Introduction

Steganography is an art of sending hidden data or secret messages over a public channel so that a third party cannot detect the presence of the secret messages. The goal of steganography is different from classical encryption, which seeks to conceal the content of secret messages; steganography

is about hiding the very existence of the secret messages.

The advantage of steganography over cryptography alone is that the intended secret message does

not attract attention to itself as an object of scrutiny. Plainly visible encrypted messages, no matter

how unbreakable they are, arouse interest and may in themselves be incriminating in countries in

which encryption is illegal. Whereas cryptography is the practice of protecting the contents of a

message alone, steganography is concerned with concealing the fact that a secret message is being

sent as well as concealing the contents of the message

Modern steganography is generally understood to deal with electronic media rather than physical objects. There have been numerous proposals for protocols to hide data in channels containing pictures, video, audio and even typeset text. This makes sense for a number of reasons. First of all, because the size of the information is generally quite small compared to the size of the data in which it must be hidden (the cover text), electronic media is much easier to manipulate in order to hide data and extract messages.

Extraction itself can be automated when the data is electronic, since computers can efficiently manipulate the data and execute the algorithms necessary to retrieve the messages.Electronic data also often includes redundant, unnecessary and unnoticed data spaces which can be manipulated in order to hide messages. Often times we use the idea of steg-keys to remedy unwanted discrepancies. The problem with these keys is that they are needed for the final extraction of the hidden message and they have to be communinated to the receiver of the message.

The main goal of this paper is to find a way so that an audio file can be used as a host media to hide textual message without affecting the file structure and content of the audio file. Because degradation in the perceptual quality of the cover object may leads to a noticeable change in the cover object which may leads to the failure of objective of steganography. For embedding data in digital media, two domains are generally considered, spatial domain and the transform domain. Though, there are many data hiding techniques, in this paper we consider the spatial domain of data hiding.

We discuss the various data hiding techniques using bit manipulation of the lowest significant bit (LSB). We take a look at how the bit planes can be increased by various number decomposition methods without compromising on the three requirements of visibility, robustness and capacity.

1.1 Problem Definition

The information hiding system is characterised by having three different aspects that contend with each other. These are capacity, imperceptibility, and robustness. It is our goal to design robust steganography technique which can hide more data with acceptable imperceptibility of stego media. We Generate more bit planes using bit plane decomposition by different number systems, which in turn will provide greater capacity that could be use to conceal more data without causing significant distortion, providing greater security against steganalysis programs.

1.2 Objective

It is our goal to design robust steganography technique which can hide more data with acceptable imperceptibility of stego media. The main objective is:

1. Embedding data in uncompressed audio files based on spatial domain.

2. Enhance the capacity by generating more number of bit planes using bit plane decomposition technique using various number systems.

3. Use double layer security using any extra files to carry key.

4. Enhance robustness by embedding encrypted data at multiple bit planes.

1.3 Tools and Platform

· Python 3.6.7 (Apple Inc. 4.2.1 build 5666)

· MacOS El Capitan

· Hard Disk : 256 TB

· RAM : 8 GB

· Wavepad Audio editor

1.4 Project Timeline

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Literature Survey

The simplest implementation of data hiding technique is the classical least significant bit data hiding technique [2]. The technique is based on manipulation of the least significant bits of the carrier image to accommodate the hidden message. The insertion of LSB varies according to the number of bits in an image. For an 8 bit image, the value of 8th bit, which is the least significant bit of each pixel, would be modified and the secret message would be embedded [3].Suppose if we wanted to insert the letter ‘A’ into an image. The binary equivalent of ‘A’ is 10000001. Now if our sample image of 8 bit has the following pixel values:

10101010 10001010 11111111 010110101

10101010 10101010 10001011 10101111

Battisti et al.[1] proposed a method of embedding data into digital media by decomposition of Fibonacci number sequence which allowed different bit plane decomposition when compared to the classical LSB scheme. The Fibonacci sequence, named after Leonardo of

Pisa, also known as Fibonacci, is a sequence of numbers in the following integer sequence:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 ... The bit planes are decomposed based on the Fibonacci sequence. The main drawback of this approach is that of redundancy and to counter that and obtain a unique representation, Zeckendorf theorem is used. To embed the intended message in the cover image, it is decomposed into bit planes by using Fibonacci decomposition. The Zeckendorf condition is checked for each bit to be modified. If the condition is fulfilled, the bit is inserted otherwise the bit following it is considered.

LSB data hiding using prime numbers is a data hiding technique proposed by Dey et.al [4] as improvement over the Fibonacci numbers data hitechnique proposed by Battisti et. al.[1] The main idethe work was to use the prime number decomposiand generate new set of bit planes and eminformation in these newly generated bit planes minimal distortion. In this approach, the researchers took an image obits and increased the number of bit planes twhere the value of n was equal or greater thaequal to the number of bit planes of the image. was achieved by converting the bit planes of image to another number system using pnumbers as the weighted function. This resulted inincrease of number of bits and consequently it cbe used for hiding data in higher bit planes minimal distortion. For decomposition, the weight function was defined as: P (0) = 1, P (i) = pi ∀ i ∈ Z+ , pi = ith Prime In case of any ambiguity, the lexicographically higher number is given preference.

The approach of LSB data hiding by natural numbers was proposed by Dey et.al.[5] In this approach, the researchers proposed data hiding by decomposition of a pixel value in sum of natural numbers. This resulted in generation of more bit planes than the Classical LSB data hiding, Fibonacci LSB data hiding and the Prime number data hiding . For decomposition, the weight function is defined as: W (i) = N (i) = i + 1, ∀ I ∈ Z+ ∪ {0} .The researchers used the same concept in case of ambiguity which gave higher precedence to lexicographically higher number. For embedding the data into the k‐bit image, a number n is chosen in a way such that all pixel values in the range of [0, 2k – 1] could be represented using first n numbers, which resulted in generation of n virtual bit planes .After finding the value of n, a k bit to n bit map is created and all valid representations in natural numbers system are marked. In case of any ambiguity, the lexicographically higher number is given preference.

[6] The paper discuss generation an entirely new set of bit planes and embed data bit in these bit planes, using decomposition techniques. For convenience of description, here, the LSB is called the 0 th bit, the second LSB is called the 1 st bit, and so on. The newly-generated set of bit-planes ’virtual’, since these bit-planes are not obtain in classical binary decomposition of technique. The embedding technique in classical LSB and Fibonacci decomposition technique with new modification. A generalized approach that follow novel data-hiding techniques using prime/natural number decomposition. The embedding technique using the prime decomposition. Experimental results obtained using this technique are reported. It is shown (both theoretically and experimentally) that the data-hiding technique using prime decomposition out performs the famous LSB data hiding technique using classical binary decomposition and that using Fibonacci p-sequence decomposition. Also, the technique using natural number decomposition out performs the one using prime decomposition, when thought with respect to embedding secret data bits at higherbit-planes (since number of virtual bit-planes generated also increases) with less detectable distortion.

[7] This paper proposed a substitutive steganographic technique that is performed in a novel domain based on the generalized (p, r) − Fibonacci sequence F p,r (n). Experimental results show the effectiveness of the proposed method and the improvement with respect to the classical LSB decomposition both for security and perceptual aspects.

[8]In this paper of embedding text-based data into a host audio file using the method of bit modification has been presented . A procedure has been developed in which the data field is edited to embed intended data into the audio file. To proceed with this, the header section of the audio has been checked perfectly because a minimal change in the header section may leads to a corruption of whole audio file. The main goal of this research work was embedding of text into audio as a case of steganography. The two primary criteria for successful steganography are that the stego signal resulting from embedding is perceptually indistinguishable from the host audio signal, and the embedded message is recovered correctly at the receiver. In test cases the text-based data has been successfully embedded to the audio file to visualize in what extent the target has been achieved. However future scope

appears end less.

[9]This paper discuss the idea of a number system using combination of catalan number and general fibonacci series that can generate more comprehensive bit planes.This paper shows using Catalan numbers is an improvement over the Fibonacci data hiding technique. In the classical LSB technique, it is possible to embed secret data only in the

first few bitplanes, since image quality becomes drastically distorted when embedding data in higher bitplanes. This method uses a bigger set of virtual bitplanes, increased number of stego bits that can be embedded. Besides, apart from the LSB method, in which the tracking of data is easy (if there is suspicion of course), the Fibonacci and Catalan methods provide a kind of encryption, via the way that they hide the bits in more bitplanes. Specifically, this method employs a larger number of bitplanes, offering not only more space for our stego data, but also greater security against steganalysis programs.

Concept and problem analysis

Design and Methodology.

The implementation of the used algorithms are done in a modular fashion. The codes for the proposed methods are quite similar barring few key differences. Modular methods of writing codes helps in the reusability of the codes making it simple and easy to use for further purposes.We have created three modules namely, Extraction module, embedding module, bit planes module.

| table representing all the used number system | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| prime | 1 | 2 | 3 | 5 | 7 | 11 | 13 | 17 | 19 | 23 | 29 | 31 | 37 | 41 | 43 |
| natural | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| fibo | 1 | 2 | 3 | 5 | 8 | 13 | 21 | 34 | 55 | 89 | 144 | 233 | 377 | 610 | 987 |
| fib(2) | 1 | 2 | 3 | 4 | 5 | 6 | 9 | 13 | 19 | 28 | 41 | 60 | 88 | 129 | 189 |
| fib(1,2) | 1 | 1 | 1 | 2 | 2 | 4 | 4 | 8 | 8 | 16 | 16 | 32 | 32 | 64 | 64 |
| catalan | 1 | 2 | 3 | 5 | 8 | 13 | 14 | 21 | 34 | 42 | 55 | 89 | 132 | 144 | 233 |

4.1 Implementation of bit planes module

Bit planes modules works as a storage module that provide with all the number systems that is used for proposed methods. It uses the following table.

References

[1.] F. Battisti, M. Carli, A. Neri, K. Egiaziarian, “A Generalized Fibonacci LSB Data Hiding Technique, 3rd International Conference on Computers and Devices for Communication (CODEC‐06), Institute of Radio Physics and Electronics, University of Calcutta, December 18‐20, 2006.

[2.] Chi‐Kwong Chan and L. M. Cheng, “Hiding data in images by simple LSB substitution,” Pattern Recognition, pp. 469–474, Mar. 2004.

[3.] Walter Bender, Daniel Gruhl, Norishighe Morimoto, and A. Lu, “Techniques for data hiding." I.B.M. Systems Journal, vol. 35, no. 3 & 4, pp. 313{336, 1996}.

[4.] Sandipan Dey, Ajith Abraham and Sugata Sanyal "An LSB Data Hiding Technique Using Prime Numbers", Third International Symposium on Information Assurance and Security, August 29‐31, 2007, Manchester, United Kingdom, IEEE Computer Society press, USA, ISBN 0‐7695‐2876‐7, pp. 101‐106, 2007.

[5.]Steganographic Techniques and their use in an Open Systems Environment‐Bret Dunbar, The Information Security Reading Room, SANS Institute 2002.

# [6.]Data Hiding Techniques Using Prime and Natural Numbers [Sandipan Dey](https://arxiv.org/search/cs?searchtype=author&query=Dey%252C+S),[Ajith Abraham](https://arxiv.org/search/cs?searchtype=author&query=Abraham%252C+A),[Bijoy Bandyopadhyay](https://arxiv.org/search/cs?searchtype=author&query=Bandyopadhyay%252C+B),[Sugata Sanyal](https://arxiv.org/search/cs?searchtype=author&query=Sanyal%252C+S), Journal of Digital Information Management, ISSN 0972-7272, Volume 6, No 3, pp. 463-485, 2008.

[7.]Substitutive steganography in the generalized Fibonacci domain,Mammi. E,Battisti, F, Carli. M, Neri. A, Egiazarian. K Proceedings of the SPIE, Volume 7245, id. 72450P (2009),02/2009

[8.]On Embedding of Text in Audio A Case of Steganography, Pramatha Nath Basu, Tanmay Bhowmik,2010 International Conference on Recent Trends in Information, Telecommunication and Computing

[9.]Data Hiding Techniques in Steganography Using Fibonacci and Catalan Numbers,Nikolaos Aroukatos, Kostas Manes, Stelios Zimeras, Fotis Georgiakodis, 2012 Ninth International Conference on Information Technology - New Generations