

Experimental Evaluation of Audio Watermarking Procedures for Mix Music

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Abstract. In this paper we evaluate the performance of four audio watermarking technologies to protect ownership or copyright of mix music which is combined two or three pre-existing song. In experimental results, only one watermarking technology can be applicable to mix music and three technologies fail to extract watermarks from mix music. The common problem of failed technologies cannot extract the second watermark from underlying mix music. The experimental results suggest that the watermarking technology for mix music requires a new paradigm to protect multiple ownership or copyright for mix music.

Keywords: Audio watermarking, Mix music, Copyright, Multiple ownership

1 Introduction

Recent years have seen a rapid growth in the availability of digital multimedia content. A major problem faced by content providers and owners is protection of their material. They are concerned about copyright protection and other forms of abuse of their digital content [1].

Under the influence of this trend in digital music field, digital technology and the Internet have not only made infinite collections of unique art available, but they have also made it possible for people to mix and mash others' works with little difficulty and no authorization. Consequently, society is witnessing a shift away from passive involvement in culture toward a more active, participation oriented scheme. The practice of borrowing ideas to create and inspire new art has never been as prevalent as it is now. One area that is increasingly affected by this shift is music. In fact, there is an entire genre of music, commonly known as "mashups," dedicated to borrowing Music Mashups: Testing the Limits of Copyright Law as Remix Culture Published by Scholarly Commons at Hofstra Law, 2010 and mix in others' works.' A music mashup⁸ is a song formed by combining two or more preexisting songs.⁹ in Copyright Law of USA [2].

Easy access and replication, however, have led to serious problems with copyright protection for media. Therefore, media owners can use this technique to insert some

information into their media for the purpose of copyright protection or ownership. A digital watermark is a kind of marker covertly embedded in a noise-tolerant digital information such as audio or image data. It is typically used to identify ownership of the copyright of such digital contents. "Watermarking" is the process of hiding digital information in digital contents. The hidden information should but does not need to contain a relation to the content. The security and enforcement of academic property rights for digital media has become an important issue [3]. This paper contributes to reply to the applicability of audio watermarking technology for multiple watermarking system such as multiple ownership protection of mix music.

2 Experimental results

To our experiment, we prepared 3 songs that have overlapping of 10%, 30%, and 50% as Fig. 1. The songs used to overlap are the same as the former and the latter. The sampling rate of each song is 44.1 KHz that is mono- CD audio quality.

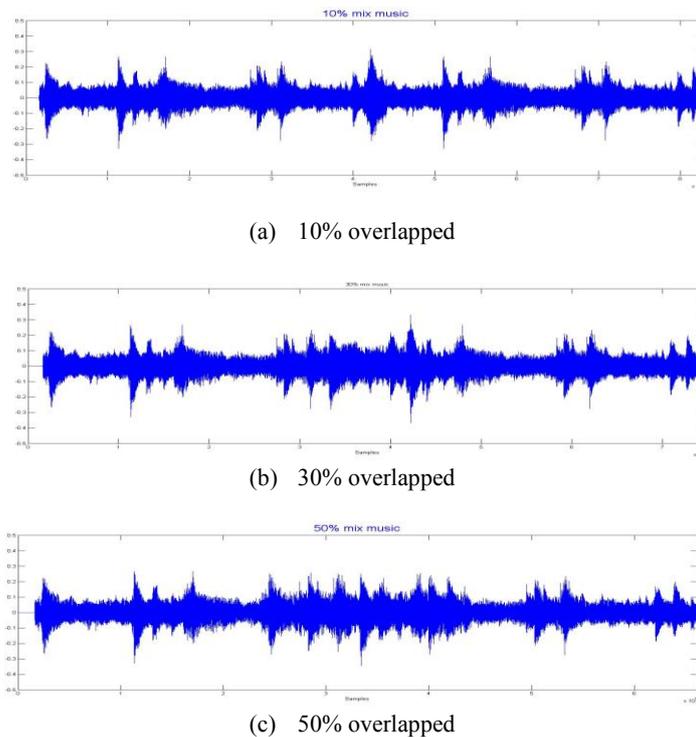


Fig. 1. 10%, 30% and 50% overlapped mix music that combine to two songs. The sampling rate of each song is 44.1 KHz that is mono- CD audio quality.

To test the applicability of existing audio watermarking technology, four watermarking techniques, one discrete cosine (DCT) domain watermarking algorithm,

three discrete wavelet transform (DWT) domain watermarking algorithm are applied. DCT algorithm embeds 64 x 64 watermark image in low frequency element of 2 x 2 DCT block. The first DWT domain watermarking algorithm embeds 24 x 24 watermark image in middle frequency bands. The second DWT domain watermarking algorithm embeds 64 x 64 watermark image in middle frequency bands by different embedding process from the first DWT algorithm and the last DWT algorithm is the implementation of dither method in DWT domain. The four watermarking technologies are applied to 10% overlapped mix music. Table 1 shows the experimental results of watermark extraction described four watermarking algorithms.

Table 1. Extracted watermarks from 10% overlapped mix music

Technologies	Extracted watermark (former)	Extracted watermark (latter)
DCT1		
DWT1	SU DA	SU DA
DWT2		
DWT3		

As seeing in Table 1, the last DWT domain watermarking algorithm which is based on dither method uniquely extracts watermarks from mix music that combine two songs. And the first DWT domain watermarking algorithm perfectly extracts the first watermark from the first song and the second watermark with some bit errors. Other algorithms fail to extract the second watermark from the second song of underlying mix music. The common of failed algorithm to extract watermark is that the first watermark is normally extracted but the second watermark is not. Even two algorithms, DCT1 and DWT2 in Table 1 never extract the second watermark. In case of DWT1 algorithm, the second watermark is not extracted from 20% overlapped mix music as in Table 2.

Table 2. Extracted watermarks from 10% overlapped mix music by DWT1 algorithm

Technologies	Extracted watermark (former)	Extracted watermark (latter)
DWT1	SU DA	

The results of two failed algorithms, DCT1 and DWT2, and the result at Table 2 imply that the typical audio watermarking technology applied a non- mix music i.e. the typical music may not be apply the mix music consistently. As the copyright law changes based on the changes of the popular music genre by modern music trend and/or birth of new music genre, the field of audio watermarking technology for supporting the copyright law should change.

3 Conclusions and future works

In this paper, we evaluated the performance of four typical audio watermarking technologies applied mix music. The experimental result showed that only one audio watermarking technology based on dither method in the DWT domain perfectly extracted the watermark from mix music. The common problem of other audio watermarking technologies cannot extract the second watermarking from the underlying mix music. This mean that the advent of mix music requires a new watermarking techniques. Our future works is improving the typical watermarking technology to be suitable for the mix music. Especially we are concentrating on the development of an audio watermarking technology to be able to survive at the overlapped areas of mix music.

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