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INFORMATION HIDING IN DIGITAL IMAGES

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Abstract

Humans are continuously attempting to find new and efficient ways to communicate secretly. A common solution to this problem is to use encryption in order to obscure the information contents of the message. However, we can think of steganography as a complementary solution. Steganographic techniques hide one piece of information inside another cover data so that they appear as a single entity.

The most simple and straightforward steganography scheme is the Least Significant Bit Substitution(LSB), where the message bit-stream is embedded into the least significant bits of the image pixels. In this thesis, we will introduce some wavelet-based techniques for modern steganography in digital imagery. The proposed techniques promote security, maximization of payload, high imperceptibility, as well as message error free recovery.

Actually, we have implemented four algorithms for embedding a message into the wavelet transform of true-colored images. Each one of them introduces a different idea and hence provides a certain advantage over the others. The first algorithm (*WLTCodedBinHide*) applies the standard technique of LSB on wavelet coefficients of the cover image. It also proposes using linear block codes in order to detect and possibly correct the truncation errors that may result from the floating point representation of the wavelet coefficients.

The second scheme (*IntWLTBinHide*) exploits the idea of reversible wavelets to store message bits directly in the LSBs of the integer coefficients. However, this requires applying a preprocessing step on the cover image to adjust the saturated pixel components in order to guarantee that the embedded message will be recovered correctly.

The next algorithm (*WLTCastBinHide*) uses the idea of casting message bits onto normalized cover coefficient using an embedding strength parameter. The extraction process, on the other hand, involves retrieving the message bit-stream by comparing the DWT coefficients of original image with the corresponding coefficients of the stego-image to decide upon the value of the embedded bit.

The last algorithm (*WLTFusedHide*) is based on merging the wavelet decomposition of the normalized cover image and the normalized secret image into a single fused result using an embedding strength factor (α). The algorithm also applies an adjustment operation on the normalized cover pixels before the embedding process takes place in order to guarantee that the embedded coefficients would not go out of range and hence the message will be recovered with acceptable accuracy even with a small value of α.

Experimental results showed the *IntWLTBinHide* provided approximately the same capacity as the most recent spatial domain (LSB-based) hiding schemes. However, it achieved a better invisibility performance. In addition, the *WLTFusedHide* achieved the best invisibility performance over all the presented algorithms, while it can embed a gray-scale image that is three times the cover image size. Generally, we can say that the proposed algorithms achieved our primary goals by providing high payload, high invisibility, and good signal recovery.

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Chapter One

Introduction

1.1 Problem Motivation

Humans are continuously attempting to find new and efficient ways to communicate. Historical examples include cave drawings, fire, and drums. Advances in civilization and technology introduced new ways including written language, telegraph, radio/television, and most recently the Internet and the electronic mail. As more and more communications are conducted electronically, new needs, issues, and opportunities are born.

When communication takes place, it may be preferred to keep the message *secret*. A common solution to this problem is to use encryption in order to obscure the information contents of the message. Although the encryption is still used in many fields, we can think of steganography as a one more tool to communicate in a hidden manner. While encryption masks the mean of communication, steganoraphic techniques hide the communication existence by means of other data usually referred to as *cover data*. In today's electronic world, A multitude of multimedia objects can serve as potential covers.

Privacy is not the only motivation of steganography. By embedding one piece of information inside another, they become a single entity, and so they should appear. This means that the embedded data should not affect the over all integrity of the cover data.

1.2 Objectives

Much of the recent work in data hiding is the area of *watermarking*, motivated by the desire for the copyright protection of multimedia on the internet. Thus far, less attention has been given to another type of data hiding: steganography. The objective of steganography is to imperceptibly embed significant amount of information into some cover media.

In this thesis, we will address the subject of modern steganography, and introduce some techniques for data hiding that uses digital imagery as a cover. The proposed techniques promote maximization of payload, allowing error free recovery of the embedded message, as well as achieving high imperceptibility. The research also encompasses a detailed performance measurement of the proposed techniques using some existing metrics.

We can summarize our objectives as follows:

1. Survey on the principal information hiding techniques & tools.

2. Implementation of some wavelet-based algorithms for hiding information in container image files.

3. Performance analysis of the proposed algorithms in terms of computational complexity, payload, imperceptibility, as well as recovery rate.