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Authentication in Telemedicine Using Double Tier Watermarking Technique.

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ABSTRACT

Telecommunication and Information technology merge together to handle medical information at remote location. During transmission, there is a possibility to attack the medical information by inserting the wrong information at sender and receiver side. Hence medical data needs protection. Using medical image watermarking technique, telemedicine provides a good healthcare system in a secured manner. This paper implements a double tier invisible medical image watermarking technique to protect patient information as well as suggestions from the remote location specialist. Proposed idea provides authentication using digital signature and avoids mismatching of patient information during diagnosis. This technique not requires key sharing between sender and receiver and easy to implement. The proposed method performance is analyzed with various quality measures like PSNR (Peak Signal to Noise Ratio), RMSE (Root Mean square Error), SSIM (Structural Similarity Index Measures), AD (Average Difference), MAE (Mean Absolute Error) and SC (Structural Content). Communication channel noises are also considered to evaluate the proposed methods against channel noise. The proposed method protects medical information in a secured manner and avoids medical information mismatching. Also, computation of quality measures proves that the proposed method provide high security in noisy channels.

Keywords: Telemedicine, Medical image watermarking, Spiral scanning technique, Authentication, Channel Noises, Quality measures.

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INTRODUCTION

Watermarking [1] is a method of hiding or embedding essential information (watermark) over a multimedia data (cover/original), which is called watermarked data (watermark + cover). Compare to stegnography, watermarking technique provide high security for data removal and replace [2]. Several types of watermarking techniques are available such as visible, invisible, robust, fragile, and reversible and non-reversible [1]. Medical image watermarking is used to protect not only the patient image but also to protect patient-information. It is categorized into ROI (Region-of-Interest) and reversible watermarking [3]. For medical images, robust and reversible medical image watermarking technique is required for high security. The data is transferred in a secure manner and retrieved back without any loss.

In telemedicine, the patient information is hidden within a medical image and transferred to the remote specialists. Then patient information is extracted without any loss from medical image. After extracting the details, remote specialist analyses the information and gives suggestions about the patient treatments through phone or by mail. In this way of transmission there is a possibility for the loss of data (suggestions). When the same specialist is analyzing the data from more than one patient, there is a possibility of mix up. To overcome this problem, this paper mainly concentrates on invisible medical image watermarking for secured communication at both sender side and receiver side.

Spatial domain and transform domain [4] are used for watermarking the medical images. Spatial domain reversible watermarking for lossless recovery of medical images is proposed [5] using Tian's method. In [6], developed reversible watermarking technique for medical images in spatial domain. This method produces a zero tolerance watermarking for noisy channel and mainly used for copyright purpose.

Medical image watermarking using steerable pyramid transform is proposed in [7]. Different features are extracted and watermark is embedded in a secured way, but to extract the watermark original cover medical image is needed. Using spatial LSB technique [8] watermarking technique, patient information is embedded within a medical image. This technique is used to ensure the integrity and protect the secrete information.

The security of the medical image watermarking is improved by using RSA digital signature [9]. Reversible data hiding technique for medical images, to protect the patient information developed in [10]. Edge detector identifies the region of interest (ROI) and Non-region of interest (NROI) from the medical image. Using graph coloring the keys are generated as dynamic. It avoids key sharing mechanism between sender and receiver. Wavelet transform [11] is used for reversible watermarking of medical images. Medical image texture area is used to embed patient information and ECG signals within a cover image.

In medical field [12], the security technique is enhanced using watermarking and encryption for Digital Imaging and Communications in Medicine (DICOM) images. To achieve high integrity, using MD5 the hash value is generated and it is combined with compressed R-S vector, patient id. Then provide reversible watermarking technique by extracting the patient id, hash value and DICOM image without any loss at the receiver side. The medical images are divided into ROI and NROI using canny edge and gabor filter edge detector [13]. The patient information is embedded within a NROI of medical images using dynamic key. And patient information is extracted correctly at the receiver side in telemedicine applications.

In all the previous methods there is no guarantee to get results from the remote location in secured manner. This paper will propose a new watermarking technique for getting the results from remote location in a secured manner.

METHODS

In this paper a novel double tier robust reversible medical image watermarking technique is proposed for telemedicine. To embed the watermark in spatial domain of cover medical image, spiral scanning technique as shown in Figure1, is used. First row of watermark image is embedded within a first row of the cover image. Second row of the watermark image is embedded into last column of the cover image. Third row of watermark is embedded within a last row of the cover image. Then fourth row of the watermark image is

embedded within a first column of the cover image. This process is repeated until all the coefficients of watermark image are embedded within a cover medical image.

For authentication digital signature is embedded along with patient information within a cover image. So the proposed method provides high security with authentication. At the receiver side the watermark and digital signature value are extracted and verified the digital signature. If digital signature is ok then only the patient information and medical image is accepted by the receiver otherwise discarded. This technique not requires any key sharing between sender and receiver.

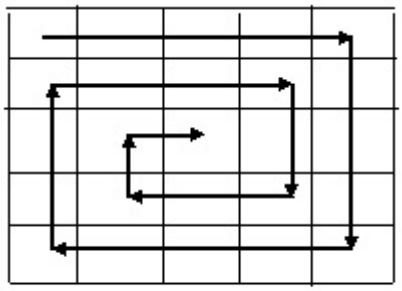

Figure 1: Spiral Scanning process

Figures 2and 3 shows the block diagram for the proposed system. The proposed algorithm is as follows:

1. Select cover medical image (cover)
2. Get patient information as an image and digital signature(watermark)
3. Embed watermark over cover image (watermarked)(Tier-1)
4. Transfer watermarked image to remote specialist
5. Extract cover, watermark and digital signature at the receiver side
6. Embed remote specialist suggestions within a watermarked image (Tier-2)
7. Transferred double tier watermarked image to local doctors.
8. Extract cover image, patient information, suggestions and digital signature from double tier watermarked image at the sender side

Embedding Algorithm:

Tier-1(Sender)

1. Select cover medical image and patient information
2. Scan the medical image using spiral scanning technique
3. Embed the patient information, digital signature within a cover image using spiral scanning technique.
4. Transmit single tier watermarked image to the receiver.

Tier-2(Receiver)

1. Consider single tier watermarked image
2. Read remote specialist suggestion image
3. Embed suggestion within a single tier watermarked image using spiral scanning technique
4. Transmit double tier watermarked image to the sender.

Extraction algorithm:

Tier-1(Receiver)

1. Consider single tier watermarked medical image
2. Extract the cover medical image, digital signature and patient information using spiral scanning technique.

Tier-2(sender)

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1. Consider double tier watermarked image.
2. Extract cover medical image, patient information, digital signature and remote specialist suggestions.

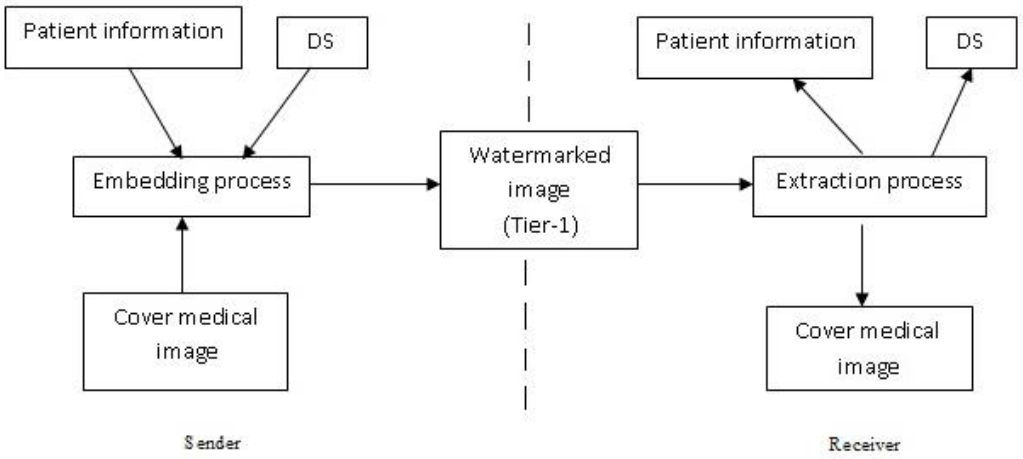

Figure 2. Single tier watermarking process: DS- Digital Signature

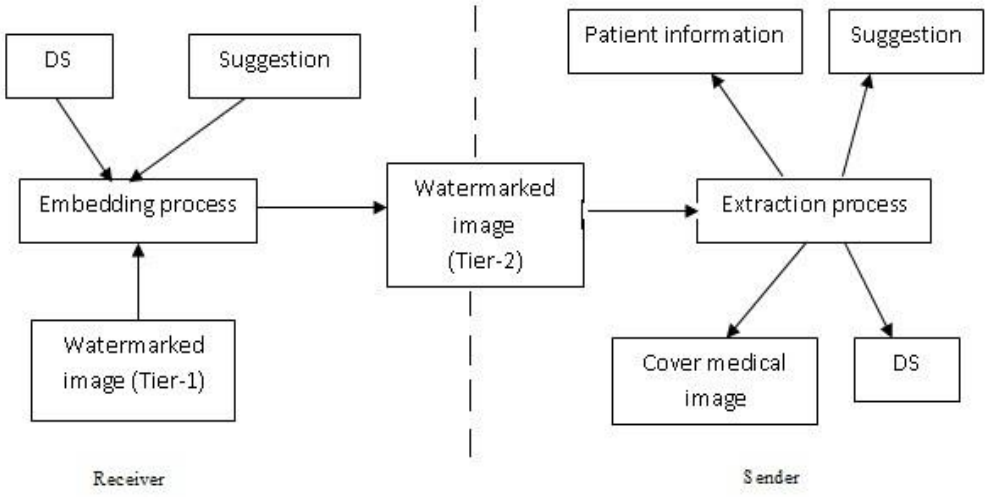

Figure 3. Double tier watermarking process

EXPERIMENTAL SETUP

In this paper, brain MRI scan image is considered as an original cover image. Binary Patient information image and doctors id are considered as a watermark image1 and it is embedded within MRI cover image. The input images are shown in figure 4. In tier1 at the sender side, the patient information is embedded within a cover image and watermarked image1 is transferred to the remote specialist. And at the receiver side, watermark information extracted from the watermarked image if the extracted digital signature is correct. Tier1 output images are shown in figure 5. Then the specialists identify the patient's problem and suggest some treatment (watermark image2). Now the specialist's suggestions are also embedded within a watermarked image1 in tier2.. The output of this process is considered as a watermarked image2 and is again transferred to the local doctors. Finally the all the images are extracted from the watermarked image2 by the sender if the extracted digital signature is correct. Outputs of tier2 are shown in figure 6.

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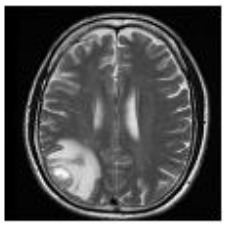


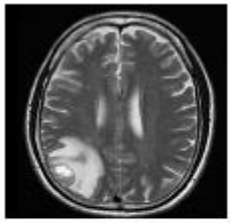
Name : AAAAA
Gender : F
Age : 30
Weight : 60kg
Patient Id : ID2490

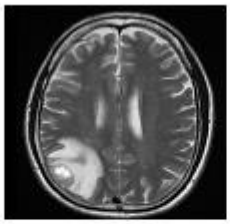
Patient Id : ID2490
Disease name : Cancer
Treatment : Chemotherapy

'SS123'

a b c d

Figure 4. Original Input. (a) Brain image, (b) Watermark1 (c) Watermark2 (d) DS (Digital Siganture)



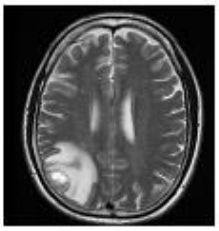


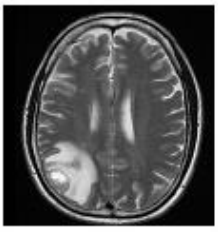
Name : AAAAA
Gender : F
Age : 30
Weight : 60kg
Patient Id : ID2490

'SS123'

a b c d

Figure 5. Tier1 output: (a) watermarked image1 (b) extracted image (c) Extracted watermark (d) Extracted DS.





Name : AAAAA
Gender : F
Age : 30
Weight : 60kg
Patient Id : ID2490

Patient Id : ID2490
Disease name : Cancer
Treatment : Chemotherapy

'SS123'

a b c d e

Figure 6. Tier-2 Output.(a) Watermarked image2 (b) Extracted image (c) Extracted watermark1 (d) exatracted watermark2 (e) Extracted DS.

PERFORMANCE ANALYSIS

Proposed system is analyzed by measuring the various quality metrics of an image. Table-1 shows the performance measures of the brain MRI image. Second column shows the values between original and extracted image using tier1. Third column shows the values between original and extracted image using tier2. Slat & pepper and Gaussian channel noises are also added in order to check the ability of proposed system.

In Table -1, without any noise the various measures values are listed and it shows that there is no loss in the extracted image and watermark at the receiver side. But if slat & pepper noise or Gaussian noise is added during transmission then some degradation in image qualities at the extraction side. In this analysis, for without noise the PSNR value is high and RMSE, AD, MAE values are in acceptable range. The SC and SSIM values are equal to 1 for without noise. This represents there is no loss in medical image and watermarks at both sender and receiver side. Suppose there is an attack with noise (salt &pepper, Gaussian) in channel, the PSNR value is low compare to without noise and RMSE, AD, MAE values are not in acceptable range. SC and SSIM values are not equal to 1.So due to noise the image quality is affected.

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Table-1: Performance measures

Quality Measures	Without Noise		With Noise			
			Salt & pepper noise		Gaussian Noise	
	Tier -1	Tier-2	Tier-1	Tier-2	Tier-1	Tier-2
PSNR	61.55	61.55	30.288	29.40	30.36	30.68
RMSE	0.1121	0.1231	3.4655	4.1302	3.4660	3.4106
AD	0.0140	0.1950	0.1965	0.0236	0.1903	0.1957
MAE	1	4.63	4.6098	6.8049	4.599	4.462
SC	0.9549	1	1.0496	1.0464	1.0490	1.0494
SSIM	0.9999	0.9999	0.9563	0.8771	0.9566	0.9566

CONCLUSION

This paper proposed a reversible invisible watermarking technique for telemedicine application in a secure manner. Using spiral scanning method both patient information and remote specialist suggestion are embedded in the cover medical image. The proposed technique provide good authentication for sender and avoid patient information mismatching during diagnosis. The watermarks are extracted without any loss at the sender and receiver side. The performance measures show that there is no loss in the watermarks and cover image during extraction without any noise.

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