Optical Watermarking for Defocused Images using 5-Level Transform of DWT and SVD

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Abstract- *Optimal water marking is a inventive technology which has extended widely around the world due to the multimedia contents. In this study we proposed optical watermarking for defocused images which is based on five level discrete wavelet transformation (5-DWT) and singular value decomposition (SVD). Another viewpoint of this study is to computing the robustness of the optical watermarking strategy, which is one of a kind of innovation that can add watermarked data to question picture information brought with advanced cameras with no particular additional equipments structural engineering. Defocusing in pictures can be communicated with convolution with a line-spread function (LSF). We utilized the estimation of full-width at half-maximum (FWHM) of a Gaussian kernel blur as the extent to which pictures were defocused, which could rough LSF. We completed examinations where the efficiency of detection were assessed as we shifted the extent to which pictures were defocused. The outcomes from the analysis uncovered that optical watermarking innovation was greatly robustness against defocusing in pictures.*

Keywords- DWT, SVD, PSNR, MSE, Defocused Image, Optical Watermarking

I. INTRODUCTION

Watermarking technology has spread widely around the globe due to the world-wide distribution of multimedia content through the various methods of networking [1][5][6]. Intellectual Property rights, like copyrights or the photographic rights of content, should be strictly protected in these various situations. We proposed “optical watermarking” technology as one solution to this problem that uses illumination containing invisible watermarked information. When the illumination is projected onto real objects and the photographs are taken by digital cameras, the digital data on the photographs also contain invisible watermarked information. One of the unique features of this technology is that it can be used to embed invisible digital watermarking information in the image data of real objects with spatially modulated illumination. Therefore, this technology has different features from conventional digital watermarking technologies. When conventional digital watermarking technologies are used, images of objects with no copyright protection, such as pictures in museums painted by famous artists, cannot be prevented from being illegally photographed. This is because that watermarked information has to be embedded into the image data before they are used in conventional watermarking technologies. Optical watermarking technology can offer a solution to resolve such difficult situations.

II. DIGITAL WATERMARKING TECHNOLOGY

Digital watermarking rapidly growing research area of digitized images, video and audio has urged the need of copyright protection, which can be used to produce verification against any illegal attempt to either reproduce or manipulate them in order to change their identity. Digital watermarking is technique providing embedded exclusive right information in images. Digital watermarking is a collection of emerging technology, such as signal processing, cryptography, probability theory and stochastic theory, network technology, algorithm design and other techniques.

2.1 Characteristics of Digital watermarking

There are a number of important characteristics that watermark can exhibit, Jalil and Mirza (2010), Bandyopadhyay and Paul (2010). The main characteristics of digital watermarking are classified into major categories as follows.

- Robustness: The watermark should be capable to resist after normal image processing operations such as image cropping, transformation, compression etc.
- Imperceptibility: The watermarked image should appear like same as the original image to the ordinary eye. The observer cannot detect that the watermark is embedded in it.
- Security: An unauthorized someone cannot detect, retrieve or change the embedded watermark.

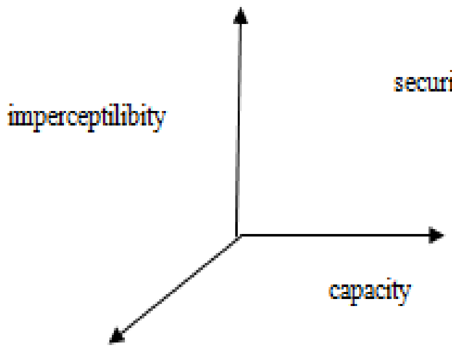


Fig 1 characteristics of digital watermarking [7]

- Transparency: Transparency relates to the properties of the human sensory. A transparent watermark causes no artifacts or feature loss.
- Capacity: Capacity describes how many information bits can be fixed. It also addresses the possibility of embedding multiple watermarks in one document in parallel. Capacity requirement always effort against two other important requirements, that is, imperceptibility and robustness (Fig 4). A higher capacity is usually obtained at the expense of either robustness strength or imperceptibility, or both.

2.2 Properties of Digital watermarking

Watermarking system has some very important popular properties. Some of these properties such as

- Effectiveness: It is the possibility that the information in a watermarked image will be properly detected; it ideally needs this probability to be 1 [8].
- Image fidelity: process of the watermarking that changes an original image to add an information to it; therefore it certainly affects the image quality. We want to keep this poverty of the image quality to a minimum, so no obvious variation in the image fidelity can be noticed [8].
- Payload size: In which every watermarked work is used to contain an information. The size of this information is often essential as many systems require a comparatively big payload to be embedded in a covered work [8].
- False positive rate: It is the number of digital works that are recognized to have a watermark embedded when in reality they have no watermark embedded. This should be reserved very low for watermarking systems [8].
- Robustness: In which a watermarked work is different at the time of its lifetime, either by transmission over a lossy channel or numerous malicious attacks that try to eliminate the watermark or create it undetectable. A robust watermark should be able to withstand additive cropping, Gaussian noise, compression and printing, scanning, scaling, rotation and their operations [8].

An application based on Digital Watermarking
The following application of Digital watermarking is given.

- Copyright protection: It is used to identify and protect official document ownership [10].
- Digital right management: It can be used for description, identification, trading, protecting, monitoring and tracking of all forms of usages over tangible and intangible assets [10].
- Tamper proofing: It is used for fragile in nature [11].
- Broadcast monitoring: In which application the number of television and radio channels delivering content has notably expanded [11].
- Fingerprinting: Fingerprints are the description of an object that tends to differentiate it from other small objects [11].
- Medical application: Names of the patients can be printed on the X-ray reports and MRI scans using techniques of visible watermarking. [9, 11]
- Image and content authentication: In this application the objective is to detect modification of the data. The characteristics of the image, such as its edges, are embedded and compared with the current images for differences.

2.3 Attacks on Digital Watermarking

There are various possible malicious, intentional or unintentional attacks that a watermarked matter. The accessibility of a wide range of image processing soft ware's made it possible to achieve attacks on the robustness of the watermarking systems. The aim of these attacks is foil the watermark from performing its intended purpose. A brief introduction to various types of watermarking attacks is follows.

- Removal Attack: In these attacks mean to remove the watermark data from the watermarked object.
- Geometric attack: All manipulations that distress the geometry of the image such as flipping, rotation, cropping, etc. should be detectable [7].
- Protocol Attack: In this attack does neither mean at destroying the embedded information nor at disabling the detection of the embedded information.
- Cryptographic attacks: It is dealing with the brilliancy of the security. [12]

III. LITERATURE REVIEW

Neha Narula (2015) et al presents that the Digital watermarking is an application related to the copyright security. Any digital object can be used as a carrier to carry knowledge. If the knowledge relates to object, then it is wellknown as a watermark which can be invisible or visible. In the era of digital knowledge, there are the multiple risk regions like copyright and integrity violation of digital objects. In case of any dispute during violation, content creators can prove ownership by recovering the watermark. In this paper, a comparative study of two more recent digital watermarking techniques, namely DWT and DWT-SVD over RGB images is presented. In case of DWT (Discrete Wavelet Transform) watermarking technique, decomposition of the original image is done to embed the watermark and in case of DWT-SVD watermarking technique, firstly original image is decomposed according to DWT and then a watermark is embedded in singular values obtained by applying SVD (Singular Value Decomposition). The performances of the proposed techniques are compared on the basis of PSNR values. [14]

Ms. Roshan Jahan (2013) et al present that in this paper a new digital image security scheme is applied, which incorporates watermarking algorithms using DWT-SVD and optimized chaotic based image encryption obtained through genetic algorithm with high level of robustness and security. In this proposed scheme first of all the watermark image has been encrypted using the best hybrid model for image encryption composed of genetic algorithm and chaotic function. After that the encrypted image is embedded into the original image to form the watermarked image. In the first stage of the proposed encryption algorithm encrypted images are constructed using secret key and chaotic function. In the next stage, these encrypted images are used as initial population for genetic algorithm. In this paper, a first time genetic algorithm has been applied to the watermark image for encryption. The similar coefficient NC, peak noise to signal ration (PNSR) and correlation coefficient (CR) are used to evaluate the transparency, robustness and security of the algorithm. All the Experiment has been performed in MATLAB and outcomes are provided to illustrate that the proposed approach is providing good results. [15]

Pooja Malhotra (2013) et al present that Robustness geometric against the distortion is one of the crucial most important subjects in watermarking. In this paper, a novel DWT-SVD (discrete wavelet transform- singular value decomposition) image watermarking algorithm that is robust against ordinary image processing and affine transformation is presented. And also use DWT transform to obtain four various frequency subbands. Watermarking is embedded in the high frequency subbands by SVD (singular value decomposition). This is unlike classical viewpoint that assumes watermarking should be embedded in middle or low frequency to have good robustness. PSNR (Peak signal to Noise Ratio) and Normal Cross Correlation are computed to measure image quality and template matching. In addition, the competency of the suggested system is confirmed under geneal image processing operations and a comparative study is made against our past method [16]

Sumit Kumar Prajapati (2012) et al present that With the rapid growth of the Internet and the development of digital multimedia technologies, illegal copying, tampering, modifying and copyright protection has become very important issues. Hence, there is a strong need of developing the techniques to face all these problems. Digital watermarking emerged as a solution for protecting the multimedia data. In this paper, the propose a method of nonblind transform domain watermarking based on Discrete Wavelet Transform- Discrete cosine Transform- Single Value Decomposition. The Discrete cosine Transform coefficients of the Discrete Wavelet Transform coefficients are used to embed the watermarking information. The parameters used to test the robustness of the proposed algorithm are the Peak Signal to Noise Ratio (PSNR) and Weighted Peak Signal to Noise Ratio (WPSNR) and correlation coefficient (ρ).Also, Robustness of the proposed algorithm are tested for various attacks including salt and pepper noise and Gaussian noise, salt & pepper, sharpened and contrast adjustment. The experimental results show that the proposed method is more robust against different kinds of attacks and the watermarked image has good transparency. [17]

Seema (2012) et al present that In order to improve the robustness and imperceptibleness of the algorithm, a novel embedding and extracting method with Discrete Wavelet Transform- Single Value Decomposition is proposed. The approximation matrix of the third level of image in Discrete Wavelet Transform domain is modified with Single Value Decomposition to embed the singular value of the watermark to the singular value of Discrete Wavelet Transform coefficient. The suggested extracting and embedding technique was employed to accelerate the hybrid Discrete Wavelet Transform - Single Value Decomposition watermarking and to avoid the lack of watermark. This hybrid technique leads to optimize both the fundamentally conflicting requirements. The experimental outcomes describe both the good robustness under various attacks and the high fidelity. The time needed to achieve the program is greatly decreased.[18]

IV. PROPOSED METHODOLOGY

In our algorithm, we worked on optical water-marking using 5- DWT and SVD:

Discrete Wavelet Transform (DWT)-

DWT includes deterioration of the picture into frequency channel of steady data transmission. This causes the closeness of accessible disintegration at each level. DWT is executed as multistage change. Level wise deterioration is finished with multistage transformation.

Singular Value Decomposition (SVD)-

A picture can be presented to as a network of positive scalar qualities. Formally, SVD for any picture say an of size $m \times m$ is a factorization of the structure given by $A=USV^T$, where U and V are orthogonal grids in which sections of U are left singular vectors and segments of V are correct particular vectors of picture A. S is a corner to corner network of singular values in decreasing way. The essential thought behind SVD system of watermarking is to discover SVD of the picture and the modifying the singular quality to insert the watermark. In Digital watermarking plans, SVD is utilized because of its primary properties:

1) A little unsettling included the picture, does not bring about the vast variety in its singular qualities.

2) The singular quality represents to characteristic mathematical picture properties.

Proposed Algorithm

Embedding Process

1) Consider an N x Ngray image size.
2) Change image into double for fast processing.
3) Apply Gaussian Kernel blur with window size 16x16 (defocused image).
4) Apply 5-DWT on cover defocused image and watermark defocused image, then cover defocused image is split into four bands: c_LL4,c_LH4,c_HL4,c_HH4 and watermark defocused image is split into four bands: s_LL4,s_LH4,s_HL4,s_HH4
5) Apply SVD on c_LL4 and s_LL4 band on cover defocused image and watermark defocused image.

   $$S= S_1+\beta S_2,$$

   where β is scaling factor for controlling strength of an image, S is singular matrix, S_1 and S_2 are singular matrix of cover defocused image and watermark defocusssed image
6) Apply SVD formula for combining orthogonal and singular matrix of both images:

   $$SVD=S*U*V^{'}$$

   Where U and $V^{'}$ are orthogonal matrix, and S is singular matrix.
7) Apply 5-IDWT for reconstruct the matrix

Extraction Process

8) Again, using 5-DWT on watermarked image, then split into four new bands: wm_LL4, wm_LH4,wm_HL4,wm_HH4
9) Again,apply SVD on wm_LL4 watermarked image and extract watermark image using this formula:

   $$S=S_3-S_1/\beta$$

   Where S_3 is a singular matrix of watermarked image
10) Apply inverse five level DWT (5-IDWT) for reconstruct the matrix.
11) Calculate the PSNR &MSE of watermarked image.

   $$MSE(x) = \frac{1}{N}||x - x^\wedge||^2 = \frac{1}{N}\sum_{i=1}^{N}(x - x^\wedge)^2$$

   $$\text{PSNR} = 10log_{10}\frac{Max(x)}{MSE(x^\wedge)}$$

   Where x is cover defocused image and $x^\wedge$ *is* watermarked, N is size of cover defocused image

1) Image Dataset

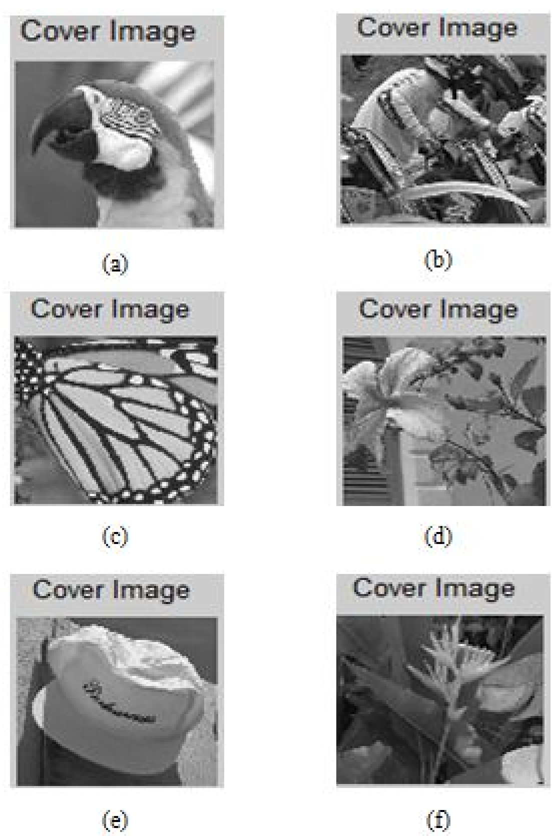


Fig 2. Image Dataset

2) Read Cover Image and Watermark Image

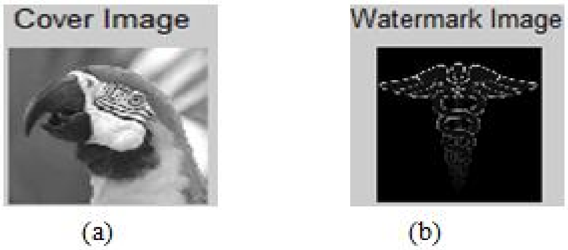


Fig 3. (a) Show Cover Image and (b) Watermark Image

3) Defocused Cover Image and Defocused Watermark Image with Gaussian Kernel Blur

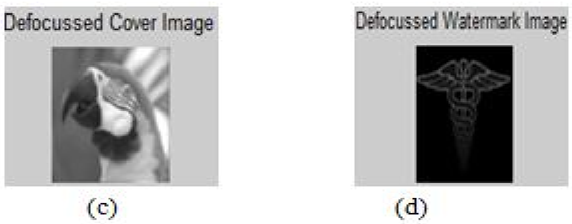


Fig 4. (a) Show Cover Defocused Image and (b)Watermark Defocused Image

4) Embedded Image

Fig 5. Show Watermarked Image

5) Apply Noise Attack with 0.001 density

Fig 6. Show Noise Attack, Recovered Cover Defocused Image and Extracted Watermark Defocused Image

6) Apply Rotate Attack with 10°

Fig 7. Show Rotates Attack, Recovered Cover Defocused Image and Extracted Watermark Defocused Image

V. RESULT ANALYSIS

Image	Base MSE	Base PSNR
(a)	0.3094	53.2260
(b)	0.1945	55.2409
(c)	0.2781	53.6890
(d)	0.2396	54.3364
(e)	0.2583	54.0088
(f)	0.1198	57.3454

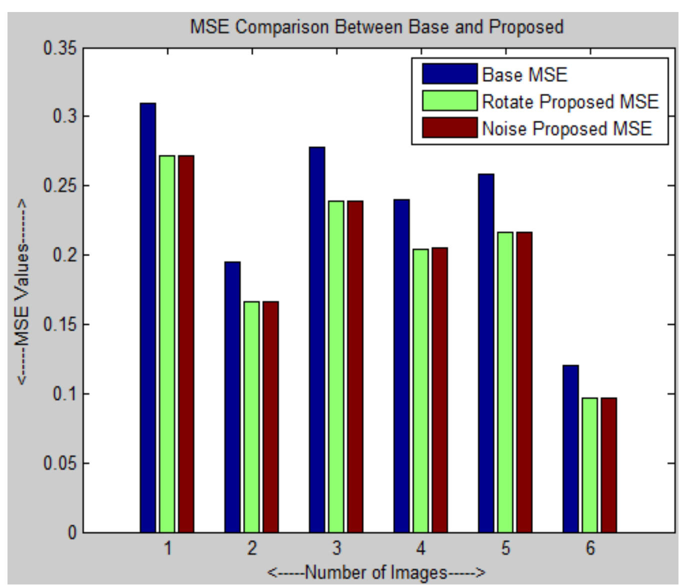
Table1. Show Base MSE and PSNR Results

Image	Proposed MSE	Proposed PSNR
(a)	0.2719	53.7860
(b)	0.1668	55.9077
(c)	0.2387	54.3526
(d)	0.2047	55.0191
(e)	0.2164	54.7773
(f)	0.0971	58.2601

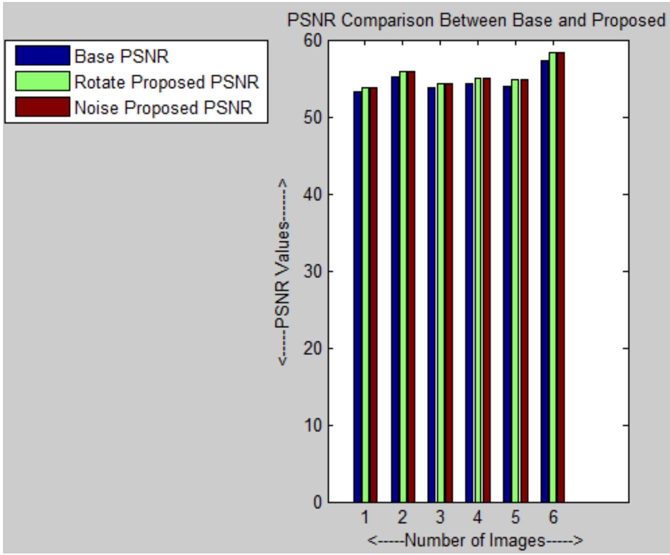
Table2. Show Proposed MSE and PSNR Results For Noise Attack

Image	Proposed MSE	Proposed PSNR
(a)	0.2719	53.7873
(b)	0.1668	55.9098
(c)	0.2386	54.3539
(d)	0.2046	55.0209
(e)	0.2164	54.7789
(f)	0.0970	58.2639

Table3. Show Proposed MSE and PSNR Results For Rotate Attack



Graph 1. MSE Comparison between Base and Proposed System



Graph 2. PSNR Comparison between Base and Proposed System

VI. CONCLUSION

In this study, we present optical watermarking for defocused image which is based on five level discrete wavelet transform (5-DWT) and singular value decomposition (SVD). In this paper, we present another viewpoint to computing the robustness of the optical watermarking strategy, which is a one of a kind innovation that can add watermarked data to question picture information brought with advanced cameras with no particular additional equipment structural engineering. In the experimental results, we evaluated accuracy on the basis of paek signal noise ratio and mean square error. These experimental outcomes depend on upon the qualities of the particular optical framework utilized as a part of the experiments. Be that as it may, in light of perceptions of the defocused pictures (confined point pictures and watermarked region pictures) in the experimental results, we found that optical watermarking innovation has high resistance to defocused pictures.

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