WaterMark an Image with SVD

1st Onat Budak
ITU BBF
ITU
istabul, Turkey
budako21@itu.edu.tr

***Abstract*—In the last 2 decade, many digital watermarking schemes have been used. This paper specifically focus on the scheme that proposed by Chin-Chen Changi, Piyu Tsai and Chia-Chen Lin. They developed an algorithm for SVD based water-making they changed the singular values in D. This experiment check the accuracy of their algorithm in pyhton programming language.**

I. Introduction

In the era of the Internet information have became easy to access and more easy to duplicate or copy. This activities is of course illegal and makes the creators violated.For the sake of protecting the copyright of property, people have been proposed several methods. For digital images, most widely used one is watermarking(Changing the host image in a specific way and marking the image) this watermarked image must have 3 properties, it must be hard to delete from the image, it must be hard to detect with human eyes, and the watermark must be extractable from the image in clear way so the ownership can be clear.This paper will review a watermarking scheme made by Chin-Chen Chang , Piyu Tsai , Chia-Chen Lin with singular value decomposition(SVD)

II. Singular Value Decomposition SVD

SVD is one of many numerical analysis method to inspect matrices. With any matrices can be transform to 3 matrices, these are U ,D and V (Respectively in image)

$$C_{m\times n} = U_{m\times r} \times \sum_{r\times r} \times V^{1}_{r\times n}$$

Using SVD to analyze matirces has various advantages biggest one is original matrix does not have to be square matrix. D matrix contains singular values and a change in D matrix is less effective on original image so it can be utilize.

III. SVD Algorithm for WaterMarking

As mentioned before this method proposed by Chin-Chen Chang , Piyu Tsai , Chia-Chen Lin. These scheme utilize D matrix in SVD to mark images, D matrix is sorted(biggest to smallest) and we are using the first element of D matrix and also the biggest element in the matrix to modify the image. After that using inverse of the SVD we reconstruct the image from U ,D and V matrices.

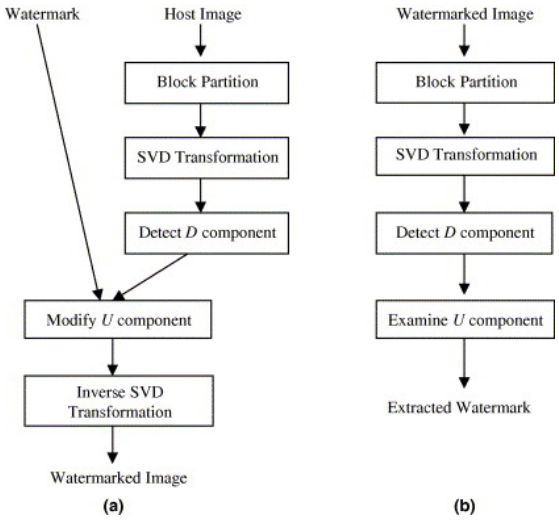
There are 7 steps in embedding watermark

1. Splitting the host image into pieces
2. Performing SVD on to this pieces
3. Finding largest Singular Value in D matrix D(1,1) and quantize it by Q. Z = D(1,1) mod Q
4. When embedded watermark bit value is 1, if Z ¡ Q/4 we have to modify D(1,1) to D(1,1) -Q/4 + Z. Else D(1,1) will be D(1,1) + 3Q/4 - Z
5. When embedded watermark bit value is 0, if Z ¡ 3Q/4 we have to modify D(1,1) to D(1,1) + Q/4 - Z. Else D(1,1) will be D(1,1) + 5Q/4 - Z
6. Multiplying U x D X VT to construct the piece again (inverse SVD).
7. Uniting the pieces to remake the image

Extracting the watermark has 4 steps

1. Splitting the host image into pieces
2. Performing SVD on to this pieces
3. Finding largest Singular Value in D matrix D(1,1) and quantize it by Q. Z = D(1,1) mod Q
4. if Z ¡ Q/2 the corresponding bit in extracted watermark will be 0. Else it will be 1.

With these steps the image is resisting to change but the algorithm can tell the difference which eyes can not see.

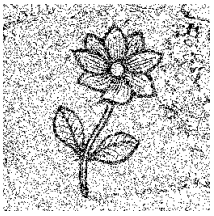


IV. Experiment Results

We have implemented a SVD Function in pyhton with utilizing QR method to find eigen values and eigen vectors.

The problem with QR algorithm it does not find exact values but it converges to them, the meaning of this is (because of the floating point system in pyhton) values can not be zeros or whole number, this result in round off error in every SVD decomposition.

512x512 pictures have been used to hide watermark and the watermark itself is 256x256.



Because of the error that mentioned before the watermark can not be extraced as desired also the host image and the attacked image have PSNR: 27.534982935537556. After the QR algorithm did not work we have utilized the numpy library svd function to find exact values. And tried various image to test results.

PSNR: 33.61454251093673 for panda

PSNR: 32.977047326786675 for deer

PSNR: 49.32607921567465 for Cat

V. Conclusion

In this paper the watermarking scheme proposed by Chin-Chen Chang , Piyu Tsai , Chia-Chen Lin is tested. The SVD they proposed is quite different than other ones before them (DCT, DFT, and DWT). The experiment results quite successful in terms of extracting the watermark even the handwritten SVD can easily be distinguishable.But other than the CAT image, attacked images can also be visible by human eyes this might also be due to Python implementation other languages or other data types might end in better result. The visibilty of attacked images violets the rule of watermarking therefore this method is not suggested by Onat Budak.(All this experiment made in python 3.11.7, it might not work as expected after 3.12)