CHAPTER 1
INTRODUCTION

1.1 Background

The Digital era has grown rapidly and has affected many aspects of our lives. People are increasingly inseparable from gadgets and the Internet, where they can easily get a large amount of audio data, such as music [1]. According to data from the International Federation of the Phonographic Industry (IFPI) an average person listens to 18.4 hours of music per week, this is equivalent to 52 and a half 3-minute songs per day [2]. With the increase of music listeners, it opens multiple ways to free download unauthorized copyrighted music. It is highly required for digital multimedia data to have copyright protection. Digital copyright is used to prevent unauthorized reproduction, manipulation, and distribution of digital multimedia data. Downloaded music files are estimated 95% to be illegal file-sharing, which means digital copyright infringement. Digital copyright infringement is the use or production of copyright-protected material without the permission of the copyright holder [3]. Music copyright infringement could cause declining revenue and possibly lower music-making bids. So, digital copyright infringement has become a critical issue that needs to be tackled and data hiding is a solution for that issue.

Data hiding technology is promising technology to protect copyright information and prevent the copyright infringement [4]. Digital multimedia owners strive to embed digital watermarks into the original file for copyright protection without sacrificing the original quality. Through data hiding, the author and the user's information like logo, serial number, user ID, publisher ID, and transaction details can be hidden into the original content [5]. The embedded copyright information is able to authorized user or agency using a secret key. One branch of data hiding is digital watermarking, the process of embedding and hiding information with specific purpose into the host signals. The host signals are including multimedia data and in this thesis, it is specified to audio data. To achieve a good digital audio watermarking for copyright protection, the algorithm should have meet four essential characteristics: high quality of imperceptibility, high level of robustness, high embedding capacity, and high security level [6].

Many studies on data hiding have been done before, but combining data hiding

with CS techniques is still rarely discussed, as in the [7, 8] study. In [7], the proposed method can suppress the audio host while hiding the information. The data hiding technique proposed in this paper is Hadamard multiple orthogonal codes on Spread Spectrum (SS), this study evaluates the performance in terms of payload, compression ratio, audio quality, and watermark quality. The proposed method can hide the data without being seen, in the range of 729-5292 bps with a compression ratio (CR) of 1.47-4.84. Experimental results show that the proposed method has good robustness, good audio quality, can reconstruct audio while maintaining payload and CR.

The next previous study regarding this watermarking research also presents High Payload Qr-Based Data Hiding Using Secured Compressed Watermark in Polar Domain. This study proposes a secure compressed watermark system based on QR and blind audio watermarking combined with CS technique because at the time of detection it does not require original audio. The proposed method on this parameter has selected parameters resulting in an average ODG value of -1.79, an average SNR value of 23.35, and a payload watermark of 307.62 bps [8].

SS-based audio watermarking methods [7, 9, 10] have a simple watermark structure in embedding and extraction. The SS-based audio watermarking also has a great imperceptibility and robustness against conventional attacks. In [10], proposed a new SS-based audio watermarking technology that is robust to strong attacks while maintaining high embedding capacity because some watermark bits are represented by a single PN Sequence. In addition, the embedding method in Xiang has resistance to attack but the embedding capacity is low at 84 bps compared to the capacity in this thesis which is much higher. However, from a computational point of view, it has low computational complexity. The audio watermarking system in this study can increase the watermark capacity using the same SS algorithm by combining CS techniques.

In this previous study [11], Stanković *et al.* discusses the Analysis of the Reconstruction of Sparse Signals in the DCT Domain Applied to Audio Signals. In this paper, DCT is studied in the context of sparse audio signal processing using CS theory and methods. The DCT coefficient of the sparse signal, calculated by the reduced set of available samples, can be modeled as a random variable. Numerical examples on audio signals validate the accuracy of the presented theory and the efficiency of the reconstruction algorithm when compared to other base-line audio signal reconstruction algorithms. DCT has been employed in several common approaches for compressing photos and videos due to its great compression ability [12].

Those previous studies above are different since this research focus on the Data hiding based on combining CS and DCT sparsity technique. Previous research of [7] discussed more about memory efficiency of data hiding process. Then, the previous research [11] only discussed the reconstruction of audio signals using DCT without embedding a watermark. Furthermore, this thesis elaborate the bit capacity of the watermark in the audio signal based on the compression process and matrix cutting in DCT. The DCT output is diagonalized and then diagonally cut the signal for compression and watermark insertion using the Multibit SS method. At the receiving end, the compressed and watermarked signal is detected by matrix A and reconstructed. The proposed hiding data is blind watermarking combined with [8]. By maintaining audio quality, high capacity, compression ratio is also considered in this thesis.

The audio watermarking system in this thesis use the compressive sampling technique to compress the size of watermarked audio efficiently. In the audio embedding process, mono channel are used used to simplify the embedding process, as replacing them with stereo audio does not make a significant difference [13]. The pixel size of the image watermark used is 64x64 with *bmp format, in the pixel detection process a smaller number is needed to detect the presence or absence of a watermark. The reduction in the number of pixels to be watermarked results in increased immunity to host signal attacks[14]. The watermark embedded in the audio utilize DCT method to transform the host audio from time domain to frequency domain and Multibit SS technique to spread the watermark bits throughout the host audio spectrum.

Based on the issues above, this thesis about Data Hiding Based on Compressive Sampling and Multibit SS using Discrete Cosine Transform Sparsity Technique is important to conduct. This digital audio watermarking is a necessary technology to be applied in the digital audio industry. This thesis also has a positive impact for environment, especially for digital audio producer. This data hiding can be beneficial for the audio owner to keep their copyright safe and audio piracy prevention.

1.2 Problem Formulation

Multi-bit SS audio watermarking technique produces watermarked audio with high capacity because in the Multi-bit SS technique one key code represents multiple-bit watermarks. Thus, many watermarked bits are inserted resulting in a large watermarked audio file size.

1.3 Objectives

The purpose of this thesis is to design an audio watermarking system while simultaneously compressing the host using the methods used are Compressive Sampling, Multi-bit SS, and Discrete Cosine Transform. Thus, the transmitted audio host has a smaller size and also saves computational costs.

1.4 Scope of Works

Related to the problem formulation, scope of problem can be identified as follows:

1. The watermarking is focused only to audio and embedding image watermark to the audio host using Multi-bit SS method.
2. The inserted watermark into the audio signal is a 64x64 pixels in*.bmp format
3. Ten audio sample is used for watermarking simulation and the audio file format is in *.wav with 44.1 kHz sampling rate, mono channel, and 8 bit depth.
4. The audio watermarking system performance is observed objectively.
5. Parameters used for determining the performance of audio watermarking are SNR, ODG, Payload, Compression Ratio, and BER.
6. The audio host is attacked with Noise Additive.

1.5 Research Method

1. Identification of Research Problems

   At this stage, the identification of the problem is carried out using a study literature. The literature used comes from published research results in paper journals and paper conferences.

2. Design a Problem-Solving Model

   At this stage, a problem-solving scheme is designed for data hiding techniques. This technique is carried out based on the compressive sampling method and Multibit Spread Spectrum with the Discrete Cosine Transform technique.

3. Problem Solving Models and Research Validation

   At this stage, Problem solving technique is tested objectively to determine the watermarked audio quality

4. Data Collection and Analysis

   The data used are the results of testing and analysis is carried out to determine the performance of the resilience of hidden information and the quality of the content.

5. Conclusion

   Conclusions are made based on the results of data analysis and the achievement of objectives.

1.6 Bachelor's Thesis Organization

The rest of this thesis is organized as follows:

- Chapter 2 BASIC CONCEPT

  Chapter 2 encompass basic explanation of audio watermarking, the methods used in the designed system, and type of attacks tested to the system.

- Chapter 3 SYSTEM DESIGN

  Chapter 3 describes the work flow and system design in the software for audio watermarking.

- Chapter 4 PERFORMANCE EVALUATION

  This chapter presents the system analysis on the results obtained from the design, testing and simulation stages of the system.

- Chapter 5 CONCLUSIONS Chapter 5 comprises the conclusions and suggestions of this thesis.