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Secure Transmission of Medical Image by Blind Watermarking Technique

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Abstract

Digital watermarking is one of solutions to protect intellectual properties and copyright by hiding information, such as a random sequence or a logo, into digital media. This paper deals with a new blind robust watermarking technique for embedding secrete medical information as a watermark in a host image. As a host image a color medical image is used, and a blue plane goes through the DWT. The diagnosis information of the patent is used as a watermark binary image. The embedding process is done in the LL Sub band of the blue plane of the host image, for DWT a bi-orthogonal wavelet filter is used for corresponding. This can be extended for store more than one watermark information in one medical image by embedding the watermark images in the different sub bands of the host image. The resulting watermark is having good PSNR and robust against different attacks.

Keywords: Watermark, Robust, Medical image, DWT, PSNR.

Introduction

Nowadays, the developments in digital technology have resulted in explosion in the use of digital media products such as image, audio and video. This raises, however, security concerns due to digital multimedia products high vulnerability to the illegal copying, distribution, manipulation, and other attacks. The digital watermarking systems, in literature, have been developed to remedy these security threats. In order to be effective transformation and secure exchange of medical information, it is required to apply digital watermark [1][2], it must be robust and secure, recoverable from a document, provide the original information embedded reliably, and be non-intrusive and also removable by authorized users. In the conventional medical image watermarking techniques the watermarking is fragile in nature. Medical image watermarking is classified into two. 1) Tamper detection and authentication and 2) EPR data hiding. Tamper detection watermarks are able to locate the regions or pixels of the image where tampering was done. Authentication watermarks are used to identify the source of image. EPR data hiding techniques gives more importance in hiding high payload data in the images keeping the imperceptibility very high. Different kinds of watermarking methods were identified for medical images.

This paper deals with the blind and Robust watermarking technique is proposed which are difficult to remove from the object in which they are embedded despite a variety of possible attacks by pirates including compression such as JPEG, scaling and aspect ratio changes, rotation, translation, cropping, row and column removal, addition of noise, filtering, statistical attacks [3].

Describing about the different medical image watermarking techniques are represented in the section 1, A generic wavelet transform based image compression scheme is reviewed in section 2, the description of different topological reordering techniques are represented in section 3, the proposed watermarking technique is discussed in section 4, results are described in the section 5, concluding remarks are given in the section 6.

Wavelet Transform based Image Compression

The widely used unitary transforms for data compression are transformations 2-D images are changed from spatial to frequency transformation such as FFT, DCT, and DWT is a better decomposition capability and having high redundancy than remaining frequency transformations.

In DWT, an image can be processed by passing it through an analysis filter bank followed by a decimation operation [4]. This analysis filter bank, which consists of a low pass and a high pass filter at each decomposition stage, is commonly used in image compression. When a signal passes through these filters, it is split into two bands. The low pass filter, which corresponds to an averaging operation, extracts the coarse information of the image. The high pass filter, which corresponds to a differencing operation, extracts the detail information of the image. The output of the filtering operations is then decimated by two.

A 2D-DWT can be accomplished by performing two separate one-dimensional transforms. First, the image is filtered along the x-dimension using low pass and high pass analysis filters and decimated by two. Low pass filtered coefficients are stored on the left part of the matrix and high pass filtered on the right. Because of the decimation, the total size of the transformed image is same as the original image. Then, it is followed by filtering the sub-image along the y-dimension and decimated by two. Finally, the image is split into four bands denoted by LL, HL, LH and HH after one level decomposition and as shown in Fig.1. In the diagram, ‘L’ indicates low pass filter and ‘H’ indicates high pass filter. In the second level, the LL band is further decomposed into four bands. The same procedure is continued for further decomposition levels. This process of filtering the image is called pyramidal decomposition of image.

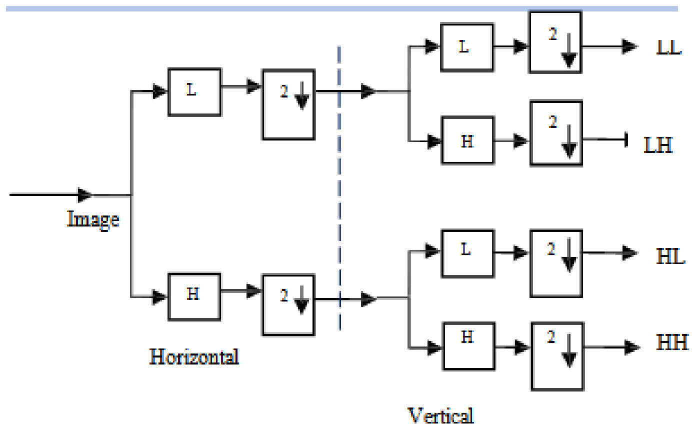


Figure 1: Pyramidal decomposition.

Bi-Orthogonal Wavelet Filter

Where the associated wavelet transforms is invertible but not necessarily orthogonal. Designing bi-orthogonal wavelets allows more degrees of freedoms than orthogonal wavelets [38]. One additional degree of freedom is the possibility to construct symmetric wavelet functions. In the bi-orthogonal case, there are two scaling functions φ (t), φ% (t), which may generate different multiresolution analyses, and accordingly two different wavelet functions instead of just one ψ, ψ.

Topological Reordering

The rearrangement of coefficients is based purely upon coefficient position, rather than a function of coefficient value, hence it is designated as topological re-ordering. The advantage of re-ordering is better accessibility of the successive coefficients for the estimation of current coefficient value. Due to re-ordering, the size of a particular sub band is altered.

Zig-Zag Coding

A zigzag code is described by a highly structured zigzag graph. Due to the structural properties of the graph, it has low-complexity. Zigzag coding is the technique is used to re order the coefficients of the image Sub bands. This process orders the coefficients from low frequency to high frequency [7-11] [13]. The scanning is starts from the top left most Coefficients. This provides better entropy coding and has high access with the successive pixel, the coefficients are get scanned according to the zigzag ordering, to achieve the perceptual invisibility of the mark, without a loss of robustness against signal processing techniques. By Zigzag coding it is possible to access the successive pixels easily.

The process of the zigzag is shown in bellow Fig.2.For medical images zigzag scanning is used, where it can possible to scan the medical image without loss in the image pixel. The scanning processes get starts from top to bottom and left to right without neglecting any coefficient. In this work zigzag coding is applied to the LL Sub band of the Blue plane of the Image.

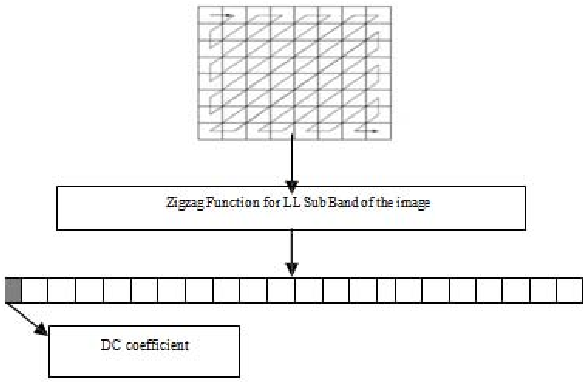


Figure 2: Zigzag Scanning for the DWT Coefficients of LL Sub band.

Proposed Watermarking Technique

With the proposed watermarking techniques the secrete logo image is embedded in the host image and extracted from the image so the proposed techniques is having both embedding and extraction procedures

Watermark Embedding Procedure

This section describes the proposedwatermarking technique. The watermark is embedded in the quantized and rounded LL sub band. The embedding algorithm consists of five main steps; the block diagram of the watermark embedding technique is shown in bellow Fig.3.

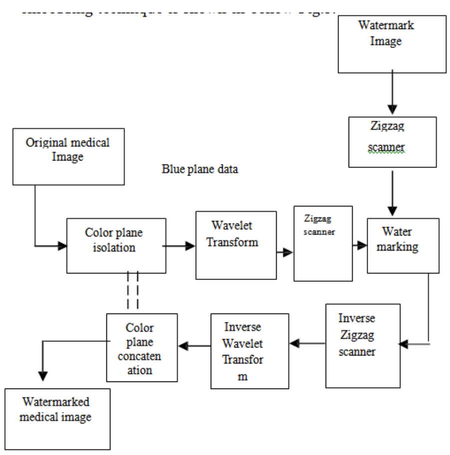


Figure 3: Proposed watermark embedding system.

The Embedding process is shown in the Fig. 3. Isolating the image into three color planes. The blue plane information of image is passed through a wavelet transformation unit for the resolution decomposition of the blue plane information. Hierarchical pyramidal decomposition architecture with bank of low pass and high pass filters are used for the decomposition of the original image. The transformation is performed using bi-orthonormal wavelet transform. Wavelet transform is a very useful tool for signal analysis and image processing, especially in multi-resolution representation. The image is go with the 3 level image decomposition and the coefficients of LL sub band information on which watermark image could be embedded. For the transformation a Zigzag scanning operation is carried out. Similarly for the Logo image also perform the zigzag coding.

The coefficients after zigzag coding the image of 2D is converted to 1D image for the watermarking process the lease significant bits of the image are considered and the watermarking is carried out at the lease significant bits by considering a constant of watermarking strength coefficient.

Watermark Extraction Procedure

Our watermarking scheme deals with the extraction of the watermark information in the absence of the original image. The aim of the watermark extraction process is to reliably obtain an estimate of the original watermark from a possibly distorted version of the watermarked image. The detection process is inverse procedure of the watermark insertion process. One of the advantages of wavelet-based watermarking is its ability to spread the watermark all over the image. If a part of the image is cropped, it may still contain parts of the watermark. These parts of watermark may be detected by certain mechanism even if the image has been further scaled or rotated.

The Logo that embedded in the medical image is get extracted based on the location where the logo is get placed and the extraction process is shown in the block diagram.

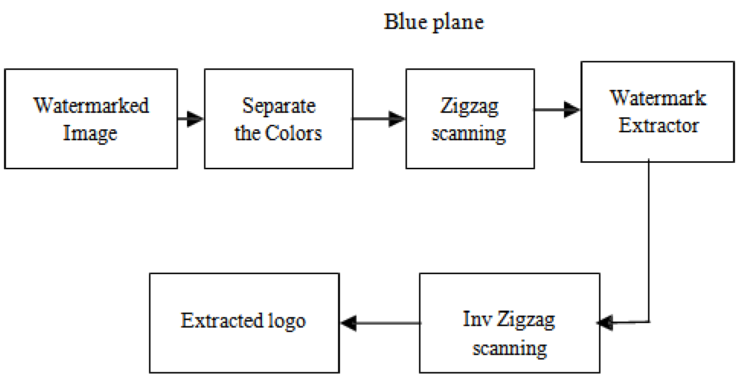


Figure 4: Proposed Watermark Extracting System.

In the extraction algorithm the watermarked image is get separated into the color planes in which the Blue plane goes under the extraction process that is given to the zigzag scanning it convert the 2D Blue plane image into the 1D image that is given to the logo extractor. The location of the watermark that be stored should know to the receiver and the strength of the watermark should be known than only the image is extracted from the Blue plane and that should be in a 1D mode so it need to convert that to 2D Signal the coefficients after the watermark extractor are given to the Inv. Zigzag from this we can extract the logo the block diagram of the Extraction process is shown in the Fig. 4

Results

Experiments are performed on five color medical images to verify the proposed method. These five images are represented by 110x110 host image and a logo binary image of 64x64 image is used for the embedding in the host image Here the Image is processed under different attacks as Geometrical, Filtering, and Noise attacks. And also measured the performance, evaluate the quality of the Extracted image. For embedding the logo image in the host image the watermark image is embedded with the strength of 0.5.

Without Attacks:

Experimental results have been obtained with an implementation of the proposed watermarking scheme on 'medical' image. Binary logo of size 64x64 is used in the experiments. 'Medical image' is initially go through the DWT. Reordered watermark is embedded in the re-ordered LL sub band. Watermark bit is embedded at a location of last 4096 bits. Watermark can be embedded in level 2 decomposition also. Original image, original logo, watermarked image and extracted logo are shown in Fig5.the proposed method has the PSNR value is 39.3dB.

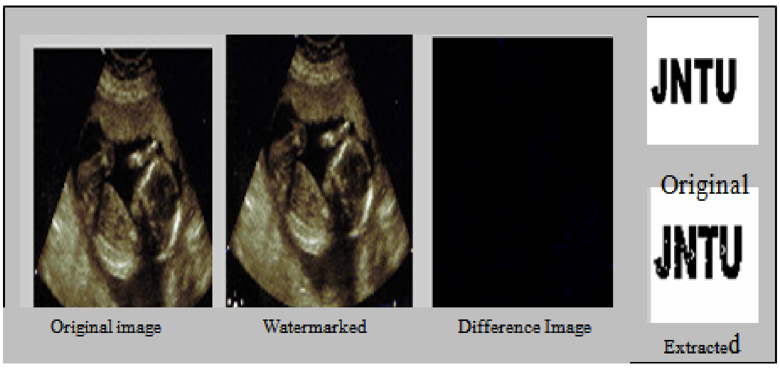
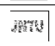


Figure 5: Watermark image ('logo'), watermarked error image, Watermarked image, extracted logo.

With Attacks

The proposed method is robust to various noise and filtering attacks. Watermark is extracted even after tampering. The other attacks, where the watermark is successfully retrieved are adding different noises, rotation, sharpening, average filtering and rectangular cropping.

Table 1: Performance of the Proposed Watermark by Different Signal Processing Attacks.

S.no	Attack	Quantity	Retrieved watermar k	PSNR	NCC	SIM
1	Salt and pepper noise	0.08		30.48	0.975	0.893
2	Sharpeni ng	5x5		31.18	0.832	0.841
3	Gaussian noise	0.05		28.23	0.956	0.832
4	Rotation by angle:	+50		35.12	0.953	0.849
5	Rectangular Cropping:	50%		20.32	0.832	0.762
6	Average Filtering	9x9		29.14	0.770	.8231
7	Speckle noise	0.08		28.88	0.962	0.892

Conclusion

The proposed watermarking algorithm is highly robust and can survive many image processing attacks. Quality of the watermarked image is good in terms of perceptibility and PSNR. Topological re-ordering gives more protection to the watermark. In this paper implementing the topological re ordering to only in LL sub band, this can extend by embedding the image to remaining sub band also.

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