RGB COLOR IMAGE WATERMARKING USING DISCRETE WAVELET TRANSFORM DWT TECHNIQUE AND 4-BITS PLAN BY HISTOGRAM STRETCHING

KARRAR ABDUL AMEER KADHIM

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Universiti Teknologi Malaysia

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This dissertation is dedicated to my beloved parents, fiancée, brothers, sister and my friends.

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ABSTRACT

Recently, access to multimedia data has become much easier due to rapid growth of the internet; everyone could access these data, and use them for personal or commercial purposes, for these reason copy right problems appeared. Digital watermarking techniques are used to protect the copyrights of multimedia data by embedding secret information in the host media, for example, embedding in images, audios, or videos. Many watermarking techniques have been proposed in the literature to solve the copyright violation problems, but most of these techniques failed to satisfy both imperceptibility and robustness requirements. In this thesis, adaptive color image watermarking technique is proposed. The proposed technique involves two main stages, which are, embedding, and extraction. Before embedding stage, a host image is converted from RGB to YCbCr color space to preserve imperceptibility and robustness, then, Cb component is extracted and partitioned into four quadrants. In the embedding stage select Cb component to apply DWT to decompose the cover image to four frequencies which are LL, HL, LH and HH, then selected the LH2 band to embedding the watermark image, while watermark image will convert to 4-bits plane to compress the image to ensure the capacity. In the extracting stage, DWT is used again to decompose the selected quadrant of watermarked image, and finally the watermark image is extracted. To prove the efficiency of proposed technique, six types of attacks are applied on watermarked image namely, Gaussian noise, Salt & Pepper Noise, Sharpening filter, Median filter, Rotation, and JPEG Compression. The experiments results have shown that the proposed technique successfully withstood against all the mentioned attacks, and at the same time preserved the watermarked image quality.

ABSTRAK

Baru-baru ini, capaian kepada data multimedia telah menjadi lebih mudah disebabkan oleh pertumbuhan pesat internet. Semua orang boleh mendapatkan data-data ini, dan menggunakannya untuk tujuan peribadi atau komersial, atas sebab inilah masalah hak cipta muncul. Teknik *"Watermarking"* digunakan untuk melindungi hak cipta data multimedia dengan memasukkan maklumat rahsia dalam media hos. Sebagai contoh, memasukkan maklumat rahsia dalam imej, audio, atau video. Pelbagai teknik penandaan air yang telah dicadangkan dalam literasi untuk menyelesaikan masalah pelanggaran hak cipta tetapi kebanyakan teknik ini gagal memenuhi keperluan ketidak boleh nampakan dan kekukuhan. Dalam tesis ini, teknik penyesuaian imej warna tera air telah dicadangkan. Teknik melibatkan dua peringkat utama iaitu pembenaman dan pengekstrakan. Sebelum peringkat pembenaman, imej hos ditukar dari RGB ke ruang warna YCbCr untuk mengekalkan ketidak bolehnampakan dan kekukuhan. Kemudian, komponen Cb diekstrak dan dibahagikan kepada empat kuadran. Pada peringkat pembenaman, komponen Cb dipilih untuk digunakan DWT bagi menguraikan imej penutup kepada empat frekuensi iaitu LL, HL, LH dan HH. Seterusnya, jalur HH dipilih untuk membenamkan imej tera air, sementara imej tera air akan menukarkan/ditukarkan ke 4-bit satah untuk memampatkan imej bagi memastikan kapasiti. Pada peringkat pengekstrakan, DWT digunakan semula untuk menguraikan kuadran imej tera air terpilih. Akhirnya, imej tera air diekstrak. Untuk membuktikan keberkesanan teknik yang dicadangkan, enam jenis serangan digunakan pada imej tera air iaitu gangguan Gaussian, gangguan Salt & Pepper, penajaman penapis, penapis Median, Putaran, dan mampatan JPEG. Keputusan eksperimen menunjukkan teknik yang dicadangkan berjaya bertahan dengan semua gangguan, dan pada masa yang sama mengekalkan kualiti imej tera air. Hasil eksperimen membuktikan bahawa teknik yang dicdangkan berjana mengatasi semua gangguan tersebut dan pada masa yang sama mengek alkan kualiti imej yang di *"watermark"*.

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LIST OF ABBREVIATIONS

DWT	Discrete Wavelet Transform
DCT	Discrete Cosine Transform
ECC	Error Correction Codes
LSB	Last Significant Bit
RGB	Red Green Blue
PSNR	Peak Signal Noise Ratio
MSE	Mean Square Error
DFT	Discrete Fourier Transform
SRLE	Sliding Run Length Encoding
CF	Compression Factor
HVS	Human Visual System
NCC	Normalized Cross-Correlation

CHAPTER 1

INTRODUCTION

1.1 Introduction

There is no doubt that using the Internet has become ubiquitous in the 21st century and it is quite true that everyone feels it is an indispensable part for the future of business communication. Going by the systematic digital data attainment and the way it can be easily transmitted, duplicated and modified. The copyright protection of the intellectual property of the sensitive or critical digital information is an important legal issue globally. According to Tsai et. al., (2000) and Wu, C. W. (2002) recently highlighted that, through analyzing the trend of studies in digital watermark for audio, image or video data; it can be seen that watermark techniques provide the essential mechanism for ownership authentication.

Using the Internet as a global communication or data tool, different multimedia data classes have grown to be easily attacked. This is because everybody can download these data from different sources and modify them without been authorized to do so legally. The many copyright problems have lately become so common (Dharwadkar, N. V. & Amberker, B.B., 2010). The digital watermarking which was produced like a tool is essentially to safeguard multimedia data from copyright violations or just being incorrectly used again (Cox, et al,. 2008). Digital watermarking techniques are utilized to safeguard the copyrights of multimedia data by embedding secret information within the host media, for instance, text images, video and audio. There are two watermarking methods which are suggested. The first

thing is as simple as adding an obvious watermark which may be clearly seen in the cover image. The second thing is by embedding a concealed watermark inside the host image.

Watermarking algorithms can be classified based on the domain used for watermark embedding. Studies have shown that two popular techniques; spatial and transform watermarking techniques exist. Spatial domain watermarking techniques are useful for higher data embedding applications. Transform domain watermarking techniques are suitable in applications where robustness is of prime concern. These techniques as proposed include, Discrete Cosine Transform (Chandramouli et al., 2001); Discrete Fourier Transform (Premaratne, P., 1999); Discrete Wavelet Transform (Kundur, D. and Hatzinakos, D.,1998); Discrete Hadamard Transform (Anthony, T.S.; Shen, J.; Tan, S.H. and Kot, A.C., 2002); Contourlet Transform (Jayalakshmi, M. ; Merchant, S.N. and Desai, U.B.,2006); and Singular Value Decomposition (Mohan , B.C. and Kumar, S.S.,2008) are some of the useful transformations for image processing applications.

With the introduction of the JPEG2000 standard digital image, watermarking schemes that are derived from Discrete Wavelet Transform (DWT) are becoming a robust area attracting lots of attention. Nearly all watermarking schemes consider Discrete Cosine Transform known as DCT method of preference. A summary is available in (Cox et.al. 2008). Though, study result shows that DWT has the potentials of enhancing the strength of watermark against intentional and unintended attacks. The primary reason would be that the former JPEG standard depended on DCT and today using the creation of JPEG 2000, schemes according to DWT are widely attaining interest. Though, watermark robustness varies using the underlying changed algorithms', provisions must automatically get to harden a watermark against attacks. The methods are, e.g. multiple embedding, Nasir, I. Weng, Y. and Jiang, J. (2008) and the use of error correction codes (ECC) (Friedman, G. L., 1993) are being used to restore the embedded watermark.

DWT is basically a recent method used in place of an image but in a new time and frequency scale. The basic function of DWT is decomposing the input signal to multi-resolutions. DWT can be used to decompose input signal that poses as image into low frequency (LL) and high frequency (HL, LH and HH). HL here means the horizontal detail, while LH stands for the vertical detail and HH for the diagonal part. The lowest frequency band which serves as the optimal approximation of the original image, is influenced using the DWT decomposition progressions technique which represent the maximum scale and distinguishing degree (Qun, C. et.al 2007 ; Yusof, Y. & Khalifa, O. O., 2007).

1.2 Background of the Study

It is generally believed that, many studies centers on the development of watermarking schemes for grayscale images than color images (Liu, K.C. and Chou, C.H., 2007). Consequently, available records show that, information hiding has been an important research area in recent years. However, the techniques to help address the issue of unauthorized copying, tampering and multimedia data delivery through the internet require urgent attention. Information hiding techniques currently involves merely the steganography and digital watermarking. In recent times, many watermarking schemes have been developed using DWT and DCT. This implies that where watermark is embedded perceptually with the most significant components, then the scheme has to be robust to attacks but, the watermark may be difficult to hide. Similarly, if the watermark is embedded in perceptually insignificant components, then it is bound to hide the watermark while interestingly the scheme may be less resilient to attacks (Navas, et al., 2008).

The piracy of digital assets like software, images, video, audio and text or data extended has been a bother for entrepreneurs of individual’s characteristics. Placing digital watermarks directly into these assets could be a major approach to safeguarding these data possession. Most of the watermarking information provides a few errors for the object being watermarked. These deliberate errors are known as

marks. These marks must have a minor contact over the effectiveness inside the data and can be handled in manners the malicious attacker cannot destroy marks without making the data useless. It ought to be observed that watermarking action does not prevent copying of digital objects; nevertheless it might prevent unofficial copying by showing systems for verifying the initial getting digital objects.

Generally, the quality in the digital image following a watermark embedding process is degraded. Thus, the degradation amount of a watermarking formula needs to be given serious attention inside the evaluation from the watermarking plan performance. A couple of from the recommended watermarking information may be robust enough nonetheless they may drastically degrade the conventional in the digital media. Actually, there is a trade-off among watermarking performance needs including visual imperceptibility, robustness and embedding capacity but to cope with this trade-off, a technique is needed to determine it. Although, we will find several metrics to evaluate watermarking performance needs, none of individuals watermarking metrics gave concrete on measure this trade-off.

Furthermore, digital watermarking schemes concerning the data taken into account through getting rid of might be categorized as blind and non-blind approaches. In non-blind watermarking approaches, both data for actual host image and understanding statistics about watermarked image are known inside the amount of watermark recognition and extraction (Tao and Eskicioglu, 2004). In contrast, in blind approach finding the watermark and not mention for the original image is preferred (Al-Otum and Samara, 2010). We find several difficulties regarding the blind watermarking approaches. On one hand, high effectiveness of blind watermarking may also be proven. Therefore, a completely new technique referred to as semi-blind watermarking was introduced. Within this kind of watermarking approach, only the original watermark or perhaps the watermarked multimedia statistics are known (Tao and Eskicioglu, 2004; Shieh, and Athaudage, 2006).

Similarly, Paunwala, and Patnaik, (2011), applied semi-blind strategy in their approach by which principal direction within the subject watermarked image as record particulars are available throughout duration of watermark extraction to

prevent while using the initial host image. Consequently, within the non-blind approaches within the original host particulars are essential carrying out a extraction time to uncover the rightful owner. However, in blind approaches finding and eliminating the watermark information will finish off very hard when the watermarked image is extremely assaulted either deliberately or inadvertently. Therefore, the semi-blind approach as being a key choice is greater quality compared to blind approach and even more effective compared to non-blind approach.

To summarize, within the watermarking approaches, the possession in the attacked image cannot be recognized against a myriad of intentional and unintentional attacks and preserve the conventional in the watermarked image concurrently. In addition, several intentional attacks with the aim of eliminating or altering in the embedded watermarks may appear soon. Furthermore, an over-all purposed attack modeling is complicated as some severe attacks cannot be simply modeled or perhaps the behavior of other watermarking attacks may be unknown. In this case, acquiring a correctly-balanced trade-off one of the robustness, the visual imperceptibility along with the embedding capacity has changed into challenging within the digital watermarking research area.

An issue surrounding using the internet today is users "stealing" other individual’s images and taking advantage of them on the web site without permission. It's impossible to prevent someone from installing images out of the web pages. If we are an artist, we will most likely wish to safeguard your images by watermarking them.

1.3 Statement of the Problem

Immediate digital image watermarking is certainly an urgent requirement for several today’s programs such as digital cameras and smart phone cameras. Evaluating watermarking technique, transform domain watermarking approaches require greater computational complexity over spatial domain techniques (Wolfgang

et al., 1999; Lan, H. et al., 2008 & Tsui, T. 2006 Kougianos et al., 2011). This could further be as a result of forward and inverse changes in the transform-domain watermarking approaches. However, it is common to understand that, there are difficulties with spatial-domain techniques. For instance, high embedding errors in ISB bit-planes result in many researchers employing low-order bit-planes for instance LSB for data hiding (Maity & Kundu, 2007). However, the lower-order bit-planes techniques does not contain visually significant information so, the embedded watermark may be simply corrupted or transformed by unauthorized clients without affecting on visual effects. Abolghasemi et al. (2010) for instance recommended a technique using co-occurrence matrix and bit-plane clipping that could find out the hidden data in LSB.

Studies have revealed the existence of several diversities of attacks against watermarking methods. For example Basu, S. et al. (2010), experimental investigations showed that watermarking approaches in the past were prone to several kinds of malicious attacks. Consequently, in order to identify the ownership of the digital media, they had to be made unavailable to extract the embedded watermark. Additionally, several attacks against watermarking schemes may be too complex to model (Cox et al., 1997). Consequently, a universal watermarking approach that could withstand several kinds of attacks and, concurrently, satisfies the conventional as well as the embedding capacity needs getting a minimal complexity isn't discovered yet. In this case, approximation approaches may be used to have the ability to discover the possession in the attacked watermarked image with low computational complexity. The best way to develop a solution that could withstand against various kinds of attacks is lacking the knowledge of their exact actions.

Ibrahim (2011), use watermarking technique using DWT and encryption canny edges, so as to include an watermark image include the cover image. Through the use of this method researcher was able to get acceptable results for PSNR and NCC after shedding a number of potential attacks. The main requirements for watermarking are: Imperceptibility, Robustness and capacity. Managed researcher attention imperceptibility and robustness, but neglected capacity, so were some of the extracted watermark pictures after the attack prone to damage because the size of

watermark image .Therefore, it is necessary to attention imperceptibility and robustness and capacity simultaneously to get the best results extracted after a number of potential attacks.

1.4 Research Question

An urgent need rises for improving the algorithms that are used to maintain the security and confidentiality of data. This need is because of the weakness of some encryption algorithms, watermarks, and the large number of internet piracy, as well as using without permission from the rightful owner. In order to solve these problems, there are some primary issues discussed hereunder:

- How to include a watermark image in the cover image without causing an obvious deterioration and what will be the storage capacity required?
- How to use DWT to decompose the original image to band of four frequencies.
- How to achieve transparency without loss of durability, strength and vice versa?
- How to compress the Watermark image and the ability to extract it without any effect on image features.
- How to make (extract) watermark image using cover image without having an influence on both images, which are watermark image and the cover image?

1.5 Aim of the study

The main aim of this study work is to come up with a proposed method of scheming color image by using watermarking through discrete wavelet transform (DWT) and Histogram Stretching methods. This study aims further at achieving and developing robustness, imperceptibility and available capacity of cover image for the watermarked image, which can withstand against various attacks.

1.6 The Objectives of the Study

This research work was set out to achieve the following objectives, to:

1. To improve watermarking technique on RGB color image through the use of discrete wavelet transform technique (DWT) for cover image.
2. To apply histogram stretching for watermark image to do 4 bit plan to ensure the robustness and compress watermark image.
3. To evaluate the performance of the proposed technique against potential Attacks as well Robustness (NCC) and Imperceptibility (PSNR).

1.7 Scope of the Study

The scope of this research contains two types of images. First one is the cover image, standard images which are Lena and pepper RGB color, which is of (512 x 512) bytes as a size, the source for those standard images from USC-SIPI dataset. Second one is Watermark image, which is UTM logo grayscale image of (128 x 128) bytes as a size. RGB color scheme will be used for cover images. DWT transform will be applied for cover image in order to decompose it into four frequencies. Histogram stretching will be used for watermark image compression. Compressed watermark image will be embedded in the "HH" band of the transformed cover image to insure the robustness and enhance the watermark image after extract it.

1.8 Purpose of the Study

This study is essentially carried out introduce an approach which was based on statistical data in terms of embedding watermark and the extracting watermark. This is to establish an equilibrium which provides a balanced trade-off among robustness, visual imperceptibility and embedding capacity. This is achievable

through proposing a new robust image watermarking technique using histogram equalization and the remnant information of the embedded watermarks so as to identify the ownership of the watermarked image even after severe attacks. The proposed approach is realizable in order to achieve a reliable balanced trade-off between visual imperceptibility, robustness and embedding capacity. Watermarking scheme can resist different kinds of attacks while preserving the host image quality with a high embedding capacity as well. According to Golshan, F. et al.,(2011) watermarking approaches encounter restrictions. For this reason therefore, several techniques must be employed simultaneously to attain the acceptable degree of trade-off among robustness, imperceptibility and capacity.

1.9 Thesis Organization

Chapter one contents the main aim for proposed technique, in this chapter we talking about the introduction of the image watermarking and the background of the watermarking study and what the problem statement for watermarking. Then we explain the important question to solve those problems. In objective we discuss the research work to achieve the solution for problem statement. The last one is the purpose of study.

Chapter two talking about the literature review for data protection and data hiding, and the types of data protection and talking about some of previous researcher works. The watermarking types details and what the basic requirement of digital watermarking, also the summary of related works.

Chapter three contents simple introduction about the research methodology for research objective study to execution the proposed objectives. The embedding and extracting watermark image and apply some of a potential attack such as Gaussian noise, Salt & Pepper, Sharpening, rotation and JPEG compression.

Chapter four is the results and discussion contents introduction and implementation of results explain the execution stapes to illustrate the embedding, extracting, attack of the watermarking image and then evolution of results to combine with the previous watermarking results.

Chapter five the conclusion contents simple introduction and the contribution to illustrate the new technique we used it with the digital watermarking. The future work to explain the more studies in watermarking issue depend on how to improve the main requirement for watermarking.

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