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A COMBINATION OF REVERSIBLE DATA HIDING AND MEDICAL IMAGE COMPRESSION

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Abstract: In this paper, a new lossless reversible data hiding technique is presented coupled with compression. Medical images, different from other images, require additional care when embedding other information inside them because the additional information should not change the image quality and readability. Lossless data hiding techniques are used for overcome any misdiagnose caused by embedding data into medical images. In this paper, proposed a lossless reversible data hiding. The proposed technique implements a pure lossless reversible data hiding scheme. It can be used to hide patient's information hiding at boundary of Region of Interest (ROI) in medical images. Run Length Encoding is used for compression. It has recovery facility without any loss of information. The experimental results show that the host image and hidden information can be exactly retrieved from the Stego image.

Keywords: Reversible data hiding, Medical image compression, RLE

1. INTRODUCTION

Protection of digital multimedia content, over networks has always been a challenge for researchers. In recent days, the internet offers secure data communication for secret information, important messages, documents, images and videos. But with advanced hacking tools, any secure communication can be violated easily. To overcome this problem, cryptography and steganography have been introduced. In cryptography, the data hidden in the encrypted data. The original data can only be extracted with the secret key. When the attacker discovers to access an encrypted message, it is impossible to recover the content. But if the secret key is broken or stolen, this technique will no longer protect the information. Data can also be hidden behind a cover image such that an observer is not aware of its existence. This type of data hiding is called steganography.

So far, some algorithms for data hiding have been proposed, but most of them fail to recover the cover image after data extraction. However, in some medical and military applications, it is desired that the original cover media to be recovered losslessly after data extraction. The hiding techniques satisfying this constraint are referred to as lossless reversible data hiding techniques.

Any data hiding is categorized based on the type of manipulation into two broad categories as frequency domain and spatial domain based. In the spatial domain, manipulating the intensity values at the pixel level, least significant bits, etc. In frequency domain, manipulating the intensity values at the coefficient level by utilizing certain frequency domain conversion transforms.

Medical images contain information about the human body. It used for various reasons such as surgical and diagnostic plans. In the field of profiling patients' data, medical images need more space and storage. Also, we need to transfer the medical image records on the net which needs high bandwidth. So, here compression is needed. Thus, medical image compression is used in the applications such as profiling patients' data and transmission systems. According to the significance of medical images, lossless compression is chosen. So, medical images require compression and compression ratio is important. Some of the recent lossless compression techniques are

- Run length coding
- Huffman coding
- Arithmetic encoding
- Entropy coding

Generally, to compress the sequential data, Run length coding is used. It achieves compression by eliminating repetitive data.

In this proposed method lossless reversible data hiding for hiding information and Run Length Encoding is applied to compress the image. The remaining part of this paper is organized as follows, Section 2 discusses about related work in this research area, section 3 describes the proposed method, Section 4 analyses the performance of the proposed method and Section 5 presents the conclusion and future work.

2. RELATED WORK

In 2008,M.A.Ansari et.al proposed different techniques of image compression in Telemedicine [1]. This article deals with basic redundancies used to achieve compression, particularly focussing on medical image.

M. Mary Shanthi Rani et.al (2016) [2] proposed for secret communication by combining the concepts of Steganography and QR codes. The proposed method contains two phases: (i) Encrypting the message by a QR

code encoder and thus creating a QR code (ii) Hiding the QR code within a colour image.

M. Mary Shanthi Rani et.al (2016) [3] focused DWT (Discrete Wavelet Transform) , DCT (Discrete Cosine Transform) and IWT(Integer Wavelet Transform) secret data are embedded within a video file using both the methods, spatial and frequency, and the outcomes are analysed and compared.

The secret data [4] is hidden into the quantized DCT co-efficients of the JPEG compressed image. Finally, to generate the JPEG compressed stego-image, the entropy decoding method is employed.

If the data is hidden in LSB as in [5], a hacker can recover the hidden message by mark out the LSBs of all pixels and fix them into bytes. To avoid this and to raise the power of security, the stego image with hidden data is encrypted and the encrypted image is hidden in other cover images at random based on random number generator.

Anupriya Sohal et al. (2015) [6] After the embedding process, the resultant object i.e. the stego object is quiet good in quality with respect to visibility. In extraction procedure it has been aimed to extract the original message intact, which has been executed successfully by the above mentioned extraction algorithm.

M. Mary Shanthi Rani et.al [7] has developed a new approach that data hiding with compression in medical images. This technique gives the best result with low computation complexity. Run length coding is used for lossless compression, the receive image by the receiver is the same as the original image sent and the hidden data by the sender.

In 2008, K. A. Navas, et.al presented Electronic Patient Report (EPR) data hiding for telemedicine [8]. This article deals with novel blind and reversible data hiding technique in ROI images using integer wavelet transform and it particularly focused on medical images

M. Mary Shanthi Rani et al (2017) [9] proposed to hide the data in both Region of Interest (ROI) of medical images and Non Region of Interest (NROI) of medical images and recover the data as well. Medical image and hidden data are recoverable without any loss of data. a novel message hiding technique in RGB Domain is presented in [10].

C Nagaraju et.al [11] developed embedding patient information and Electrocardiogram which is further encrypted to ensure better security in spatial domain [11].

Mary Shanthi Rani et.al [12] has developed a method for hiding stego images using the Visual Cryptography VC shares which are insignificant and cannot be taken by Steganalysis tools. VC and Steganography take part in information security.

Mohit Gupta et al. (2012) [13] proposed the secret message is encoded before embedding in order to increase the capacity of the proposed data hiding system. The main advantage of this method is that at the time of extraction there is no requirement of the original cover image which increases the security of the proposed steganography system

A new approach for VC validation is developed in[14], by hiding QR Code in a NROI of the secret image without The sample result is shown in Figure 5.

affecting its quality. The originality of the proposed method is multifold.

3. Proposed Method

In the proposed technique, a new method of text data hiding into an medical image is proposed. This method is well suited for hiding patient information into a medical image producing a stego image. Moreover, the stego image is compressed using a reversible lossless compression technique for efficient and fast transmission. In this technique, lossless compression technique run-length encoding is used for compressing the stego medical image so as to reconstruct the image at receiving end without any loss in image informations, which are very vital for medical diagnosis. The special feature of this algorithm is data hiding combined with compression. It would be useful specifically for PACS. The algorithm of the proposed method is executed in three phases. Phase one executes the text hiding in medical image, phase two compresses the stego medical image and phase three executes decompression and hidden data retrieval.

The steps of the proposed algorithm is outlined as follows

3.1 Phase One – Data Hiding

Steps:

- Read the input medical image.
- Change the color image into gray scale image.
- Find the Region of Interest by locating the rectangle enclosing it, with its top left and bottom right co-ordinates as shown in Figure.2 (b).
- Give the text data as hidden data(for example: Patient id and Name)
- each character of text convert into its consequent ASCII value as given in Table 1.
- To avoid replication of hiding same text characters, count the ASCII values.
- Find the zero valued pixel p(x,y) bordered by pixels at four corners(Top ,Bottom, Left,Right) with value 0.
- Hide the ASCII value at p(x,y).
- P(x,y) pixel value divided by 10 and restore Quotient at p(x,y-1) and reminder at p(x,y-2), resulting in stego image.

3.2 Phase Two – Image compression

After the data hiding process in phase one, the stego image is compressed using Run length encoding and transferred through the internet.

Steps:

- The stego image is changed into a vector using spiral order Figure 4 (a).
- Using Run Length Encoding, the above vector is changed into two vectors representing the element and its modified run length as shown in Figure 4(b) & (c)

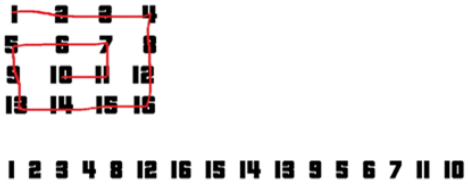


Figure 1. Example of image to Vector using spiral order

3.3 Phase Three – Decompression and Data Retrieval

Phase three decompress and decodes the image and retrieves the medical image and the hidden data. The compressed image taken from the previous phase is reconstructed to obtain the stego image by executing the modified run length decoding procedure as given below:

Steps

- Create a vector of stego image by using the elements and modified run length vectors.
- Convert the vector obtained in the earlier step to 256x256 matrix.
- Retrieve the value of p(x,y) which is the ASCII value of the hidden character, if the following conditions are true:
  - p(x,y) ≠ 0 and
  - p(x+1,y)= P(x-1,y)= P(x,y+1)=P(x,y-1)=0
- Restore p(x.y) with zero to get the original medical image.
- Convert the ascii values to their equivalent characters to obtain the secret data.

RESULT AND DISCUSSION

The proposed method is analyzed using medical images of size 256x256 with 256 gray levels. Results of the proposed method is given in Table

Table 1: Secret Message

Input Text	R	A	J	N	P	R	O	J	E
ASCII Value	114	97	106	97	110	32	112	114	111

Figure 2. (a) Original medical image256x256

Figure 2.(b) Image with Region of Interest 181x218

In the proposed method, an original medical image of size 256x256 is used, information is hidden near Region of Interest so that there will not be any visible distortion. This is illustrated in Figure 2 (b) which shows the actual region measured for hiding.

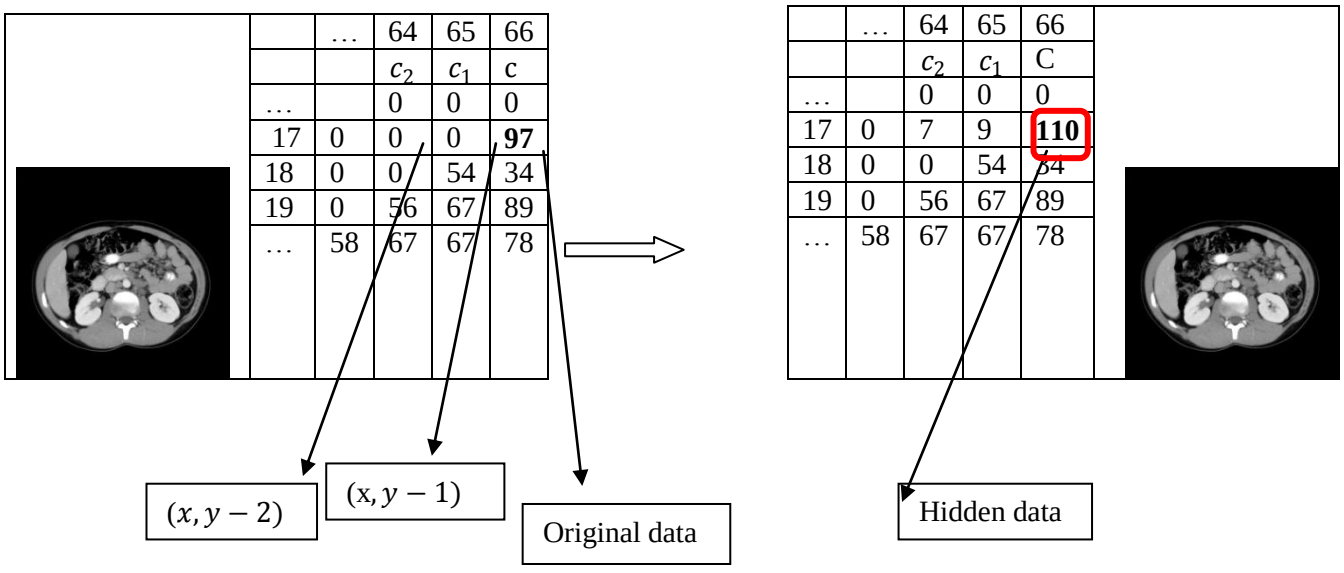


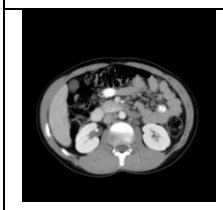
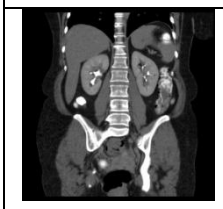
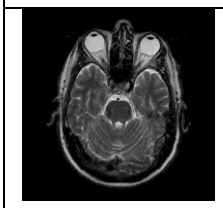
Figure 3. Image before and after hiding

100	100	93	99		99	99	99	97		97		97	
			(a)	Image to vector									
	100	99	97				2		5		3		
	(b)	Element					(c) Run Length						

Figure 4: Sample result of Phase 2

The performance of the proposed method is analysed by measuring encoding and decoding time that are tabulated in Table 1. The proposed algorithm is very simple to execute and Table 1 shows that the data hiding and encoding time takes less than a second.

Table 2 : Measurement of Processing Time

Image	**Process**	**Elapsed Time (seconds)**	**Total (seconds)**
	Data hiding	0.016	0.098
	Run length Encoding	0.008	
	Run length Decoding	0.069	
	Data Retrieval	0.005	
	Data hiding	0.016	0.09
	Run length Encoding	0.008	
	Run length Decoding	0.061	
	Data Retrieval	0.005	
	Data hiding	0.016	0.097
	Run length Encoding	0.008	
	Run length Decoding	0.066	
	Data Retrieval	0.007	

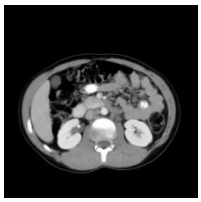
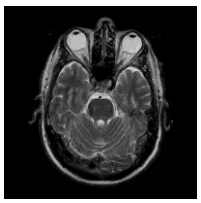
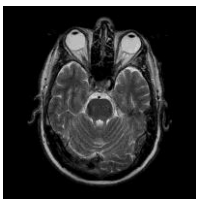
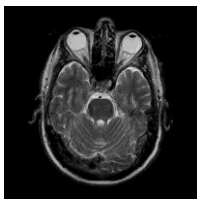
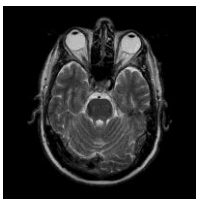
The quality of the reconstructed image is assessed by measuring the standard metric Mean Square Error (MSE) between the host image and stego image as well as original and reconstructed image which is calculated as follows,

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[A(i,j) - Y(i,j)]^2$$

$$PSNR = 10\log_{10}(\frac{Max(A)^2}{MSE})$$

Table 3: MSE and PSNR of Stego Image and Reconstructed Image

Compared Medical Images	MSE	PSNR	Compared Medical Images	MSE	PSNR

Original Image	Stego Image			Original Image	Reconstructed image		
		0.81	49.046			0	infinity
		0.81	49.046			0	infinity
		0.81	49.046			0	infinity

The results of Table 3 shows that there is very little visible distortion between the stego images and the reconstructed images. It is also value noting that MSE is 0 revealing that the reconstructed image is accurately similar to the host image. The retrieved data is similar as the hidden data in these three sample images. The MSE and PSNR values in Table 2 for all sample images is same (PSE=0.9565, MSE=48.4240) indicating that the same number of pixels are modified in these three images.

Table 4 compares the proposed method with the existing method [7] [15] and the result shows the effectiveness of the proposed method.

Table 4: Comparison with Existing method

S.No	Method		Elapsed Time (Seconds)		Total (Seconds)
1	Existing [15]		Stego	6.79	7.2100
			Compression	0.42	
2	Existing [7]	Image 1	Stego	0.0251	0.1031
			Compression	0.0780	
		Image 2	Stego	0.0245	0.0909
			Compression	0.0664	
		Image 3	Stego	0.0262	0.1023
			Compression	0.0761	
3	Proposed	Image 1	Stego	0.024	0.098
			Compression	0.074	
		Image 2	Stego	0.025	0.09
			Compression	0.065	

		Image 3	Stego	0.022	0.097
			Compression	0.075	

CONCLUSION

In this proposed method, an efficient reversible method is presented. The merits of the proposed method over similar existing methods are multifold (i) increasing hiding capacity (ii) good visual quality stego and reconstructed images (iii) less encoding time. In Compression, RLE method is used. It gives better result then normal RLE.Gray scale images are used for testing the proposed method and our future work would be to extend to color images as well.

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