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Reversible Watermarking Technique for Data Hiding, Accurate Tamper Detectionin ROI and Exact Recovery of ROI

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Abstract: Medical images are passed away through networks without any noise or disturbances for diagnostic decisions. Patient Details embedded into the medical image and transferred to another location without degradation or no change in actual quality of image. While transferring medical images tampers may be introduced. To avoid tampers this paper propose a block based fragile method water marking technique to verify integrity of ROI, distortion inside ROI, Authentication of ROI, Data hiding and exact recovery of ROI using reversible water marking technique. The medical image can be divided into 3 parts as Region of interest (ROI), region of Non interest (RONI) and Border pixels. The recovery of ROI embedded into RONI. Number of Experiments is conducted in thirty medical images to achieve 100% accuracy with zero loss in ROI.

Keywords: Authentication of ROI, Data hiding, Region of interest (ROI), Region of Non interest (RONI).

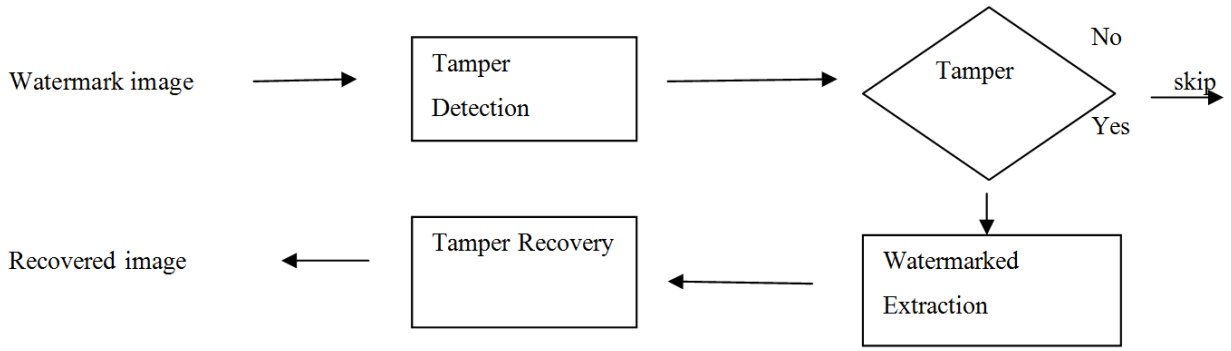
I. INTRODUCTION

Medical images transferred from one location to another location for faithful interaction between patient and physician. Patient details[1] Like Patient Name, Gender, Age and Patient ID embedded in to the medical image and sent to the another location for diagnostic decisions. While embedding Patient details in to image maintain Confidentiality. Tampers may be introduced while transferring data due to accessing of unauthorized users. To maintain integrity of medical images and transmission through commercial networks may lead to more cost and wastage of time [2]. To avoid this water marking techniques are introduced.

Watermarking techniques are classified in two categories.1.spatial domain and 2.frequency domain. In spatial domain [3-6] data directly embedded into host image. In frequency domain [7-9] data embedded into transformed host Image.

Water marking techniques can be classified as reversible and irreversible techniques. Lossless of original image can be obtained from the reversible water marking techniques [8-11]. There is no possibility recovery of original image without loss in irreversible water marking technique [7]. This paper proposes a reversible watermarking technique [2].

Watermarking methods can be divided in to four methods: fragile, semi-fragile, and robust and hybrid .1. Fragile Technique [3-6,14] allows the watermark to easily be destroyed by smallest modifications 2.The semi-fragile method allows protects data hidden in medical images against intentional and unintentional attacks.3.Robust Technique [7-9,13] specifies copyright protection from malicious attacks.4. Hybrid Technique [15-17] specifies the mixture of robust and fragile to provide authentication, integrity and copyright protection.



Block Diagram1: Tamper Detection

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Medical image divided into 3 parts as ROI, RONI and Border pixels. ROI is more important than RONI from diagnosis point of view. Care must be taken while embedding data in ROI. The recovery data of ROI is placed in the RONI [4-6, 9, 17-19].When tampers are attacked the entire ROI replaced with the information in the RONI. After tampers detected recover the exact recovery of ROI without no loss. Detection of Tampers shown in the BlockDiagram1.

This paper proposes novel block based fragile method using following contents.

1. Accurately identify the tamper blocks and calculate the average and variance values of tamper blocks.
2. If tampers are occurred, recover the original ROI with zero loss.
3. Recovering exact ROI with simple mathematical calculations.
4. No data embedded inside ROI, without avoiding distortion inside ROI.

II. PROPOSED METHOD

This paper proposes a digital image watermarking technique for authentication and data hiding using block based fragile method.

A. Embedding Procedure:

In this proposed method the embedded algorithm consists following way. First, the medical image segments the ROI pixels, RONI pixels and Border pixels. Seperate ROI region from the medical image as rectangular or polygon shapes chosen by physician. Care must be taken while dividing the ROI region. Next calculate the hash value of ROI, to increase security calculate the hash value using SHA-1 technique [21] containing 160 bits. Concatenate Patient data with Hash value. Divide the ROI region into 4*4 non overlapping blocks and RONI region into 8*8 non overlapping blocks. Map each ROI block into RONI using (i)

$$BLK_{RONI} = [(k*BLK_{ROI}) \bmod N_b] + 1 \qquad (i)$$

The size of ROI block is less than the RONI block.16 pixels inside the ROI block collected as recovery data. These recovery data embedded in to the 2 or 4 least significant bits (LSB) of the Mapped RONI block. Encrypt the recovery data of ROI using hash value by a secret key k. In the above equation (i) BLK_{RONI} is block number of RONI, k is secret key, BLK_{ROI} is block number of ROI and N_b is number of blocks.finally, watermarks are embedded in to the medical image in embedding procedure. Now the watermark medical image is ready to sent far away

Locations or remote locations for diagnostic decisions. Furthermore, the embedding part used the LSB method that has multiple advantages—simplicity, high capacity, and very low distortion to the watermarked image. The PSNR of a watermarked image varies from 90 to 51 dB by increasing the embedded data from 8 to 64 kb.

B. Extraction procedure:

The extraction process consists of four steps. Firstly, hash value and Patient data extracted from the LSBs of the watermarked region. Then, the LSBs of the watermarked region are converted to their original values, which in the US image is zero. After that, hash value of the image is calculated. In the last part, compare the hash values of extracted hash value and original hash value if the two values are same or near by the value the medical image is authentic. Otherwise the medical image was tampered. To detect tamper areas inside ROI and recover the original ROI, divide the received watermark image into nonoverlaping blocks of 4*4 and 8*8 respectively. For each ROI block identify mapped RONI block using (i).Extract the ROI pixels from the mapped RONI block. Calculate average and variance values of ROI block and pixels extracted from the mapped RONI block. When a block in ROI detected as tampered block replace the block with the extracted pixels used to recover the original ROI. Embedding and Extraction medical images with patient details are shown in Figure 3 and 4.

III. RESULTS

Experiments are conducted in 30 medical images like CT scan, Ultra Sound images. Quality of watermarked images are calculated using Peak signal to noise ratio(PSNR) and Mean Square Error (MSE).Performance Analysis of Different images like CT Scan and Ultra sound scan images are shown in Table 1 and 2.

A. Mean Square Error **(MSE)**: MSE between original and watermarked image is measured by:

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

I is Original Image and K is Watermarked Image.

B.Peak-Signal-to-Noise Ratio **(PSNR)**: The PSNR between the original and watermarked image is obtained by:

$$PSNR = 10\log_{10}\frac{255^2}{MSE}\text{dB}$$

Larger PSNR means the original and watermarked image are more similar to each other. To have acceptable perceptual value, the PSNR should be greater than 30 dB. Difference between original, watermarked, tampered and recovered images are shown in Fig 1 and Fig 2.Figure 1 shows watermarked image and recovered image. There is no difference between watermarked image and recovered image. Figure 2 shows tampered blocks in medical image and recovered image, Black color rectangular shape shows

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as tampered blocks. Table 1 shows results of different images and Table 2 shows Average performance of proposed method. In the proposed method PSNR of watermarked and Recovered images are greater than 50dB.So, the images are effective.

Original image Watermarked image Recovered image

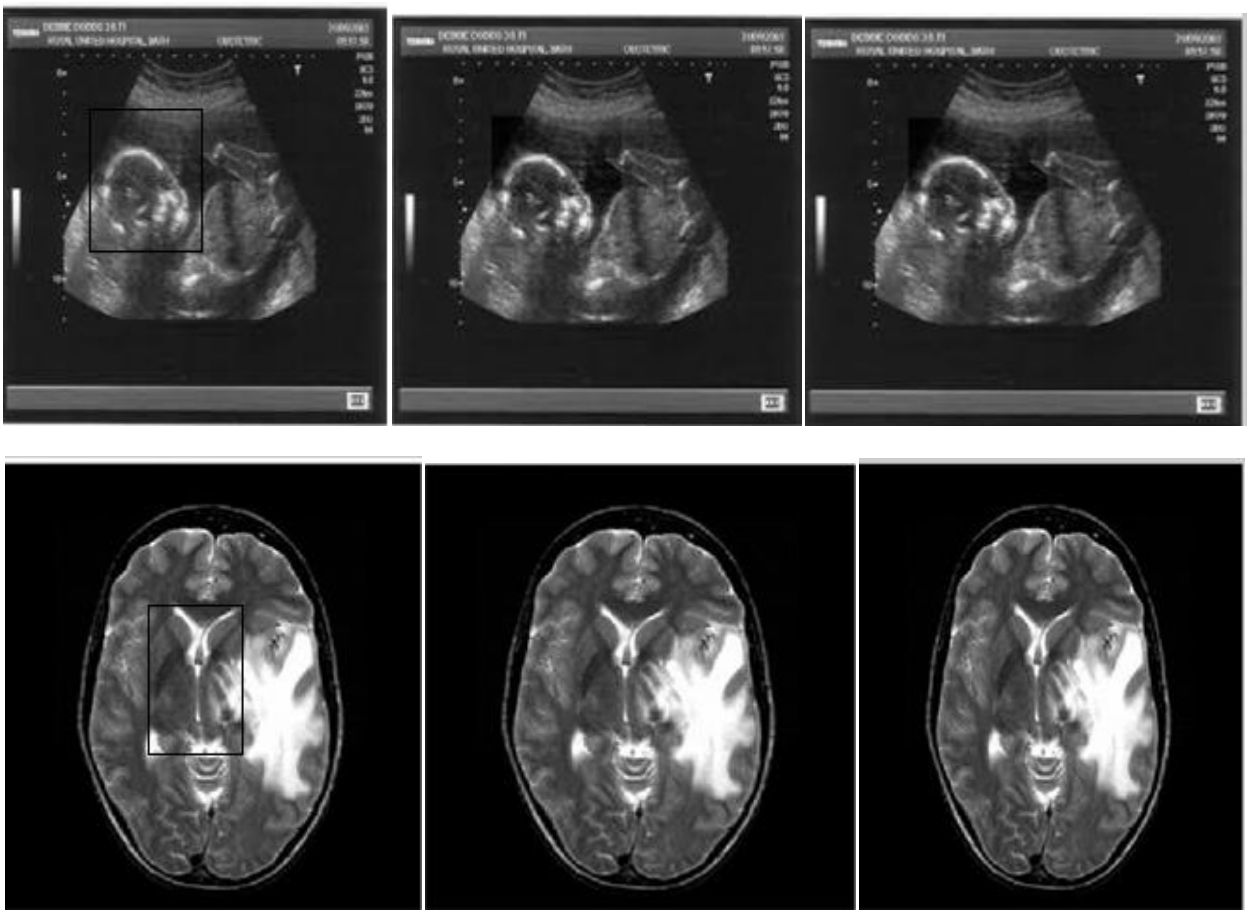
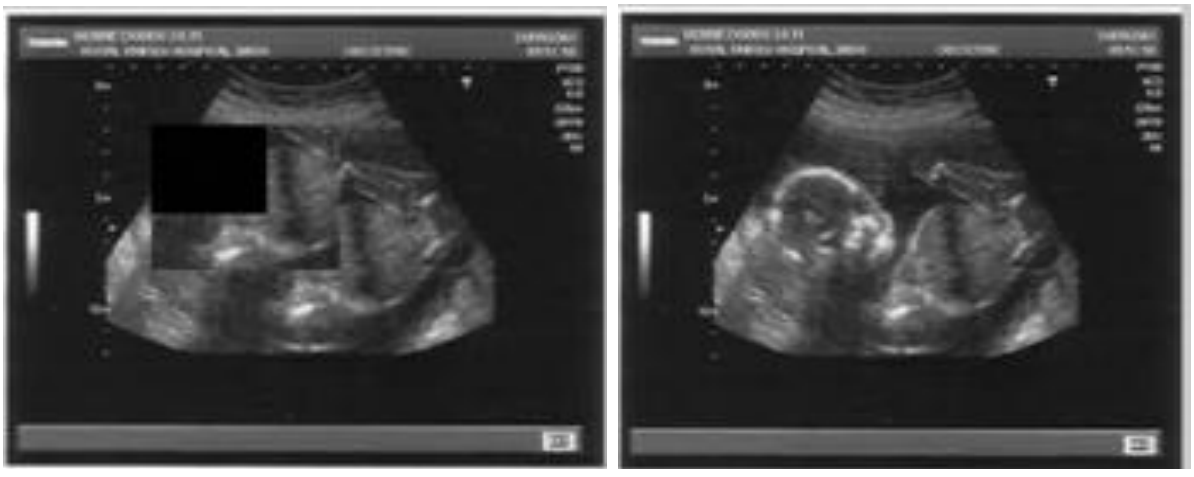


Fig 1: Original, watermarked and recovered images of ultrasound image and CT scan image.ROI region marked as rectangular shape.

Tampered image Recovered image



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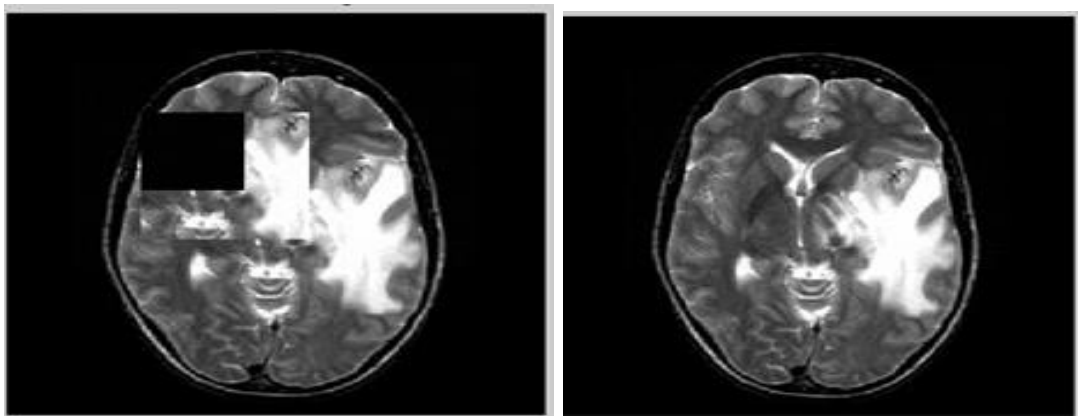

Fig 2: Tampered and recovered image of ultrasound image and CT scan image.

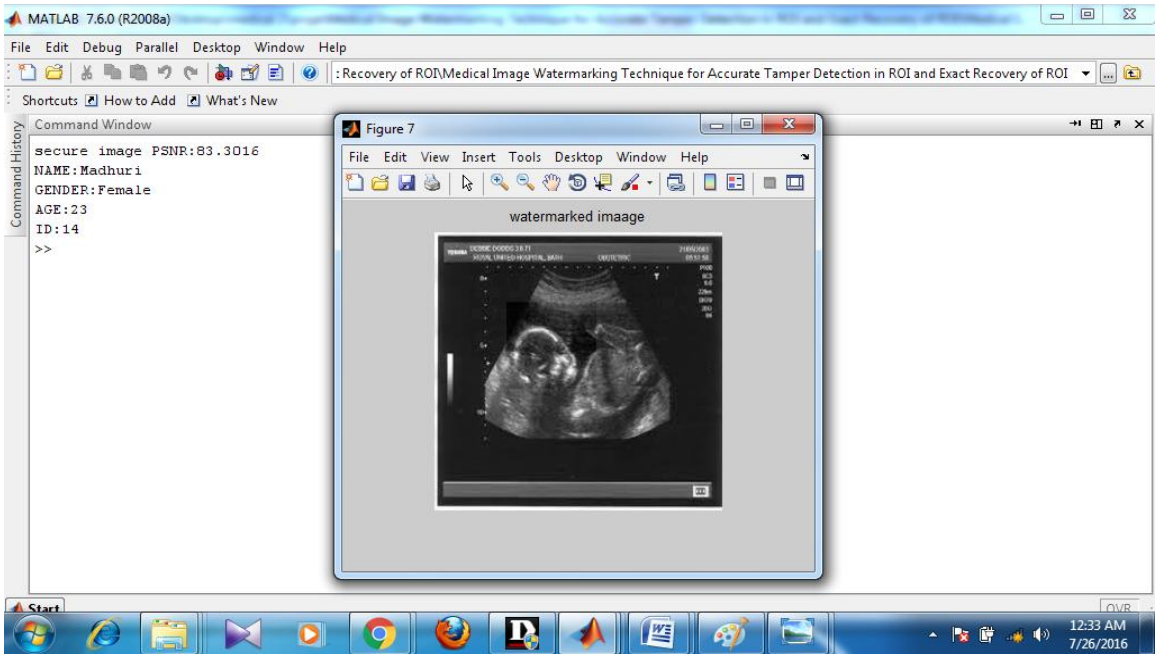

Fig 3: Embedding Patient Details in medical image.

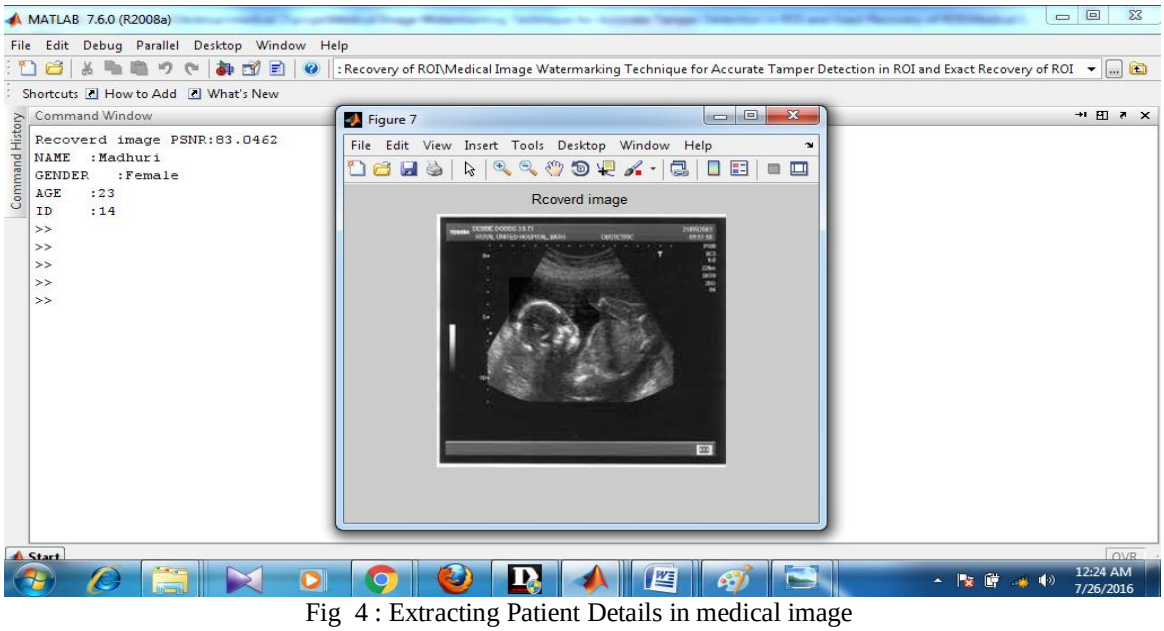

Fig 4 : Extracting Patient Details in medical image

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IV. PERFORMANCE ANALYSIS

Table 1: Results of embedding data in medical images

Image	Size of image	Bit depth	Size of ROI	No of blocks in ROI	PSNR
CT	480*512	16 bits	208*216	1512	97.2519
US	256*256	8 bits	80*80	400	83.5454

Table 2: Average Performance in the proposed method

Image	Average PSNR
CT Scan	97.2492
US Scan	82.0424

V. CONCLUSION AND FUTURE SCOPE

Preserving security and authenticity of medical images has become a necessity since the ever-increasing distribution of digital medical images between clinical centers and hospitals. This paper propose a fragile block based method for detection tampers and exact recovery of ROI. Patient Details embedded and extracted without no loss and no change in original image. The values of PSNR, MSE Produces high quality watermarked medical images. The proposed method accurately identifies the tamper block inside ROI using average and variance values. Pixels in tampered blocks replaced with the original pixel values to recover exact recovery of ROI. It is not suitable for checking tampers inside ROI when the extracted hash value matches with the recalculated hash value. But now schemes are approaching to detect tampers whether or not the ROI or entire medical image is tampered. In Future work it will be extended by large size of medical images.

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