Audio Watermarking For Embedding Maximum Characters With Statistical Features

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***Abstract*—** In this paper an audio watermarking algorithm of embedding maximum character length is discussed based on segmentation and statistical features with four consecutive bins. As the length of audio file is more, capacity of embedding character will be required more. This paper shows much better results than the existing algorithm with relation of three consecutive bins. Initially audio signal is applied to the segmentation block which gives equal number of segments. Where segment is the group of four consecutive bins, one bit is embedded by reassigning the number of samples in four bins. By increasing the number of embedding characters, SNR will be slightly decreased.

***Keywords*-** *Audio watermarking,segmenting algorithm,bins,SNR.*

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I. INTRODUCTION

Audio watermarking technology is used to embed useful information in an audio carrier. After embedding, the audio signal is slightly modified but this modification is so slight that human ear cannot get the acoustic difference. This technology also used in copyright management and secure communication .Audio watermarking technology gives an opportunity to generate number of copies of audio file which perceive by listeners is similar to the original but different from one another using embedded useful information. There are two types of audio watermark: secret watermark and public watermark. Secret watermark means, watermark is readable only to the authorized person who knows the secret key. Public watermark means, watermark is read by everyone. This watermark is easily detected and removed by unauthorized person.

Audio watermarking is used for ownership protection [5] [6]. According to IFPI (International Federation of the Phonographic Industry)[7],STEP 2000[8] and SDMI (Secure Digital Music Initiative)[9],audio watermarking is robust to different attack such as cropping, Compression , resampling etc. Watermark location can be fixed using four audio features which selected by Wu [10]. Histogram specification applied in audio watermarking by Xiang [3-4] to improve the robustness to TSM attack. The histogram specification using three bin algorithms shows strong robustness to TSM attack but weak under LPF [4], this is the drawback. The embedding character capacity is low by using 3-bin algorithm hence using 4-bin algorithm ability of embedding character will be improved.

II. SEGMENTING HIDING CONCEPT

The 3-bin algorithm is weak under low pass filter (LPF) attack, because during the watermark hiding middle bin among three consecutive bins will take large change in the sample number as compare to other two bins. In this paper the Improvement is, use four consecutive bins and hence middle two bins have the small change in the sample number than the other two neighboring bins. Beta represents relation between different bins. Beta relation among three consecutive bins, is defined as,[4]

$$\beta k = \frac{2h(k+1)}{h(k)+h(k+2)} \quad (1)$$

Beta relation among four consecutive bins, is defined as [4],

$$\beta k = \frac{h(k)+h(k+3)}{h(k+1)+h(k+2)} \quad (2)$$

Beta relation for three bin algorithm and for four bin algorithm is as shown in fig.1and fig.2

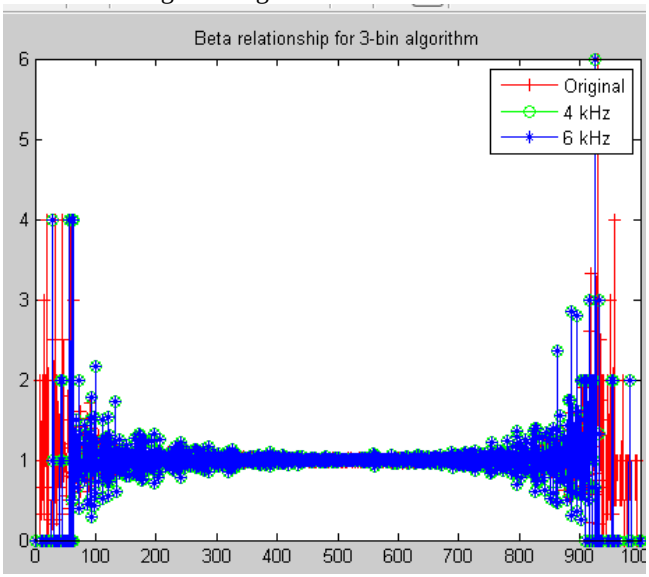

Fig.1 Beta Relation For 3-Bin Algorithm

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III. SEGMENTING ALGORITHM

In the audio watermarking algorithms, it is very important to resist two attacks of low pass filtering (LPF) and time scale modification (TSM). Mansur proposed to embed watermark by changing the interval lengths between salient points in the signal.[1] A histogram is defined as splitting the range of sample value into equal-sized bins. Histogram is described as,

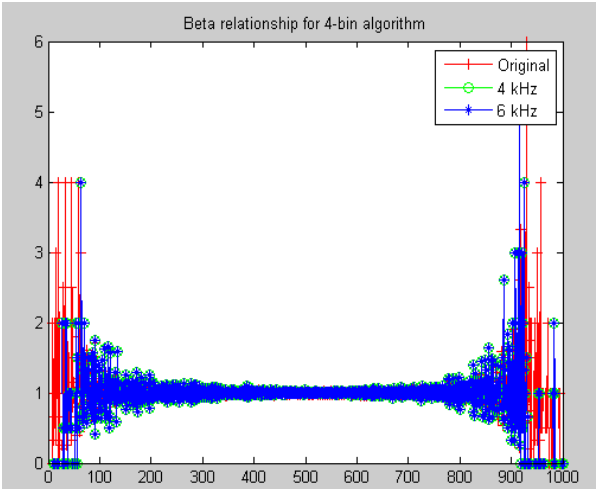


Fig.2 Beta Relation for 4-Bin Algorithm

$$H= \{h(i)|i=1,\ldots..,L\} \quad (3)$$

Where H is histogram of audio file and h(i) is number of samples in the i^{th} bin.

Watermark W={Wi|i=1,…,L} is hidden into audio carrier F={f(i)|i=1,..,N}. As embedding scheme discussed, audio carrier is segmented into equal segments.[4].The interval M of bins is calculated as,

$$M = 2K\sigma/Lh \quad (4)$$

Where, k = 2. [3]
L_h is obtained as:

$$Lh = 4 * L/Ls \quad (5)$$

Bin1, Bin2, Bin3 and Bin4 are the four consecutive bins which contains the a, b, c, and d samples in the number. To embed one bit information expression is given as follows [2]

$$(a+d)/(b+c) \geq T1 \text{ If } w(i)=1$$

$$(a+d)/(b+c) \leq T2 \text{ If } w(i)=0 \quad (6)$$

Where, T1, T2 are the thresholds which controls the performance of watermark robustness and the embedding distortion. The values of T1 and T2 assigned from T1≥1.05 and T2≤0.95.

A. *Embedding bit 1:*

If embedded bit is '1' and (a+d)/(b+c)≥T1 is sufficient then operation is not required. Otherwise number of sample a, b, c and d are reassigned until satisfying the condition as, (a'+d')/(b'+c')≥T1.[2] Extract few samples from bin2 and bin3 their sample number denoted as I2 and I3 which add into bin 1 and bin4 such as;
a'=a+I2, b'=b-I2, c'=c-I3 and d'=d+I3. Modification rule described as follows:

$$f_2'(i)=f_2(i)-M \quad 1\leq i\leq I_2$$

$$f_3'(i)=f_3'+M \quad 1\leq i\leq I_3 \quad (7)$$

Where, $f_2(i)$ and $f_3(i)$ is the modified sample in bin2 and bin3 $f_2'(i)$ and $f_3'(i)$=modified version of $f_2'(i)$ and $f_3'(i)$, M= bin width.[2]

B. *Embedding bit 0:*

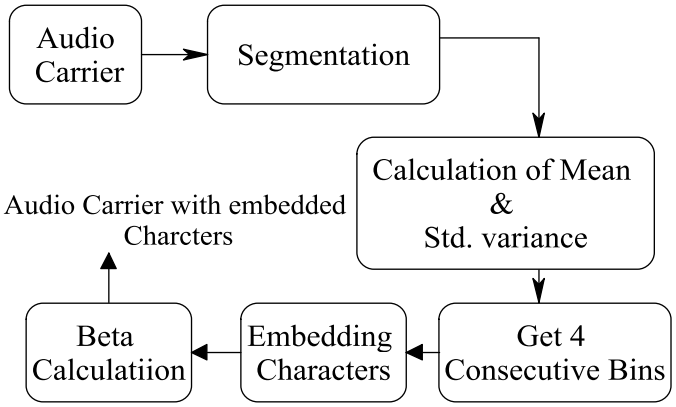
If embedded bit is'0' and (a+d)/(b+c)≤T_2 is sufficient then operation is not required. Otherwise number of sample a, b, c, and d are reassigned until satisfying the condition as (a'+d')/(b'+c')≤T_2.[2]
Extract few samples from bin1 and bin4 their sample number denoted as I_1 and I_4 which add into bin 2 and bin3 such as
a'=a-I_1, b'=b+I_1, c'=c+I_4 and d'=d-I_4. Modification rule described as follows:

$$f_1'(i)=f_1(i)-M \quad 1\leq i\leq I_1$$

$$f_4'(i)=f_4'(i)+M \quad 1\leq i\leq I_4 \quad (8)$$

Where, $f_1(i)$ and $f_4(i)$=modified sample in bin1 and bin4 $f_1'(i)$ and $f_4'(i)$=modified version of $f_1'(i)$ and $f_4'(i)$ M= bin width.[2]

C. Block Diagram



Steps:

- Initially Audio carrier is applied for segmentation.
- Equal number of segments carried by segmentation.
- Calculate mean and standard variance.
- Get four consecutive bins.
- Embed the characters.
- At the output we get embedded audio carrier.

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IV. PERFORMANCE MEASUREMENT AND RESULT

Segmenting algorithm using 4-bin improves the embedding capacity in audio carrier. As increase the number of embedding characters, the SNR is slightly decreases.

Table No. 1: Different length of audio file with maximum embedding characters

Length of Audio file in minute	*Maximum Embedding characters*
1.1	40
2	80
3	100
4	115

The following fig 3 shows the graphical representation of table No.1

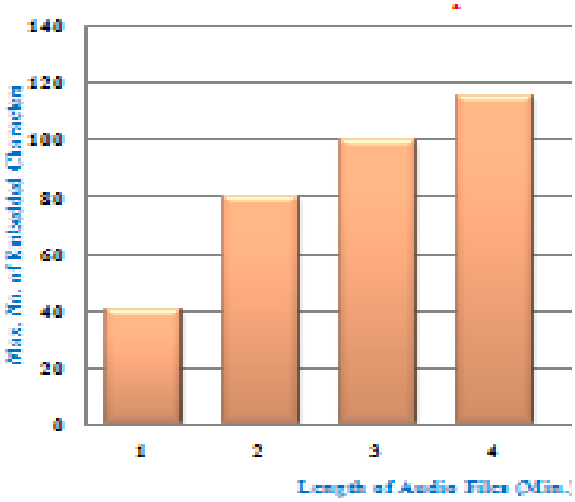

Fig.3 Length of audio file Vs embedded char. graph

We have used number of Audio file for Embedding characters and also successfully tested on the proposed algorithm. We found that the relation between SNR and number of embedded characters better than the previous work.

Table No.2: SNR Values for maximum characters embedded with 3 Minutes audio file

SNR in db	*No. of characters embedded*
55.55	20
55.51	40
54.30	60
53.87	80
53.66	90
53.81	100

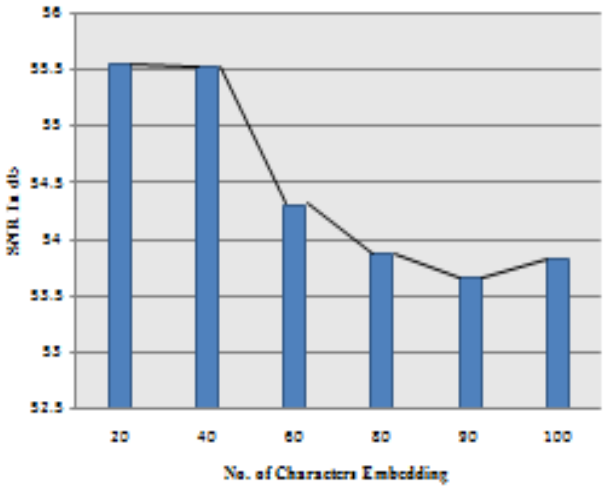

Fig.4 SNR Vs Embedding characters for 3 Minute audio file.

From fig. 4 we know the relation between SNR and no. of embedding characters.

Table No.3: SNR Values for maximum characters embedded with 4 Minutes audio file.

SNR in db	*No .of characters embedded*
55.55	20
55.51	40
54.3	60
53.86	80
53.75	90
53.91	100
53.64	115

The following fig.5 shows the graphical representation of table no.3

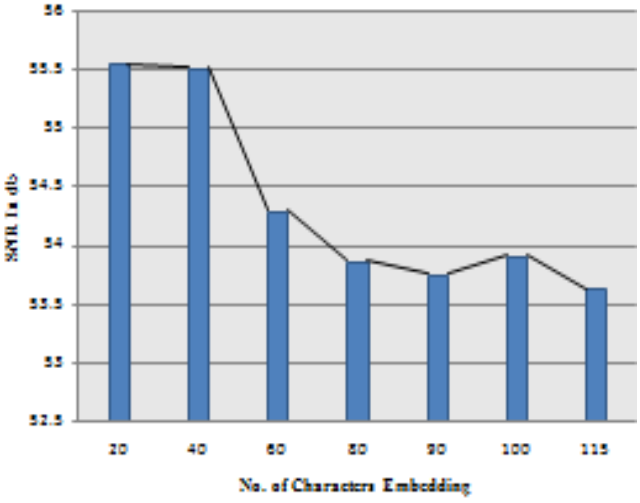

Fig.5. SNR Vs Embedding characters for 4 minute audio file

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V. CONCLUSION

Based on the segmenting idea, it is very important that if number of embedding characters more; then length of audio file should be required more. While testing for 1 minute audio file, number of embedding characters is not more than 40, because length of audio file is not sufficient. Further the character length increase for 4 minutes audio file.

The algorithm proposes the capacity of embedding maximum characters for small audio file as in Fig. 3, by increasing the embedding characters the SNR values slightly decrease which affect the quality of audio file after embedding.

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