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Embedding Patient Information in Medical Images using Watermarking Approach for Authentication

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Abstract

Digital Watermarking describes methods of embedding the data into the cover image or host an image. The data which is to be embedded is called watermark. Watermark is the secret message that is embedded into host image, to keep the copyright information inside the host image and prevent it from any unauthorized modifications. There are two types of watermarking namely visible watermarking and invisible watermarking. This medical image watermark technique can avoid unnecessary modification by unauthorized person. In this paper Discrete Wavelet Transform based watermarking scheme is used for medical image watermarking using MATLAB software. The proposed method provides performance metrics better than the existing method.

Keywords: Image watermarking, Discrete Wavelet Transform, PSNR, MSE

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1. Introduction

Digital image watermarking is a method of embedding the data into the cover image or host image. The embedding method can be spatial domain based or transform domain based. In spatial domain based method the watermark content is embedded into coefficients of image transform.

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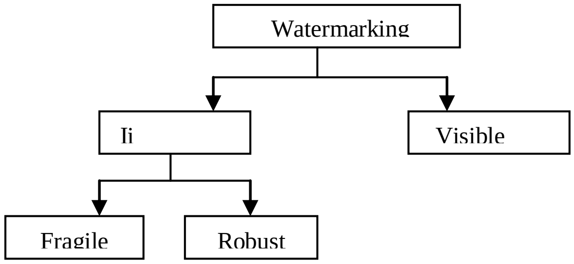


The embedding method can be spatial domain based or transform domain based. In spatial domain based method the watermark content is embedded into coefficients of image transform. The image transform can be either of Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) or Discrete Wavelet Transform (DWT). With the different resolution levels, DWT can provide both space and frequency localization and so DWT is more effective when compared to other transform domain watermarking. But transform domain watermarking provides more invisibility than spatial domain watermarking.

Medical images or medical information (such as X-Ray images, CT scan, MRI Scan images etc.,) need to be more secure and reliable. The medical information should be secure and prevented from modification by unauthorized person and also replacement of one's report by others. These problems can be resolved by hiding the patient information in the medical images by watermarking approach, so that the doctor can diagnose the medical image and also it is more secure. When the medical image watermarking is done, a special care is needed, so that the medical content is not disturbed or lost. The patient information is embedded into medical image without disturbing the quality or original content of the medical image.

2. Proposed Method

In this paper, DWT based watermarking method is used for medical image watermarking. In the proposed method of watermarking, the patient details are embedded into medical image as watermarking content. The DWT is applied to the cover image and watermark image. When DWT is applied to the image it divides the image into four non overlapping multi resolution sub bands. After DWT is applied to the cover image and watermark image, the watermark content is embedded in LL component of the cover image.

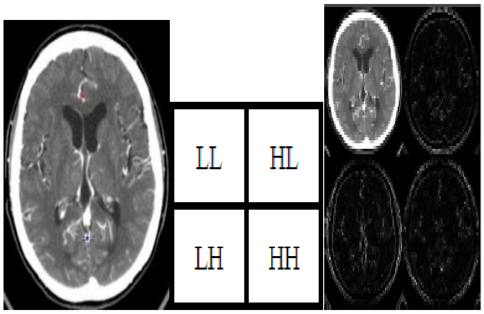


Fig. 1(a) Input image (b) Four sub bands of the image after applying DWT. (C) Output image of DWT

3. Techniques Used

3.1 Discrete Wavelet Transform

DWT is the method that is used to transform the image from spatial domain to frequency domain. When DWT is applied for an image, it divides the image into four non overlapping multi resolution sub bands ie., 3 high frequency sub-band LH (Low-High), HL (High-Low), HH (High-High) and one low frequency band LL (Low-Low). The low frequency sub-band LL represents the coarse scale DWT coefficient or approximation coefficient and the high frequency sub-band LH, HL, and HH represent the fine scale DWT coefficient or the detailed coefficient. This is one level DWT.

The LL sub band can be further applied with DWT and this is 2 level DWT and it is possible to compute N level DWT by continuing the same method. In DWT based watermarking method the watermark data is embedded into LL sub band. Embedding the watermark content into low frequency sub band will increases the invisibility and robustness of watermarking method. The watermark content is embedded into low frequency sub band without degrading the quality and content of the original image.

3.2 Embedding Algorithm:

The patient details are embedded into medical image as watermark content by watermarking as follows. The above flow chart shows the embedding algorithm for the DWT based watermarking.

1. First the input image host image and watermark image is read as input from the user. The image size may be either of 512x512, 1024x1024, and 2048x2048. DWT is applied to the input image and the image is divided into four sub bands.
2. After applying the DWT to the input image the low frequency and high frequency sub band can be obtained. Then, the LL component is separated and it divided into 3*3 non overlapping blocks. Here the LL component is chose to embed the watermark content since it increases the invisibility and robustness.
3. In each block the centre pixel is considered as threshold $b_i$and the pixels around it is considered as neighbourhood pixel. The gray difference between the centre pixel and neighbor pixel of the 3*3 blocks are computed. The gray difference is computed using the formula,

mi= gi – gc,

Where, i = 1 to 8. m i are the gray differences,

gi are the gray values of neighbor pixels

gc is the gray value of the centre pixel

4. According to the sign of the result of gray difference, the b_i is given with binary values 0 or 1 as follows,

bi=1 ; if mi>0

bi=0 ; otherwise

5. All the applied values of bi are applied with X-OR function and it is assigned to a separate variable.

6. Then the pixel values of watermark content X-ORed with the previous XOR result. The watermark bits embedded into the low frequency component of the host image blocks one after the other.

7. The above step is repeated until all the bits of watermark content are embedded into the low frequency component of host image. Finally the watermarked image is now obtained by taking inverse DWT.

3.3 Extraction Algorithm

The watermark content or the patient detail is separated from the medical image or watermarked image by the following algorithm. The first four steps of embedding algorithm s repeated for the extraction algorithm.

1. The watermarked image is applied with DWT to acquire the low and high frequency sub bands separately.

2. The LL component is divided into 3*3 non overlapping sub blocks.

3. The gray difference between the centre pixel and neighbor pixel of the 3*3 blocks are computed.

4. Depending on the sign of the gray difference the binary value 0 or 1 is assigned. These binary bits are then applied with XOR operation.

5. Finally the watermark content is extracted from the watermarked image by XORed result.

4. Experimental Results

The proposed method is simulated using MATLAB software. For the proposed DWT based medical image watermarking, different medical images of different image dimensions are taken as input images ie., host image. The patient details are stored as digital images. These digital images which contain the patient information are taken as the watermark image. The watermarking of patient information into the medical image is executed by the proposed DWT based medical image watermarking and the simulation results are given in following diagrams.

The performance metrics used to examine the performance of proposed method are Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR). MSE is used to find the similarity between the original image and watermarked image. As the MSE value is low it indicates that the similarity is high.

$$MSE = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\left(I(x,y) - I'(x,y)\right)^2$$

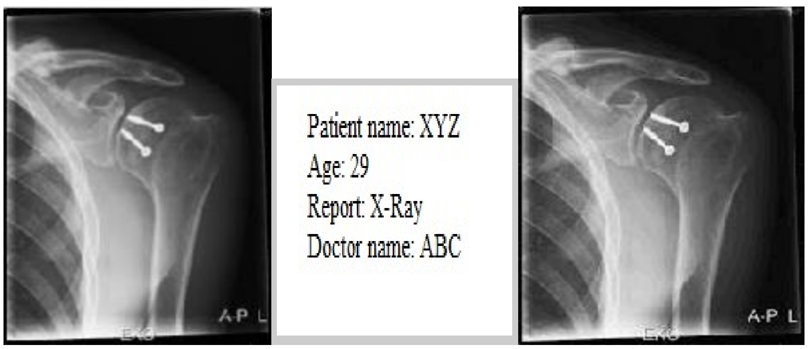
Where I(x,y) is the original image

I'(x,y) is the watermarked image.

The PSNR is used to examine the visual quality of the watermarked image. PSNR is calculated by using the following formula.

$$PSNR = 10\log_{10}\frac{\max^{2}}{MSE}$$

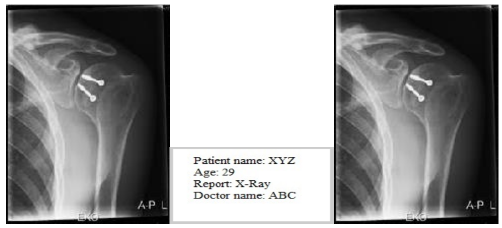
Where max=255, and MSE is Mean Squared Error. The simulation results are shown in the following figure.



(a) (b) (c)

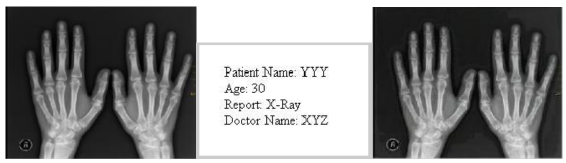
Fig 2. Simulation result 2 of DWT based medical image watermarking for 512x512 image. (a) host image (b) watermark image (c) output watermarked image

Types of imaging		Method[3]		Method[4]		proposed method	
		MSE	PSNR	MSE	PSNR	MSE	PSNR
CT scan images	2048x2048	2.11	44.71	1.79	45.60	0.073	59.49
	1024x1024	4.01	42.23	2.05	45.01	1.31	54.31
	512x512	6.81	39.83	1.79	45.69	1.403	53.92
MRI scan images	2048x2048	2.22	44.70	1.66	45.93	0.24	56.32
	1024x1024	3.98	42.38	2.68	45.83	1.38	54.21
	512x512	6.86	39.40	1.66	42.25	1.41	54.03



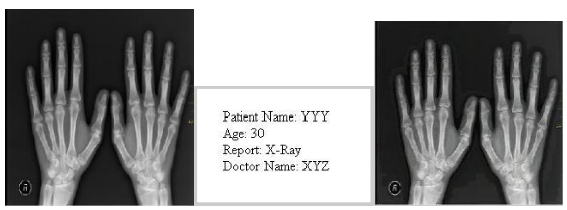
(a) (b) (c)

Fig 3. Simulation result 3 of DWT based medical image watermarking for 1024x1024 image. (a) host image (b) watermark image (c) output watermarked image



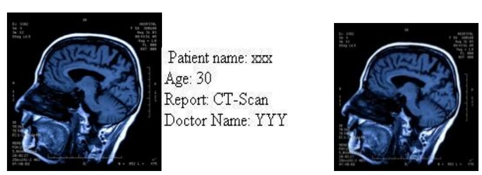
(a) (b) (c)

Fig 4. Simulation result 4 of DWT based medical image watermarking of 512x512 image. (a) host image (b) watermark image (c) output watermarked image



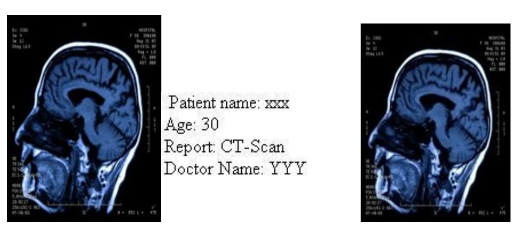
(a) (b) (c)

Fig 5. Simulation result 4 of DWT based medical image watermarking of 1024x1024 image. (a) host image (b) watermark image (c) output watermarked image



(a) (b) (c)

Fig 6. Simulation result 4 of DWT based medical image watermarking of 512x512 image. (a) host image (b) watermark image (c) output watermarked image



(a) (b) (c)

Fig 7. Simulation result 4 of DWT based medical image watermarking of 1024x1024 image. (a) host image (b) watermark image (c) output watermarked image

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The calculated values are compared with previous methods and they are tabulated. Table 1 shows the comparison of MSE and PSNR of different methods and the proposed method for different input images.

TABLE 1.
Comparison Of Mse And Psnr

Types of imaging		Method[3]		Method[4]		proposed method	
		MSE	PSNR	MSE	PSNR	MSE	PSNR
CT scan images	2048x2048	2.11	44.71	1.79	45.60	0.073	59.49
	1024x1024	4.01	42.23	2.05	45.01	1.31	54.31
	512x512	6.81	39.83	1.79	45.69	1.403	53.92
MRI scan images	2048x2048	2.22	44.70	1.66	45.93	0.24	56.32
	1024x1024	3.98	42.38	2.68	45.83	1.38	54.21
	512x512	6.86	39.40	1.66	42.25	1.41	54.03

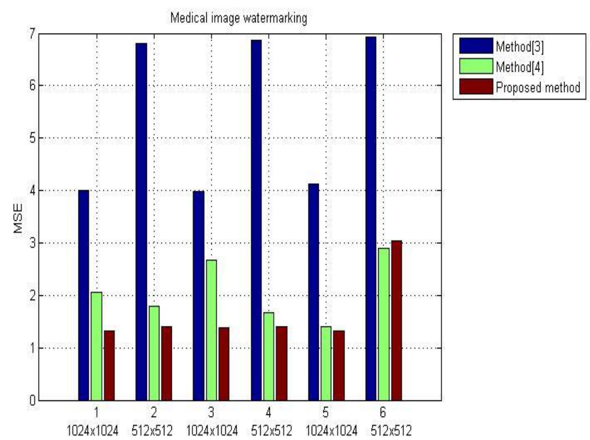

Fig. 8 Results of PSNR values for different sized images

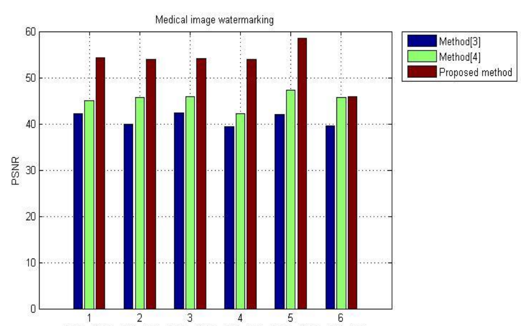

Fig. 9 Results of PSNR values for different sized images

The performance metrics used to examine the performance of proposed method are Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR). MSE is used to find the similarity between the original image and watermarked image

5. Conclusion And Future Scope

In this paper, the hiding of patient details in medical images by using one level DWT based watermarking has been proposed for medical image authentication and watermarking has been effectively done for different imaging of different sizes. The proposed method is examined by the performance metrics MSE and PSNR. From the above simulation results, comparison table and the bar graph shown, it is clear that the proposed method provides MSE values 4 times lower than the existing methods and PSNR values are increased by 34%. When we use higher level DWT methods for watermarking it is expected to give the result with lesser execution time when compared to this method. The future work is to perform watermarking by using 2 level and 3 level DWT for the medical image authentication.

References

[1] Md.Moniruzzaman et al., “Wavelet based watermarking approach of hiding patient information in medical image for medical image authentication”, ICCIT. IEEE 17th International Conference on Computer and Information Technology,2014.

[2]. S.C.Rathi and V.S. Inamdar, “Medical Images Authentication through Watermarking preserving ROI”, Health Informatics – An International Journal (HIIJ) , vol.1, no.1, August 2012.

[3]. A.Giakoumaki, S. Pavlopoulos, D. Koutsouris, “A Multiple Digital Watermarking Applied to Medical Imaging”, Proceedings of the 2005 IEEE, Engineering in Medicine and Biology , 27th Annual Conference Shanghai, China, September 1-4 , 2005.

[4]. Chandra M. B. and Srinivas K. S., “Robust multiple image Watermarking Scheme using Discrete Cosine Transform with Multiple Description”, International Journal of Computer Theory and Engineering, vol. 1, pp. 1793-8201, 2009

[5]. Imen Fourati Kallel, Mohamed Kallel, Mohamed Salim BOUHLEL, “A Secure fragile Watermarking Algorithm for Medical Image Authentication in the DCT Domain”, IEEE , 2006.

[6]. B.L. Gunjal, R.R. Manthalkar, “Discrete Wavelet Transform Based Strongly Robust Watermarking Scheme for Information Hiding in Digital Images”, Third International conference Emerging Trends in Engineering and Technology. India, pp 124-129, November 2010.

[7]. Fengmai LIANG, Lijia WANG,”An improved Wavelet based Color image Watermark Algorithm”, Journal of Computational Information Systems 7, vol. 6, pp.2013-2020, 2011.

[8]. S. A. Mostafa, N. El-sheimy, A. Tolba, F. Abdelkader, and H. M. Elhindy, “Wavelet packets-based blind watermarking for medical image management,” The open biomedical engineering journal, vol. 4, 2010.