IMPROVED IMPLEMENTATION OF DIGITAL WATERMARKING TECHNIQUES

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Dedicated to my family.

Thank you for your perseverance

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Praise be to God, who sent his messenger with guidance and the religion of truth to proclaim it over all religions, and make it a good example for those who had hope for Allah, then praise be to God Almighty whom through his will and his grace that supported the completion of this work.

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ABSTRACT

With the advancement of high speed computer networks, multimedia storage and transmission technology, anenormous amount of information is being communicated in digital form. There is a constant threat to copyright, ownership and integrity of digital data. Therefore information security has become an emerging area of research. Security of images is an area of major concern as digital images are available all over World Wide Web. Numerous watermarking techniques have been developed to protect images from illegal manipulations. In this project, spatial domain and transform domain have been proposed. Histogram shifting falls under the spatial domain method and spread spectrum falls under transform domain method. For the proposed Histogram Shifting, modification of the histogram and shifting is applied for embedding the stage, add to that our contribution in this method incorporated the threshold concept to improve the visual quality of the host image. In the proposed Spread Spectrum, a chaos-based spread spectrum watermarking algorithm is developed in the DCT domain for still image. The most significant feature of chaos is its sensitivity to initial conditions. This characteristic of chaos has been used successfully for secure watermarking applications. Local properties of the image and the features of the human visual system are considered in order to optimize the watermark strength in addition to the incorporated luminance masking effect of the HVS in the masking image, since the human eye is less sensitive to change in regions with high brightness as well as in very dark regions in comparison to mid-grey regions, where the distortion is most noticeable. The contribution only uses luminance masking for enhancing the visual quality of images in the embedding stage instead of using a combination of different masks and that leads to less complexity. The performance of the proposed watermarking schemes have been evaluated by using the watermarked images of size 512×512, and the watermark (payload) is of the same size as the host image in the spread spectrum with a different amount of variables "random bit streams" used in the histogram sniffing. The simulations are performed in MATLAB 7 software environment. The PSNR metric and SSIM with GMSD are applied to measure the degradation of the images. A comparison is made between the results of the proposed algorithms with each other and also compared with the best method namely Bit Plane Mapping and demonstrates that the proposed methods are superior in performance and especially the proposed Spread Spectrum.

ABSTRAK

Dengan kemajuan rangkaian komputer berkelajuan tinggi, storan multimedia dan teknologi transmisi, sangat banyak maklumat dikomunikasikan dalam bentuk digital. Terdapat satu ancaman berterusan kepada hak cipta, hak milik dan integriti data digital. Oleh itu keselamatan maklumat telah menjadi sesuatu penyelidikan yang baru muncul. Keselamatan imej adalah sesuatu bidang yang menjadi kebimbangan utama kerana imej digital boleh didapati di seluruh Jaringan Sejagat (World Wide Web). Banyak teknik tera air telah dibangunkan untuk melindungi imej dari manipulasi haram. Dalam projek ini , domain spatial dan pengubahan domain telah dicadangkan. Peralihan Histogram berada di bawah kaedah domain ruang dan spektrum penyebaran berada di bawah kaedah pengubahan domain. Untuk Peralihan Histogram yang dicadangkan itu, pengubahsuaian histogram dan peralihan digunakan untuk membenamkan pentas, disamping sokongan tambahan dengan sumbangan kami dalam kaedah ini digabungkan dengan konsep ambang untuk meningkatkan kualiti visual imej perumah. Dalam Serakan Spektrum yang dicadangkan itu, spektrum penyebaran algoritma berasaskan huru-hara – tera air dibangunkan dalam domain DCT untuk imej pegun. Ciri yang paling ketara daripada algoritma huru-hara adalah kepekaannya terhadap keadaan awal. Ciri huru-hara Ini telah digunakan dengan jayanya untuk aplikasi tera air yang selamat. Ciri-ciri imej tempatan dan ciri-ciri sistem visual manusia dipertimbangkan untuk mengoptimumkan kekuatan tera air sebagai tambahan kepada kesan pelitupan luminans HVS yang diperbadankan dalam pelitupan imej, kerana mata manusia adalah kurang sensitif terhadap perubahan di kawasan-kawasan dengan kecerahan tinggi dan juga di kawasan-kawasan yang sangat gelap berbanding dengan kawasan-kawasan separa kelabu, yang mana kesan herotan adalah yang paling ketara. Sumbangan ini hanya menggunakan pelitupan luminans untuk meningkatkan kualiti visual imej dalam peringkat pembenaman dan bukan menggunakan gabungan litupan-litupan yang berbeza dan yang membawa kepada kurang kerumitan. Prestasi skema tera air yang dicadangkan telah dinilai dengan menggunakan imej tera air bersaiz 512 × 512, dan tera air (muatan) adalah saiz yang sama dengan imej perumah dalam spektrum penyebaran dengan jumlah yang berbeza pembolehubah "sedikit rawak aliran" yang digunakan dalam penghiduan histogram. Simulasi dilakukan dalam persekitaran perisian MATLAB 7. Metrik PSNR dan SSIM dengan GMSD digunakan untuk mengukur penguraian imej. Perbandingan dibuat antara keputusan algoritma yang dicadangkan antara satu sama lain dan juga berbanding dengan kaedah terbaik iaitu Pemetaan Satah Bit dan menunjukkan bahawa kaedah yang dicadangkan adalah berprestasi unggul terutama Serakan Spektrum yang dicadangkan.

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LIST OF ABBREVIATIONS

DCT	-	Discrete Cosine Transform
DWT	-	Discrete wavelet transform
GMSD	-	Gradient Magnitude Similarity Deviation
HSW	-	Histogram Shifting watermarking
HVS	-	Human Visual Quality
JPEG	-	Joint Photographic Experts Group
LSB	-	Least Scientific Bit
PoO	-	Probability of Occurrence
PSNR	-	Peak Signal to Noise Ratio
QOS	-	Quality Of service
SME	-	Mean Squared Error
SNR	-	Signal to Noise Ratio
SSIM	-	Structural Similarity
T	-	Threshold

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CHAPTER 1

INTRODUCTION

1.1 Overview on Data Embedding

Digital revolution is a nowadays milestone, in which digital data almost covers our lifestyle completely. Such a revolution is a consequence of the advances in the technology of capturing devices, which become available at affordable prices and better efficiency. Hence, huge amount of digital data are taken, stored and exchanged every moment for luxury, education, commercial, security and many other purposes that impacts directly all sides of human life. Sharing these large amounts of digital data (or data for short) is becoming even more easy thanks to the advances in speedy communication networks that allow transferring these data at a low cost with more reliability.

Although that revolution increases the quality performance of our life, the continuous production of data requires a proper management for many purposes. Copyright protection and ownership documentation come at the top of these purposes. Data classification/description is another requirement for efficient data indexing. Obscuring meta-data for covert communication is highly demanded. Embedding medical reports along with the medical images for reliable archiving

becomes more desirable in hospitals. Integrating properly different data of a same object in huge databases is of high necessity for better Quality of Service (QoS). On the other hand, as data are increasingly generated in multimedia formats, correlating and synchronizing these data (such as images, audio and/or textual subtitles in video streams) comes under highly demanded sector of data management. Generally, the more data are generated, the more management is required.

Hence, it is significant developing reliable data management techniques that achieve the aforementioned purposes. The existing techniques achieve such management using *data embedding* (or *data hiding* [1]).

Table 1.1: The number of publications in data embedding area in duration from 1992 to 1998 [3].

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Publications	2	2	4	13	29	64	103

Data embedding includes embedding external data into a host for management purpose(s). The external data presents the management data, which are embedded obscurely into the host. The embedding of data is an ad-hoc process, in which the requirement(s) of application of data in question is considered while achieving the embedding [2]. The ad-hoc nature of data embedding leads to developing sub-research areas (or branches) under general data embedding area.

Data embedding can be considered as a newly developed branch in computer engineering. In Table 1.1, it is shown that the contribution in this branch started in 1992, with two papers only, followed by two papers in 1993. But the number of

publications increased significantly after holding the first conference on data embedding in 1995 [3].

The interest of scientific community in data embedding was increased along with the recent development of memory, processing and communication technologies, which emphasize the need to overcome the illegal duplication of data, such as music, video and even electronic documents, by accommodating copyright data into data in question.

Even though, steganography (science of hiding data into a host for covert communication) is a branch of data embedding, in which some literatures indicate that an early interest steganography was recorded in 15^{th} century, where a method about hiding data into music scores was proposed at then [4].

1.2 Problem Statement

The visual quality of images is distorted differently by watermarking methods. In some images, such distortion affects significantly the quality of the watermarked image; and consequently the application of the watermarking methods is limited practically.

Hence, the following problems that will be overcome in this project:

1. The visual quality of a watermarked image is distorted. Such distortion should be measured and evaluated objectively.

2. The set of possible factors that affect the degree of distortion in watermarked images (such as embedding capacity or selected bit-plane of watermark insertion) should be analyzed from the performance of watermarking methods. This analysis is significant in order to re-design the watermarking methods of less visual quality distortion.

1.3 Objectives of Thesis

The set of objectives of this project are summarized as follows:

1. To improve the digital watermarking method in the spatial domain namely, Histogram Shifting.
2. To improve the digital watermarking method in the frequency domain namely, Spread Spectrum.
3. To study the efficiency of SSIM, PSNR in Histogram Shifting and PSNR,GMSD in Spread Spectrum for evaluating the visual quality performance for the both methods.

1.4 The scope of the work

In this project, the affect of embedding a watermark on the visual quality of an image is studied. This affect is studied on invisible watermark, which is classified under robust kind. A blind watermarking method is used to evaluate the visual quality.

The spatial-domain based watermarking method is considered, namely, those that are based on Histogram Shifting and another method done in the transform domain namely Spread Spectrum. In Figure 1.1, the detailed scope is illustrated.

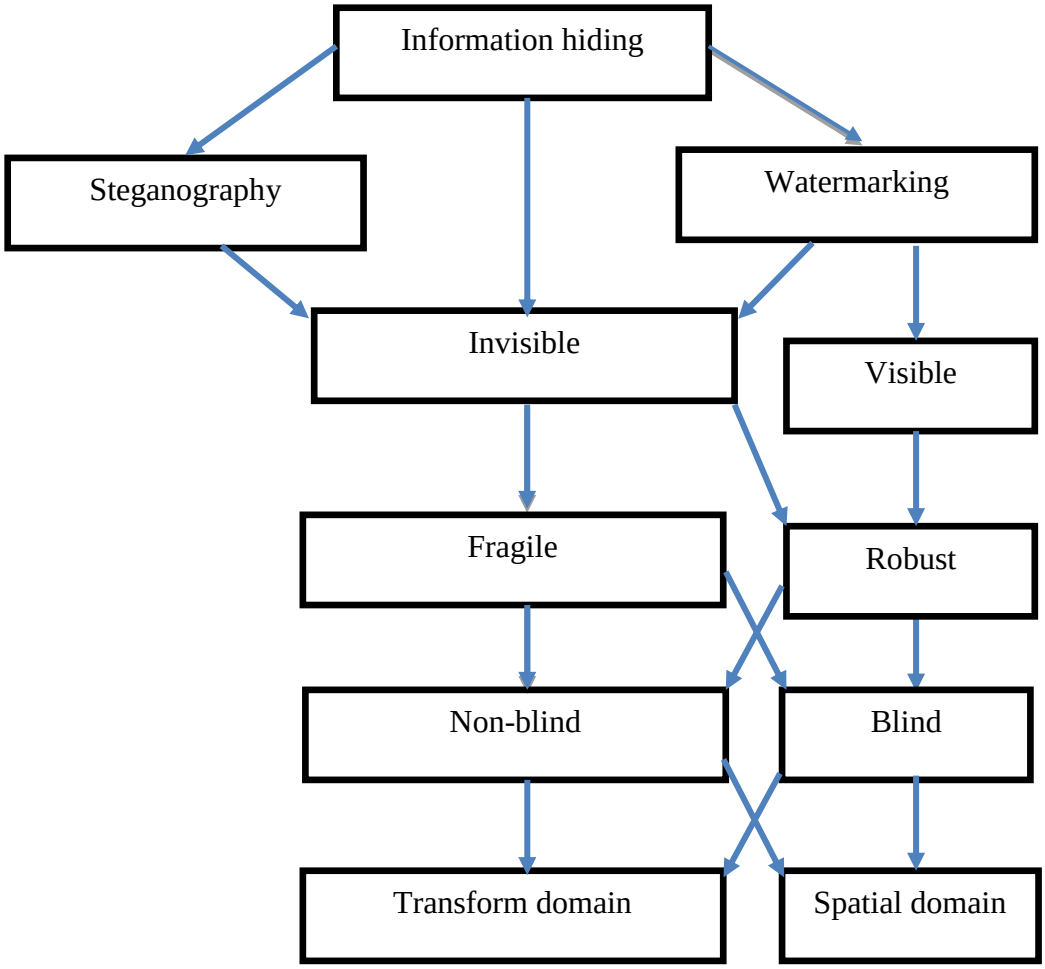

Figure 1.1 The detailed scope of the project.

1.5 Organization of the Thesis

Chapter One: present overview details about the Watermarking and problem statement that we are going to solve it and the objectives for this research.

Chapter Two: The watermarking aspects had been discussed. Starting with the General Framework of Data Embedding and watermark schemes, requirements to fulfill when achieved it and watermark system model, Mathematic Description of Watermarking Scheme, Watermarking and theory of communication.

Chapter Three: literature survey of two methods in details, some of relevant. Literatures were surveyed (up- to 56 references), which covers most of the essential aspects of watermarking and data embedding area. This includes the methods that are intended to be applied and evaluated according the objectives of the project. The literature survey defines some problems that our project aims at overcome them.

Chapter Four: Include project methodology and design whole methodology in general, in addition start to design the algorithms of two methods (Histogram Shifting, Spread Spectrum), as result, we designed algorithms based on literature survey (embedding and extracting)for each method in order to improve and achieve the aim of the research.

Chapter Five: Result and analysis have been given in proper way and discussed in details.

Chapter Six: The conclusion and the future work have been done.

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