

# Reversible Watermarking Technique and Spectrum Analysis: A Novel Approach

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**ABSTRACT:** Advancement of technology has made it easier for anyone to access the digital data without informing the owner. To ensure the authentication and to increase the security of copyrights, a method was introduced called digital watermarking. The watermarking method always should contain very less distortion. In this paper we have studied the reversible watermarking effect of multimedia content embedded in audio signal. We have also performed the spectral analysis of those original audio signals, the audio signals after watermarking and the audio signals after extracting the information so that we can confirm about the authentication of the watermarking. We have compared the three audio signals using some parameters also. This reversible watermarking process is based on Differential Expansion Algorithm but the implementation will be in a different approach.

**KEYWORDS:** Differential Expansion, Digital Watermarking, Multimedia Content, Reversible Watermarking.

## I. INTRODUCTION

There are two research fields are connected with digital watermarking: data hiding (steganography) [1] and authentication [2]. The purpose of data hiding is to transmit and conceal the secret data whereas the goal of authentication process is to verify whether the received data is tampered or not. Reversible Watermarking technique is basically an authentication checking process. It is used to increase the copyright security of the digital information. Using this process we can embed any digital content like text, audio, signal into another image, audio or video. In which content we are embedding the file, that is called the cover file and which content we are embedding is called the input file or message. The message or the input file always should be less than the cover file.

Previously, lots of work has been done in this reversible watermarking field. Generally they used an image as the cover file. Those who have used an audio as cover file, they mainly focused on the robustness of the embedded message. The main problem of those techniques is proper generalization.

In difference expansion (DE) embedding methods, to create features with a small magnitude a common feature is used. Basically in order to create vacancies for bits embedding, the difference operators, and further expand are used. The DE embedding process was originally developed by Tian [3]. In 2002 J. Tian et al. [3] was proposed a wavelet based reversible watermarking technique to losslessly remove redundancy in a digital image for space allocation to embed the watermark. They have extended their work in [4, 5, 6]. In 2004 Alattar et al. introduced a reversible watermarking algorithm with very high capacity of data hiding of color images. This algorithm was able to hide many bits in differential expansion of vectors of adjacent space [7]. In 2006, Liu and Lin [8] proposed audio watermarking in spectrum domain to increase the robustness. Here invariant features were considered and BCH code was applied. In 2011 Kang et al. [9] was developed another robust audio watermarking which was based log coordinate mapping. The mapping was against the geometric distortion such as pitch shifting, time-scaling and random cropping. In the same year Xiang et al. [10, 11] had studied various robust audio watermarking on time domain and DWT. In 2013 Pun and Yuan et al. [9] had proposed a robust audio watermarking on SWT domain. In this paper they applied the robust audio segment extractor to achieve the robustness against compression, filtering, pitch shifting and time-scaling.

This present work proposes a study on reversible watermarking technique based on differential expansion to in ensure the authentication and security of an audio file.

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## II. METHODOLOGY

There are several methods to authenticate the reversible watermarking technique. But we choose Differential Expansion algorithm for our further work. It is a high quality and high capacity reversible watermarking method for multimedia content. We also have chosen an audio as cover file instead of image. If the audio contains more than one channel we have selected only one channel at a time to embed the payload into that area. There is a huge research scope in audio reversible watermarking. This method is applicable for other multimedia contents also. Here at first we have converted all the input files into binary form so that we can use any multimedia content as payload and then followed the calculation process of differential expansion method.

We also have converted the audio file (cover file) as a matrix. There are two processes for reversible watermarking:

- a. Embed- To embed the payload (message) into the audio file we have to follow the following steps:

- Step 1: Suppose X, Y are two matrix values of the selected audio file.
- Step 2: Difference (h) = (X-Y)
- Step 3: Convert the difference into a binary form.
- Step 4: Average (l) = (X+Y)/2
- Step 5: Payload (b) = 1/0 [The 1st bit of the binary form of the input file]
- Step 6: Embed the Payload at LSB of 'h' through the formula:

$$\text{New Difference (h')} = 2 * h + b$$

We also have converted the audio file (cover file) as a matrix. There are two processes for reversible watermarking: Hence the new Values are:

$$X' = l + [(h' + 1) / 2];$$

$$Y' = l - (h' / 2);$$

Now X', Y' are the two new matrix values after embedding the payload.

- b. Extract- To extract the message from the audio file we have to follow the following steps:

- Step 1: X', Y' are two changed matrix values of the selected audio file.
- Step 2: Difference (h) = (X'-Y')
- Step 3: Convert the difference into a binary form.
- Step 4: Average (l) = (X'+Y')/2
- Step 5: Payload (b) = 1/0 [The 1st bit of the binary form of the input file]
- Step 6: Extract the Payload 'h'. Just remove the 1/0 from 'h' which was embedded at the time of embedding process.

We can also calculate the new difference through the formula

$$\text{New Difference (h')} = 2 * h + b$$

Hence the new Values are:

$$X = l + [(h' + 1) / 2];$$

$$Y = l - (h' / 2).$$

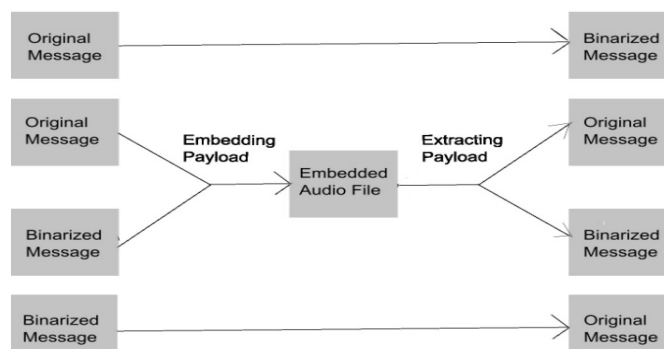


Fig. 1

Fig. 1: Reversible Watermarking technique based on Differential Expansion method

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After completing both the process we can get back the original audio file and the message separately. The bit rate and the size will also be the same of the resultant audio file and the original audio file.

### III. METHODOLOGY

Our proposed system has used 2.40 GHz Intel Core i3 processor based system. For reversible watermarking process we have used Matlab R2012a and for spectrum analysis we used Sigview v2.6 software. We have done our experiment using an image as message file and an audio as the cover file.



Fig. 2

Fig. 2: Cover File + Message

Our work showed the visual effects of spectrum of three audios (Before embedding payload, after embedding payload, after extracting payload) (Fig: 3, 4, 5) and later measured the parameters (Table 1) of those audios and calculated the tampering amounts (Table 2) between the audios. We have used an audio named 'a.wav' for our further work.

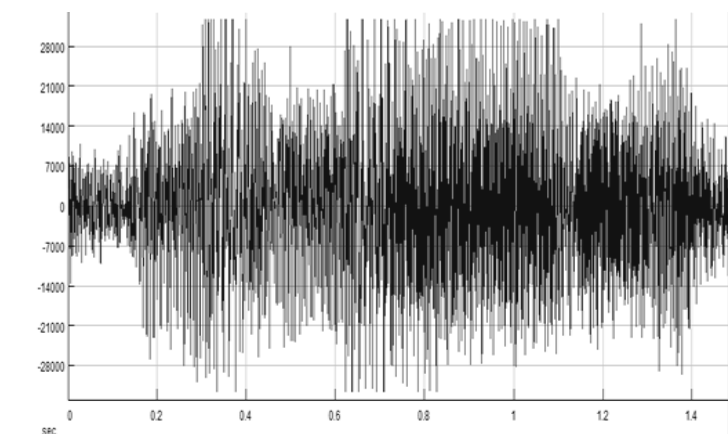


Fig. 3

Fig. 3: Spectrum of the audio before embedding the payload

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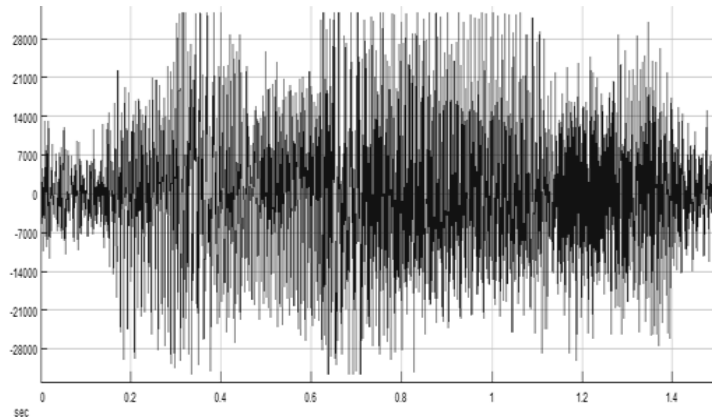


Fig. 4

Fig. 4: Spectrum of the audio after embedding the payload

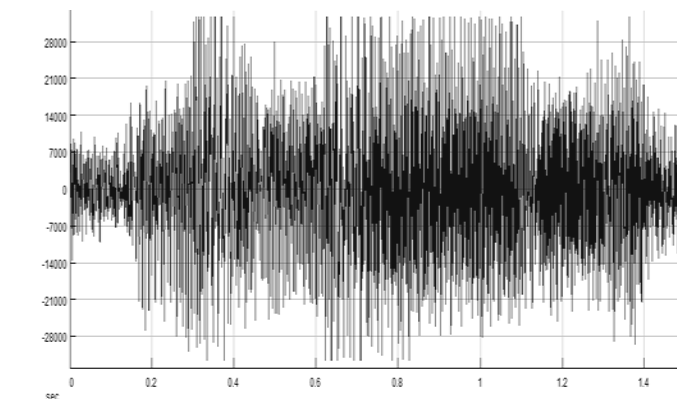


Fig. 5

Fig. 5: Spectrum of the audio after extracting the payload

Here we can notice that the spectrums of those three audio signals are almost same. The Slight change can be negotiable. Even we cannot differentiate the audios when we will listen to it. Every audio signal consist its frequency. The tampering amount can be verified by measuring some parameters of that audio frequency such as standard deviation, mean, crest factor, zero-crossing rate, and Total harmonic distortion.

In table 1 in case of every parameter the value of before embedding the payload and after extracting the payload should be same. Particularly then we can conclude that the message is extracted from the audio properly. Here we have also calculated the difference of those parametric values.

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Parameters	Before Embedding Payload (A)	After Embedding Payload (B)	After Extracting Payload (C)
Standard Deviation	10814.2	10855.6	10814.2
Mean	-4.41665	-18.1357	-4.41665
Crest Factor	3.0301	3.01852	3.0301
Zero Crossing Rate	1844.78	1856.82	1844.78
Total Harmonic Distortion	23.5526%	28.5249%	23.5526%

Table 1

Table 1: Parameters value of the mentioned audio file during three different times

A-B	B-C	C-A
-41.4	41.4	0
-22.5235	22.5235	0
0.01158	-0.01158	0
-12.04	12.04	0
-4.9723	4.9723	0

Table 2

Table 2: Difference between the parametric values

In table 2 we can notice that parametric value of the audio before embedding the payload and after extracting the payload are same. Hence we can say that the message is extracted from the cover file properly. But in the first column we can notice that the parametric value of the audio before embedding the payload and after embedding the payload are different. In the same way in the second column the parametric value of the audio after embedding the payload and after extracting the payload is also different. Now finally from this table we can easily check the tampering amount of the audio and can ensure about the authentication and security of the specific audio file. We can try this method about any multimedia content as cover file as well as message.

## IV. CONCLUSION

Previously lots of work has been done in this reversible watermarking field. But In our paper we have performed reversible watermarking technique on audio files whereas they used usually the image files. In case of differential expansion algorithm, they also have used an image to show the experimental result. Among the several methods to authenticate the reversible watermarking technique we have performed our study based on Differential Expansion algorithm since it is a high quality and high capacity reversible watermarking method for multimedia content. In this paper the main focus was to take any multimedia content as cover file as well as message easily. We have implemented and modified only one algorithm of reversible watermarking. More advanced methods will significantly lead this area of research.

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