Faculty of Information and Communication Technology

MULTILAYER REVERSIBLE DATA HIDING VIA HISTOGRAM SHIFTING

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in fulfillment of the requirements for the degree of Doctor of Philosophy

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DECLARATION

I declare that this thesis entitled Multilayer Reversible Data Hiding via Histogram Shifting is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :  ……..

Name : Hamida Mohamed Almangush

Date : 11 November 2016

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Doctor of Philosophy.

Signature	:	……..
Name	:	Professor Dr. Mohd Khanapi Bin Abd Ghani
Date	:	11 November 2016

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DEDICATION

To my family, especially my husband and my children.

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ABSTRACT

Concealing messages from unauthorised people has been desired since written communication first began. With advancements in digital communication technology and the growth of computer power and storage, the difficulty of ensuring the privacy of individuals and the protection of copyright has become increasingly challenging. Steganography finds a role in attempting to address these growing concerns. Problems arise in the steganography method because of the trade-off between capacity and imperceptibility whereby increasing the embedding capacity increases the distortion in the stego object and it thus becomes suspect. Another problem is concerned with non-retrieval of the original cover object whereby misplacing data could be crucial for example in the case of medical images. Reversible data hiding technique based on histogram shifting addresses the problem of retrieving the original cover. Embedding the secret message by shifting the histogram between the pair of the peak and minimum points wastes the embedding capacity and does not control the distortion in the stego image for various secret messages sizes. In this research, a technique for reversible data hiding is proposed which enables the retrieval of both the hidden secret message and the original image at the receiver's side. The proposed technique considers the size of the secret message and the distribution of the colour values within the cover image to determine the value of the optimal pair or set of container and carried colours within the best sub image instead of the pair of peak and minimum points. The experimental results show that the proposed technique increases the embedding capacity within the cover image and produces a stego image with a high peak signal-to-noise ratio value. In addition, the experimental results show that by using the proposed re-shifting and extraction formulas, the technique has the ability to extract the hidden data and retrieve the original images from the stego images. In comparison to the traditional histogram-shifting techniques, the proposed technique significantly improves the stego image quality and the embedding capacity. Thus, this research has contributed to two principles, namely improvements in capacity and quality.

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ABSTRAK

Menyembunyikan mesej daripada orang yang tidak dibenarkan telah diinginkan sejak komunikasi bertulis pertama bermula. Dengan kemajuan teknologi komunikasi digital dan pertumbuhan kuasa perkomputeran dan penyimpanan, kesukaran dalam memastikan rahsia individu dan perlindungan hak cipta menjadi semakin mencabar. Stenografi mengambil peranan dalam usaha untuk mengatasi masalah yang semakin membimbangkan ini. Masalah timbul dalam kaedah stenografi kerana keseimbangan di antara kapasiti dan ketakbolehkelihatan, iaitu peningkatan kapasiti membenam meningkatkan keherotan pada objek stego dan menjadikannya suspek. Satu lagi masalah yang membimbangkan ialah ketidakbolehan dalam mendapatkan semula objek penutup asal yang dengannya kehilangan data boleh menjadi penentu, contohnya dalam kes imej-imej perubatan. Teknik penyembunyian data berbalik yang berasaskan anjakan histogram dapat mengatasi masalah mendapatkan semula penutup asal. Membenamkan mesej rahsia tersebut dengan menganjak histogram di antara pasangan titik puncak dan titik minimum mengurangkan kapasiti membenam dan tidak mengawal keherotan pada imej stego untuk berbagai saiz imej rahsia. Dalam kajian ini, teknik penyembunyian data berbalik dicadangkan bagi membolehkan dapatan semula kedua-dua mesej rahsia yang tersembunyi dan imej asal di sebelah penerima. Cadangan teknik ini mempertimbangkan saiz mesej rahsia tersebut serta taburan nilai warna dalam imej penutup untuk menentukan nilai pasangan optimum atau set bekas dan warna yang dibawa dalam sub imej terbaik menggantikan pasangan titik puncak dan titik minimum. Keputusan eksperimen menunjukkan cadangan teknik ini meningkatkan kapasiti membenam di dalam imej penutup dan menghasilkan imej stego dengan satu nilai puncak nisbah isyarat-hingar yang tinggi. Tambahan lagi, keputusan eksperimen menunjukkan melalui cadangan formula anjakan semula dan pengekstrakan, teknik ini berupaya untuk mengekstrak data tersembunyi dan mendapatkan semula imej-imej asal daripada imej stego. Berbanding dengan teknik tradisional anjakan histogram, cadangan teknik ini jelas sekali memperbaiki kualiti imej stego dan kapasiti membenam. Lantaran itu, kajian ini telah menyumbang kepada dua prinsip iaitu peningkatan kapasiti dan kualiti.

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Hamida Mohamed Almangush, Melaka, October 2016

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LIST OF ABBREVIATIONS

APD	Adjacent Pixel Difference
ASCII	American Standard Code for Information Interchange
BCH	Bose, Chaudhuri, and Hocquenghem
BCR	Bit Correct Ratio
BER	Bit Error Ratio
BM	Boundaries Map
BMP	Bitmaps
BPB	Bit PerBit
BPC	Bit Per Continuer
BPF	Bits Per Frame
BPP	Bits Per Pixel
BPS	Bits Per Second
DCT	**Discrete Cosine Transform**
CD	Compact disc
CDCS	Class Dependent Coding Scheme
CT	Computerized Tomography
DE	Difference Expansion
DWT	**Discrete Wavelet Transform**
ECI	Embedding Capacity Improvement
EL	Embedding Level
EPR	Electronic Patient Record
ER	Embedding Rate

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FBI	Federal Bureau of Investigation
FR	Full Reference
H	Height
HF	High Frequency

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LIST OF PUBLICATIONS

Hamida Mohammed Almangush, Mohd K. AbdGhani, Ahmed B. Abugharsa. (2012)"A Novel Reversible Data Hiding Technique with High Capacity and Less Overhead Information". International Journal of Computer Applications, 43(19), Pages 42-47.

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CHAPTER 1

INTRODUCTION

1.1 Overview

As long as there has been written communication, humans have had the desire to conceal their secret messages from the curious eyes of others. Information hiding techniques have become the newest hot spot in security research (Rudramath and Madki, 2012). New applications and new technologies bring new threats, thus new protection mechanisms have to be invented. Moreover, the need for confidentiality of valuable information, private and sufficiently secure communications in several applications such as e-banking, e-trading, mobile telephony, medical data interchange, the military, intelligence agencies etc., is rapidly increasing (Souvik et al., 2011; Por et al., 2008). With these forces driving the need, research into information hiding has grown explosively.

Steganography is the art and science of hiding communication and it has been used throughout history for secret communications. The word steganography comes from the Greek "Steganos", which means covered or secret and "–graphy" meaning writing or drawing. Therefore, steganography means, literally, covered writing (Jayaram et al., 2011; Cheddad et al., 2010). The emergence of the computer and the evolution of the sciences and techniques have breathed life again into this art, with the use of new ideas and techniques that draw on computer characteristics in the way that data is represented (Bachrach and Shih, 2011). The most well-known computer representation of all data including images files, audio files and video files is binary. These binary files include redundant bits that can be modified without causing any awareness by human senses by means of hearing or sight (Naji et al., 2009; Jayaramu and

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