Visual Binary Watermark Embedding in Corner Points

Ersin Elbasi, and Naim Olcer

***Abstract*—** Nowadays digital watermarking is one of the popular research areas. Watermarking is an information hiding technique used to hide a mark. In this study we proposed a novel robust image watermarking via finding corner points. In this novel algorithm small watermarks have been embedded discrete wavelet coefficients of cover image. Ten different attacks are applied to watermarked image to measure quality of watermark. Scope of the study is showing variations of peak signal to noise ratio and similarity ratio values on different attacks on square regions and comparing these values after attacks**.**

***Keywords*—**Watermarking, corner detection, wavelet, copyright protection.

I. Introduction

Digital watermarking is an information hiding technique to hide a mark such as image, signal, serial number or text in multimedia element. Application areas of watermarking are copy control, copyright protection, broadcast monitoring, fingerprinting, medical applications and content authentication. In the real world, watermarking techniques can be implemented to many different areas, such as photograph, audio and video. The hidden object is the watermark while the carrier is the marked object. There are three types of watermarks: Fragile, robust, and invertible. Fragile watermarks are destroyed if the carrier image is subject to considerable modifications. Robust watermarks cannot be removed from the image unless the image is totally destroyed. Robust watermarks resist all types of known modifications. Invertible watermarks can be recovered from the carrier image using a given key, while non-invertible watermarks can be detected but not recovered.

Jane and Elbasi presented a study about combination of Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD) to embed watermark and lower and upper (LU) decomposition non blind watermarking algorithm to detect watermark [1]. Fang and Tian worked on improved blind watermarking algorithm based on two dimensional DWT. They used Arnold scrambling before embedded the watermark to improve security. In the extracting process, they had used only relevant key without the original image. Their algorithm had applicable for grayscale and color images [2]. Lu and et al. presented digital image watermarking based on DWT and sub-sampling. Sub-images sequences are constructed as a video segment and watermark is embedded in DWT domain of each sub-image by using video watermarking techniques [3].

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Liu and Zhao proposed a watermarking method based on feature points detected by using adaptive threshold and it satisfied to decide most robust feature points. Vertexes of triangle was found by modified Harris corner detection and watermark embedded in this triangle. They used Human Visual System to guarantee the image quality [4]. To protect copyrights Madane and Shah applied an algorithm of digital image watermarking by using DWT. They used principle component analysis (PCA) for learning of low dimensional representation in the context of image. With their algorithm the PCA algorithm is able to detect all the types of watermark images [5]. Yang and et al. also studied with content based watermarking technique that robust geometry attacks. They proposed Multi-scale Curvature Product (MSCP) corner detection algorithm which is detected corners from the low frequency components of the images after 3-level lifting wavelet transformation. They compared their second-generation digital image watermarking algorithm with the algorithms of the first generation watermarking [6]. To solve security of digital medical image problem Miao and et al. had study about zero watermarking encryption algorithm based on the Arnold scrambling to preprocess original watermarking and Discrete Fourier Transform (DFT). To provide double protection for medical images their algorithm combines the image visual feature vector [7]. Viswanatham and et al. presented a hybrid algorithm that combine DWT and DCT. To evaluate their study with peak signal to noise ratio (PSNR) value and also looking correlation between original and watermarked image [8-11].

II. Methodology

In this study, employing corner detector, watermark embedding, several images attacks and watermark extracting algorithm were used. Firstly, corners of image found with Harris corner detector [9]. Then, select one corner point from detected corners. After that, drawing a square with edge 70 and cropping this square from original image. Then, embedding watermark image to this cropping image. In watermark embedding procedure, input is a cropped image (A) and binary image watermark (W), output is watermarked image (AW). First, using DWT, decompose the cover work, A, into four sub bands: approximate (LL), horizontal (HL), vertical (LH) and diagonal sub bands (HH). Then, decompose LL band into LU factorization with its components L, diagonal matrix (D) and U. Apply SVD to D and apply SVD to W. After this applying, modify SDw, the singular values of D component, by adding the singular values of the watermark, W, with the scaling factor α. Since the singular value of the watermark image is directly added to the singular values of D with the scaling factor, it is wise to reconstruct D by updated

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coefficient Dw. Because the D of LL sub band is updated, it is time to gather L, Dww and U to obtain LL1w. After that, compute the inverse DWT to obtain the watermarked cover image, AW. Finally, store the locations of 1's in W in order to use them as a key in the extracting algorithm [4].

After that, applied several images attacks on original image, these are Filter Attacks, Scaling, Gaussian Attacks, Histogram Equalization Attacks, Gamma correction Attacks, JPEG Compression Attacks, Rotation Attacks, Intensity Adjustment Attacks, Noise Attack Pepper & Salt, Speckle Noise Attacks, and Decoding Attacks.

Finally, watermark extracting algorithm procedure is as input is attacked watermarked image (AW*) that shows same corner point cropped image and the output is extracted watermark (W*). First, using DWT, decompose watermarked and possibly attacked image, AW*, into four sub bands: LLw, LHw, HLw, and HHw. Then decompose LLw into LU factorization with its components and apply SVD to D*. After that, extract the singular values of the watermark Sw* and the watermark with its SVD components. Finally, use the key which is the location of pixels stored in the embedding algorithm. If the mean value of pixels in the key (TH) for W* is positive, assign that pixel value to binary 0, otherwise to binary 1. After the extract image, PSNR and similarity ratio (SR) calculated and compared for each attacks.

Steps of proposed algorithm are shown in Fig. 1.

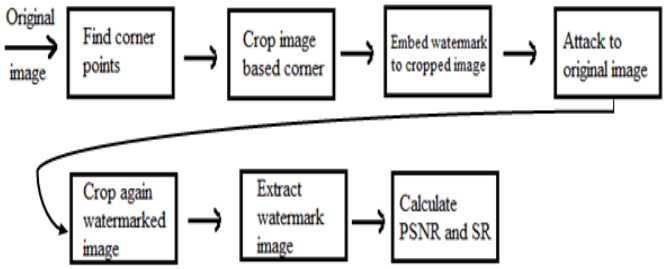
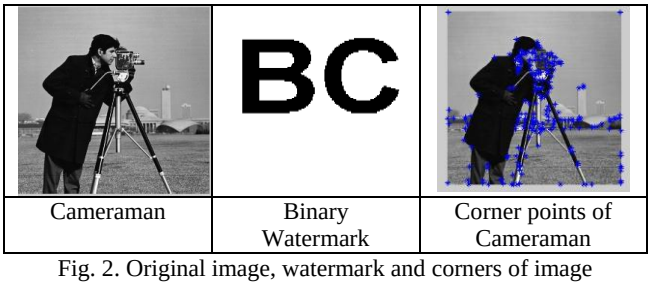


Fig. 1.Steps of proposed algorithm

III. EXPERIMENTS

Original image that is Cameraman image respectively are 8 bit 256x256 gray scale images, watermark image and all corner points which are detected with Harris corner method are shown in Fig. 2. In this study, invisible watermarking was used.



Cameraman	Binary Watermark	Corner points of Cameraman

Fig. 2. Original image, watermark and corners of image

MATLAB was used for all ten different attacks. These attacks parameters are filter attack used window size is 3x3 with using two dimensional correlation, scaling attack resized image 256 to 128, Gaussian attack mean is zero, variance is 0.001, histogram equalization attack used automatic, Gamma attack used gamma is 1.5 that mapping is weighted toward lower output values, JPEG compression used quality is 25, rotation attack used 20^0 angle, intensity adjustment used low and high intensities 0 and 1, pepper &salt noise attack used noise density 0.2, speckle noise attack used variance 0.2. The attacked images are shown in Fig. 3.

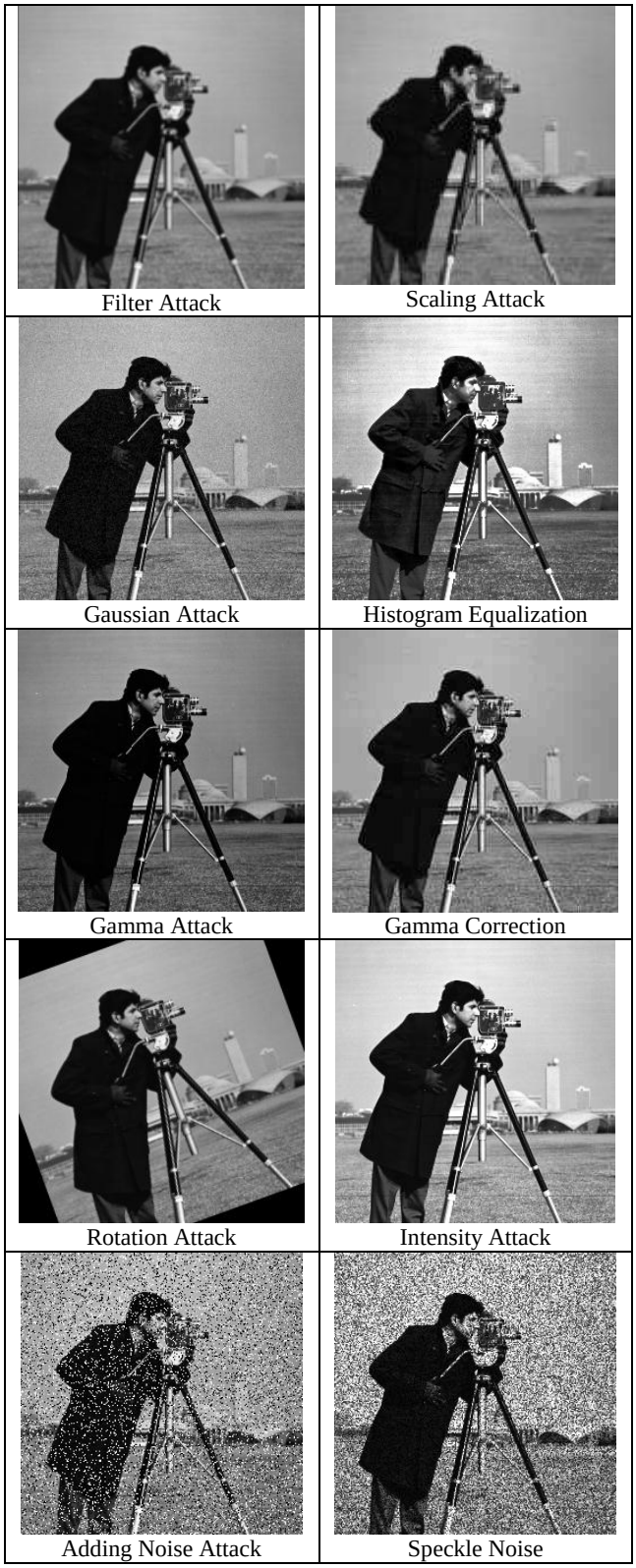


Fig. 3. Attacks on watermarked image

In this study, PSNR and SR are used to measure quality. PSNR that is used as a measure of quality of reconstruction in image watermarking, and SR that is division of represent the number of matching pixel values in compared images and the number of different pixel values in compared images. Figure 4 shows that original image, first level DWT decomposition and selected corner square region with PSNR values before and after filter attack.

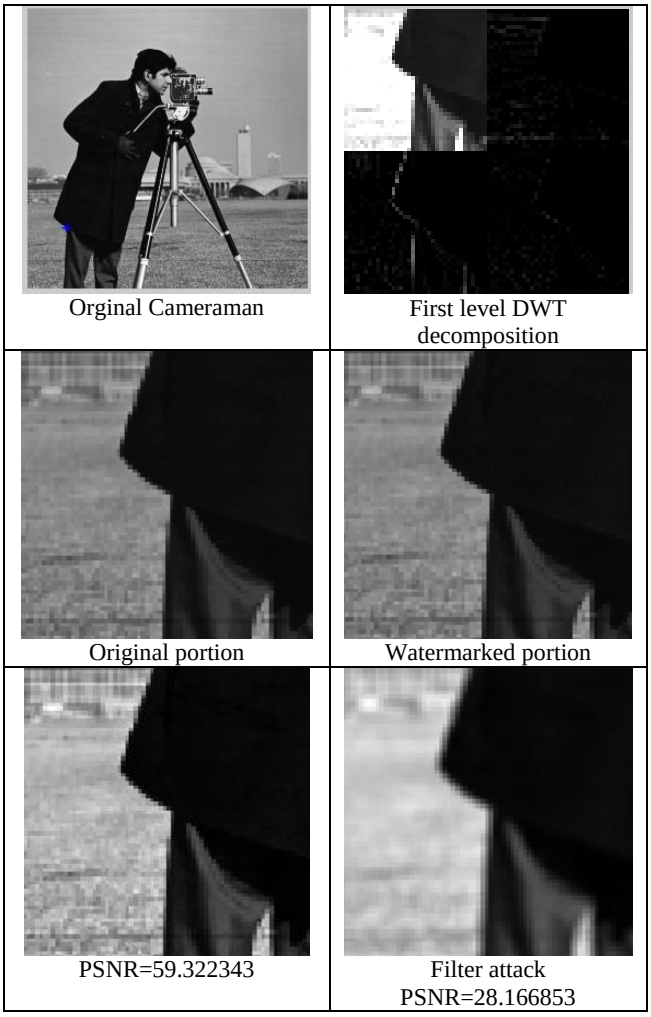


Fig. 4. Embedding in corners, watermarked portion, attacks

Figure 5 shows that all SR values for image attacks to watermarked image.

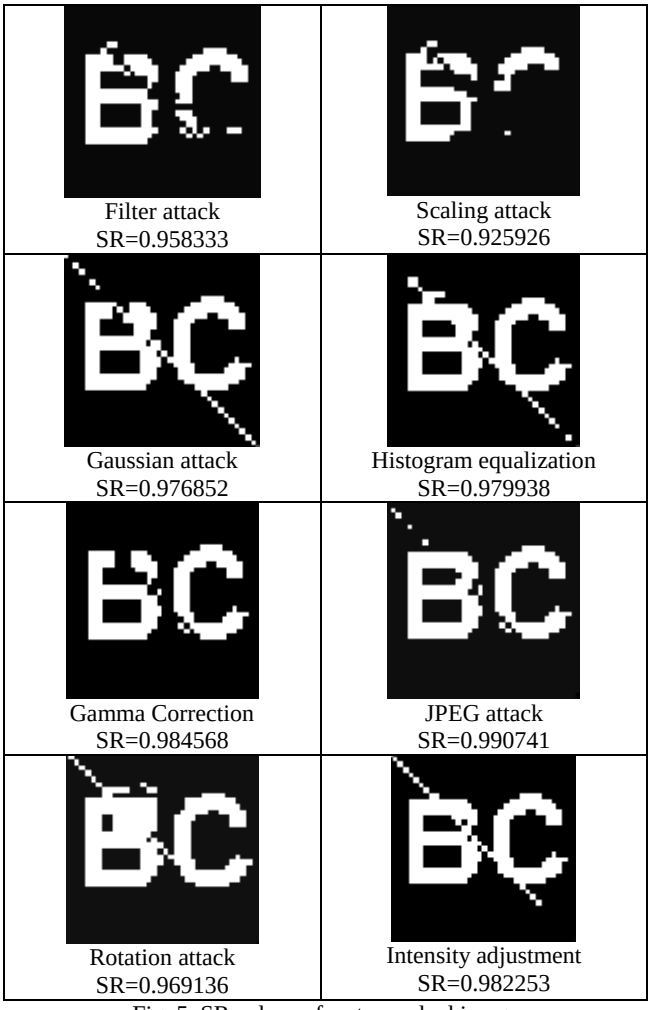


Fig. 5. SR values of watermarked image

In Table 1 the PSNR and SR values are calculated for image and respectively presented. The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images; original and watermarked image. The higher the PSNR shows the better the quality of the compressed or reconstructed image. For two images that are perfect copies of each other PSNR value is infinity. Since PSNR is in logarithmic scale slight improvements are sufficient. For instance, PSNR before rotation attack is 59.322343; this value is watermarked image's PSNR value. However its PSNR value changed after rotation attack. It could be 8.595790. This difference between PSNR values, show us, this image not an original watermarked image. So, original watermarked images had some change. The SR between two images is used as quality measurement; it is calculated similarity between watermark images after and before attack. When different pixel values converge to 0, SR will be close to 1 which is the optimum and desired condition. SR for original watermark image is 1. Recovered watermarks quality under the above attacks is assessed based on subjective evaluation of SR. In all attacked cases the SR value is more than 0.9. If the image is original watermarked image, PSNR and SR values will be same or similar before and after attack.

TABLE I
PSNR, PSNR_AFTER AND SR VALUES

Attacks	PSNR	PSNR_After	SR
Filter Attack	59,322343	28,166853	0,958333
Scaling Attack	59,322343	28,301375	0,925926
Gaussian Attack	59,322343	30,190835	0,976852
HistogramEqualization Attack	59,322343	22,781750	0,979938
Gamma Correction Attack	59,322343	19,565459	0,984568
JpegCorrection Attack	59,322343	30,821841	0,990741
Rotation Attack	59,322343	8,595790	0,969136
IndensityAdjustment Attack	59,322343	21,105403	0,982253
Noise Attack	59,322343	11,553956	0,979167
SpeckleNoise Attack	59,322343	16,251673	0,977623

IV. CONCLUSION

In this paper, digital image watermarking with finding corner point based on DWT method is proposed. By Harris corner detector finding corners, square regions around feature points are computed. After computing square region, it is cropped and the watermark is embedded. Ten different attacks are applied to watermarked image and then watermarking is detected and extracted.

When looking to variations of PSNR and SR values on different attacks on square regions, it is seen that SR and PSNR values are changing. Mostly, the SR value is more than 0.9 in all attack cases.

This study introduces small watermark images are embedding to original image and showing the results. The experiment performed on image reveals that the proposed watermarking algorithm has robustness for attacks while still keeping the quality of the image.

Our study is going to apply second level of DWT on same images and compare results of one level and second level.

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