International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 10, October-2014, pp: (69-75), Impact Factor: 1.252, Available online at: www.erpublications.com

Zero-Watermarking Technique for Medical Image Authentication

Asaad Flayyih Qasim
Dept. of computer, studies planning and follow up office,
Ministry of Higher Education and Scientific Research, Baghdad, Iraq

Abstract: In this paper, we present zero-watermarking technique for medical image based on thinning file in order to ensure the authenticity and integrity of the medical images. Medical images, different of other images, require careful attention when hiding watermark information within them because the watermark bits may be affect on the region of interest (ROI) and misdiagnose. Therefore, zero-watermarking technique has been proposed. Watermark embedding process is carried out by apply the thinning algorithm for select the suitable places in which the watermark bits will be embedded in the original medical image to protect the ROI without tamper. Experimental results demonstrate that the distortion due to embedding the watermark is too small to be perceptive. The watermarking technique uses a 512×512×8 bits magnetic resonance grayscale image as a sample.

Keywords: Zero-watermarking; Image Authentication; Medical Image.

Introduction

Speedy development of internet in every field leads to availability of digital data to the public. Internet has been spread in many applications like telemedicine, online-banking, teleshopping etc. One of this application telemedicine is crucial one, where Internet is used to transfer or receive medical data by healthcare professional. Due to advancement in information and communication technologies, anew context of easier access, manipulation, and distribution of this digital data have been established. The medical images can be readily shared via computer networks and easily used, processed, and transmitted by using great spread network [1]. In the last decades, uses of advanced electronic and digital equipments in health care services are increased, where traditional diagnosis system has been replaced by e-diagnosis system. In fact, in most of the hospitals physicians diagnose their patients by relying on the provided electronic and digital data (such as Ultrasonic, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and X-ray images) [1,2].

In today's world the medical images can be given to the patient directly or send to the patient by online and also maintained as a soft and hard copy in the hospital for diagnosing and later in the future purpose. The problem rises here that is while sending or giving the data to the patient we have to find whether the data belongs to particular patient or not and also the privacy of the patient is needed. Hence authentication is required [2]. To avoid this type of problem, we used the latest technique called watermarking for authentication of the medical image. Medical image watermarking means embedding the patient information in the medical image. Why have we chosen the watermarking for medical image to authenticate is, because it increases the storage compatibility and avoids storing of multiple information, etc [3].So there is a need to embed watermark in the medical images. To fulfill the need of privacy, integrity and authenticity we can use the digital watermarking scheme for receiving correct information and providing proper treatment to the patients [4]. Digital image watermarking is a particular subset of steganography, which is the art of hiding a covert message in a carrier message. Examples of messages are other images, or ASCII code such as text files, or numbers. Medical image watermarking systems can be broken into three broad categories: robust, fragile, and semi-fragile [5].

In previous literature there are many watermark techniques designed for medical images. *El-Sheimy N. et al.* [6], presented a new method for protecting the patient information in which the information is embedded as a watermark in the discrete wavelet packet transform (DWPT) of the medical image. *Mohamed A. et al*. in [7], introduced a new approach for watermarking of medical image that they are trying to adapt to telemedicine. This approach is intended to insert a set of data in a medical image. These data should be imperceptible and robust to various attacks. In [8] *Rupinder K.*, proposed semi-fragile watermarking technique to embedded binary watermark into medical image based on the Discrete Cosine Transform (DCT) domain. The binary watermark is achieve low degradation level of the host image and thus gives high quality level.In this paper, we propose a new zero-watermarking technique based on thinning algorithm for medical image. This paper is organized in the following manner. The watermark inserting and extracting method is proposed in Section 2. Experimental results are shown in Section 3. Section 4 concludes this paper.

Proposed Zero-Watermarking Technique

In this section, new zero-watermarking technique is proposed based on thinning algorithm to insert the watermark information into the MRI images without any distortion as possible. The main idea is to decrease the distortion that results due to hide watermark. For that, we need to select the locations hiding very carefully. The proposed technique suggest inserting three bits from the watermark data into the three bits of pixel byte who has the lower effect in the value of pixel's and less sensitive to the Human Visual System (HVS). Thus, is not susceptible enough to notice and release the modifications in it. The main stages of the proposed zero-watermarking technique are illustrated in Fig.1.

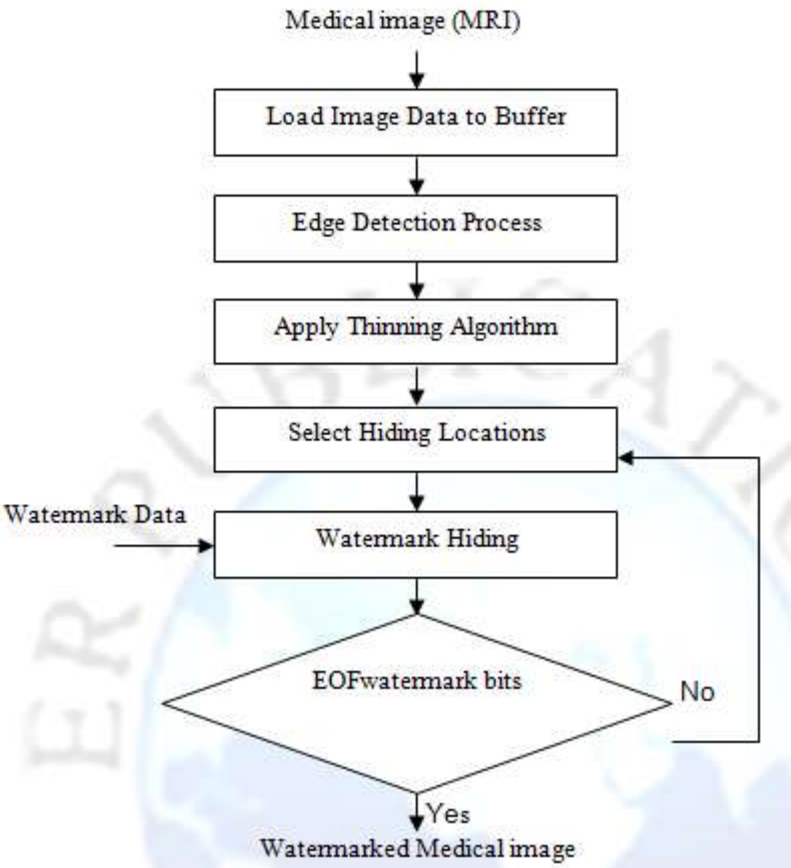

Fig.1: Block diagram of the proposed zero-watermarking technique

1. Input Image

The input of the proposed technique is an 8-bits (gray scale) medical image which is scanned by using magnetic resonance technology or it can be got from database. In the proposed technique, the medical image is used as host image to embed watermark. The data of input image is loaded into buffer in order to use in the next steps from the proposed technique. Fig.2. shows an example of input medical image.

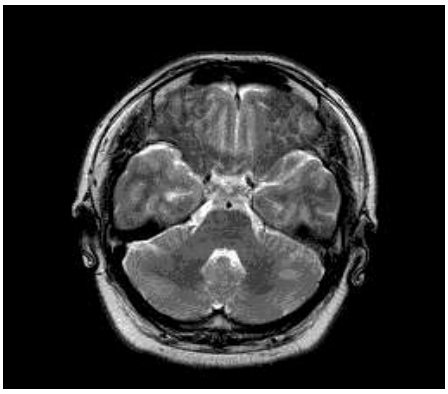

Fig.2: An example of input medical image

2. Edge Detection Process

An edge is defined by a discontinuity in gray level values. In other words, an edge is the boundary between an object and the background. The shape of edges in images depends on many parameters: variation in the illumination, orientation, discontinuities in image brightness, and the noise level in the images. Edges include the most important information in the medical image (ROI), and can provide the information of the object's position. In this step, edge detection process is used to identifying the edges regions which is used to insert the watermark data into medical image. As known, there are a number of different gradient filters to edge detection are available. Since the Laplacian operator is performs a simple, quick to compute, 2-D isotropic measure of the second spatial derivative of an image. Also, the Laplacian of an image highlights regions of rapid intensity change and it will be used in the proposed technique to detected edges in medical image. The Laplacian operator utilizes filter (3×3) pixel masks which is shown in Fig.3 [9].

$$\begin{vmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{vmatrix}$$

Fig.3: Laplacian operator Convolution Mask.

Fig.4. shows an edges image after applied Laplacianoperator for input medical image.

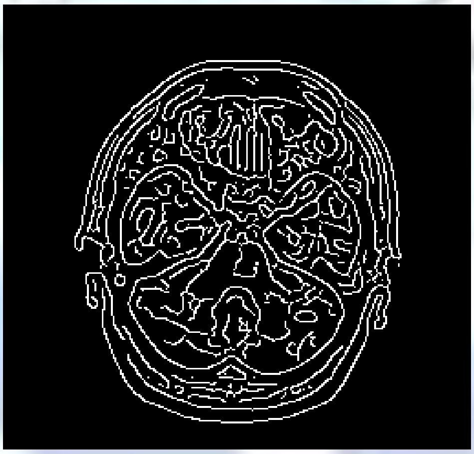

Fig.4: The edges image resulted by Laplacian operator.

3. Thinning Algorithm

The structural shape or skeleton of a region can be obtained by deleting edge points of that region iteratively until a unit thickness is reached. In this mode it is commonly used to tidy up the output of edge detectors by reducing all ridgelines to one pixel thickness. The deletion process must be carried out such that 1) the end points are not removed, 2) the connections are not broken and 3) excessive erosion of the region is avoided. Fig.5. shows center pixel with reference to the 8-neighborhood notation [10].

P_9 [i-1, j-1]	P_2 [i-1, j]	P_3 [i-1, j+1]
P_8 [i, j-1]	P_1 [i, j]	P_4 [i, j+1]
P_7 [i+1, j-1]	P_6 [i+1, j]	P_5 [i+1, j+1]

Fig.5: Neighborhood Arrangement by Thinning Algorithm.

Step 1 Flags a contour point P_1 for deletion if the following conditions are satisfied:

a) $2 \leq N(P_1) \leq 6$
b) $T(P_1)=1$
c) $P_2 \cdot P_4 \cdot P_6=0$
d) $P_4 \cdot P_6 \cdot P_8=0$ ... (1)

where $N(P_1)$ is the number of nonzero neighbors of P_1, that is:

$$N(P_1) = P_2 + P_3 + P_4 + \ldots P_8 + P_9. \quad \ldots (2)$$

$T(P_1)$ is the number of 0-1 transition in the ordered set P_2, P_3, $P_4 \ldots P_8$, P_9 that are the eight neighbors of P_1. If any condition is not satisfied the point (P_1) cannot be deleted, for example the values of P_2, P_3, $P_4 \ldots P_9$ as shown in Fig.6, then T (P_1) =2

Therefore, P_1 is not deleted from the image.

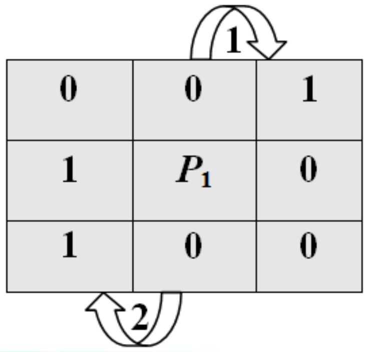

Fig. 6: Counting the 0-1 Transition in the Ordered Set P_2, P_3, $P_4 \ldots P_8$, P_9

Step 2 it is the same as step 1 except change in conditions (c) and (d) which be as follows:

c′) $P_2 \cdot P_4 \cdot P_8=0$
d′) $P_2 \cdot P_6 \cdot P_8=0$ ... (3)

In the first step, it is applied to every border pixel in the binary region under consideration. If one or more conditions (a)-(d) are violated, the value of the point in question is not changed. If all conditions are satisfied the point is flagged for deletion. However, the point is not deleted until all border points have been processed. This delay prevents changing the structure of the data during execution of the algorithm. After step1 has been applied to all border points, those that were flagged are deleted (changed to 0). Then step2 is applied to the resulting data in exactly the same manner as step1. Fig.7. shows a thinning image after applied thinning algorithm for edges medical image.

Fig.7: The resulted thinning image using thinning algorithm.

4. Selection of Hiding Locations

After obtain the thinning image for input image, then we need to decide what the locations are to use for hiding the watermark. Inserting watermark data in the thinning pixels gives a higher fidelity for medical image and lowery perceptible by human eye. Therefore, we embed watermark data into thin pixels in order to preserve the ROI in medical image. In this case, we must use the restricted conditions when insert the watermark bits to decrease the distortion.

5. Watermark Hiding

The main aim is to insert a watermark bits into the thin pixels of medical image. Before the hiding process, we need to convert the watermark information to sequence of binary information (0 and 1). The algorithm of proposed zero-watermarking technique is as shown follow:

Input: Medical Image, and Watermark Data.
Output: Watermarked Medical Image.

Step 1: Begin
Step 2: Load medical image and save data to buffer.
Step 3: Apply edge detection process using Laplacian operator.
Step 4: Apply thinning algorithm on the image that resulted by step 2.
Step 5: Select hiding locations from thinning image with attention to not influence on the ROI.
Step 6: Embed 3 bits from the watermark data in 3 LSB of thin pixel and change higher bits of the same pixel as follows:

If $(W_i=I_i) \rightarrow$ nothing is doing for each i=0,1,2
If $(W_i=0 \ \& \ I_i=1) \rightarrow I_i=0$ for each i=0,1,2 **&**
If $(W_i=0) \rightarrow I_i=1$, i=3

else if $(I_{i+1}=0) \rightarrow \{I_{i+1}=1 \ \& \ I_i=0\}$, i=3
else if $(I_{i+2}=0) \rightarrow \{I_{i+2}=1 \ \& \ I_i , I_{i+1}=0\}$, i=3
.
.
else if $(I_n=0) \rightarrow \{I_n=1$, n=7& $I_i=0$ for each I_i ,i=3,…..,6}
else $I_i=0$ for each I_i ,i=3,…..,6

else if $(W_i=1 \ \& \ I_i=0) \rightarrow I_i=1$ for each i=0,1,2 **&**
If $(I_i=1) \rightarrow I_i=0$, i=3
else if $(I_{i+1}=1) \rightarrow \{I_{i+1}=0 \ \& \ I_i=1\}$, i=3
else if $(I_{i+2}=1) \rightarrow \{I_{i+2}=0 \ \& \ I_i , I_{i+1}=1\}$, i=3
.
.
else if $(I_n=1) \rightarrow \{I_n=0$, n=7& $I_i=1$ for each I_i ,i=3,…..,6}
else $I_i=1$ for each I_i ,i=3,…..,6

Where W_i: is one bit of the watermark data,

i: the index of the bits in one pixel, where i=i+1, i=0,…..,n,

I_i: is one bit of a thinning pixel of medical image.

Step 7: Repeat steps (4) & (5) until EOF watermark bits.

Step 8: Save and display the watermarked medical image.

Step 9: End

6. Watermark Extracting

The first step of the watermark extraction consists also apply of edge detection process using Laplacian operator on watermarked medical image. Then, thinning algorithm is applied in order to select hiding locations which are used to stored watermark bits in watermark embedding process. Lastly, extract 3 bits from each pixel in the watermarked medical image.

Experimental Results

To test the performance of the proposed zero-watermarking technique, several medical images are used. This technique embeds the watermark bits based on thinning algorithm. This test has been carried out by using three MRI images with size 512×512. Fig.8. shows the medical images with their watermarked versions.

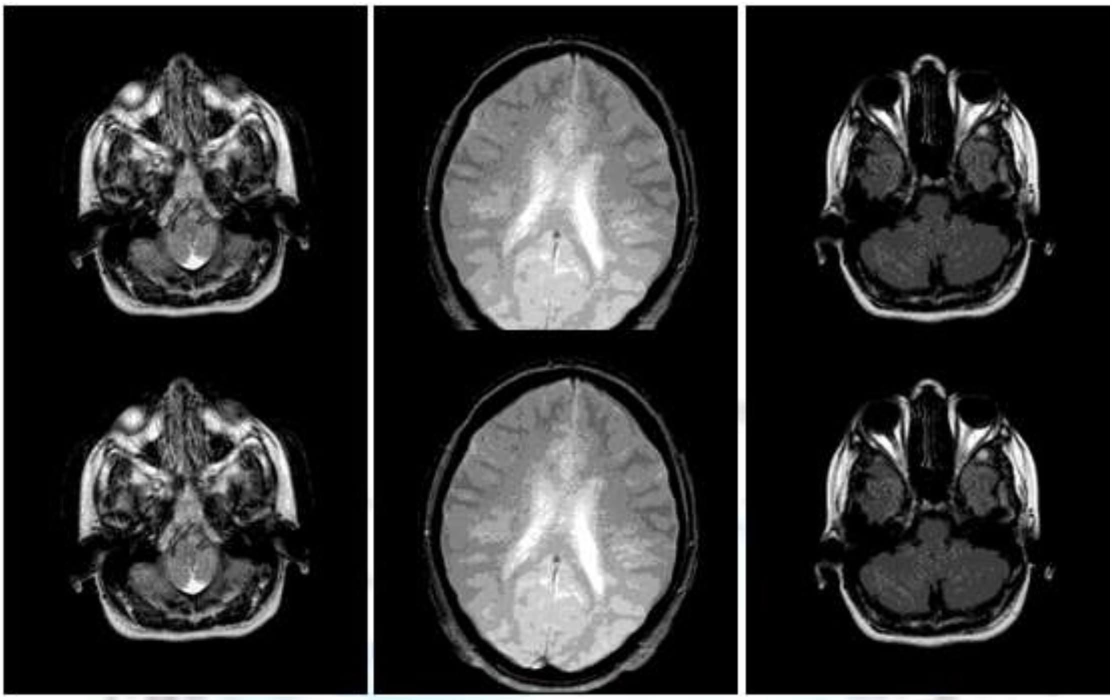

Fig. 8: Results of proposed zero-watermarking technique based on thinning algorithm, first row represent the original images, second row represent the watermarked images.

As displayed in Fig.8, it is very difficult to sensitive the resultant distortions due to embed watermark information into the medical images. We assess the proposed zero-watermarking technique in terms of quality for watermarked medical image. Therefore, three image quality measures are used. These measures are peak signal-to-noise ratio (PSNR) [11], universal image quality (UIQ) index [12] and structural similarity (SSIM) index [13]. The results of quality assessment are shown in Table 1.

Table (1): Quality assessment for the proposed zero-watermarking technique

Watermarked Image	PSNR	UIQ	SSIM
Image_1	49.65	0.992	0.952
Image_2	48.96	0.988	0.904
Image_3	50.14	0.995	0.976

Table (1) shows the results of hiding 3 bits of the watermark bits into the 3 LSB of the thin pixels only with changing higher bits in it. As clear in this Table, the proposed zero-watermarking technique achieves the best results with respect to quality of medical images. Also, the distortion amount in watermarked medical image is not imperceptible when the capacity of watermark data increases.

Conclusions

In this paper, we have proposed zero-watermarking technique for medical images based on thinning algorithm which can be used for authentication of medical image. Experimental results show that the distortion by hiding the watermark data is too small to be imperceptible. Thus, the proposed zero-watermarking technique can preserve the ROI without change and achieve very high quality for medical image. Future work will focus on making the watermarks robust against geometrical attacks and optimizing the technique to provide higher capacity and quality.

References

[1]. Imen Fourati Kallel, Mohamed Kallel, Mohamed Salim BOUHLEL, "A Secure fragile Watermarking Algorithm for medical Image Authentication in the DC Domain", IEEE 2006.

[2]. P. Viswanathan, Dr. P. Venkata Krishna, "Text fusion watermarking in Medical image with Semi-reversible for Secure transfer and Authentication "International Conference on Advances in Recent Technologies in Communication and Computing, 2009.

[3]. A. Ferreira et. al. Integrity for electronic patient record reports. In Proc. 17th IEEE Symposium on Computer based Medical Systems, 2004.

[4]. Mandeep K. AND RUPINDER K. "REVERSIBLE WATERMARKING OF MEDICAL IMAGES: AUTHENTICATION AND RECOVERY-A SURVEY," Journal of Information and Operations Management, vol.3, Issue 1, pp-241-244, 2012.

[5]. N. F. Johnson, Z. Duric, and S. Jajodia. Information Hiding: Steganograph and Watermarking - Attacks and Countermeasures. Kluwer Academic Press, Dordrecht, the Netherlands, 2001.

[6]. El- sheimy N., Salwa A.K., Tolba A.S., Abdelkader F. M. and Hisham M. E., "Wavelet Packets-Based Blind Watermarking for Medical Image Management," The Open Biomedical Engineering Journal, vol.4, pp.93-98, 2010.

[7]. Mohamed A. H. Abdellatif M.A., El-bey B., "A Watermarking of Medical Image: Method Based LSB," Journal of Emerging Trends in Computing and Information Sciences, vol. 2, no. 12, December 2011.

[8]. Rupinder K., "A Medical Image Watermarking Technique for Embedding EPR and Its Quality Assessment Using No-Reference Metrics," I.J. Information Technology and Computer Science, vol. 2, pp. 73-79, 2013.

[9]. T. Acharya and A. Ray, "Image Processing Principles and Applications," Published by John Wiley & Sons, Inc., Hoboken, New Jersey, pp.242–246, 2005.

[10]. Gonzalez, R. and Woods, R., "Digital Image Processing" Second Addition, Prentice-Hall Inc., 2002.

[11]. C.G. Boncelet, "The NTMAC for authentication of noisy messages," IEEE Trans. on Information Forensics and Security, vol. 1, no.1, pp.320–323, 2006.

[12]. Wang Z. and Bovik C., "Universal Image Quality Index," IEEE SP letters, vol. 9, pp. 81-84, March 2002.

[13]. Wang Z., Bovik C., Sheikh H. , and Simoncelli E., "Image quality assessment: From error visibility to structural similarity," IEEE Transactions on Image Processing, vol. 13, no. 4, pp. 600-612, Apr. 2004.