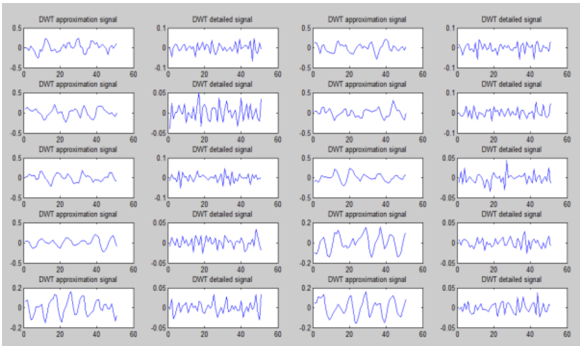


Fig 6.1D Discrete Wavelet Transform (DWT)

The energy S(i) is sum of absolute values of approximation coefficients multiplied by other absolute values of approximation coefficients.

Step 5: Compare the energy of each coefficients. The energy S(i) is greater than next energy values S(i)+1 then the condition is TRUE. In TRUE condition the relational value get 1.The energy S(i) is less then next energy values S(i)+1 then the condition is FALSE. In FALSE condition the relational value get 0.The relational values gotten between each adjacent section is called relational value array.

Step 6: The binary-pixel watermark image and relational value array on perform exclusive OR operation to get a key. With this key the watermark can be extracted. Send this key to the extracting side.

Fig 7.Watermark image

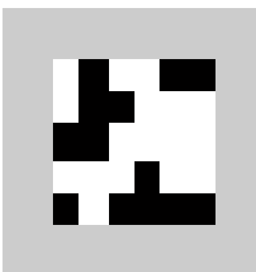


Fig 8.Key

III.WATERMARK EXTRACTION

The watermark extraction is the reverse process of watermark embedding. The watermarked audio signal is processed and finally the watermarked image is extracted.

Step 1: The audio signal is divided into number of sections.

Step 2: Each sections are called audio data blocks. Each section has N samples.

Step 3: One level Discrete Wavelet Transform (DWT) is applied to every segmented frame. The approximation coefficients of one level DWT is obtained.

Step 4: Energy will be calculated in approximation coefficients.

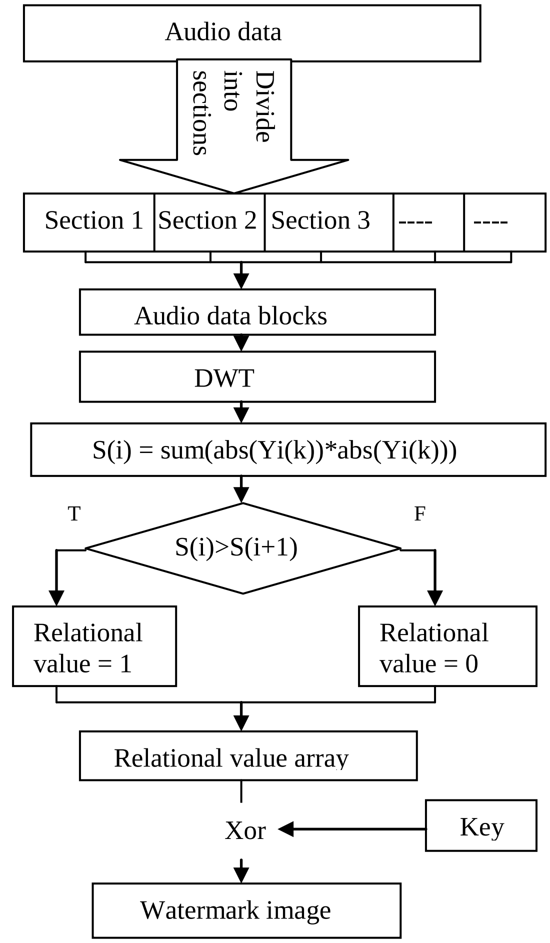


Fig 9.Flow chart for extraction method

Step 5: Compare the energy of each coefficients. The energy S(i) is greater than next energy values S(i)+1 then the condition is TRUE. In TRUE condition the relational value get 1.The energy S(i) is less than next energy values S(i)+1 then the condition is FALSE. In FALSE condition the relational value get 0. The relational values gotten between each adjacent section is called relational value array.

Step 6: The relational value array and key on perform exclusive OR operation to recover the original watermark image in the extraction side.

Fig 10.Recovered image

IV.RESULTS AND DISCUSSIONS

The audio signal is taken for the simulation process. It is sampled at the rate of 44.1kHz.The 5 X 6 binary watermark image embedded into the audio signal to get a secret key. In extraction method the audio signal and generated key is Xored to recover the original watermark image. Our simulation results are analyzed by calculating Signal to Noise Ratio (SNR), Bit Error Rate (BER) and Normalized Cross Correlation (NC) values for different audio signals.

Signal to Noise Ratio (SNR) is a specification that measures the level of the audio signal compared to the level of noise present in the signal. It is important sound level measurement used in describing the capabilities and qualities of many electronic sound components. It is used to calculate for original and watermarked audio signals.

Table I.SNR values for different audio signals

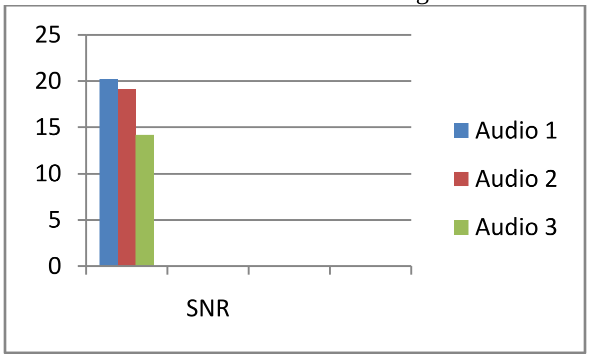
Audio signal	SNR(dB)
Classic	20.22
Handel	19.10
Pop	14.19

The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio is the number of bit errors divided by the total number of transferred bits during a studied time interval.BER is a unit less performance measure, often expressed as a percentage. The bit error ratio can be considered as an approximate estimate is accurate for a long time interval and high number of bit errors.

Table II. BER and NC values of different audio signals against various attacks.

Methods	Noise addition			Re-sampling		
	SNR	NC	BER	SNR	NC	BER
S. Wu S., J. Huang J., D. Huang et al.	13.15	0.93	1	23.17	1	0
L. Liang et al.	13.24	0.88	3	32.36	1	0
Proposed method	14.19	0.83	5	20.22	1	0

Chart I.SNR values for different audio signals



V.CONCLUSION

In this proposed method, watermark bits are embedded into an audio signal by modifying their DWT coefficients. The proposed scheme does not require any additional information to discover the watermark from test image. High robustness is ensured by the proposed scheme together with the usage of selected higher energy region and DWT based watermark embedding. The proposed method offers strong robustness against several kinds of attacks such as Noise addition, Re-sampling and etc.,

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