“DESIGN AND ANALYSIS OF SECURE IMAGE USING WATERMARKING”

CSE 4003: CYBER SECURITY, J COMPONENT

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Abstract

With the ground breaking advancement in technology in the past two decades, the sharing of multimedia has been very easy. With this, the problem of attacking such digital media and modifying them has been a critical issue here. So, to avoid this, various techniques has been developed to protect such shared media files from unauthorized access to such data and media. Today, digital watermarking has been widely used in almost every sector for securing and attaining the copyright and protection of one's files. So, here we implement digital watermarking for securing the media files such as images using various techniques like DWT and DCT, and also be trying to attack them to validate our digital watermarking scheme and conclude that the digital watermarked image is secured.

Since the sharing of media has been made very easy and convenient, this has created a loop hole in the protection of such files. Today, attackers with various tools can easily attack, change, modify or delete the media files hence creating various problems. This has been a great issue in the past few years as nearly every work is done online. So, watermarking can reduce this attacks at high extent by securing the image and attaining the copyright and protection for it.

Keyword: DCT, DWT, Digital watermarking, attacks

1. Introduction

1.1 Theoretical Background

Watermark is a label or tag which insert into multimedia data to make original data secure from illegal manipulation and distribution. It can be visible or invisible. In order to maintain the digital watermarking method to be effective, we are using spatial and frequency domain techniques DWT and DCT.

DCT represents data in terms of frequency space. It converts an image into its equivalent frequency domain by partitioning image pixel matrix into blocks of size. DCT is useful because it imitates the way humans perceive the light hence parts that are not perceived and be thrown away. The transformation is orthogonal and fast algorithms can be used for computation. It is secure against simple image processing operations like low pass filtering, brightness and contrast adjustment, blurring etc. Hence can be used to secure watermarked images from intruders.

The objective of DWT design is to maximize memory efficiency while allowing maximum flexibility. The Discrete Wavelet Transform is utilized in a wide range of signal processing applications, including audio and video compression, noise removal in audio, and many others. A simple watermarking system is implemented using the DWT. In both the horizontal and vertical axes, the 2-D DWT is an extension of the 1-D DWT. The image is decomposed into sub-images, three details, and one approximation using the 2-D DWT. The approximation is identical to the

original, but on a 1/4 scale. It divides a picture into horizontal (HL), vertical (LH), and diagonal (HH) detail components, as well as a lower-resolution approximation picture (LL). We can improve the robustness of our watermark by embedding it in these places with little to no influence on image quality. Because the DWT is a multi-scale analysis, it can help the watermarking algorithm.

1.2 Motivation

Since digital images play such an essential role in multimedia technologies, users' privacy is becoming increasingly vital. And, in order to provide the user with such protection and privacy, digital watermarking is critical to safeguard against unauthorized user access. For safeguarding and attaining the copyright and protection of one's files, digital watermarking has been widely employed in practically every area.

1.3 Aim of the proposed work

The main aim of this project is to protect original image from other unauthorized users by applying watermark using two different - DWT (Discrete Wavelet Transform) and DCT(Discrete Cosine Transform) watermarking algorithm and analyzing these two algorithm by testing various attacks on the watermarked image.

1.4 Objective of the proposed work

Our project's purpose is to protect images from unauthorized users and attackers by incorporating digital watermarking techniques utilizing various algorithms such as DCT or DWT, as well as attempting to attack the watermarked picture to evaluate our digital watermarking technique. The digital watermarking process can be achieved in two main steps:

- Embedding of data to be used as watermark on original/cover image
- Extraction of embedded watermark in first step from the watermarked original/cover image

We will also test the watermarked image by trying out different forms of attacks.

2. Literature Survey

2.1 Survey of the Existing Models/Work

1. "DIGITAL WATERMARKING SCHEMES FOR AUTHORIZATION AGAINST COPYING OR PIRACY OF COLOR IMAGES" by Keshav S Rawat, Dheerendra S Tomar

This paper gives an overview of all the digital watermarking techniques like DCT and DWT and how these algorithms protect the images by processing the image in the form of a digital signal and then embedding a watermark to secure the host image. Here it states that DWT is a algorithm which is used for various processing applications as most of the real life signals encountered are time varying in nature which is what the algorithm can process. It helps in removing noise in image and also helps in authentication of original image by embedding high energy watermarks in the regions where human vision is less sensitive without effecting the image quality.

2. A Study on Digital Watermarking Techniques-L. Robert, T.Shanmugapriya

This paper reviews various aspects and techniques about digital watermarking. Images can be represented as pixels in spatial domain or in terms of frequencies in transform domain. To transfer an image to its frequency representation we use reversible transforms like Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), or Discrete Fourier Transform (DFT).

3. "DWT-DCT based blind watermarking algorithm for copyright protection", Liu Ping Feng, Liang Bin Zheng, Peng CaoA

The analysis of DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform) based blind watermarking algorithms for copyright protection was the major topic of this paper. When compared to a DCT-only watermarking strategy, we discovered that combining the two transforms increased watermarking performance. To further strengthen security and durability, the watermark is scrambled using the Arnold transform and placed in a spread spectrum pattern. According to this study, the suggested approach is resistant to common attacks such as Gaussian white noise, median filtering, cropping, scaling, and JPEG compression, and the watermarked image's imperceptibility is satisfactory.

4. "Combined DWT-DCT Digital Image Watermarking" by Ali Al-Haj Amman, Jordan

Ali Al-Haj evaluated and mentioned the performance of DWT-DCT watermarking algorithm. For sake of comparison, the watermarking performance of both DWT and DCT algorithm were evaluated individually. The result obtained for DWT only showed better undetectable performance and security was obtained. However, robustness performance was not acceptable hence with equally powerful transform, DCT was combined. Ultimately, improvement in robustness was considerably high

5."Digital Colour Image Watermarking using DWT-DCT Coefficients in RGB Planes" K. Chaitanya, E. Sreenivasa Reddy, K. Gangadhara Rao

This paper mainly focused on how to protect our color image from attackers by employing DWT-DCT coefficients in RGB planes, which is also the most secure copyright protection approach. In comparison to previous techniques, this robust watermarking methodology is offered for improving data hiding security, robustness, and quality. We examine the proposed method in this paper by calculating the MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) between the original and watermarked images, as well as the NC (Normalized correlation) and SC (Standard correlation) between the original watermark image and the extracted watermark image. They also used the frequency transformations DWT and DCT applied to the Blue channel of the original image to improve security and embed the color watermark image.

6. "A Comparative Study of DCT and DWT Image Compression Techniques combined with Huffman coding", Maghari, Ashraf Y.A

The rapid increase of high-resolution images necessitates the development of efficient data storage and transmission methods over the internet. As a result, Maghari and Ashraf Y.A. both published a comparison research comparing the DWT and DCT algorithms to the Huffman algorithm. Gray-scale file images were used in the experiment. In terms of compression and decompression time, DCT-H outperforms DWT-H.

7. "Intelligent image watermarking robust against cropping attack "by Seyed Sahand Mohamadi Ziabari

In this paper by using the factors which are used to find the best embedding blocks such as region of interest, priority factor, complexity factor, the researcher/author has made the watermarked image resist against the cropping attack and perceptual distortions. Also, by using the genetic algorithm the best coefficients are selected by the authors for embedding the watermarks. In the results we see that the imperceptibility and robustness of conventional algorithm are improved by using some preprocessing operations which sort the image blocks according to their robustness against cropping attack. the author has concluded the paper by specifying that in this paper using genetic algorithm the Priority Coefficient prepare and sort the image blocks for embedding.

8. Hiding text data in image through image watermarking using DCT & DWT: A research paper By: Garima Gupta; Ajay Khunteta

In this paper the author's main focus is to raise the complexity of the hiding algorithm. Hence three different equations are used to hide the secret text data inside an image. Along with the equations some complex steps like DWT to keep the quality of the image high. The images taken will be processed by a transformation called DWT. the data also needs to be calibrated in accordance with the range of DWT processed sub band of image. For that the text will be first converted to ASCII representation and then it will be processed through DCT or DWT. the authors have chosen 3 sub bands for embedding data they are: low high frequency band high low frequency band high frequency band of level 1 low frequency band the algorithm is a complex one and the use of three different equations for the three distinguished sub-bands is very hard to crack. The authors tested the system over the Gaussian noise attack and it was seen to generate satisfactory results.

9. "Digital Watermarking Based on DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform) "by Nawaf Hazim Barnouti, Zaid Saeb Sabri Khaldoun L. Hameed

This research is primarily concerned with the evaluation of several digital watermarking methods for embedding and extracting copyright protection based on DWT and DCT. Both procedures were used separately here, followed by the extraction of the signature image from the cover image. This was accomplished using the DCT and DWT methods, as well as a combination method. The DWT and DCT approaches shown good performance in this work, but the robustness performance was not acceptable. The performance of the combined DWT+DCT watermarking approach was improved. The combined DWT-DCT technique resulted in a significant improvement in robustness.

10. "Digital Image Watermarking Techniques: A Review", Mahbuba Begum, and Mohammad Shorif Uddin

This research provided a brief description of several forms of attacks in the digital watermarking technology, as well as a comparison of several types of algorithms, including their benefits, drawbacks, and aspects. Due to its multi-resolution capabilities, this article concluded that DWT is a high-quality and robust methodology for picture watermarking. Though DCT was discovered to be a good and resilient watermarking technology, some of the attacks were found to be vulnerable, and the signatures recovered from them were shown to be largely same based on the testing results.

2.2 Summary/Gaps identified in the Survey

- Although there are various methods to protect an image from attackers, we attempted to compare two different watermarking algorithms, DWT and DCT, in this project by testing various attacks on the watermarked image and comparing the original watermark and the extracted watermark to find the best one to protect our image from attackers.

- The drawbacks of digital watermarking is that it vanishes if the image is altered. Some procedures, such as compressing or resizing a photo from one type to another, may cause the watermark to fade and become unreadable. During the extraction process, the original watermark is necessary; it does not prohibit image copying, but it can track down and detect the ownership of copied image files.

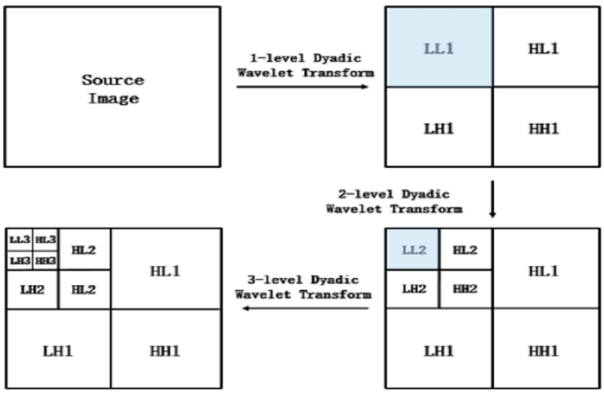
3. Overview of the Proposed System

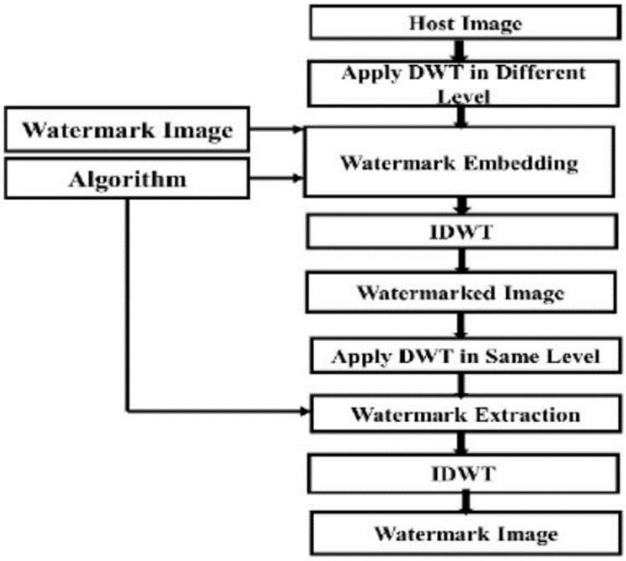
3.1 Introduction

Data is represented in frequency space rather than amplitude space by DCT. It partitions the picture pixel matrix into size blocks to convert an image into its equivalent frequency domain. DCT is effective because it mimics how people sense light, allowing bits that are not perceived to be discarded. The transformation is orthogonal, and computation can be done with fast algorithms. Simple image processing techniques such as low pass filtering, brightness and contrast adjustment, blurring, and so on are all supported. As a result, it can be utilized to keep attackers out of watermarked images.

The aim of DWT design is to maximize memory efficiency while allowing maximum flexibility. The Discrete Wavelet Transform is utilized in a wide range of signal processing applications, including audio and video compression, noise removal in audio, and many others. A simple watermarking system is implemented using the DWT. In both the horizontal and vertical axes, the 2-D DWT is an extension of the 1-D DWT. The image is decomposed into sub-images, three details, and one approximation using the 2-D DWT. The approximation is identical to the original, but on a 1/4 scale.

3.2 Proposed Architecture / model for DWT





First, the host image, which will be used to embed the watermark. The host image is decomposed into four non-overlapping multi-resolution subbands: LL, HL, LH, and HH, which are lower and higher frequency subbands, respectively. Because of its superior image quality, DWT watermarkes the image into a higher frequency subband. Then, in these subbands the watermark is embedded using the watermarking algorithm. The algorithm divides the host image into 8* non overlapping subblocks. Then we apply an inverse discrete wavelet transform to each block after its subband coefficient are modified which produces the watermarked host image. For further extracting on the watermark the DWT is applied in the same suband level, this again decomposes watermarked image into 4 multi resolution subband: LL1, HL1, LH1, and HH1. Finally, after applying the inverse discrete wavelet transform we achieve the watermarked image.

Proposed Architecture / model for DCT

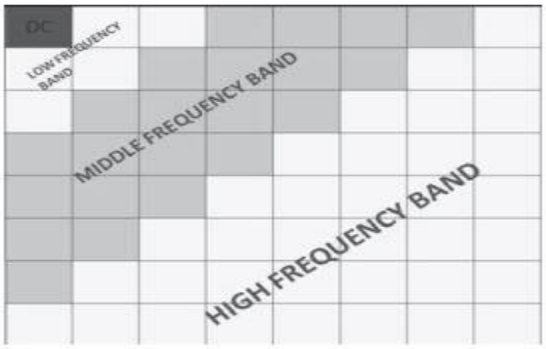
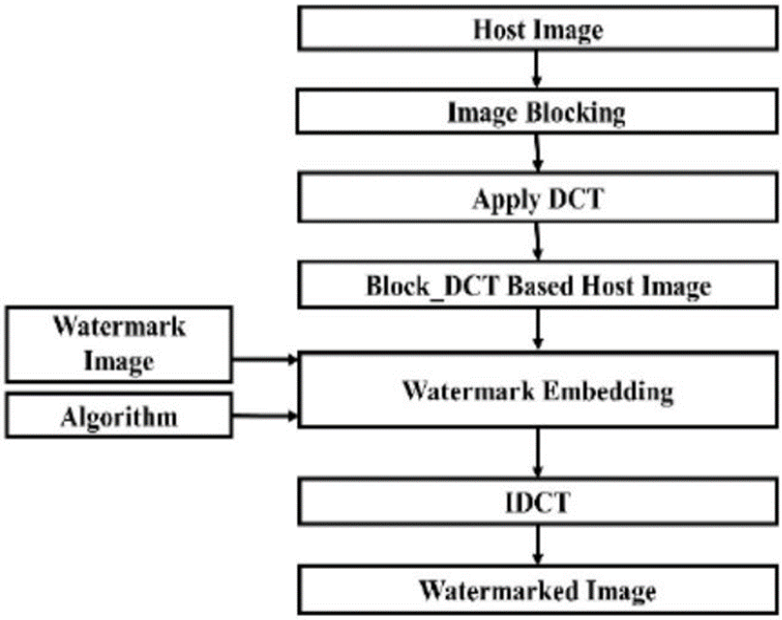


Fig: Three frequency bands of the DCT coefficients



In this algorithm at first we take the original/host image and we divide it into 8 x 8 blocks and after dividing it into blocks, we apply DCT in each block. Then we embed the watermark bits from watermark image into mid frequency coefficient DCT blocks. We only embed the watermark bits in mid coefficient block because to maintain the visibility of the image then after embedding the watermark, we perform IDCT (Inverse Discrete Cosine Transform) to get watermarked image.

4. Proposed System Analysis and Design

DWT

- If DWT is selected, first the cover image and watermark image is read. The watermark image is converted to gray level scale.
- This method in image processing includes decomposition images into frequency channels of constant bandwidth
- Two-dimensional image is divided into four sub-bands, which include: LL, LH, HL and HH at level one DWT domain where the first letter means using low-pass or a high-pass frequency operation to the rows and second letter refers to which filter is applied to the columns.
- Each sub-band can be also divided until the required number of levels is achieved. The human visual system is way more sensitive to the LL sub-band which represent low frequency component and the digital watermarking is commonly embedded in one or more of the other three sub-bands which have better image quality.

DCT

- First the cover image is selected for digital watermarking then either DCT or DWT is selected. If DCT is selected:
- DCT image watermarking works by dividing the host image into different image blocks.
- The application applies the DCT transform to this image.
- Then, the method inserts the watermark into the block and DCT-based host image with the help of an algorithm.
- The inverse discrete cosine transform (IDCT) is then applied to obtain the watermarked

5. Results and Discussion

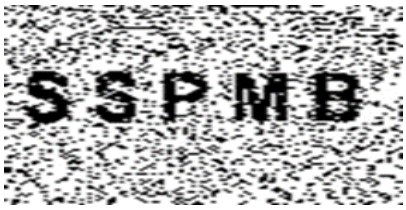
Using DWT algorithm

Original Image

Watermark image

Watermarked Image

Extracted watermark



Blur Attack

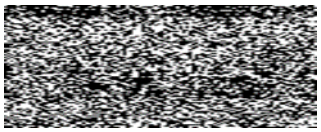
Image after attack

Extracted Watermark

Rotate 180 Attack

Image after attack

Extracted watermark



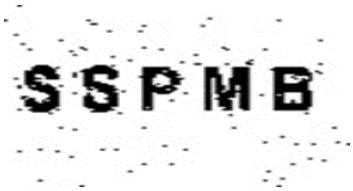
Using DCT algorithm

Original Image

Watermark Image

Watermarked Image

Extracted Watermark



Blur Attack

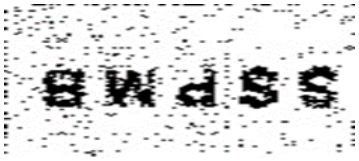
Image after attack

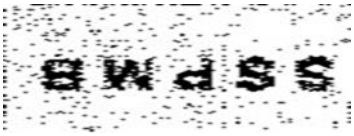
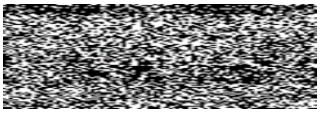
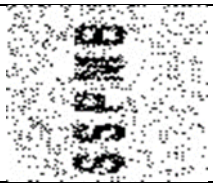
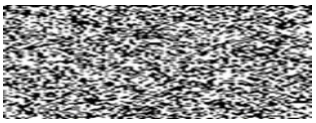
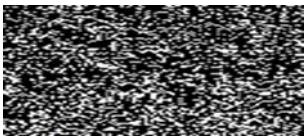
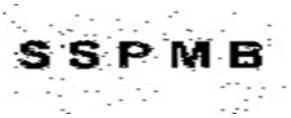
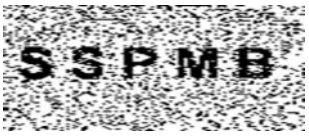
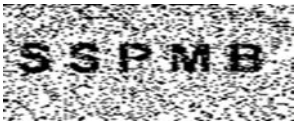
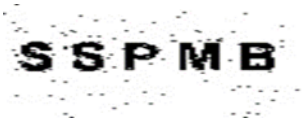
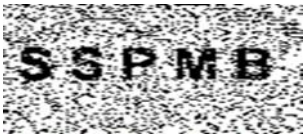
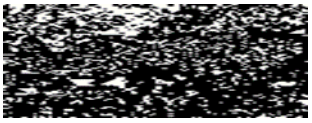
Extracted watermark

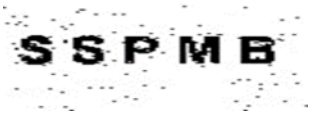
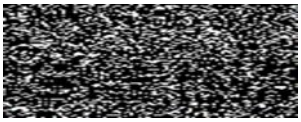
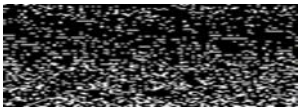
Rotate 180 Attack

Image after attack

Extracted watermark



Types of attack	DCT Extraction	DWT Extraction	Result
Blur attack			Both of the extraction showed highly non identical image as compared to the original watermark.
Rotate 180			DWT performed better than DCT.
Rotate 90			DWT performed better than DCT.
Chop 30			Both of the extraction showed highly non identical image as compared to the original watermark.
Gray			DWT extraction showed highly grained image as compared to DCT.
Randline			DWT extraction showed highly grained image whereas DCT image is disturbed.
Cover attack			DWT is highly grained and and is better than DCT.
Brighter 10			Both of the extraction showed highly non identical image as compared to the original watermark

Darker 10			DWT is highly grained and and is better than DCT.
Larger size			Both of the extraction showed highly non identical image as compared to the original watermark
Smaller size			Both of the extraction showed highly non identical image as compared to the original watermark

Conclusion

We used the DWT and DCT algorithms for watermark embedding and extraction. According to the data, DWT displayed a very non-identical watermark in over 80% of the extractions when compared to DCT, safeguarding the original watermark picture. Both algorithms have their own set of benefits, however after careful consideration, we concluded that the DWT technique is the more robust and secure watermarking approach for image protection. This research concludes that DWT is a high-quality and reliable picture watermarking approach.

Robustness, imperceptibility, and capacity are the three most important requirements for developing an effective watermarking system. It is practically impossible, however, to meet all of these requirements at the same time. In the future, a combination of both of these approaches could be used, with the benefit of each approach significantly improving watermarking performance when compared to the original DWT and DCT algorithms separately.

6. Reference

[1]. Keshav S Rawat, Dheerendra S Tomar, “DIGITAL WATERMARKING SCHEMES FOR AUTHORIZATION AGAINST COPYING OR PIRACY OF COLOR IMAGES”.

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[4]. Ali Al-Haj Amman, Jordan, “Combined DWT-DCT Digital Image Watermarking”.

[5]. K. Chaitanya, E. Sreenivasa Reddy, K. Gangadhara Rao, "Digital Colour Image Watermarking using DWT-DCT Coefficients in RGB Planes".

[6]. Maghari, Ashraf Y.A, “A Comparative Study of DCT and DWT Image Compression Techniques combined with Huffman coding”

[7]. Seyed Sahand Mohamadi Ziabari “Intelligent image watermarking robust against cropping attack”.

[8]. Garima Gupta, Ajay Khunteta , “Hiding text data in image through image watermarking using DCT & DWT”.

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[10]. Mahbuba Begum, and Mohammad Shorif Uddin, “Digital Image Watermarking Techniques: A Review”.