DIGITAL IMAGE WATERMARKING - PART 3

Chapter 3: CONTRIBUTIONAL WORK DESCRIPTIONS AND RESULTS

3.1 **SYSTEM REQUIREMENT SPECIFICATIONS**

3.1.1 SRS Document

Section 1: Introduction

1.1 Purpose: The goal of this project ***is to analyze the performance of color channel for DCT-based watermarking scheme and to propose a robust algorithm which resists various attacks like JPEG Compression, Addition of Noise and Cropping attack***.

1.2 Scope: The advent of the Internet and the wide availability of computers and printers make digital data exchange and transmission a simple task. However, making digital data accessible to others through networks also creates opportunities for malicious parties to make salable copies of copyrighted content without permission of the content owner. Therefore **all digital data should be watermarked before uploading it on the Web**.

1.3 Definitions and Acronyms:

Definitions:

Embedding: Something to be hidden in something else

Cover image: Image in which the watermark is embedded i.e. the original image.

Embeddor/Extractor: An entity or person that embeds and extracts is called an embeddor or an extractor, respectively.

Watermark: A form, image or text that is impressed onto paper, which provides evidence of its authenticity.

Digital Watermarking: A process that embeds data (watermark) into a multimedia object to help protect the owner's rights to that object. Spatial domain watermarking: A technique in which the watermark is embedded by directly modifying the pixel values.

Transform domain watermarking: A technique in which a digital image is processed by means of a specific transform.

Robust watermarks: Watermarks which are difficult to remove from the object in which they are embedded, despite various attacks they might be subjected to.

Fragile watermarks: Watermarks that are easily destroyed by any attempt to tamper with them.

JPEG compression: JPEG is currently one of the most widely used compression algorithms for images and any watermarking system should be resilient to some degree of compression.

Horizontal flip: A kind of attack on the watermarked image. These images are flipped without actually losing much information.

Rotation: Small angle rotation does not usually change the commercial value of the image but can make the watermark un-detectable.

Scaling: This attack on watermarked images is generally neglected but is the most common attack. This happens when a printed image is scanned or when a high resolution digital image is used for electronic applications such as Web publishing.
Noise attack: In this attack random noise is added to the content in an attempt to garble the watermark beyond any reasonable level of usefulness.
Discrete Cosine Transform: The DCT allows an image to be broken up into different frequency bands, making it much easier to embed watermarking information into the middle frequency bands of an image.
Middle Frequency Band Coefficient Exchange Algorithm: This technique utilizes the comparison of middle-band DCT coefficients to encode a single bit into a DCT block. The DCT block will encode a "1" if Pk(i1, j1) > Pk(i2, j2); otherwise it will encode a "0". The coefficients are then swapped if the relative size of each coefficient does not agree with the bit that is to be encoded.
Acronyms:

- DCT: Discrete Cosine Transform
- DWT: Discrete Wavelet Transform
- LSB: Least Significant Bit

1.4 Overview:
This document tells about the requirement specifications of the project. Firstly it introduces to the requirements of the project. Then it describes the functionalities that the product provides, motive of the product. The various constraints and assumptions made in the development of the product are briefed. The most important look-and-feel i.e. the external interfaces and user-friendly GUIs of the product are demonstrated. The design constraints and software system attributes are also briefed. This whole document gives idea of the requirement specifications of the product.

Section 2: General Description
2.1 Product perspective and product function: The advent of the Internet and the wide availability of computers and printers make digital data exchange and transmission a simple task. However, making digital data accessible to others through networks also creates opportunities for malicious parties to make salable copies of copyrighted content without permission of the content owner. This raised the need to develop a mechanism which prevents duplication of digital data. Watermarking was an excellent solution to this problem. But the infringers performed various attacks to destroy the watermark and remove the token of ownership from the image. Various algorithms have been proposed and researchers are working on new robust techniques to prevent watermarked images from different attacks. Our motive in doing this project has been to analyze the performance of color channel for DCT-based watermarking scheme and to propose a robust algorithm which resists various attacks like JPEG Compression, Addition of Noise and Cropping attack.
The product i.e. the algorithm for preventing JPEG Compression, Addition of Noise and Cropping attack contains of two parts:

1. Watermark embedding algorithm

2. Watermark recovery algorithm

The basis of this algorithm is the Middle-band Coefficient Exchange Algorithm. This technique utilizes the comparison of middle-band DCT coefficients to encode a single bit into a DCT block. The DCT block will encode a "1" if Pk(i1, j1) > Pk(i2, j2); otherwise it will encode a "0". The coefficients are then swapped if the relative size of each coefficient does not agree with the bit that is to be encoded.

Improving the algorithm by applying swap on four locations and thus making it more robust. Also, we preprocessed the images by equalizing histograms. This was done only after careful analysis of the different color-bands and comparison of their performance on preprocessing the images.

For making the watermarked image resistant to Cropping attack, we have embedded the watermark in different pattern such that watermark can be recovered after cropping the image to a very tiny portion.

2.2 User Characteristics: As this is a product for preventing a prevailing unlawful act in the digital society, user does not provide much information as input to the product. The user is required to give the cover-image and the watermark logo which is to be embedded in the cover. At the time of recovery, the watermark and the watermarked image are fed as input and the watermark from the image is compared to the actual watermark. The PSNR values are returned to the user.
The algorithm against cropping attack asks the user to specify the most important portion of his image and the watermark is embedded in the center of that portion. This embedding is not sequential, unlike the basic algorithm, but in a spiral pattern. Similarly at the time of recovery the user is asked to specify the pixel-location from where to start recovering the watermark.

2.3 Constraints and assumptions: The constraint for algorithm preventing cropping is that the pixel positions of the most important portion of the image are to be specified even after cropping attack i.e. during recovery.

Section 3: Specific Requirements

3.1 External Interfaces and functions: No specific GUIs needed to be developed for this product. Although the pop-up boxes of recovered watermarks are shown in the results section. The functions used in this product are psnr() to calculate the PSNR values of the outputs as shown below:
psnr(image,secret,y,x)

3.2 Software system attributes:

Specific Knowledge Required

- MATLAB
- Digital Image Processing
- Fundamentals of Multimedia
- Water Marking literature and Security Algorithms
- Digital Watermarking
- Spatial Domain Image Watermarking

- Frequency Domain Image Watermarking

System Requirement / Tools Used

The proposed scheme has been implemented on MATLAB, so the system requirements would be governed by the minimum system requirement of the version of MATLAB you intend to work on. Make sure that the system has enough RAM and processing power because the programs are computationally very heavy.

MATLAB 7.0.4

MATLAB is a high level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation. Using MATLAB, you can solve technical computing problems faster than with traditional programming languages such as c, c++. One can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement, and computational biology. Add-on toolboxes (collections of specialpurpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

3.2 **METHODOLOGY**

3.2.1 Learning Phase

Phase 1(Dec'06-Jan'07): LEARNING PHASE

- **Familiarity with the domain**: Worldwide research activities and the industrial interest in digital watermarking is increasing dramatically in today's world owing to the increasing popularity of internet. The field of digital image processing is very vast and watermarking is only a subset of it. Understanding the interdependence and correlation of these two fields was very crucial to our project. In this phase we studied about the real time applications of watermarking and the ways in which people exploit the vulnerability of digital data on the net. For example, some employees hide their resumes inside an image to avoid interception by the organization's e-mail server.
- **Gather Information**: With the help of various research papers and internet, we learnt the concepts of watermarking: types of watermarks, watermarking techniques and different embedding algorithms. But watermarking alone is not a solution to the problem of illegal copying because people generally destroy the watermark embedded in the image by various attacks. We studied the commonly used attacks on the watermarked image and existing methods to retain the watermark even after these attacks. As the watermark is embedded in the image, we also studied the different image formats like bmp, jpeg etc.
- **Learn MATLAB**: MATLAB is a high level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical

computation. Using MATLAB, you can solve technical computing problems faster than with traditional programming languages such as c, c++. One can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement, and computational biology. Add-on toolboxes (collections of special-purpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

3.2.2 Designing and Implementation Phase

Phase 2(Jan '07-Feb '07): ALGORITHM FOR COLORED IMAGES

We used the "middle band coefficient exchange algorithm" as basis for embedding and recovery of the watermark from colored images:

EMBEDDING ALGORTIHM: The watermark is embedded separately in all color channels. A block of 8*8 is considered and frequency transformation (DCT) of each block is done.

for-loop for length of the watermark

DCT for each block:

For red: p=dct2(image(j:j+blocksize-1,i:i+blocksize-1,1));

For green: p=dct2(image(j:j+blocksize-1,i:i+blocksize-1,2));

For blue: p=dct2(image(j:j+blocksize-1,i:i+blocksize-1,3));

Each bit of the monochromatic watermark represents embedding in each block as shown below:

if '0' is encountered

if p(1,2)>p(2,1)

Source: http://www.botskool.com/programming-tutorials/fourth-year-projects/digital-image-watermarking-page-3