Imperial Journal of Interdisciplinary Research (IJIR)
Vol-2, Issue-9, 2016
ISSN: 2454-1362, http://www.onlinejournal.in

Image Watermarking Scheme Using Combined DCT-DWT-SVD Transforms

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Abstract: *Digital watermarking, which is the act of hiding a signal (watermark) into an image, is one of these proposed techniques that is used to protect the rights of owners. While the tremendous growth in computer networks, coupled with the exponential increase of computer performance, has facilitated the distribution of multimedia data such as images; publishers, artists, and photographers may be unwilling to distribute pictures over the Internet due to a lack of security since any images can be easily duplicated and distributed without the owner's consent. Digital watermarks have been proposed as a way to tackle this tough issue. The use of a digital signature could discourage copyright violations and may helpdetermine the authenticity and ownership of an image. In this work, we have proposed a DCT-DWT-SVD based method for embedding the watermark in the images. Our proposed scheme is shown to be robust, while its performances are evaluated with respectto the peak signal-to-noise ratio (PSNR), Structuralsimilarity (SSIM) index. The robustness of the scheme is also evaluated against different attacks, including a filtering attacks, geometric attacks etc.*

1. Introduction

Media security has been the point of convergence of significant exploration action in the most recent decade, essentially in light of its wide application territory. Advanced watermarking, specifically, is the procedure that implants information called a watermark into a sight and sound item, (for example, content, sound, picture, and video), such that the watermark can be recognized or removed later to make an affirmation about the article [1]. Aside from duplicate control and copyright security, show observing, fingerprinting, indexing, therapeutic applications, and substance verification are other application regions of computerized watermarking. With the end goal of outlining and building up another watermarking calculation in those application territories, the most vital properties are heartiness and imperceptibility [2], which are the primary purposes of this study.

There are fundamentally 2 ways to deal with implant a watermark: spatial area and change space water-checking. In the spatial area, the watermark is installed by changing the pixel values in the first picture. The easiest spatial area watermarking strategy is to implant the bits of the message specifically into the minimum huge piece plane of the spread picture [3]. Change space watermarking is like spatial area water-checking; for this situation, the coefficients of changes, for example, discrete cosine change (DCT), discrete Fourier change (DFT), or discrete wavelet change (DWT) are altered [4].

Watermark location is ordered into 3 classes: non-visually impaired, visually impaired, and semi-blind watermarking. Non-blind watermarking requires the first picture to distinguish the watermark, the visually impaired strategy does not require the first picture to identify the watermark, and the semi-blind watermarking procedure requires the watermarked record for identification.

In this study, visual, undetectable, and non-blind double watermarking is implanted into the spread picture in the change space. Whatever remains of this paper is sorted out as takes after. Segment 2 surveys related studies on spatial and change area watermarking in the writing. Watermark implanting and extraction calculations are clarified in point of interest in Sections 3 and 4, individually. Segment 5 shows the test results, and, nally, Section 6 closes this work.

2. Related works

The standard of change area watermarking strategies is to adjust change coefficients with a proper calculation. In this study, a novel watermarking calculation with the blend of DWT and particular worth decay (SVD) by means of lower-and-upper (LU) disintegration will be executed. Thusly, past studies in the writing are talked about in the accompanying content.

a) Discrete wavelet change (DWT): Due to its awesome recurrence segment partition properties, the DWT, as opposed to the DCT, is exceptionally valuable to recognize the coefficients to be watermarked [5]. The DWT isolates a picture into a lower determination picture [low-low (LL)] and level [high-low (HL)], vertical [low-high (LH)], and inclining [high-high (HH)] point of interest segments. The sizes of the DWT coefficients are bigger in the LL groups at every level of disintegration. Installing the watermark in larger amount subbands expands the power of the watermark. Be that as it may, the picture visual fidelity might be lost, which can be measured by the crest sign to-commotion proportion (PSNR). With the DWT, the edges and surface can be effectively identified in the high-recurrence groups, HH, LH, and HL. The huge coefficients in these groups typically show edges in the picture. Consequently, the DWT comprehends the human visual framework better in contrast with the DCT.

Dugad et al. [5] proposed a wavelet-based plan for watermarking pictures by inserting the watermark into the LL band coefficients similarly as Cox et al. had already proposed [6]. Hsieh and Tseng proposed a DWT-based calculation in the accompanying strides: a unique picture was deteriorated into wavelet coefficients. Next, a multienergy watermarking plan, in view of the qualifiedsignificant wavelet tree, was utilized to accomplish a hearty calculation [7]. Elbasi and Eskicioglu implanted a pseudorandom grouping as a watermark in 2 groups (LL and HH) utilizing DWT [8]. After that study, Elbasproposed a novel video watermarking framework in light of the concealed Markov model (HMM), which split the video groupings into a gathering of pictures (GOP) and after that inserted bits of the twofold into every GOP with a wavelet area watermarking calculation in the LL and HH subbands [9].

By and large, the vast majority of the picture vitality is aggregated at the lower recurrence coefficient set of LL groups, and in this manner installing watermarks in these coefficient sets may debase the picture significantly. Be that as it may, inserting the watermark in the LL groups effectively builds power [10]. One certainty that makes our study novel is that we build the vigor of the watermarked picture under specific assaults without corrupting the picture, by implanting a parallel watermark on the LL band. This additionally clarifies why the LL subband is decided for watermark installing.

b) Singular value deomposition (SVD): Any $m \times n$ matrix A can be calculated into $A = U \times S \times V^T$(orthogonal) (corner to corner) (orthogonal). The segments of U (m) (left solitary vectors) are eigenvectors of and the sections of V (n) (right particular vectors) are eigenvectors of $A \times A^T$ [11]. The U and V frameworks are orthogonal grids, so that $U^T \times U = I$ and $V^T \times V = I$, where I is the unit network. Segments of the U and V grids are called left and right solitary vectors, which speak to flat and vertical points of interest of a picture, separately [12]. Their solitary qualities on the inclining of S (m × n) are the square foundations of the nonzero eigenvalues of both $A \times A^T$ and $A^T A$. In the event that An is a picture, for this situation, S, the corner to corner network with rank R, has the luminance (dark scale) estimations of the picture layers created by U and V.

Gorodetski et al. proposed a methodology on implanting a few information through slight alterations of particular estimations of a little piece of the sectioned spreads [13]. Chandra partitioned the picture into sub-pieces, connected SVD to those squares, and changed their biggest particular quality by a watermark and a scaling variable [14]. Liu and Ran utilized a pseudo-Gaussian arbitrary number as a watermark and added it to the solitary estimations of the first picture [15]. Calagna et al. isolated the spread picture into squares and connected SVD to every piece. So as to adjust the implanting limit with bending, the watermark was inserted in the greater part of the nonzero solitary qualities as indicated by the neighborhood components of the spread picture [16] in that study. Bao and Ma proposed a picture versatile watermarking plan for picture validation by applying a basic quantization-record tweak process on wavelet area SVD [17]. Ghazy et al. outlined another watermarking calculation in the accompanying request: the first picture was isolated into pieces, and after that the watermark was installed in the solitary estimations of every square independently. Watermark identification was executed by removing the watermark from the solitary estimations of the watermarked pieces [18].

Estimation of picture and video quality is a testing issue in an extensive variety of uses [19][20]. The quality measures can be ordered into 2 bunches: subjective and objective. There are various target measures.

a) Mean squared error (MSE): This is an old, proven measure of control and quality. The MSE is defined as in Eq. (3):

$$MSE = \frac{1}{M \times N} \sum_i \sum_j [\mathrm{A(i, j)} - \mathrm{A}\,\omega\mathrm{(i, j)}]^2 \quad (1)$$

where A(i; j) is the first picture and Aw(i; j) is the watermarked picture, both of which contain M N pixels.

b) PSNR: This is most ordinarily utilized as a measure of nature of remaking in picture watermarking. It is a proportion between the most extreme estimation of a sign and the extent of foundation clamor [23]. It is most effectively characterized by means of the MSE for a 8-bit dim scale picture, as appeared in Eq. (4).

$$PSNR = 20 \times \log\left(\frac{255}{\sqrt{MSE}}\right) \quad (2)$$

3. Watermark embedding algorithm

In our proposed study, the watermark embedding procedure is as follows.

Input: Cover work (A) and binary image watermark (W) Output: Watermarked image (AW)

1. Using DWT, decompose the cover work, A, into 4 sub-bands: LL, LH, HL, and HH.
2. Decompose the HH band further to get two level DWT decomposition.
3. Take diagonal component and obtain DCT of it and then apply chirp –Z-transform..
4. Apply SVD to D: D = (UDw) × (SDw) ×(VDw^T) .
5. Apply SVD to W: W = (Uw) × (Sw) ×(Vw^T) .
6. Modify SDw, the singular values of the D component, by adding the singular values of the watermark, W, with the scaling factor :Dw = SDw + α × Sw.
7. 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 coefficient Dw: Dww = (UDw) × (Dw) × (VDwT) .
8. Because the diagonal matrix (D) of the LL subband is updated, it is time to gather L, Dww, and U to obtain LL1w: LL1w = L ×Dww×U .
9. Compute the inverse DWT to obtain the watermarked cover image, AW.
10. Store the locations of the 1s in W in order to use them as a key in the extraction algorithm. A flow diagram of the watermark embedding algorithm

4. Watermark extraction algorithm

According to the watermark embedding algorithm in the previous section, the watermark extraction procedure is as follows.

Input: Attacked watermarked image (AW*)

Output: Extracted watermark (W*)

1. Using DWT, decompose the watermarked and possibly attacked image, AW*, into 4 subbands: LLw, LHw, HLw, and HHw.
2. Decompose the HHw further two second level and get diagonal subband of detailed coefficients and apply DCT and CZT to it..
3. Apply SVD to D*: D = (UDw*)× (SDw *) × (V Dw *) .
4. Extract the singular values of the watermark Sw*: Sw* = $\frac{(SDw^* - SDw)}{\alpha}$.
5. Extract the watermark with its SVD components: W = (Uw) × (Sw*)× (V w^T) .

5. Experimental Results

Images used in this proposed watermarking algorithm arelena, Baboon, Peppers, Tulips, Koala respectively are 8-bit gray-scale images. Figure below shows lena and watermark used as a binary image. In order to obtain good visual quality of watermarked images, choosing a scaling factor value, , plays an important role in watermark embedding procedures. If the value of is chosen close to 0, the watermarked image is less distorted and the maximum PSNR can be obtained. However, for lower values, watermarked images are less robust to several attacks, which means a lower SR. Therefore, while choosing the optimum valueof alpha, it is useful in practice to investigate the PSNR values of extracted watermark images after several attacks and to make a trade-of analysis of them.Though the frequency domain watermarking has higher computational cost, it has proven to be more robust and imperceptible than the spatial domain watermarking. Currently, the discrete wavelet transform (DWT), discrete cosine transform (DCT), and the discrete Fourier transform (DFT) are the commonly used frequency domain watermarking; however, the DWT is most widely used due to its frequency spread, multiresolution ability, and the spatial localized nature of its wavelet. The results at different levels has been shown below

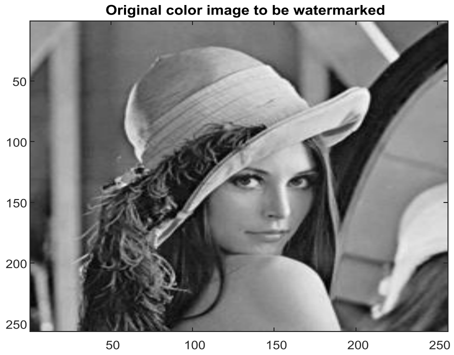

Figure 1: Input Image to be watermarked

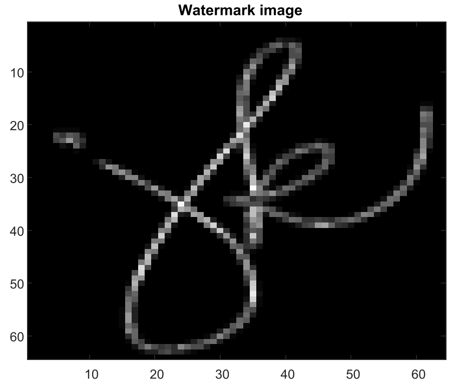

Figure 2: Watermark used for embedding process

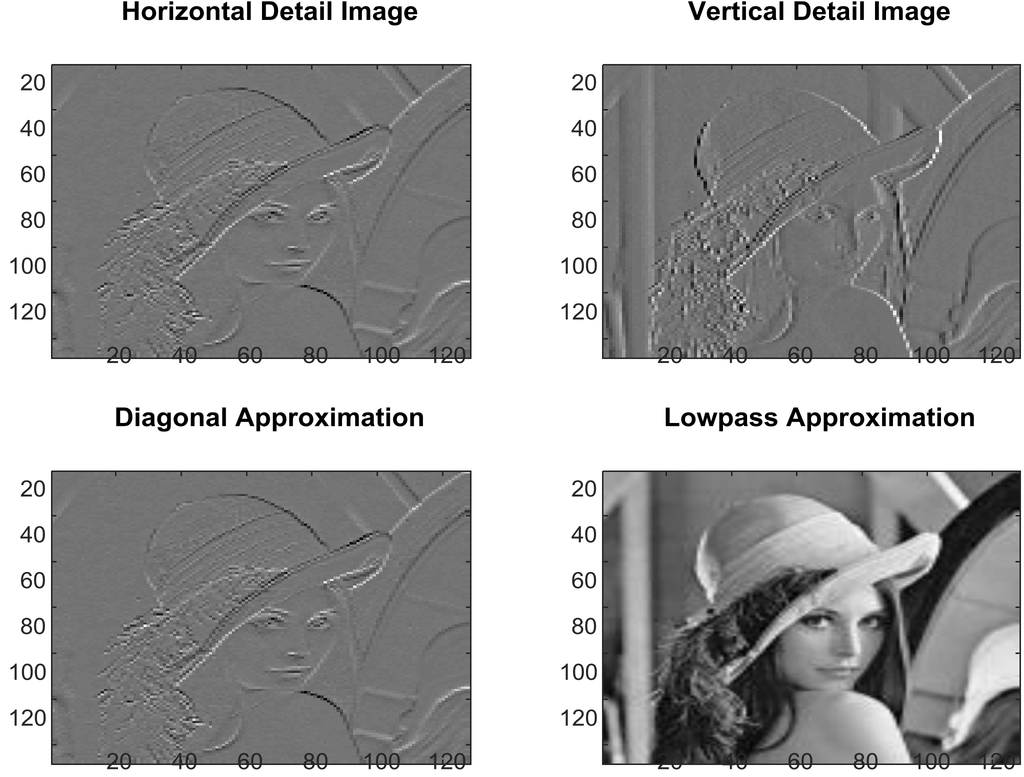

Figure 3: Detailed and approximation coefficients at first level decomposition

The results for quality assessment have been given below for all the images considered in our work.

Table 1: PSNR values at different attacks

Image Name PSNR	lena	Baboon	Peppers	Tulips	Koala
Median filter attack	34.7341	31.0785	36.5631	35.6831	31.7334
Gaussian Noise addition attck	32.5115	30.2349	33.5346	33.4884	30.6942
sharpening attack	30.4468	28.8571	30.8513	30.6345	29.1625
Gamma correction attack	24.1390	24.2505	24.1214	24.2040	24.4880
Flipping attack	27.6257	28.0668	27.8274	27.9970	27.6049
Rescaling attack	36.1772	31.5698	36.4456	34.9702	32.7858
Histogram attack	27.8507	27.4276	27.6876	31.5017	27.1300

Table 2: SSIM values at different attacks

Image Name PSNR	Lena	Baboon	Peppers	Tulips	Koala
Median filter attack	.8153	.6571	.8786	.8651	.7201
Gaussian Noise attack	0.7130	.6759	.7613	.7948	.6946
sharpening attack	.5748	.5204	.6213	.6611	.5448
Gamma correction attack	.7087	.6549	.7276	.7809	.6315
Flipping attack	.1681	.0887	.1656	.1901	.0658
Rescaling attack	.9229	0.7731	.9445	.9171	.8288
Histogram attack	.5823	.5277	.6506	.6680	.6291

Results in graphical form for PSNR and SSIM are shown below for various attacks

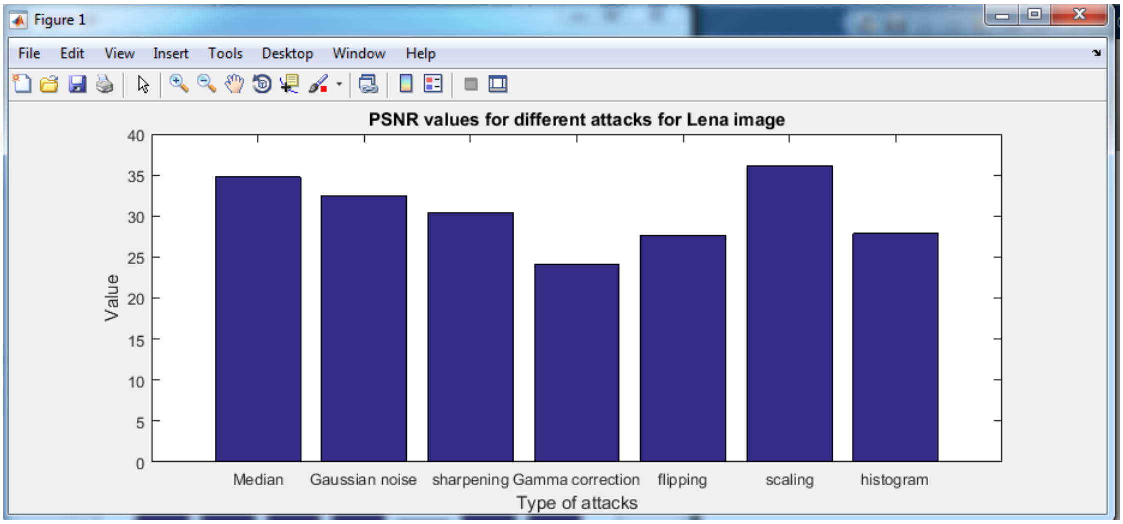

Figure 4: PSNR values for different attacks for Lena image

In this work, we have used several attacks on the watermarked image and results has been compared using PSNR and SSIM values. The attacks implemented on watermarked image before extraction of watermark are Median filtering, Gaussion noise, sharpening attack, gamma, correction attack, flipping attack, scaling and histogram attack. It has been found that gamma correction, flipping and histogram attacks effect more and show the degraded extracted watermark. On the other hand, median filtering and scaling attacks does not affect much in terms of PSNR values.

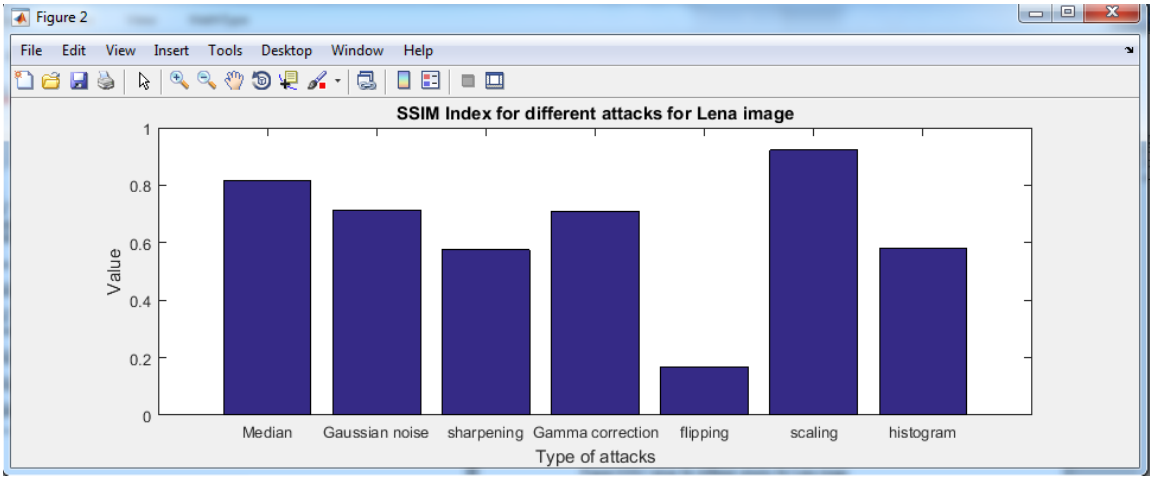

Figure 5: SSIM values for different attacks for Lena image

Similarly flipping attack show less correlation between the extracted watermark whereas scaling attacks shows more similarity between the two. Other attacks effect lies in between the two.

6. Conclusion

In this work, we increase robustness of the watermarked image under certain attacks without degrading the image by embedding a binary watermark on the digonal band. This is why the HHsubband is chosen. Another novel aspect of this study is to make an optimization analysis and decide on the scaling factor used in embedding and the threshold value used in extraction experimentally. Proposed reversible watermarking algorithm uses a combination of the three transforms, which are as follows: the DWT transform, the DCT transform, and the SVD transform. Even if each one has already been used individually to build watermarking systems, combining them allows them the best robustness and to benefit from the advantages of several transformations. Several attacks has been tried on the watermarked image and results has been compared using PSNR and SSIM values. The attacks implemented on watermarked image before extraction of watermark are Median filtering, Gaussion noise, sharpening attack, gamma, correction attack, flipping attack, scaling and histogram attack. It has been found that gamma correction , flipping and histogram attacks effect more and show the degraded extracted watermark. On the other hand, median filtering and scaling attacks does not affect much in terms of PSNR and SSIM values.

References:

[1] S.P. Mohanty, N. Ranganathan, R.K. Namballa, \VLSI implementation of invisible digital watermarking algorithms towards the development of a secure JPEG encoder", Proceedings of the IEEE Workshop on Signal Processing System, pp. 183{188, 2003.

[2] C. Cruz-Ramos, R. Reyes-Reyes, M. Nakano-Miyatake, H. Perez-Meana, \A blind video watermarking scheme robust to frame attacks combined with MPEG2 compression", Journal of Applied Research and Technology, Vol. 8, pp. 323{369, 2010.

[3] F. Akar, Y. Yalman, H.S. Varol, \Data hiding in digital images using a partial optimization technique based on classical LSB method", Turkish Journal of Electrical Engineering & Computer Sciences, Vol. 21, pp. 2037{2047, 2012.

[4] Q. Zhang, Y. Li, X. Wei, \An improved robust and adaptive watermarking algorithm based on DCT", Journal of Applied Research and Technology, Vol. 10, pp. 405{415, 2012.

[5] R. Dugad, K. Ratakonda, N. Ahuja, \A new wavelet-based scheme for watermarking images", Proceedings of the 1998 International Conference on Image Processing, Vol. 2, pp. 419{423, 1998.

[6] I.J. Cox, J. Kilian, F.T. Leighton, T. Shamoon, \Secure spread spectrum watermarking for multimedia", IEEE Transactions on Image Processing, Vol. 6, pp. 1673{1687, 1997.

[7] M.S. Hsieh, D.C. Tseng, \Hiding digital watermarks using multiresolution wavelet transform", IEEE Transactions on Industrial Electronics, Vol. 48, pp. 875{882, 2001.

[8] E. Elbasi, A.M. Eskicioglu, \A DWT-based robust semi-blind image watermarking algorithm using two bands", Proceedings of the SPIE 18th Annual Symposium on Electronic Image Security, Steganography, and Watermarking of Multimedia Contents VIII, Vol. 6072, pp. 1{11, 2006.

[9] E. Elbasi, Robust multimedia watermarking: hidden Markov model approach for video sequences", Turkish Journal of Electrical Engineering & Computer Sciences, Vol. 18, pp. 159{170, 2010.

[10] S.P. Singh, P. Rawat, S. Agrawal, \A robust watermarking approach using DCT-DWT", International Journal of Emerging Technology and Advanced Engineering, Vol. 2, pp. 300{305, 2012.

[11] G. Strang, Linear Algebra and Its Applications, Stamford, CT, USA, The Thomson Corporation, 2005.

[12] E. Yavuz, Z. Telatar, \Improved SVD-DWT based digital image watermarking against watermark ambiguity", Proceedings of the 2007 ACM Symposium on Applied Computing, pp. 1051{1055, 2007.

[13] V.I. Gorodetski, L.J. Popyack, V. Samoilov, V.A. Skormin, \SVD-based approach to transparent embedding data into digital images", Proceedings of the International Workshop on Mathematical Methods, Models and Architectures for Computer Network Security, Vol. 2052, pp. 263{274, 2011.

[14] D.V.S. Chandra, \Digital image watermarking using singular value decomposition", Proceedings of the 45th Midwest Symposium on Circuits and Systems, Vol. 3, pp. 264{267, 2002.

[15] R. Liu, T. Tan, \An SVD-based watermarking scheme for protecting rightful ownership", IEEE Transactions on Multimedia, Vol. 4, pp. 121{128, 2002.

[16] M. Calagna, H. Guo, L.V. Mancini, S. Jajodia, “A robust watermarking system based on SVD compression", Proceedings of ACM Symposium on Applied Computing, pp. 1341{1347, 2006.

[17] P. Bao, X. Ma, \Image adaptive watermarking using wavelet domain singular value decomposition", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 15, pp. 96{102, 2005.

[18] R.A. Ghazy, N.A. El-Fishawy, M.M. Hadhoud, M.I. Dessouky, F.E.A. El-Samie, \An efficient block-by-block SVDbased image watermarking scheme", Ubiquitous Computing and Communication Journal, Vol. 2, pp. 1{9, 2007.

[19] E. Elbasi, \A survey on digital image & video watermarking", First Portion of Second Examination Report, Graduate Center, The City University of New York, 2006

[20] E. Elbasi, \Multimedia security: digital image and video watermarking", PhD, The City University of New York, 2007.