AN IMPROVED SCALING FACTOR FOR ROBUST DIGITAL IMAGE WATERMARKING SCHEME USING DWT AND SVD

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ABSTRACT

As the internet has becoming very popular for digital media sharing, the digital media is easy to be accessed, downloaded and vulnerable to image processing attacks. Digital watermarking is a technique used to secure information by embedding an additional information known as watermark into the original data. The proposed scheme is approach to improve scale factor for robust image watermarking using two level of Discrete Wavelet Transform with Singular Value Decomposition. The first and second level of DWT decomposition are performed on HL and HL1 sub band respectively. One of the main contribution of this proposed approach is the decomposition of host image using two level DWT decomposition. The aim of this project primarily is to enhance the robustness of watermarking techniques by obtaining the most optimize scaling factor which increased and control the strength of watermarked image. Scale factor is a coefficient that can influence the quality and robustness of watermarked image. To achieve the research objectives, three phases of research framework are fulfilled; First phase is the analysis on scaling factor, DWT and SVD, secondly is the watermark encoding and the generation of scale factor value and lastly is the evaluation of watermarked image quality and robustness based on the scale factor. The highest PSNR recorded is 69.2112 with best scale factor 0.01. The experimental result shows significant improvement on the quality and robustness of the watermarked image using this proposed scheme.

ABSTRAK

Oleh kerana internet telah menjadi suatu medium yang sangat popular untuk perkongsian media digital, media digital mudah diakses, dimuat turun dan terdedah kepada serangan pemprosesan imej. *Digital watermarking* adalah teknik yang digunakan untuk memasukkan maklumat tambahan yang dikenali sebagai *watermark* ke dalam data asal. Pendekatan yang dicadangkan dalam penyelidikan ini adalah untuk memperkenalkan faktor skala yang lebih baik untuk teknik *watermarking* dengan menggunakan *Discrete Wavelet Transform* dan *Singular Value Decomposition*. Tahap pertama dan kedua *DWT decomposition* dilakukan pada HL dan HL1 sub band masing-masing. Salah satu sumbangan utama pendekatan yang dicadangkan ini ialah penguraian imej asal menggunakan dua peringkat *DWT decomposition*. Tujuan projek ini terutamanya adalah untuk meningkatkan keteguhan teknik *watermarking* dengan mendapatkan faktor skala yang paling optimum untuk meningkatkan kualiti dan mengawal kekuatan *watermarked image*. Faktor skala adalah koefisien yang dapat mempengaruhi kualiti dan ketahanan *watermarked image*. Untuk mencapai matlamat penyelidikan, tiga fasa rangka penyelidikan dipenuhi; Fasa pertama adalah analisis faktor skala, *DWT* dan *SVD*, kedua ialah pengekodan *watermark* dan penjanaan nilai faktor skala dan akhirnya adalah penilaian kualiti *watermarked image* dan kekukuhan berdasarkan faktor skala. Nilai *PSNR* tertinggi adalah 69.2112 dengan menggunakan factor skala 0.01. Hasil keputusan menunjukkan peningkatan yang ketara terhadap kualiti dan keteguhan imej *watermarked image* dengan menggunakan skema cadangan ini.

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LIST OF ABBREVIATIONS

CZT	- Chirp-Z-Transform
DCT	- Discrete Cosine Transform
DFT	- Discrete Fourier Transform
DWT	- Discrete Wavelet Transform
MSE	- Mean Square Error
NC	- Normalized Correlation
PSNR	- Peak Signal to Noise Ratio
SVD	- Singular Value Decomposition

CHAPTER 1

INTRODUCTION

1.1 Introduction

Rapid development of computer technologies and network communications make the distribution of multimedia data via the internet become very popular and crucial. People get to share their life moments and uploaded on social networking. Thus, the availability of multimedia data on the network is free to be access and download. The internet is an open system which means internet is accessible, has no boundary and vulnerable to attack. Due to the circumstances, transmitted data via internet is easily modified, altered and stolen. Therefore, copyright and ownership protection has becoming a very serious issue in these past years. As a way to resolve this issue, watermarking technique is introduced. Digital watermarking is a technique to secure information by embedded additional information known as digital signature or watermark into original content (Mohamed & Sujatha, 2010).

There are two main processes in watermarking technique; encoding and decoding (Mahmoud *et* al. 2010). The encode process involve the reading of the host image (H) and using mark image (W) to generate the watermark image (HW). While decode process is the extraction of the mark image from the watermarked image.

As the technologies keep advancing throughout the year, the attacks toward watermarking are increasing. The most common attacks in watermarking are removal attacks, simple attack, detection-disabling attacks and ambiguity attacks (Sanyam *et* al, 2015). Further discussion about watermarking attacks will be provided in the next chapter.

1.2 Background of the Problem

Social networking has widely been used for information sharing these days. People always share their life moments as images and uploaded it on the social networking. Thus, the images are freely to be accessed and downloaded. Unfortunately, people who have bad intention could download the images and they might make modification to the images illegally. Thus, one of the solution to this problem is using digital watermarking techniques.

As been mentioned earlier, digital watermarking is a technique to secure information by embedding additional information known as digital signature or watermark into original content (Mohamed & Sujatha, 2010). The applications of watermarking technique are numerous such as copyright protection, digital fingerprinting, content authentication, broadcast monitoring, temper detection and localization, ID card, time stamping and miscellaneous applications.

Even though watermarking technique is used to secure information by protecting the ownership and copyright protection, there are some security issues unsolved until today. Generally, watermarking has five important features that considered in the most practical application. Those five features are imperceptibility, robustness, capacity,

security and false positive (Tao *et* al, 2014). Imperceptibility is an important condition for digital watermarking; that is the visual similarity between the embedded watermark image version and original (host) image one of the media element and the perceptual quality of the original signal should be transformed imperceptibly by the insertion of the watermark.

One of the reasons to keep the imperceptibility of the original image after being encode with watermark is to ensure with presence or absence of a watermark, the original image could not be distinguish with watermarked image. In addition, any suspicious perceptible object may give a clue to attacker to detect the watermark and perhaps its precise location could be detected. Watermarking is said to be robust when it has the ability to resist against attacks that attempt to remove or destroy the watermark without degrading the quality of watermarked image (Khaled, 2013). Watermark must be robust to prevent any distortions applied to the watermarked signal when it is being transmitted across the internet. But unfortunately, it is impossible for watermark to be robust against all signal processing operations.

In watermarking technique, scale factor influence the strength of watermark by making it invisible with different value of scaling factors. Next, capacity is defined using the largest quantity of information that inserted watermarks are capable of hiding, and embedded watermarks can be extracted credibly for the purposes of authentication and copyright safeguard. The capability relies on the size of original data. If more original pattern is attainable, more bits can be embedded. The forth feature of watermarking is the security. All existing watermarking algorithms must be safe and robust thus it can be used for copyright protection, data authentication or tracking the illegal distribution of digital content. Lastly, false positive refers to the non-existing watermark in the process of watermark detection. It is actually refers to the number of false positive that is predictable to occur during running of the detector.

Figure 1.1 shows the problem characteristic of robust watermarking technique based on scaling factor. Brief explanation about the scenario in robust image watermarking, existing watermarking technique, the gaps, trend and attack, limitation of existing techniques and desired solution are provided in the figure.

In this study, the features of watermarking will be focusing on the robustness as well as the quality of the watermarked image. To achieve the robustness of the watermarked image, the selection of the scaling factor is important. This is because, scaling factor determine the quality and robustness of watermarked image by selecting ratio that mix the host image and watermark image (Irshad & Pant, 2014).

Scaling factor should not be too low because it will reduce the quality of watermark robustness hugely. Similarly, it should not be too high as well as it will reduce the quality of watermark image in the aspect of imperceptibility (Irshad & Pant, 2014). Thus, there is a need for optimal selection of scaling factor in order to balancing between robustness and imperceptibility. To measure the quality of the watermarked image, the Peak Signal to Noise Ratio (PSNR) is used and to evaluate the robustness of the watermarking scheme against image processing attacks, Normalized Correlation (NC) is used (Ramanjaneyulu & Rajarajeswari, 2010).

PSNR of an image can be calculated using the mean squared error (MSE). The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images. This ratio usually used to measure the quality between original and a compressed image. The higher the PSNR, the better the quality of the compressed image. While, the MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error. Meanwhile, NC is used to evaluate the robustness of the proposed scheme. Further discussion about PSNR and NC calculation will be discuss in Chapter three.

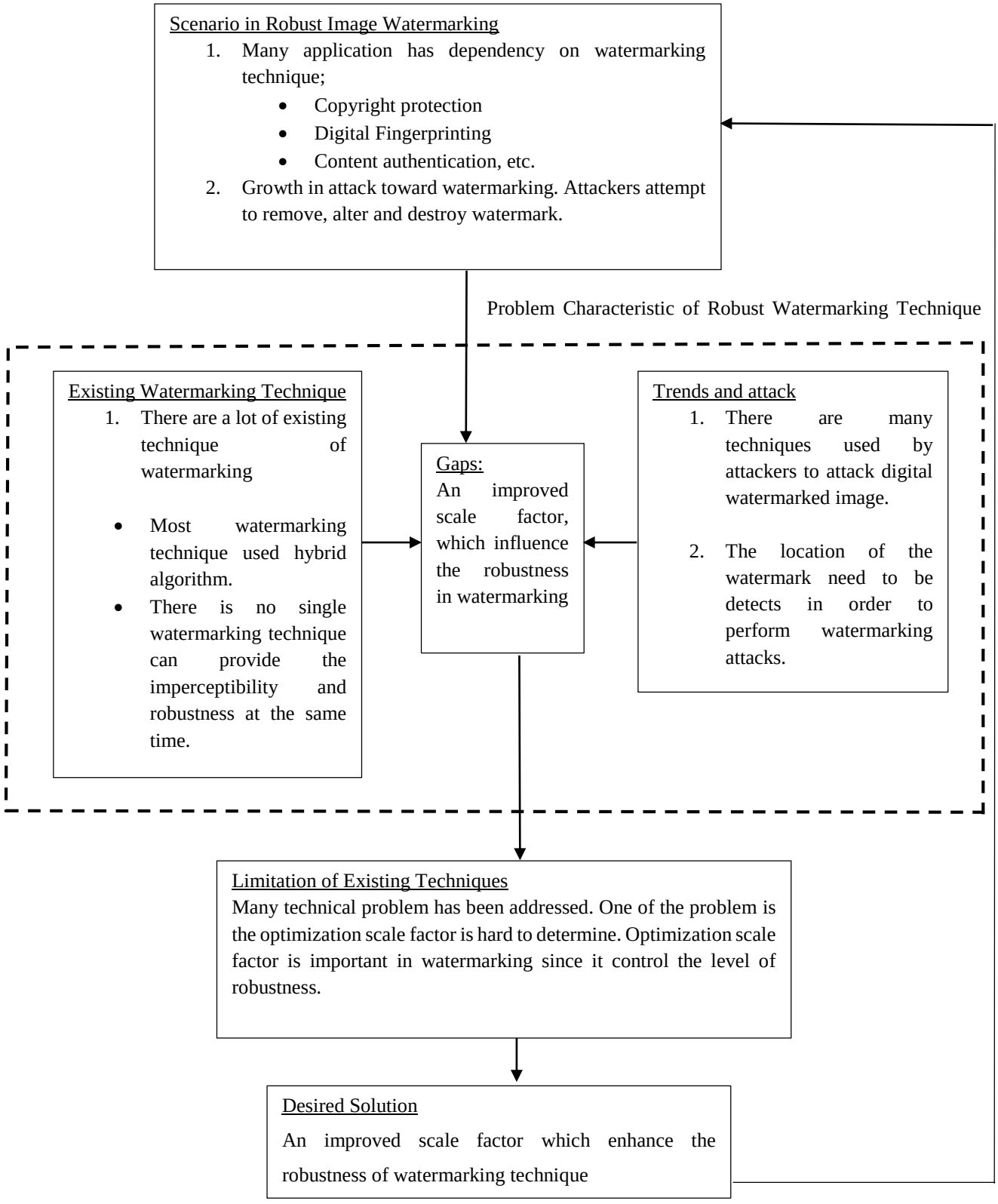

Figure 1.1 Problem Characteristics of Robust Watermarking Technique Based on Scaling Factor

1.3 Statement of Problem

The exchange of digital documents became a very easy task these days. With extraordinary technology revolution digital documents are facing with confidentiality and copyright issues. Digital documents such as images, videos and audios are easily duplicated, modified and illegally attacked without failure. Thus, digital images need to be protected and watermarking technique was introduced. Watermarking should be robust. In term of robustness, watermarking algorithm has three classification; fragile, semi-fragile and robust. Robust watermarking should be able to resist against attacks that attempt to remove or destroy the watermark without degrading the quality of watermarked image. However, the robustness is controlled by a single scaling factor (SSF). Unfortunately, determining the optimal values of the scaling factors is difficult problem. Scaling factor α controls the strength of watermark image. Thus, optimum value of scale factor should be used in watermarking to ensure the watermark is robust. Therefore, further study on the selection on optimize scaling factor is conducted and the value of optimize scale factor for this proposed scheme is proposed.

Thus, the main research question to be answered in this study is:

"Does the robustness of watermarking will be strengthened if the improvement of scaling factor is obtained through the implementation of Discrete Wavelet Transform and Singular Value Decomposition on embedding watermarking process?"

To ensure the main research question above to be answered at the end of this study, by answering additional research question follow would be helpful:

i. Does scaling factor influence the robustness of watermarking in digital image?

ii. How to obtain the improved value of scale factor using DWT and SVD technique algorithm?

iii. Does the proposed scaling factor in this proposed scheme enhance the robustness of watermarking technique in digital image?

1.4 Research Aim

The aim of this research to enhance the robustness of watermarking techniques using DWT and SVD by the selection of optimize scale factor.

1.5 Research Objectives

i. To study the effect of scaling factor on robust watermarking technique using DWT and SVD algorithm on digital image.

ii. To propose an improved scaling factor that can enhance the robustness on watermarking technique in digital image.

iii. To evaluate the quality of watermarked image and the robustness of the watermarking scheme based on scaling factor using PSNR and NC.

1.6 Scopes

i. Watermarking technique : Discrete Wavelet Transform (DWT)
: Singular Value Decomposition (SVD)

ii. This research study will focusing on the robustness as well as the quality of watermarked image.

iii. Test data : Host image (Lena image)
: Host image (Mandrill image)
: Watermark image (Cameraman image)
: Watermark image (Flower image)

iv. Image format : .png

1.7 Expected Contribution of the Research

i. The presentation considerations, definitions and discussion on related topic of watermarking.

ii. Enhancement of robust digital image based on the selection of improved scale factor using DWT and SVD.

iii. Achievement of good quality watermarked image and robust proposed scheme.

1.8 Organization of the Thesis

This thesis is organized into five chapters. Chapter 1 is the introduction of this research. Chapter 2 is the presentation of literature review that discusses on watermarking, existing techniques and related works. In addition, the summarization of issues and research gap also stated in this chapter. Chapter 3 discussed the research methodology of this study which consist of three phases. Chapter 4 will discuss the design and implementation of proposed algorithm. Chapter 5 discussed the detailed of experimental result. Finally, Chapter 6 is the conclusion of this research.

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