CASE STUDY

Copyright Protection Scheme for Digital Images Using Visual Cryptography

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Abstract

The aim of this case study is to demonstrate a digital watermarking scheme using visual cryptography for copyright protection of a digital image. A binary image, called watermark, is split into two shares via a 2-out-of-2 visual secret sharing scheme. Then, one of the shares called the master share is extracted from the host image using a fixed pseudo-random points, and the other share also known as ownership share, made by relating the master share and the watermark, is held by the owner which is also given to an authorized 3rd party copyright verifier. Based on the security property of visual cryptography, the two shares on their own cannot leak any information about the watermark. The experimental results show that even after the image was modified, the invisible watermark was successfully extracted from it.

Introduction

Compared to the old days, it has become super easy to make your information accessible to anyone around the world. That also means that it's trivial for someone to take your information, use it, and claim that it is his own.

As an example, you may take a digital picture of a historical event that you may consider selling to Seattle Times. However, since you're greedy, a human being, and want to maximize the profit, you might've sent the photos to bunch of different companies to make them go on a bidding war. One individual that works at some company may then modify the image a little bit, claim that it's their original work, and essentially steal it. So what are you left with? Nothing, unfortunately, because you didn't know that you can protect your image even if it's in a digital format. How? You can embed extra information into digitized data to use as a protection—that is what digital watermarking is essentially.

Visible digital watermarking is something that is visible on the content. Invisible watermarking on the other hand can get a lot more interesting because the soon-to-be-criminal does not know that there is extra information in the data that he's trying to steal. Why do we care about invisible watermarking? That's because anything that one can "see" can be removed fairly easily—though it may require sophisticated software, it is definitely easier to remove something that one can see than removing something that one doesn't know what to remove. For example, if there's a logo at a right-bottom of a video, one can cover it up with another logo.

As we can see, there's clearly a reason to have invisible watermarking technology around. Compare to the visible watermarking that can be used for several purposes, invisible watermarking can do a lot more, enough to justify many different companies to put some researchers to work to build software that can do digital watermarking.

Visual Cryptography

Visual Cryptography is a special encryption technique to hide information in images in such a way that it can be decrypted by the human vision if the correct key image is used. The technique was proposed by Naor and Shamir in 1994. Visual Cryptography uses two transparent images. One image contains random pixels and the other image contains the secret information. It is impossible to retrieve the secret information from one of the images. Either transparent images or layers are required to reveal the information. The easiest way to implement Visual Cryptography is to print the two layers onto a transparent sheet. An example can be seen below.

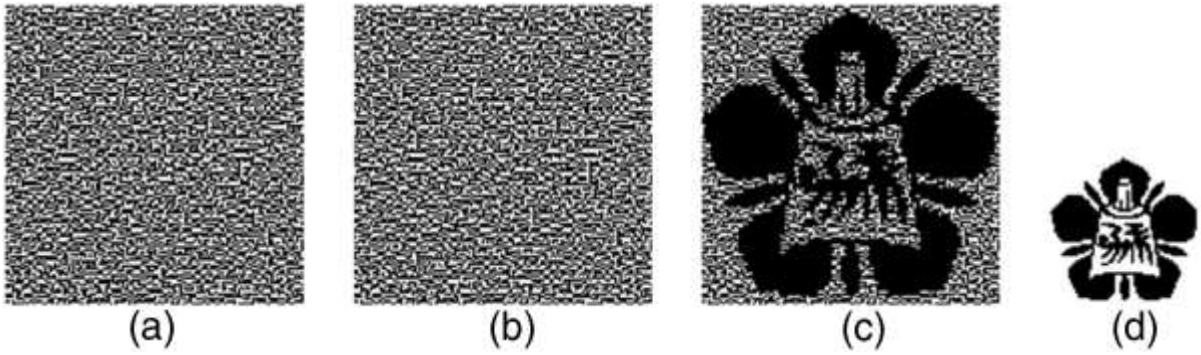


Fig 1.
(a) Master Share (b) Ownership Share (c) Extracted Watermark (d) Original Watermark

Simple Algorithm for Visual Cryptography:

There is a simple algorithm for visual cryptography that creates 2 encrypted images from an original unencrypted image. The algorithm is as follows:

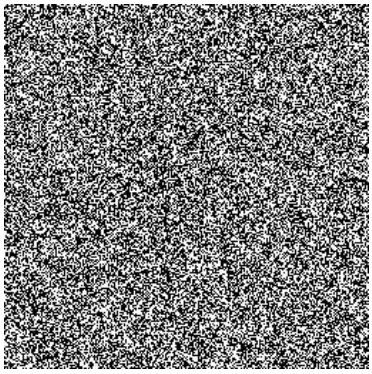
1. Create an image of random pixels the same size and shape as the original image.
   Random1.
2. Create a second image whose pixels are the exclusive-or (XOR) of the first image and the original image.
   Random2 = Random1 ***xor*** *Original.*
   This will image will "look random".
3. The two apparently random images can now be combined with XOR to re-create the original image.
   Random1 ***xor*** *Random2 = Original.*

The Methodology Attempted

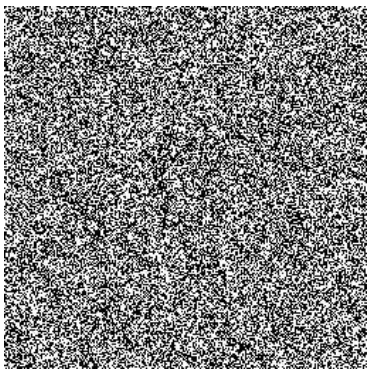
1. Ownership Share Generation

In this step, first, pseudo-random points are generated using a fixed key as a seed. Depending on the intensity of these points, a temporary master share is generated. Now the master share is *xored* with the original watermark image to get the ownership share.

(a)



(b)



(c)

(d)

Fig 2. (a) Original Image (b) Master share (c) Ownership share (d) Watermark

2. Master Share Generation from Stolen Image

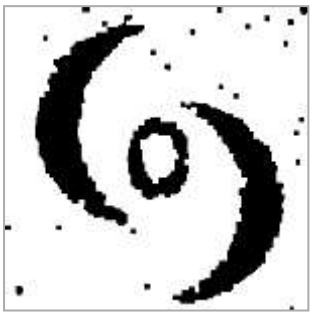
To emulate stolen image, the original image was taken and modified by adding various effects, noise, etc. The master share from each one of them was then generated using the same points as taken earlier.

3. Watermark Extraction and Verification

The generated master shares were then *xored* with the ownership share. The results were as follows:

Fig 3. (a) Original Image Blurred (b) Extracted Watermark

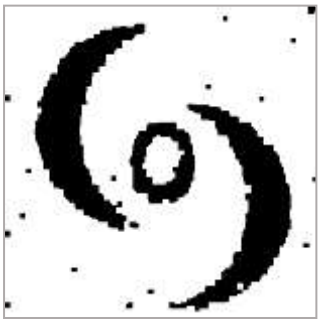
(a)



(b)

Fig 4. (a) Original Image with Noise (b) Extracted Watermark

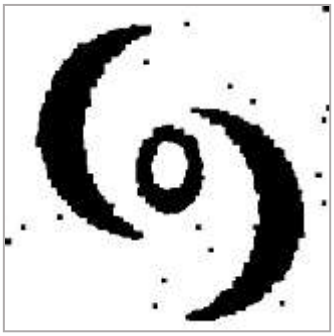
(a)



(b)

Fig 5. (a) Original Image with Fake Visible Copyright (b) Extracted Watermark

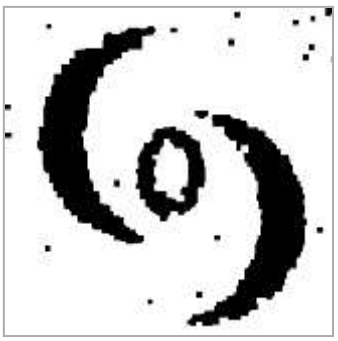
(a)



(b)

Fig 6. (a) Original Image with Distortion (b) Extracted Watermark

(a)



(b)

Conclusion

Template matching was used to match the extracted watermark with the original watermark and the results were noted. The results were positive despite modifications to the original image thus

No.	Type Of Modification to Image	Accuracy of Extracted Watermark
1	Minor Contrast Adjusted	88.14 %
2	Blurred Entire Image	85.58 %
3	Decreased Brightness	77.41 %
4	Salt Pepper Noise Added	87.06 %
5	Fake Visible Watermark Added	88.07 %
6	Distorted Entire Image	86.32 %

Source Code

GitHub: https://github.com/breejesh/DigitalWatermark

References

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4. A Visual Cryptography Based Digital Image Copyright Protection by Adel Hammad Abusitta. http://file.scirp.org/pdf/JIS20120200004_68758797.pdf