



Advanced Image Watermarking Using SVD Technique

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Abstract— Digital image watermarking is the enabling technology to prove ownership of copyrighted material, to solve the problem of piracy and to detect the originator of illegally made copies. Digital watermarking is a technique which allows an individual to add hidden copyright notices or other verification messages to digital audio, video, or image signals and documents. The information which is embedded is called watermark which can be visible or invisible depending upon whether the watermark appears visible or invisible to the casual viewer. The objective of the presented research work is to present a more secure dual level, simple, highly imperceptible, and robust watermarking technique. In this research work, a dual Level semi blind image watermarking scheme in transformed domain is proposed. Singular Value Decomposition (SVD) is used to transform the image. The two watermarks are embedded into green component and blue component of the image. To generate the edge image canny edge detector is used. The proposed algorithm is implemented and experiments are conducted to check the performance of the algorithm using MATLAB 7.10.0 version. The performance of the presented image watermarking algorithm is evaluated on the basis of Imperceptibility, security, complexity, embedding time, and robustness and experiments are conducted on many colored images of various sizes.

Keywords— S.V.D, watermark, edge-detection

I. INTRODUCTION

In the past duplicating art work was quite complicated and required a high level of expertise for the counterfeit to look like the original. However, in the digital world this is not true. Now it is possible for almost anyone to duplicate or manipulate digital data and not loose data quality. So watermarking has become a major field to solve the problems of illegal manipulation, distribution and piracy of digital media [44, 45]. Digital watermarking is a technique which allows an individual to add hidden copyright notices or other verification messages to digital audio, video, or image signals and documents. Such hidden message is a group of bits describing information pertaining to the signal or to the author of the signal (name, place, etc.).

The information which is embedded is called watermark. It can be text or an image. Two types of digital watermarks may be distinguished, depending upon whether the watermark appears visible or invisible to the casual viewer. Visible watermarks can be a logo or text on frames of videos either in all frames or in just a few selected frames. Invisible watermarks or Hidden watermarks on other hand are present in the file in such a way that they cannot be sighted but have to be extracted. Watermarking can be classified according to working domain, type of document to be embedded, and human perception. According to the working domain watermarking can be classified into two categories: Spatial domain watermarking, and transform-domain watermarking

Into the field of watermarking, a survey of articles found in literature describes an in-depth understanding and knowledge of image watermarking techniques. The whole work tries to solve the authentication problem and embed the watermark in such a way that it could not be removed or degraded from the image after various media operations. But still these algorithms are not secure. By attacking the watermarked media someone can easily pirate or copy the media contents by removing the watermark from the media. So the problem is to make any algorithm more secure and achieve high authenticity for original image.

II. LITERATURE REVIEW

In 1994 Van Schyndel et al [1] changed the LSB of an image to embed a watermark. Since then, more and more researchers have studied digital watermarking problem. In general, watermark can be embedded in spatial domain or transform domain or compressed domain of the multimedia. Spatial domain techniques directly modulate the pixels. In the spatial domain approach, such as van Schyndel et al [1], Johnson and Katezenbeisser [2], Kimpan *et al.* [3], Verma *et al.* [4], Jassim Mohammed Ahmed and Zulkarnain Md Ali [5], the pixel value of an image is modified to embed watermark information. R.G.Van Schyndel et al. [1] in 1994 discuss two methods of watermarking. The first is based on bit-plane manipulation of the LSB, which offers easy and rapid decoding. The second method utilizes linear addition of the watermark to the image data and is more difficult to decode, offering inherent security. The LSB technique was later improved by Johnson and Katezenbeisser [2] in 1999, which included an additional security, by using an pseudo-random number generator to determine the pixels to be used for embedding based on a given "seed" or key. A variable block size based adaptive watermarking, in spatial domain was proposed by Kimpan *et al.* [3], where the original image was

divided into different blocks of varied size and the watermark was embedded into the blocks by analyzing and adjusting the brightness of a block. In a later period of 2006, Verma *et al.* [4] proposed a probability block based watermarking method for color image with fixed block size. In 2011, Jassim Mohammed Ahmed and Zulkarnain Md Ali [5] made an improvement to the LSB technique by randomly embedding the bits of the message in the image to produce more secured system. In 1996, J.J.K.O'Runaidh *et al.* [6] present a perceptual watermarking method operating in the transform domain. They argue that water marking needs to be adaptive in order to be robust and place the watermark in the perceptually most significant components of the image. A. Rajani, T. Ramashri [14] proposed developed a watermarking algorithm in a combination of Discrete Cosine Transform (DCT), Singular Value Decomposition (SVD) frequency domains and Canny Edge detection technique. The proposed algorithm is a Non-blind watermarking algorithm. By using SVD the robustness of the algorithm can be increased. By incorporating edge detection technique invisibility of the watermark can be increased. The proposed algorithm is more secure and robust to various attacks like JPEG Compression, rotation, histogram equalization, scaling, cropping, salt & pepper noise, and filtering etc.

III. IMPLEMENTATION OF PRESENT WORK

In this research work, a dual Level semi blind image watermarking scheme in transformed domain is proposed. Singular Value Decomposition (SVD) is used to transform the image. The two watermarks are embedded into green component and blue component of the image. One of the watermarks used is binary watermark and other is grayscale watermark. The binary watermark is the edge image generated from the original image. To generate the edge image canny edge detector is used. And the second watermark is any grayscale image. To preserve the quality of the original image & keep the algorithm more imperceptible and robust the SVD of a layer/component of an image is computed to obtain two orthogonal matrices U and V and a diagonal matrix S. The watermark W is added into the matrix S but this watermarked S is not used for inverse SVD as ater adding watermark it becomes non singular matrix which will degrade the quality of the matrix so to maintain the quality of the image a new SVD process is performed on the new matrix $S+kW$ to get U_w , S_w and V_w . Then this S_w is used in the inverse SVD process which keeps the algorithm more imperceptible. A scaling factor is used to control the strength of the watermark to be embedded. A high scaling factor degrades the quality of the image but makes the algorithm more robust again various attacks. And a low value improves the imperceptibility of the algorithm. The block diagram of proposed embedding and extraction processes of watermarking are given in Figures 1 and 2 respectively.

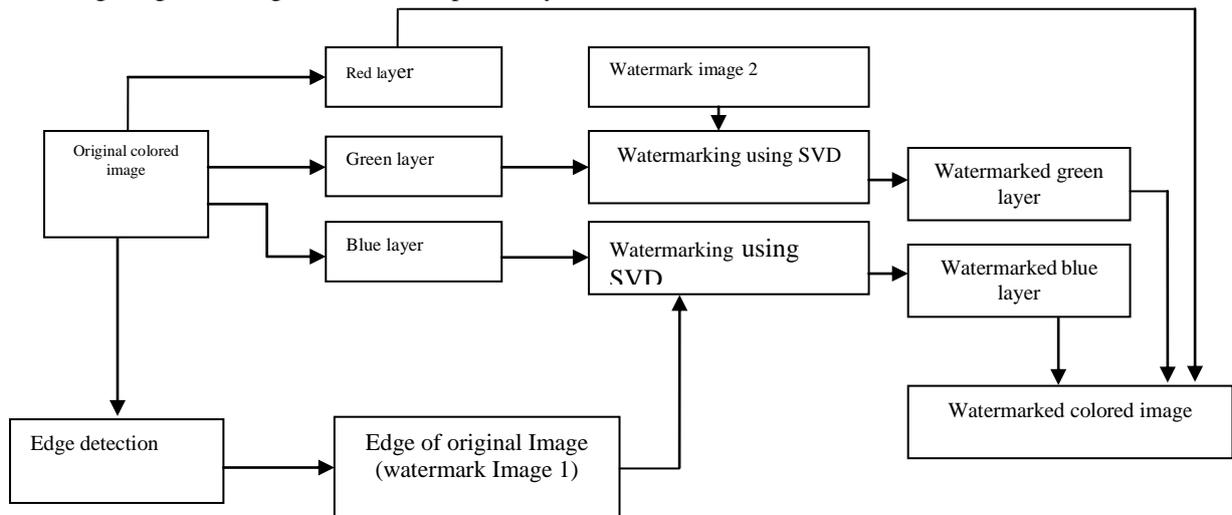


Figure 1: Watermark Embedding Process

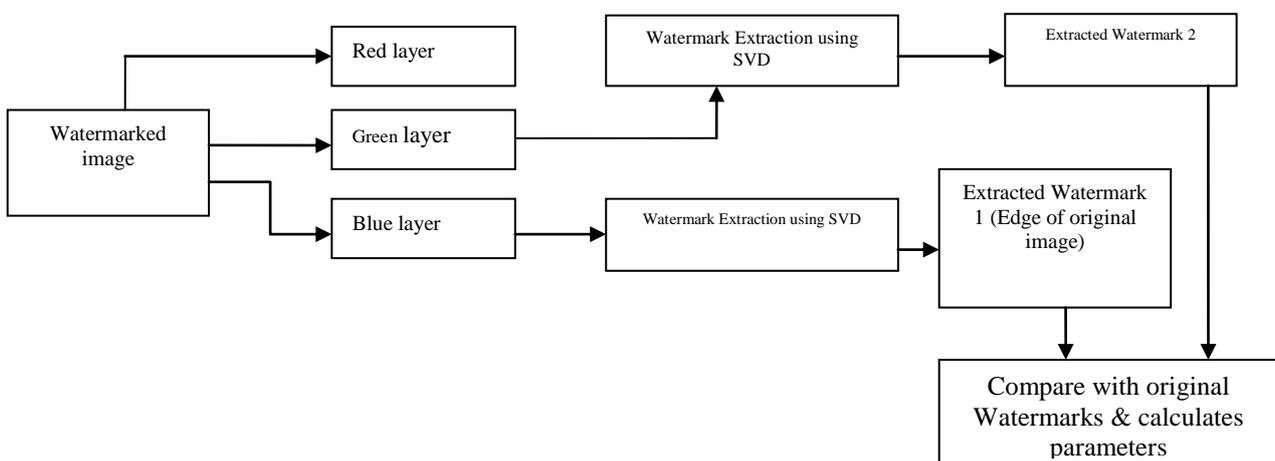


Figure 2: Watermark Extraction Process

IV. RESULTS AND CONCLUSIONS

A novel approach described for dual level image watermarking is implemented and experiments are conducted for watermark embedding and extraction using MATLAB 7.10.0 version. The performance of the presented image watermarking algorithm is evaluated on the basis of Imperceptibility, security, complexity, embedding time, and robustness. The performance of the proposed image watermarking algorithm is evaluated using many standard & non standard colored images of various sizes as original image and various grayscale images of same size as watermark image. The various images used as original image are “Lena”, “Baboon”, “Peppers”, “Baby”, & “Penguin” and various images used as watermark 2 are “Cameraman”, “Rice”, & “CU Logo”. All these images along with their information like size, format, and bits per pixel are tabulated in table 1.

Table 1: Original and Watermarked Images used in Experiments

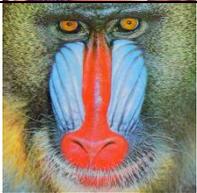
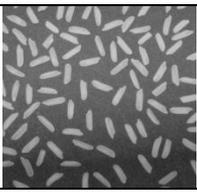
| S. No. | Image Name | Size | Format | BPP | Image |
|--------|--------------------------------|----------------|-----------|-----|---|
| 1 | Lena (Original Image) | 512 X 512 X 3 | Colored | 24 |  |
| 2 | Baboon (Original Image) | 512 X 512 X 3 | Colored | 24 |  |
| 3 | Peppers (Original Image) | 512 X 512 X 3 | Colored | 24 |  |
| 4 | Baby (Original Image) | 276 X 260 X 3 | Colored | 24 |  |
| 5 | Penguin (Original Image) | 768 X 1024 X 3 | Colored | 24 |  |
| 6 | Cameraman (Watermark Image) | 512 X 512 | Grayscale | 8 |  |
| 7 | CU Logo (Watermark Image) | 512 X 512 | Grayscale | 8 |  |
| 8 | Rice (Watermark Image) | 250 X 250 | Grayscale | 8 |  |

Figure 3 shows these original, both watermarks, and watermarked images. The watermarked image is not distorted after embedding both the watermarks and is visually almost same to the original image as shown in figure 3(a) and 3(d).



Figure 3: Watermark Embedding Results (a) Original Image (b) Edge of original (Watermark 1) (c) Watermark 2 (d) Watermarked Image

To prove the proposed algorithm imperceptible, as a measure of quality of the watermarked image Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR), and Bit Error Rate (BER) is calculated respectively for watermarked image. The values for these parameters for various original & watermark images are tabulated in table 2.

Table 2: MSE, PSNR and BER for various watermarked images

| S. No. | Original Image | Watermark image 2 | MSE | PSNR | BER |
|--------|----------------|-------------------|--------|---------|--------|
| 1 | Lena | Cameraman | 0.0002 | 84.4471 | 0.0118 |
| 2 | Lena | CU Logo | 0.0019 | 76.9342 | 0.217 |

The presented algorithm is more secure than the existing one due to the presence of the 2nd watermark and due to high robustness of proposed algorithm this second watermark is not disturbed too much with attacks. Improved values of PSNR & MSE show the better imperceptibility of the presented algorithm than previous algorithms. High value of the PSNR in case of the presented algorithm shows its better robustness over the other methods of watermarking.

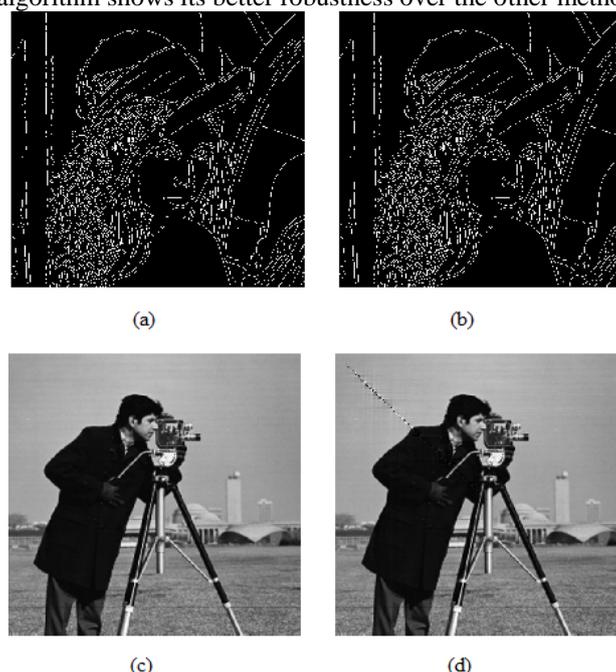


Figure 4: Watermark Extraction Results (a) Original watermark 1 (b) Extracted watermark 1 (c) Original watermark 2 (d) Extracted watermark 2

Similarity between the original watermarks and the extracted watermarks from the watermarked image is measured by computing correlation factor ρ , MSE, PSNR, and BER. Original watermarks and extracted watermarks from the watermarked “Lena” image (fig. 3d) are shown in figure 4. Correlation factor (ρ), MSE, PSNR, BER of extracted watermarks with the original watermarks is tabulated in the table 3. Also the proposed algorithm is robust to the various attacks like Gaussian noise attack, speckle noise attack, and salt & pepper noise attack. The calculated values of all the parameters are tabulated in table 3. Higher values of PSNR and correlation factor values closer to 1 show the high robustness of the proposed algorithm to the speckle, Gaussian, and salt & pepper noise attacks.

Table 3: Parameters of extracted watermarks

| Attack | Parameter | W1 & RW1 | W2 & RW2 |
|----------------------------|-------------------------------|----------|----------|
| Without Attack | Correlation factor (ρ) | 0.9990 | 0.9969 |
| | MSE | 0 | 0.9234 |
| | PSNR | Inf | 48.4770 |
| | BER | 0 | 0.0207 |
| Speckle Noise Attack | Correlation factor (ρ) | 0.9860 | 0.8470 |
| | MSE | 0.0019 | 97.0096 |
| | PSNR | 74498 | 28.2627 |
| | BER | 0.0132 | 0.0353 |
| Gaussian Noise Attack | Correlation factor (ρ) | 0.9841 | 0.7661 |
| | MSE | 0.0021 | 104503 |
| | PSNR | 74.8733 | 27.9003 |
| | BER | 0.0133 | 0.0358 |
| Salt & pepper Noise Attack | Correlation factor (ρ) | 0.9859 | 0.8745 |
| | MSE | 0.0019 | 95.5322 |
| | PSNR | 74231 | 28.3293 |
| | BER | 0.0133 | 0.0353 |

The proposed image watermarking & extraction algorithm in this thesis work is compared with existing algorithm described by R. K. Singh et. al. in [20]. The performance of the algorithm described in [20] is compared with the proposed algorithm in table 4. The presented approach of image watermarking is found better than this traditional approach of LSB DCT in many aspects as discussed below.

In [20] R. K. Singh et. al. presented multilevel watermarking using LSB technique and DCT transform.

Table 4: Comparison of Proposed Algorithm with existing work

| Performance Parameters | | Literature [58] (LSB-DCT Technique) | Proposed Algorithm |
|------------------------------|------|-------------------------------------|----------------------------|
| Imperceptibility Performance | PSNR | 30.01 | 84.45 |
| | MSE | 637 | 0.0002 |
| Embedding Time | | Not Described | Very Small (10-15 Seconds) |
| Complexity | | Simple | Simple |
| Data Payload | | Low 1 bit/pixel | High (8 bits/pixel) |
| Robustness (Watermark 1) | PSNR | 21.32 | Inf |
| Robustness (Watermark 2) | PSNR | 18.97 | 48.48 |

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