International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 4 (2015) pp. 8913-8920

http://www.ripublication.com

A New MPEG Layer III Steganography Technique By Changing Quantized Spectrum Values

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Abstract

Anew information hiding approachis proposed to hide much more information into MP3 audio file in comparison with mp3stego software in this article. The music MP3 file format because of its features such as tone quality and high compression ratio is verypopular on Internet. In this proposed method, the embedding of information is concurrentlyaccomplishedduring the performance of MP3 compression procedure. This approach hides secret information into audio files bymodifying some quantized spectrum values of mp3 audio file. Our proposed method causes a six-fold increase of capacity in comparison with that of mp3stego. The difference betweentheaudio file with secret information and itsoriginalone is imperceptible.The obtained resultsindicate that, in this research, more characters are embeddedthan those hidden inpreviously-used methods. TheMP3 audioformatsconsist of secretinformationwhich is indiscernible to human ears.

Keywords: Steganography, information hiding,capacity, MP3,

Introduction

One of the main areas of information security thatconsists of various techniques like steganography, coding and cryptography,is hidden exchange of information. In recent years, steganographyhas become one of the significant methods in information security domain. Information hiding in a cover media is the principal goal of steganography methods so that others will not detect the existence of embeddedinformation. This is a maindifferenceofothertechniques of data hiding and steganography. Other types of cover media like text and audio, despite the Most of existing steganography techniques are using images as cover media, are also used. The weaknesses of human auditory system (HAS) is used in audio based steganography methods to hide data in the audio signal. Image

steganographyduetoless precision of human visual system (HVS) rather than human auditory system has less challenging than audio steganography[1].
MP3 music files format are very popular on the internet and most music framers choose internet as a channel to propagate their creations because of low cost of sales and popularity. But steganography software using MP3 audios as hosts is rare.Hiding capacity, perceptual transparency, and robustness are three important parameters which are known as 'the magic triangle' and use in designing steganography techniques [2].Some methods attempt to be robust against various attacks like MPEG-1 layer III compression whereas, achieving high hiding capacity is goal of some other steganography techniques[3,4].Mp3stego is aninformationhiding software with low capacity which uses MP3 audios format as its hosts. The disadvantage of the Mp3stego is that it doesn't have any information about the secret informationlength.The latter part is unrecognizable characters and the former part is the correct secret information are two part of the extracted information by the Mp3stego[5]. Thisdisadvantageis corrected through embedding information about the hidden information length in host audiosin this article.
Remaining of this paper is organized as follows. In the next section we describe the structure of MP3 file format with encoder and decoder of MPEG audio layer III. Then, we explain our proposed method, followed by discussing the experimental results.

MP3 InDetail

The MP3 audio format compression algorithm invention because of its high compression ratio and quality is one of the most considerabledevelopmentsin the fieldof digital signal processing. MP3 generates a highly compressed signal with high perceptual quality by reducing or eliminating unnecessary frequencies [6]. A complete MP3 system has an MP3 encoder and an MP3 decoder. The procedures of thedecoderandencoder are controlledby a set of undetermined control signalswhich are combination of both software functions external hardware controls. The overall MP3 system structure is shown in Figure 1[7].

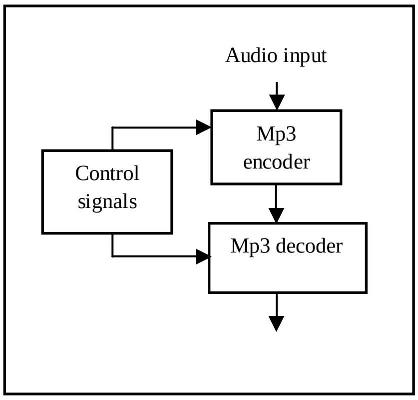

Figure 1: An overview of MP3 system architecture.

In an MP3 system, a regular PCM audio is input to the MP3 encoder and according to the standard MPEG-1 layer III encoding algorithm,thisPCM signal will be converted to an MP3 digital bitstream. An MP3 file will be generated after MP3 encoder. The decoder reconstructs the PCM audio signal by decoding the MP3 bitstream, and the analog audio signal is finally turned into audible sounds. The control signals mean external software functions and parameter controls during MP3 encoding and decoding. In the next sections, MP3 encoder and decoder will be introduced in depth [8,9].

MP3 Encoder

The aim of MP3 as a lossy data format isminimizing storage space while preserving the sound quality. The encoding process,as well as more conventional data compression techniques, involves both perceptual optimization which leads to the complexity [10]. The encoding process considers the features of human auditory system. For instance, human ear cannot hear frequencies above 20 kHz and below 20Hz. In addition,when two or more notes with specific frequencies are played together, human ear is often unable to distinguish betweenthem.A conceptual model of an mpeg layer III encoding algorithm is shown in figure 1. Therefore, mp3 file format needs to store only a single copy out of a similar sounding notes group todiscardthe sounds with frequencies out of the audible scale securely. To perceptually optimize the data, the Mp3 encoder which is briefly describedutilizes a complex psychoacoustic modeling. The original audio signal after applying an analyzer of filterbankis decomposed into 32 subbands [11]. MP3 encoder further divides the 32 subbands with MDCT to increase the frequencyresolutionand then acquires 576 data lines. After that, MP3 encoder performs the Huffman encoding and procedure of quantization. Eventually, the encoded MP3 bitstream is formatted [12]. The MP3 encoder to achieve the aim of decreasing bit rate removes the subbands, unsusceptible to the human ears and masked by other signals. After that, by using Huffman coding to reduce bit rate and accomplish the aim of a large number compression,compresses the audio signals [13].

MP3 decoder

The relative information of the bitstream is retrieved when the bitstream is unpacked. Then, Huffman decoding is performed and 576 MDCT data lineswhich have been reconstructed are obtained. Furthermore, to deal with the data lines, 32 subbands are acquired using IMDCT. At the end, audio data are obtained by using synthesis filterbank to deal with the subbandsin the time domain [14].

MP3 Frame

MP3 encoded bitstream is divided into frames. The frame is a central concept when decoding MP3 bitstream. Therefore, watermarking on MP3 frames is the major contribution of this thesis. An MP3 frame consists of five parts including header, CRC, side information, main data and ancillary data. A frame usually consists of 1 or 2 granules. Each granule is further divided into 32 subband blocks of 18 frequency lines. Therefore, in stereo audio, each frame includes two granules which are left and right granules and each granule is a 32 subband block of 18 frequency lines. For mono audio, a frame only includes one granule. Therefore, in mono audio a frame is the same as a granule. In this research, the proposed MP3 watermarking algorithm is a generic method for MP3 frames. However, in order to easily present, the proposed watermarking algorithm is implemented on one granule in a frame. Therefore, for stereo audio, the new algorithm is implemented on its right granules in a frame; for mono audio, the proposed algorithm is implemented on its entire frame. The experimental results of the proposed watermarking algorithm are on the mono audio only [15].

The Proposed Informationhiding Approach

The value of high frequency lines in a granule is usually small. Most high frequency lines are quantized as 0 after quantization. Then, a few high frequency quantized values will not result distortion which is detected by the human ear is slightly modified. In our proposed method the 4 quantized highest frequency lines is modified if the granule contains short blocksandlast count1-quadruple is modified if the granule has no short blocks.

Embedding process

Ourmethodembedsthesecret information in the process of quantization step to keep fixed bit rate and to select frames utilized for embeddinga random creator with a secret key is used. The first two chosen frames are used to embed data about the length of secret information if the audio is single channel and alsothe first chosen frame is used to embed information about the length of secret information if the audio is dual-channel. The embedding method and procedure is shown in Fig.2 and Fig.3, respectively.

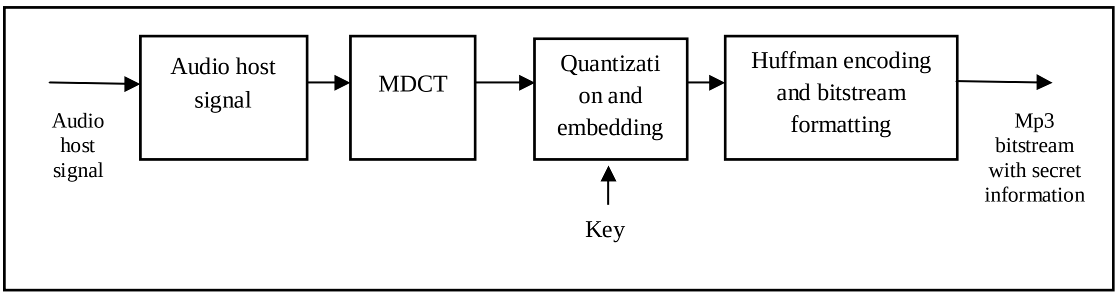

Figure2: The embedding method

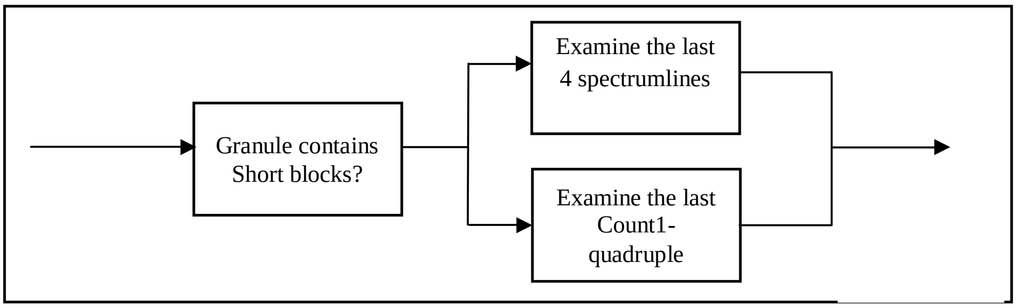

Figure3: The embedding procedure

The following figure shows the Organization of MP3 quantized values:

| xxxxxxxxxxxx | -------------- | 0000000000000000000000000 |

1

The values 000 and --- are all zero and -1,0 or +1 respectively whichtheir number is a multiple of 4. The values xxx are not bound. Count1 consists of quadruples of quantized values with absolute value which not exceeding -1, 0, and 1. Thus, quadruple has 81 different combinations which the last two values of the last quadruple will be counted as zero and this pair of values cannot be 0 at the same time.Asa result, the number of available combinations is 72 that 64 of them are used to represent 6 bits of embeddeddata. For instance, we will modify the last 4 quantized spectrum lines (granule contain short blocks) to be (-1,-1,-1,-1) or the last count1-quadruple to be (-1,-1,-1,-1) if we use (-1,-1,-1,-1) to represent 000000 and the secret bits are 000000. Generally, this method consists of two parts:Using a key to choose a set of frames for embedding and modify special quantized spectrum lines of each granule if a frame is chosen to embed secret information.

The extracting process

When MP3 decoding is performed the embedded information can be extracted. We look over the special quantized spectrum lines after Huffman decoding to extract secret bits. Fig.4 and Fig.5 respectively show the extracting method and the extracting process.

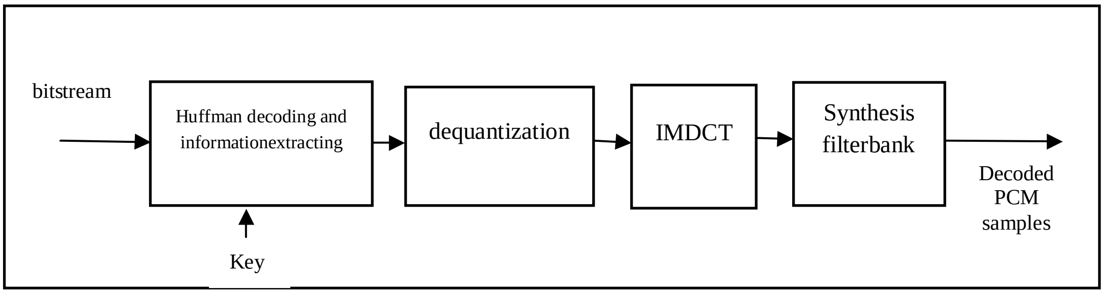

Figure4: The extracting method

The extracting processgenerally consists of twoparts:Using a user-specified key to determine the set of frames and examine the last 4 spectrum lines or the last count1-quadruple of each granule in the frame which has secret information frame., then the secret bits are 000000 if the 4 special spectrum lines are (-1,-1,-1,-1). The first 24 extracted bits are information about the length of secret information in the above mentioned example.

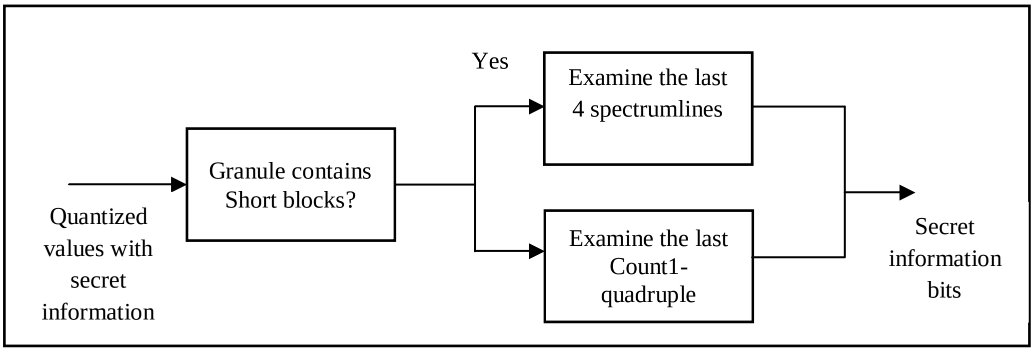

Figure5: The extracting procedure

Experimental Results

Information was embedded intojazzclassical, symphony, and folk, after that,the embedded characters were extracted correctly. People are unable to distinguish between the music with secret information and the original one. We utilize subjective tests to test the imperceptibility of our approach because the audios objective tests are unreasonable. High similarity coefficient and High signaltonoise ratio (SNR) do not necessarily mean high imperceptibility. Two kinds of experiments is performed:firstone is to present the music with secret information and original music for30 different listeners which is including 10 experts on music to ask the listeners about the difference between them; anothertestisaverage the discrimination rate of the 20 listeners by randomly present the revised music and the original music to one ofthem to ask him whether the music is embedded with secret information or not. Experiments were performed on a large set of music files. Resultsindicatethat majority of peoplecannot distinguish between the music with embedded informationandoriginal one.The number of people whichcouldnotunderstandthe difference between the music with secret information and the original music is recorded in the first test.The discrimination rate recorded in the second experiment. Table.1 shows some experiment results.

Table 1: Results of experiment

	Discrimination rate	The number of people that cannot distinguish
Classical	61.2%	35
Jazz	61.02%	30
Folk	59.88%	30
Symphony	61.04%	29

Conclusion

An audio informationhidingtechniqueaccording to modifying special spectrum lines of MPEG layer III was proposed in this article. This proposed approach has the following characteristics. Most people fromimperceptibilityaspectcannot distinguish between the music with embedded information and the original one and also in undetectibility,nobody cannot extract the correct information without having the secret key. Proposed method has a capacity which is six times largerthan mp3stego tools in hiding capacity. Secret information is extracted withoutaccess to the original audio in extracting process. Our information scheme has characteristics that information-hiding techniques must be responsible for prerequisites.

Acknowledgment

The authors would like to thank UniversitiTeknologiMalysia for funding the research under vot 05H37. We also would like to thank our research group in supporting and giving positive comment to improve our paper.

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