Analysis of SVD Watermarked Medical Images using Fuzzy Logic

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Abstract— A new image watermarking scheme has been developed which combines Singular Value Decomposition and its FFT form (i.e. FFT-SVD). It consumes a lot of less resources, also it computes a larger set of data faster without effecting the quality of the original image. The proposed scheme has been simulated in MATLAB environment.

Keywords— FFT, SVD, Medical Image, Watermarking, DFT, DCT, LPF.

INTRODUCTION

In recent years the use of Internet as a platform for distribution of digital multimedia data (such as audio, video, image) has been grown. Digital data can be stored efficiently and it can be transmitted in a fast and inexpensive way through data communication networks without losing its quality. Digital data can be easily copied from original one and the copied version is similar to original data. This creates serious concerns about illegal use and manipulation of digital data. Hence copyright protection and content integrity become an important issue. Previously digital content were protected using encryption techniques but encryption alone is not sufficient to protect digital data for long time as because in encryption process digital content has to be decrypted to get the hidden information and after the decryption the digital contents are no more being encrypted and can be easily manipulated and distributed.

Therefore it leads to a creation of a new information-hiding form, called digital watermarking. In this process the copyright information is embedded into the original digital content which is to be protected from the illegal distribution. The embedded watermark should be imperceptible and it should be robust enough to survive to attacks. The hidden information may be the serial number, random number sequence, copyright information, ownership identifiers, control signals, transaction dates, text, image, or other digital formats. Watermarking is similar to steganography and some discrete features of watermarking makeit popular for information/data hiding over steganography. Applications of digital watermarking incorporate copyright protection, fingerprinting, authentication, copy control, tamper detection, and data hiding applications such as broadcast monitoring.

SINGULAR VALUE DECOMPOSITION

Recently watermarking schemes based on Singular Value decomposition (SVD) have gained popularity due to its simplicity in implementation and some attractive mathematical features of SVD. The SVD for square matrices was first introduced independently by Beltrami and Jordan in 1870s and then was extended to rectangular matrices by Eckart and Young in 1936. Later, this mathematical tool demonstrated its usefulness in a variety of applications including image processing and watermarking. The important inherent properties of SVD from the view point of image processing applications which makes it popular to use are:

1. Singular Values (SVs) are stable i.e. any change to it doesn't affect the image quality.

2. SVs are able to represent inherent algebra properties of digital image.

3. SVD preserves both one-way and non-symmetric properties, which are not available using DCT or DFT transformations.

4. The size of matrices can be square or rectangular in SVD.

5. SVs are known to be invariant to some common attacks such as JPEG compression, noise addition, low pass filter (LPF), rotation, scaling and cropping. If A is an image of size n x n, then SVD of A is shown as below form

$$SVD(A) = USV^T \qquad (1)$$

Where U and V are orthogonal matrices, $UU^T=I$ and $VV^T=I$. Columns of U and V are called as left and right singular vectors respectively. S is a diagonal matrix of singular values σi, i=1,2,…n arranged in decreasing order and elements of S matrix are zero except diagonal elements. Therefore

$$SVD(A)=\begin{pmatrix} U_{11} & \cdots\cdots & U_{1n} \\ U_{21} & \cdots\cdots & U_{2n} \\ \vdots & \vdots & \vdots \\ U_{n1} & \cdots\cdots & U_{nn} \end{pmatrix}\begin{pmatrix} \sigma_{11} & \cdots\cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots\cdots & \sigma_{nn} \end{pmatrix}\begin{pmatrix} V_{11} & \cdots\cdots & V_{1n} \\ V_{21} & \cdots\cdots & V_{2n} \\ \vdots & \cdots\cdots & \vdots \\ V_{n1} & \cdots\cdots & V_{nn} \end{pmatrix}^T$$

$$=\sum_{i=1}^{r} \sigma_i u_i v_i^T$$

RESULTS

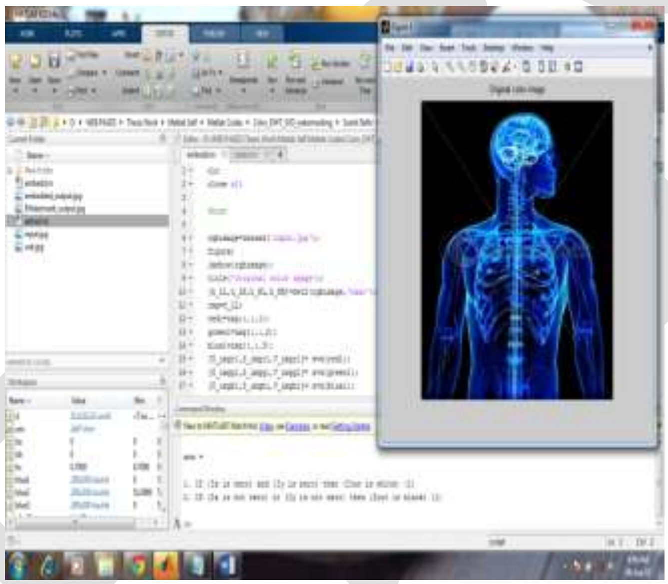

Fig-1 Original input image

The input color image of dimension 400x400 of size 60.8kb is used as an input for analysis.

INPUT IMAGES:

Image-1

Image-2

Image-3

OUTPUT IMAGES:

Output Image-1

Output Image-2

Output Image-3

Fig-2 Input watermark image

The size of the input watermark image is 38.2 kb, having dimension of 400x400

The above image is in gray scale format.

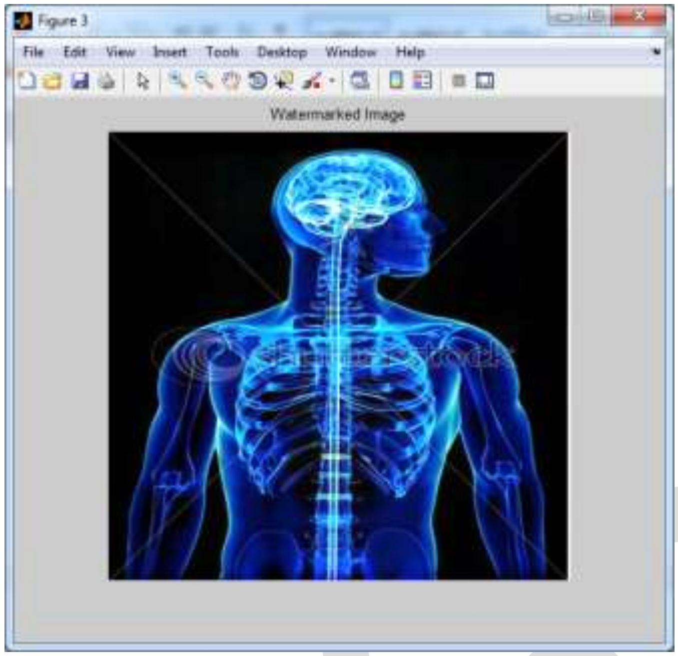

Fig-3 Input watermarked image

The output image is watermarked of the two images, almost no quality change in the image as shown above.

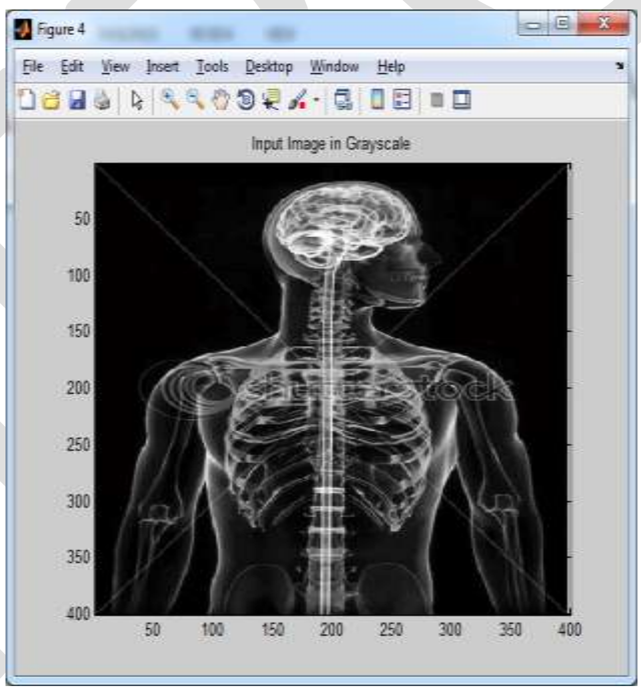

Fig-4 Image for fuzzy analysis

Input image coveted in gray scale for fuzzy analysis in MATLAB

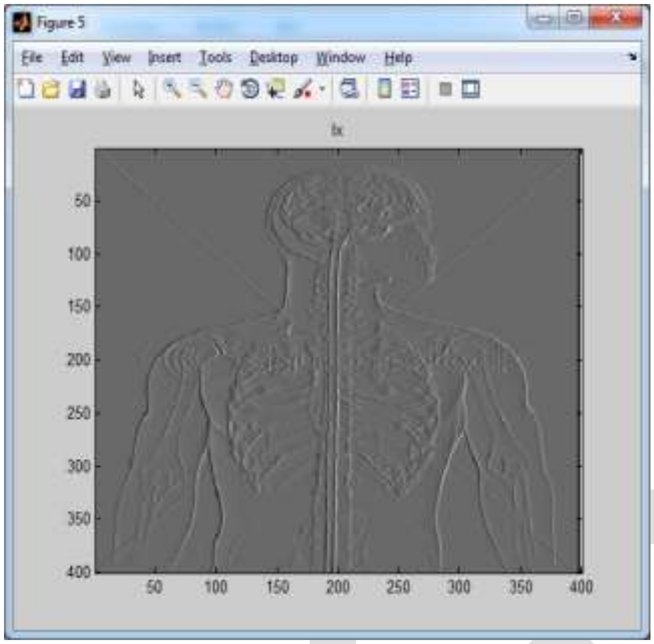

Fig-5 Fuzzy Inference System along Ix

After specifying the image gradient, Ix as the inputs of edge FIS. The output is shown as above. The fuzzy interference system present an output along vertical direction.

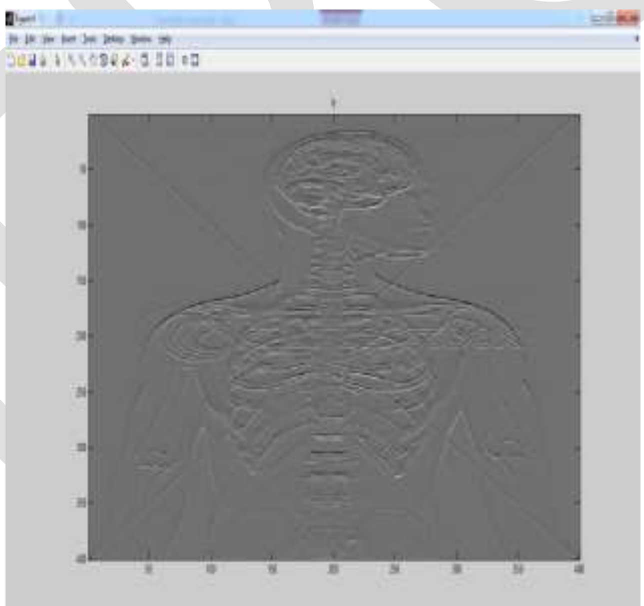

Fig-6 Fuzzy Inference System along Iy

After specifying the image gradient, Iy as the inputs of edge FIS. The output is shown as above. The fuzzy interference system present an output along horizontal direction.

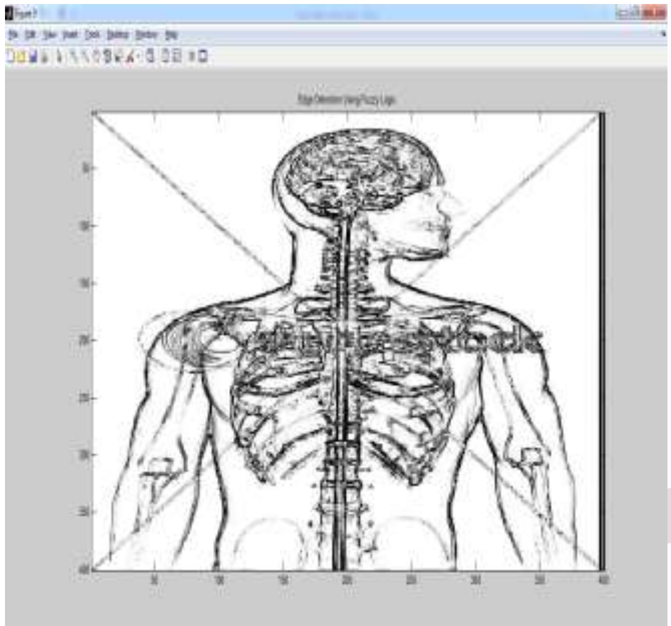

Fig-7 Edge detection using fuzzy

As we can with sx and sy, can change the values of wa, wb, wc, ba, bb, and bc to adjust the edge detector performance. The triplets specify the start, peak, and end of the triangles of the membership functions. These parameters influence the intensity of the detected edges.

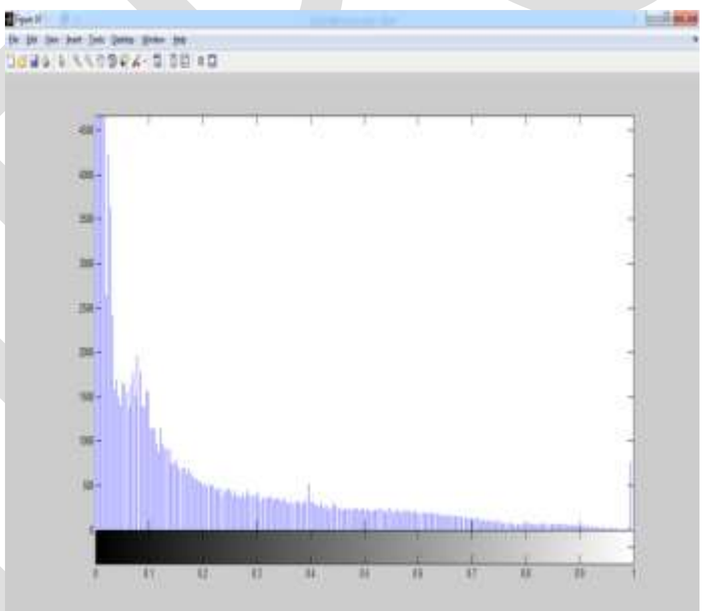

Fig-8 Histogram of the image

The histogram for the intensity image I and displays a plot of the histogram. The number of bins in the histogram is determined by the image type. If I is a grayscale image, imhist uses a default value of 256 bins. If I is a binary image, imhist uses two bins

Fig-9 Enhance the contrast of image using histogram equalization

Enhancing the contrast of image by transforming the values in an intensity image, or the values in the color map of an indexed image, so that the histogram of the output image approximately matches a specified histogram.

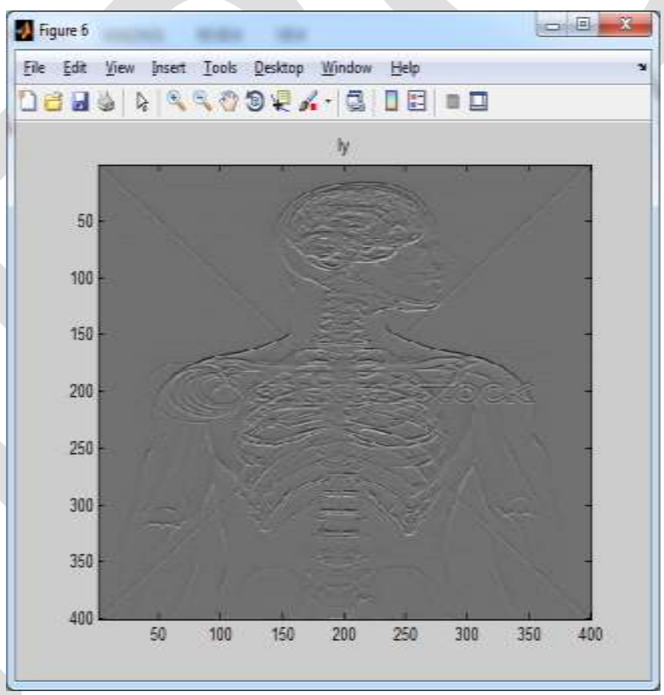

Fig-10 The output after specifying the image gradient

After specifying the image gradient, Iy as the inputs of edge FIS. The output is shown as above. The fuzzy interference system present an output along horizontal direction.

International Journal of Engineering Research and General Science Volume 3, Issue 4, Part-2, July-August, 2015
ISSN 2091-2730

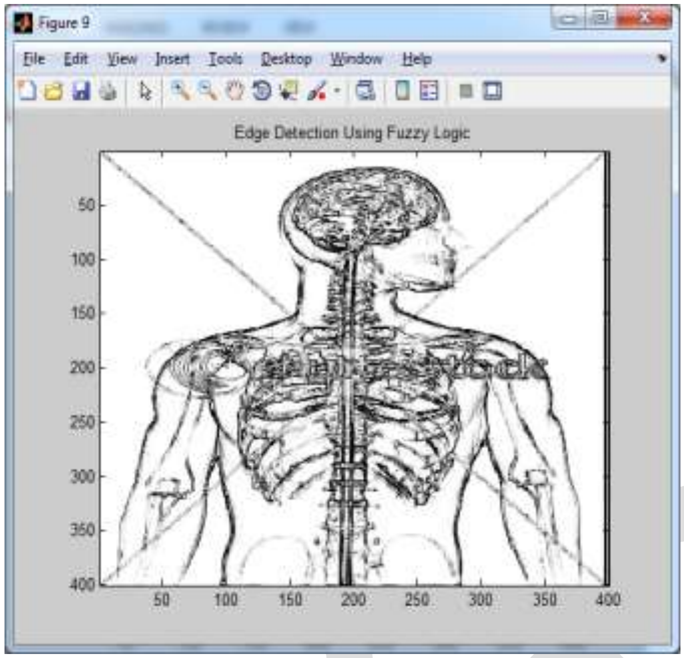

Fig-11 Evaluating fuzzy interference system (FIS)

The above result is obtained by evaluating fuzzy interference system (FIS). The output of the edge detector for each row of pixels in I using corresponding rows of Ix and Iy as inputs.

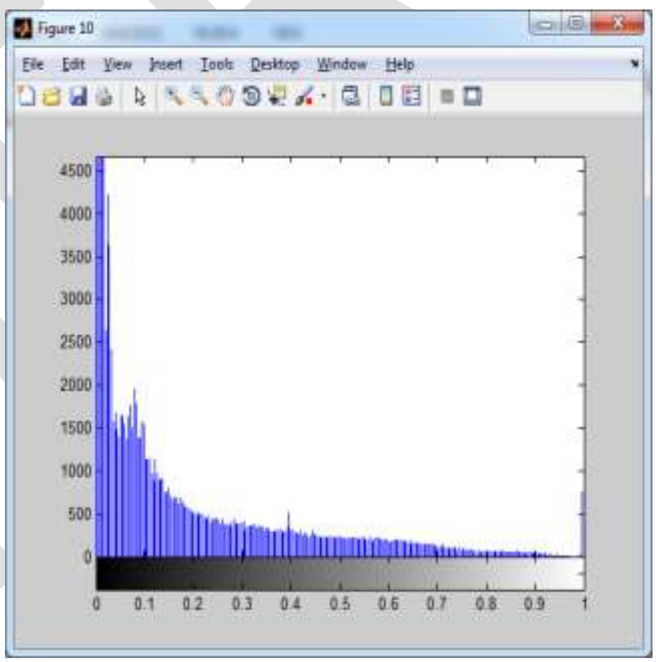

Fig-12 The histogram

The histogram is calculated by using imhist(I) which calculates the histogram for the intensity image I and displays a plot of the histogram. The number of bins in the histogram is determined by the image type. If I is a grayscale image, imhist uses a default value of 256 bins. If I is a binary image, imhist uses two bins.

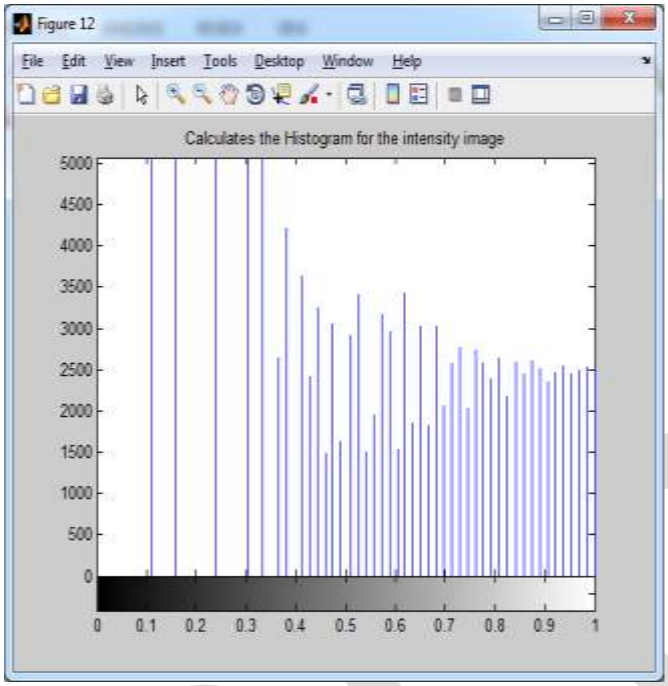

Fig-13 The histogram

The histogram is calculated by using imhist(I) which calculates the histogram for the intensity image I and displays a plot of the histogram. The number of bins in the histogram is determined by the image type. If I is a grayscale image, imhist uses a default value of 256 bins. If I is a binary image, imhist uses two bins. The resultant output is shown in fig 5.15 the output is of gray scale image which is used as input for fuzzy analysis.

Extraction

Fig-14 Input image of 60 kb in RGB format

Name	Type of	Result
Input image1	Psnr by salt and pepper	17.2630
	Snr	7.3508
	Psnr by poission noise	26.3139
	Snr	24.3904
Input image2	Psnr by salt and pepper	29.2630
	Snr	8.7508
	Psnr by poission noise	22.5100
	Snr	24.5004
Input image3		
	Psnr by salt and pepper	24.5475
	Snr	16.5092
	Psnr by poission noise	23.3003
	Snr	21.3809
Out image1	Psnr by salt and pepper	11.9375
	Snr	16.5992
	Psnr by poission noise	28.3563
	Snr	25.3829
Out image2	Psnr by salt and pepper	20.0298
	Snr	13.4650
	Psnr by poission noise	30.5171
	Snr	29.9522
Out image3	Psnr by salt and pepper	27.0200

	Snr	**14.9650**
	Psnr by poission noise	**10.5171**
	Snr	**29.9522**

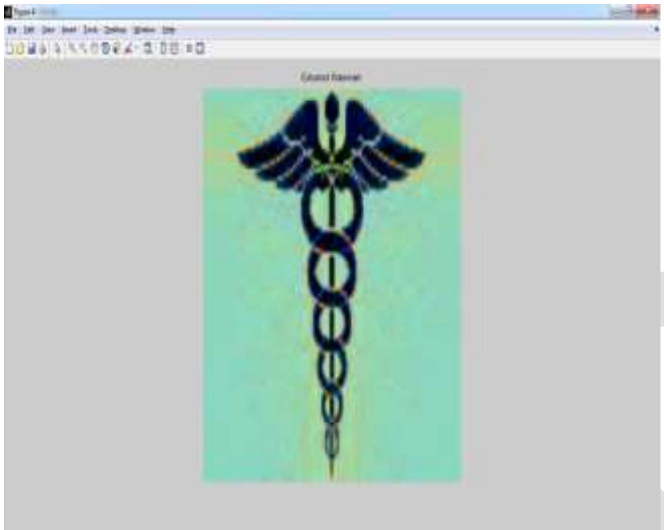

Fig-15 The extracted watermark, slightly change in quality, but the information is clearly visible.

The size of the image is 30kb.

CONCLUSIONS

Aiming at the medical images security problem during storage and transmission, we provides watermark method to protect it, and these method can be able to achieve integrity detection and accurate tampering localization. This method adopts image block, chaotic modulation in watermark information and encryption it. The watermark information will be embedded to original medical image. The proposed algorithms have the watermarked medical images with high and stable quality. The PSNR of the input image and the output image is almost same. This shows after decrypting the image the quality of the image is intact.

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