AN IMPROVED DIGITAL WATERMARKING ALGORITHM USING COMBINATION OF LEAST SIGNIFICANT BIT (LSB) AND INVERSE BIT

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FOR MY BELOVE MOTHER AND FATHER

For the love and support I received all the way in my studies.

To my mother for here sacrifices for bringing the happiness into my life.

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ABSTRACT

Software watermarking is one of the most important methods for protecting copyrights and authenticating ownership; which can be used to prevent software piracy. In order to provide high quality watermarked image, the watermarked image should be imperceptible. Least significant bit (LSB) is a technique that has been used for digital watermarking. Many researchers have improved LSB to embed watermark in the image. In this thesis, we introduce an improved digital watermarking algorithm using least significant bit (LSB). This method is chosen due to its minimal effect on the image. LSB is used by inversing the binary values of the watermark text and shifting the watermark according to the odd or even number of pixel coordinates of image before embedding the watermark. The proposed algorithm can be personalized according to the length of the watermark text. If the length of the watermark text is more than ((M*N)/8)-2 (where M*N is the amount of pixels in the image), the proposed algorithm will also embed the extra of the watermark text in the second LSB. We compare our proposed algorithm with the 1-LSB algorithm and Lee's algorithm and Yang's algorithm using Peak signal-to-noise ratio (PSNR). The value of the watermarked dock image is 54.5691 dB which is higher than the traditional LSB 53.6950 dB and Lee's algorithm 53.7041 db and Yang's algorithm 52.4518 dB. Also in the other image, the proposed algorithm got the highest value of PSNR. This improved algorithm improved its quality of the watermarked image. We also attack the watermarked image by using cropping and adding noise and we got good results as well.

ABSTRAK

Tera air perisian adalah salah satu kaedah yang paling penting untuk melindungi hak cipta dan mengesahkan pemilikan yang boleh digunakan untuk mencegah cetak rompak perisian. Untuk menyediakan imej tera air yang berkualiti tinggi, perubahan pada imej mestilah tidak dapat dikesan. *Least Significant Bit* (LSB) merupakan salah satu teknik yang telah digunakan dalam tera air digital. Ramai penyelidik telah menambahbaik teknik tera air LSB dalam imej. Di dalam tesis ini, kami memperkenalkan alkhawarizma tera air digital berasaskan LSB yang lebih baik. Kaedah ini dipilih kerana kesan yang minimum ke atas imej. Ia digunakan dengan meng-*inverse*-kan nilai perduaan teks tera air dan mengalihkan bit tera air mengikut bilangan ganjil atau genap koordinat piksel imej sebelum menerapkan tera air. Alkhawarizma yang dicadangkan boleh disesuaikan mengikut panjang teks tera air. Jika panjang teks tera air adalah lebih daripada ((M * N) / 8) -2 (di mana M * N adalah jumlah piksel pada imej), alkhawarizma yang dicadangkan akan memuatkan tambahan teks tera air ke dalam LSB kedua. Kami membandingkan alkhawarizma yang dicadangkan oleh kami dengan alkhawarizma 1-LSB, Lee dan Yang yang telah diukur menggunakan nisbah puncak isyarat-hingar (PSNR). Nilai PSNR imej tera air dock ialah 54,5691 dB dimana ia jelas lebih tinggi daripada alkhawarizma 1-LSB iaitu 53,6950 dB, juga lebih tinggi berbanding alkhawarizma Lee dan Yang (53,7041 dB dan 52,4518 dB). Bagi imej-imej yang lain, alkhawarizma kami mendapat nilai PSNR yang tertinggi. Dengan itu, jelaslah alkhawarizma kami adalah lebih baik dalam memperbaiki kualiti imej tera air. Malah, kami telah menyerang imej tera air kami dengan memotong-motong dan menambah bunyi bising tetapi kami tetap juga mendapat keputusan yang baik.

PUBLICATIONS

A fair amount of the material presented in this thesis has been published in various refereed conference proceeding and journal as stated below:

1 Abdullah Bamatraf, Rosziati Ibrahim and Mohd. Najib Mohd. Salleh. Digital watermarking algorithm using LSB. 2010 International Conference on Computer Applications & Industrial Electronics (ICCAIE 2010), 5-8 Dec. 2010, on pages: 155 – 159.

2 Abdullah Bamatraf, Rosziati Ibrahim and Mohd. Najib Mohd. Salleh. A New Digital Watermarking Algorithm Using Combination of Least Significant Bit (LSB) and Inverse Bit. Journal of computing, Volume 3, Issue 4, April 2011 (impact factor 0.21) Pages 177-184.

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ABBREVIATIONS

LSB	Least Significant Bit
DWT	Discrete Wavelet Transform
DCT	Discrete Cosine Transform
DFT	Discrete Fourier Transform
PSNR	Peak Signal-to-Noise Ratio
MSE	Mean Squared Error
HVS	Human Visibility System

CHAPTER 1

INTRODUCTION

1.1 Background Study

Privacy is the ability of an individual or group to make the information about the individual or the group secluded and thereby reveal the information selectively (Muftic**,** 2010**)**. Data privacy or data protection is the relationship between collection and dissemination of data, technology, public expectation about privacy and the legal issues (Ibrahim and Kuan, 2010). It has become increasingly important as more and more systems are connected to the internet (Ibrahim and Kuan, 2010).

Watermarking is a pattern of bits inserted into digital image, audio or video file that identifies the file's copyright information such as author and rights (Cramer, 2005). Thus, watermarking is an approach to make sure the data are protected. Watermarking is designed to be completely invisible. The actual bits representing the watermark must be scattered throughout the file in such a way that they cannot be identified and manipulated (Serrão, 1999). Thus, the watermark must be highly robust so that it can withstand normal changes to the file such as reductions from lossy compression algorithms (Gulati, 2003).

An algorithm is designed to embed watermark text in images using watermarking approach. The proposed algorithm inserts all the texts inputted in the images to protect the privacy of the watermark. The algorithm reads an image first. Text is needed to be typed in the system. Once the watermarking is done, user can send the watermarked image to other computer so that other user is able to read the watermark or the hidden

message in the image only if the same algorithm is used. Thus, the watermark can be protected without being revealed.

1.2 Motivation

In the last ten years, the usage of digital imaging has been increased rapidly. Digital images are now widely distributed on the Internet and via CDs. Digital imaging allows an unlimited number of copies of images to be easily distributed and/or forged. This presents problems if the copied images are copyrighted. The protection and enforcement of intellectual property rights has become an important issue in the digital world. Many approaches are available for protecting digital data; traditional methods include encryption, authentication and time stamping. The most popular approach is watermarking. Many researchers have proposed watermarking approaches and they try to find the best algorithm that can produce watermarked image with minimum distortion and has maximum performance. The Least significant bit was first used by Trikel et al. (1993). Then, Lee et al. (2008) modified LSB to decrease the distortion and increase the robustness by embedding randomly. The proposed algorithm modified LSB to get the minimum distortion and increase the robustness by redundancy.

In this research work, Least Significant Bit (LSB) technique was modified to get better results based on the distortion of the watermarked image. A maximum capacity of the watermark text to be embedded is determined. If the length of the watermark text is less than the maximum capacity, multiple copies of the watermarked image will be embedded into the cover image. If the watermark text is more than the maximum capacity of the first LSB, the watermarked image is embedded in the second LSB. We also proposed an improved LSB algorithm which will be compared to the traditional LSB (Kurah and McHughes, 1992) and Lee et al.'s algorithm (2008) and Yang et al.'s (2008) algorithm.

1.3 Objectives

The objectives of this research are to:

i) Design an improved algorithm based on LSB to embed watermark text inside images using watermarking approach.
ii) Develop a prototype based on the proposed algorithm in (i).
iii) Prove performance of the proposed algorithm by comparing it with other 3 previous algorithms (the traditional LSB (Kurah and McHughes, 1992), Lee et al. 2008 and Yang et al. 2008) by using PSNR value.
iv) Validate the robustness of the algorithm by using common attacking techniques namely cropping, adding salt and pepper noise and JPEG compression.

1.4 Scopes

This research only uses text as a watermark. The images that have been watermarked will be saved in BMP formats due to their higher resolution compared to other images formats. The BMP file format handles graphics files within the Microsoft Windows OS. BMP files are uncompressed, hence they are large. The advantage of using BMP files is the simplicity and wide acceptance of BMP files in Windows programs. Thus, this type of image is chosen to be used in our proposed algorithm.

The maximum capacity of the watermark text in the proposed algorithm is about a quarter of the cover image. As an example, if the size of the image is 262144 bytes, the maximum capacity of the proposed algorithm will be 65532 bytes.

1.5 Significance of Study

The significance of this study is to enable owners of images to input watermark texts to be stored in the images without affecting the quality of the image and to retrieve those watermark texts from the images. It is also important to have multiple copies of the watermark in the cover images to insure its robustness against common attacks.

1.6 Thesis Outline

The organisation of this thesis is as follows: Chapter 2 describes the fundamental concept of digital watermarking and reviews of the existing researches related to this research. Chapter 3 describes the proposed algorithm to embed watermarks in images and extract the watermarks back from the watermarked images. Chapter 4 describes the implementation of the proposed algorithm. The experimental result of the proposed algorithm and its performance comparison with existing model are discussed and analysed in details in Chapter 5. Finally, conclusion and future work are described in Chapter 6. The overviews of all chapters are listed below.

i. Chapter 2: Literature review

In chapter 2 which is literature review, digital watermarking will be discussed. The history of watermarking will be explained. Then, it will show the host signals which transfer the watermark. Digital image watermarking will be explained. Some techniques of digital image watermarking will be mentioned. Least significant bit (LSB) will be explained in details. Finally, the proposed algorithm will be compared with related techniques in digital image watermarking.

ii. Chapter 3: Methodology

In chapter 3 which is methodology, the flowchart of the proposed algorithm will be shown. The proposed algorithm will be explained in details. The proposed algorithm consists of two stages which are embedding and extracting. The algorithms and flowcharts of embedding and extracting will be shown.

iii. Chapter 4: Implementation

In chapter 4 which is the implementation of the proposed watermarking algorithm, the system and the algorithm will be explained in details. The processes of embedding and extracting will be explained with showing the windows of the system. Three types of attacks, which are cropping and adding salt and pepper noise and JPEG lossy compression, were implemented in this algorithm and they will be discussed in this chapter.

iv. Chapter 5: Results and discussion

In chapter 5 which is results and discussion, the experimental result will be discussed while embedding the watermark in the first LSB, second LSB, third LSB and forth LSB. It will also discuss the combination of the first, second, third and forth LSB. This chapter will make comparison between the proposed algorithm and other algorithms (Lee et al. 2008 and Yang et al. 2008 and Kurah and McHughes 1992).

v. Chapter 6: Conclusion

In chapter 6 which is conclusion, the contributions will be mentioned and every objective will be connected to what have been done in the research. The future work will be discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Watermarking is the process of embedding data such as logo or text in a host signal such as image or audio. The definition provided by Oxford English Dictionary for watermarking is “a distinguishing mark or device impressed in the substance of a sheet of paper during manufacture, usually barely noticeable except when the sheet is held against strong light” (Nagra et al., 2002).

There are a few techniques in digital watermarking used to imperceptibly convey information by embedding the watermark into the cover data (Katzenbeisser and Petitcolas, 2000). But, problem arises in establishing identity of owner of an object. To solve this problem, an identity is established by printing the name of the owner or logo on the objects. However, in the modern era where objects have been patented or the rights are reserved (copyright), more modern techniques are to establish the identity and leave the object untampered have come into picture (Mandhani, 2004).

According to Mandhani (2004), in contrast to printed watermarks, digital watermarking is a technique where bits of information are embedded in such a way that they are completely invisible. The problem with the traditional way of printing logos or names is that the logos or names may be easily tampered or duplicated. In digital watermarking, the actual bits are dispersed in the image in such a way that they cannot be identified and they show elasticity against attempts to remove the hidden data (Katzenbeisser and Petitcolas, 2000).

According to Al-Dharrab (2005), the motion of watermarking first appeared hundreds of years ago. It was used to mark information authenticity with various means. Watermarking technology has also been used in computer. Most of the work in computer watermarking technology is for embedding watermark into images, audio, and video files.

Since early 1990s, researches have been focussing on media research and digital image watermarking as an interesting protection measure (Nagra et al., 2002). Watermarking is preferred as a popular technique in hiding information by the researchers to enhance the security and the privacy in the organization. These measures have been implemented for many security purposes and applications. Zheng et al. (2007) stated the applications of watermarking techniques that can be used for copyright protection, content authentication, copy and usage control and content description.

2.2 History of Digital Watermarking

The first use of watermarks was by the papermakers in southern Europe during the renaissance period. Hence, the heretical religious sects were the first to embrace papermaking. However, it is possible that the images they created in their watermarks possessed religious symbolism (Smith, 2003).

An image containing a cross with circles at the points is believed to be the earliest watermark produced at Fabriano, Italy, considered the birth place of watermarking (Hartung and Kutter, 1999). Figure 2.1 shows the Cartiere Miliani paper mill. It is an image of an anvil, and the image is believed to be created as a watermark by the company (Smith, 2003).

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