AN IMPROVEMENT OF RGB COLOR IMAGE WATERMARKING TECHNIQUE USING ISB STREAM BIT AND HADAMARD MATRIX

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I cordially dedicate this thesis to the biggest treasures of my life, my parents, my brothers and my sisters who gave me their love and also for their endless support and encouragement.

To my God, Allah ʿazza wa jalla
Then to my beloved mother, wife, and parent in law

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ABSTRACT

In the past half century, the advancement of internet technology has been rapid and widespread. The innovation provides an efficient platform for human communication and other digital applications. Nowadays, everyone can easily access, copy, modify and distribute digital contents for personal or commercial gains. Therefore, a good copyright protection is required to discourage the illicit activities. On way is to watermark the assets by embedding an owner's identity which could later on be used for authentication. Thus far, many watermarking techniques have been proposed which focus on improving three standard measures, visual quality or imperceptibility, robustness and capacity. Although their performances are encouraging, there are still plenty of rooms for improvements. Thus, this study proposes a new watermarking technique using Least Significant Bit (LSB) insertion approach coupled with Hadamard matrix. The technique involves four main stages: Firstly, the cover image is decomposed into three separate channels, Red, Green and Blue. Secondly, the Blue channel is chosen and converted into an eight bit stream. Thirdly, the second least signification bit is selected from the bit stream for embedding. In order to increase the imperceptibility a Hadamard matrix is used to find the best pixels of the cover image for the embedding task. Experimental results on standard dataset have revealed that average PSNR value is greater than 58db, which indicates the watermarked image is visually identical to its original. However, the proposed technique suffers from Gaussian and Poisson noise attacks.

ABSTRAK

Dalam setengah abad yang lalu, kemajuan teknologi internet telah berkembang dengan pesat dan meluas. Inovasi ini menyediakan platform yang berkesan untuk komunikasi manusia dan aplikasi digital yang lain. Kini, semua orang boleh dengan mudah mengakses, menyalin, mengubahsuai dan mengedar kandungan digital untuk keuntungan peribadi atau komersial. Oleh itu, perlindungan hak cipta yang baik adalah diperlukan untuk mengekang aktiviti-aktiviti haram. Satu cara adalah mentera airkan asset tersebut dengan menerapkan identiti pemilik yang kemudiannya boleh digunakan untuk pengesahan. Sehingga kini, banyak teknik tera air telah dicadangkan yang memberi tumpuan kepada peningkatan tiga ukuran piawai iaitu kualiti visual atau imperceptibility, keteguhan dan keupayaan. Walaupun pencapaian mereka adalah menggalakkan, masih terdapat banyak ruang yang perlu diperbaiki. Oleh itu, kajian ini mencadangkan teknik tera air baru menggunakan pendekatan kemasukan Bit Ketara Terkecil (LSB) yang digabung dengan Hadamard matriks. Teknik ini melibatkan empat peringkat utama: Pertama, imej penutup dihuraikan kepada tiga saluran berasingan iaitu Merah, Hijau dan Biru. Kedua, saluran Biru dipilih dan ditukar menjadi aliran lapan bit. Ketiga, bit ketara kedua terkecil dipilih dari aliran bit tersebut untuk pembenaman. Dalam usaha untuk meningkatkan imperceptibility, matriks Hadamard digunakan untuk mencari piksel terbaik daripada imej penutup untuk tugas pembenaman. Keputusan eksperimen keatas dataset piawai mendedahkan bahawa purata nilai PSNR adalah lebih besar daripada 58db, yang menunjukkan bahawa imej tera air adalah seiras dengan imej asalnya dari segi visual. Walau bagaimanapun, teknik yang dicadangkan kecundang apabila berhadapan dengan serangan hingar Gaussian dan Poisson.

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BMP	Bitmap Image
DB	Decibel
DCT	Discrete Cosine Transform
DFT	Discrete Fourier Transform
DWT	Discrete Wavelet Transform
H	Hadamard Matrix
HVS	Human Visual System
ISB	Intermediate Significant Bit
ISBN	International Standard Book Number
ISRC	International Standard Recording Code
LSB	List Significant Bit
MSB	Most Significant Bit
MSS	Mean Square Strength
NCC	Norma Cross Correlation
PSNR	Peak Signal to Noise Ratio
RGB	Read Green Blue
S	Secret Data

CHAPTER 1

INTRODUCTION

1.1 Overview

The past half century has seen rapid and widespread change in digital technology. Digital image, as one of the new digital technologies, has replaced analogue photography. The Internet has also become one of the most important tools for digital images worldwide. For this reason, the security of electronic documents has become a complex concern and digital image watermarking is a solution used to reduce the number of forged digital documents (Langelaar, 2000; Kumar, 2011).

It is well known that electronic publishing offers many advantages, but there are some risks, such as the illegal use of electronic information resources protected by copyright and modifying data. Some protective solutions including authentication, integrity, confidentiality and copyright protection are necessary to avoid plagiarism issues. To find the real owner of digital data, such as images or video, digital watermarking methods are adequate. Loading and managing protected text, and then using it without supervision, is very easy for other people, so that copyright management is very important. Large amounts of money have been spent by publishers and booksellers to avoid copyright problems. Now the question has become a very important international issue.

Digital watermarking has been presented as a practical solution for identifying the documents owner, and has been applied for a variety of purposes including: copyright protection, data authentication, fingerprint, medical applications, and broadcast monitoring. Furthermore, documents can be divided into two main groups, analog and digital. Obviously, protecting data against digital documents is more difficult due to the rapid development of networks, computers, and the Internet. In other words, digital documents can easily be saved and edited on computers compared to analog documents.

There are two general approaches to watermark extraction. The first is blind watermarking and the second is non-blind watermarking (Hyeong *et al.,* 2010). In blind watermarking there is no need to have the original document, while in a non-blind extraction we need to have the original document to detect the watermark. In addition, the watermark can be visible or invisible in both digital and analog documents. For example, a visible watermark can be a signature in an image that is used to point out the owner of the image; meanwhile an invisible watermark is not easily apparent. The embedded watermark can be extracted using an extraction algorithm to identify the copyright owner (Song *et al*., 2011).

There are many classes of invisible watermarks for different applications such as fragile watermarks and robust watermarks. Fragile watermarks are designed to be easily broken by image processing operations.

Existing digital watermarking methods can be attributed to one of the two areas, including the spatial and frequency based on the contents of the receiving domain image. Many studies have been proposed based on the frequency and spatial domains. For example, digital image watermarking using LSB (Least Significant Bit), MSB (Most Significant Bit) and ISB (Intermediate Significant Bit) are three common methods used to achieve reliability and quality, at the same time, in the spatial domain (Nasir *et al.*, 2007).

Withholding of information refers to a pair of broad terms relating to image processing fields, which are steganography and watermarking. Hiding information applies to unobservable information (watermarks) and sensitive information (steganography), both fields trying to solve a wide range of tasks in time in the content of message attachments.

Conceptually, watermarking and steganography are related to each other, but at the same time they have different characteristics, requirements, and designs, which have led both of them to create and produce a variety of technical solutions. Digital watermarks can be defined as a code that will remain close to the visible or invisible data, and is inside the data before and after any process, such as decoding, but conventional cryptographic methods do not provide this. For the protection of intellectual property, digital watermarking is useful and is important in terms of invisible momentum (Mohananthini and Yamuna, 2012).

1.2 Problem Background

There are many images on the worldwide web which do not possess watermarks and as a result, they can be downloaded and modified illegally by anyone. Additionally, the rightful owner of the image cannot be identified and authenticated without watermarking (Al-Hunaity *et al*., 2007). As a result, watermarking is used to safeguard against these illegal acts through the addition of a watermark image into the host image.

Aside from its use in images, watermarking can use also be used for other documents of vital importance such as text, audio and video. In general, some concerns regarding this area of research need to be resolved, including robustness, security as well as imperceptibility.

A major issue regarding digital image watermarking is imperceptibility (Cox *et al*., 1997); this involves the insertion of a watermark into the cover image without causing any degradation. This requires that the watermarked image and host image be indistinguishable after the watermark is embedded. This means that the watermarked image as well as the original image must be so similar that they cannot be distinguished using the naked eye. Actually, the embedded watermark is said to be indiscernible if human eyes cannot differentiate between the original image and the watermarked image (Giakoumaki *et al*., 2006).

Another important issue regarding digital watermarking is robustness (Podilchuk and Zeng, 1998); this requires that the watermarking scheme be stable. It also involves signal processing attacks such as noise addition, sharpening, blurring among others. Robustness is linked to the ability to retrieve the watermark after putting the watermarked image through varied processing attacks. Thus, an image must possess adequate robustness in the event of the occurrence of any kind of attack (Hernández and Pérez-González, 1999).

The watermarking scheme employed should possess the ability to safeguard the watermark against potential signal processing operations, while simultaneously assessing the condition of the watermark after the occurrence of an unwanted incident (Cox *et al*., 1997). The last issue of importance with regards to digital watermarking is security (Barni *et al*., 2003); this refers to the protection of the watermark against users who are not permitted. In this regard, the digital watermark should be entirely undetectable.

As a result of the application of algorithms for the insertion of watermarks within the cover image as well as for their proper extraction, a secret key needs to be utilized to insure the integrity of the algorithms. Without this application, illicit users would have no trouble modifying, detecting or removing the watermark from the host image. Furthermore, based on the fact that human eyes possess various sensitivities for diverse image regions, a watermark ought to be implanted within the most important component of the host image (Macq *et al*., 2004).

While processing the watermark, it is of vital importance to locate the optimal region within the image for the insertion of the watermark. As indicated by (Hsieh, *et al*., 2001), robustness and imperceptibility are the two major factors in watermarking that endeavor to modify along with the volume of information which can be inserted within the host. Although the spatial domain is not robust in defense of attacks like compression and image manipulations such as cropping, re-sampling or format conversions, it is easy and uncomplicated to utilize as no transform is used. Nevertheless, each of the two methods possesses its own advantages. A benefit of the spatial domain method is that it is simple to apply to any image. Another benefit of spatial watermarking is that it provides a means of connectivity between robustness and quality in the watermarked images. Two essential factors with regards to spatial watermarking are informed within the watermark as well as the area where the watermark can be embedded within the host image (Macq *et al*., 2004).

A large number of studies (Bamatraf *et al*., 2011; Chopra *et al*., 2012; Luo *et al*., 2010; Kaur and Kaur, 2013; Thien and Lin, 2003; Wu and Tsai, 2003; Zhang and Wang, 2005) employed the spatial domain technique within their research.

1.3 Problem Statement

Due to the importance of watermarking in information technology, extensive research has been carried out in this field, both in the spatial domain and transforms domain technique. Although the spatial domain technique was the earlier of the two to receive attention, research on it is still far from complete. The spatial technique inserts the watermark in the underused intermediate significant bit of the image, thus allowing a watermark to be in an image without largely affecting the value of the image (Nikolaidis and Pitas, 1999).

The advantage of using this technique are that it is very simple, fast, efficient, and provides high capacity, and the quality of the watermarked image can be more easily controlled (Wu and Huang, 2007). On the other hand, the spatial domain technique has some disadvantages. One of them is that it is not robust against attack (Barreto *et al*., 2002; Li and Yang, 2007; Venkatraman et *al*., 2004), while others are that the security they provide is easy to bypass and the inability to loss compress the image without damaging the watermark (Wu and Tsai, 2003; Kao *et al*., 2008).

1.4 Research Questions

i) How can a watermark image be embedded in the host image without causing visible degradation?
ii) How can improve robustness of extracted watermark?
iii) How can a technique be developed to reach the level of robustness?

1.5 Research Aim

The purpose of this research is to propose a procedure for a color image watermarking scheme via ISB intermediate significant bits and a Hadamard matrix for the insertion of a watermark image within host image. The watermarking method put forward aims to attain and enhance the robustness and imperceptibility of color watermarked image, thus enabling the image to hold up against attack.

1.6 Research Objectives

The aims and objectives of this research include the following:

i) To improve the PSNR value by using ISB (Intermediate Significant Bit) and Blue channel for embedding.
ii) To improve the robustness of extracted watermark logo by duplicated of the hidden data through Hadamard matrix.
iii) To propose a Hadamard matrix to be used as a mask to select target pixels for embedding watermark pixels inside it.

1.7 Research Scope

The color image arrangement of the pixels includes three colors (blue, red and green). It therefore follows that each pixel contains 24 bits (for 8-bit representation) where 8-bits component for red, green and 8-bits for the blue component in pixels. The suggested method use blue channel to conceal information.

To start with, the components of the color pixels have to be taken apart, resulting in three separate M x N matrices, one for each color component, where the size of the original image is M x N. Presently, the use of various pixel value methods for encapsulating data in the matrix is done in the blue channel. The program is constructed on a Windows environment with Delphi 5.0 and Matlab R 2011 a.

i) By means of the spatial domain technique, the intermediate significant bits ISB of an image pixel.
ii) The project focuses on 256x256 RGB images of the host image and binary UTM logo binary image size (64x64) bit BMP format as a watermark. The format of the host image is also (bmp).
iii) Attacks like Poisson noise, salt and pepper and Gaussian filter noise will also be used on the watermarked text document image in order to assess the quality and robustness of the suggested watermarking method.
iv) Hadamard matrix used as a method of implanting watermark image.
v) The approach is using non-blind watermarking in spatial domain by applying ISB.

1.8 Research Framework

The Figure 1.1 explains the framework of the research and explains all watermarking stages include embedding extracting and evaluation the both PSNR and NCC value. Section 3.3, 3.4 and 3.5 explain each stage of the framework in details.

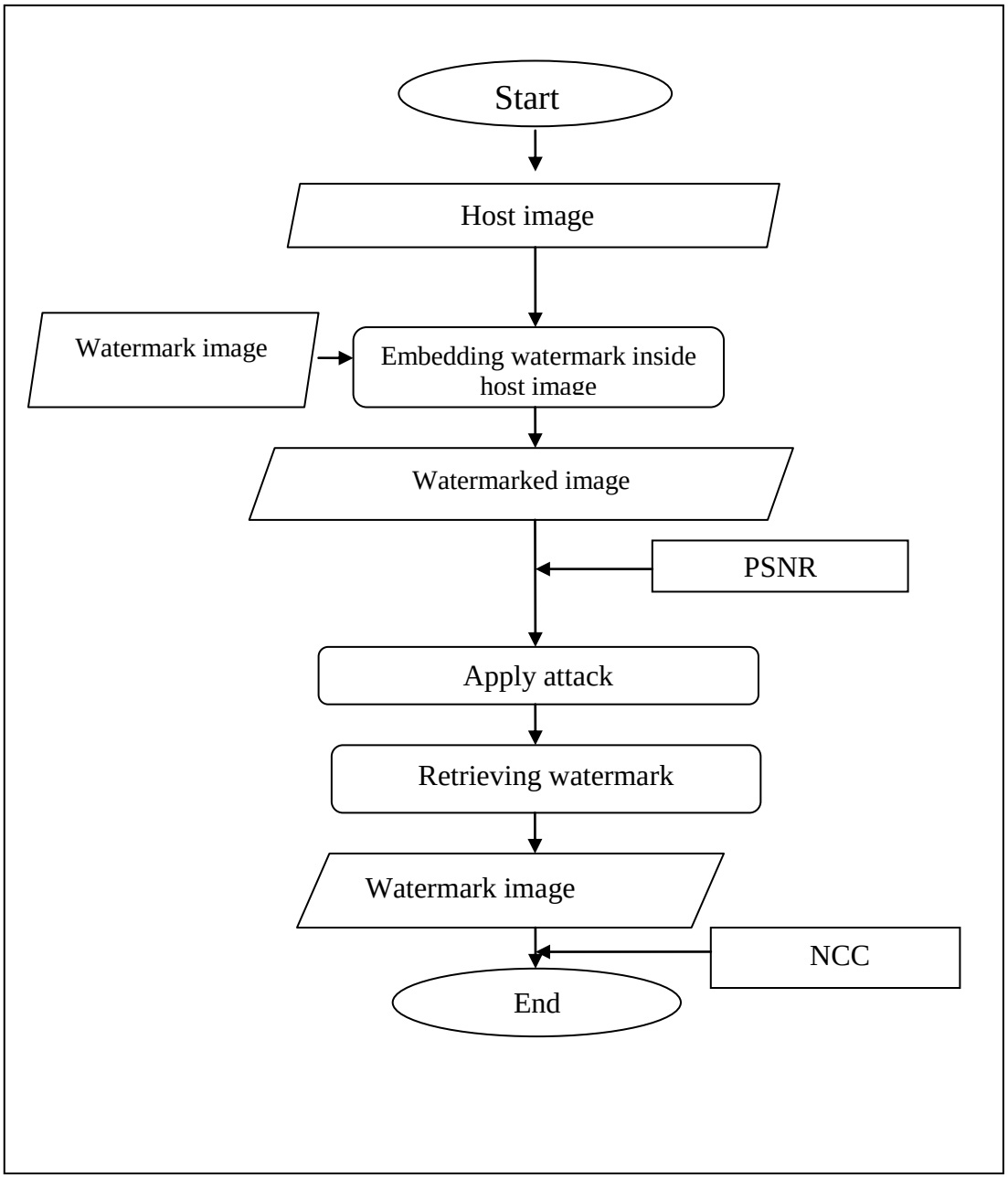

Figure 1.1: The Framework of the Proposed Method.

1.9 Thesis organization

The structure of the dissertation is: In the first chapter the research is first presented and this encompasses the problem statements, aim of the study as well as problem background. The following chapter gives a preamble as well as a standard summary regarding digital watermarking, watermarking techniques as well as the basic principles of digital watermarking. Chapter three provides a concise depiction of ISB; this chapter also outlines an explanation of the projected technique methodology. Chapter four discusses the outcomes of the methodology as outlined earlier in chapter three. Lastly general deductions of the thesis as well as proposals for areas where further research may be carried out in the future are discussed in the final chapter.

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