MEDICAL IMAGE WATERMARKING FOR TAMPER
DETECTION AND RECOVERY OF ROI

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Abstract

Transmission of restorative pictures in remote regions is a general practice in telemedicine. While transmission of Medicinal pictures, there might be shot of adjusting information purposefully or unintentionally as the transmission of these may happen through unsecure systems, for example, web. Alters are a noteworthy impede while exchanging medicinal pictures. The primary reason for existing is to stay away from wrong analysis by recognizing *the altered squares and recuperating the first return on initial capital investment.*

Keywords: Telemedicine, Return for capital invested.

I.   INTRODUCTION

Telemedicine takes out separation jump and gives access to therapeutic administrations accessible at far-away areas. It permits transmission of restorative information starting with one area then onto the next and empowers helpful and reliable communications amongst patients and therapeutic staff. This trade of medicinal pictures forces a critical essential that the therapeutic pictures were not changed by unapproved clients. This essential is called keeping up respectability of medicinal pictures. Alternately transmission of restorative picture and patient information autonomously through business systems prompts more cost and transmission time [1]. Watermarking inside a picture, watermarking methods are grouped into two classifications, specifically, spatial area and recurrence space. In spatial area watermarking procedures, information is inserted straightforwardly into have picture. In recurrence space methods, information is implanted into changed host picture.

Another characterization of watermarking procedures is reversible methods and irreversible strategies. The first picture can be gotten without misfortune from watermarked picture with reversible watermarking systems, while lossless recuperation of unique picture isn't conceivable with irreversible watermarking methods. Reversible watermarking is more reasonable for medicinal pictures . In view of utilization, watermarking procedures are sorted as strong, delicate, and half breed. Hearty watermarking procedures are utilized as a part of utilizations where insurance of copyright data of pictures is required, as strong watermarks maintain purposeful or un deliberate assaults on pictures. Delicate watermarking strategies are utilized as a part of uses which require identification of alters caused by unapproved people amid transmission of pictures and furthermore approval of wellspring of picture. Cross breed watermarking procedures are utilized as a part of utilizations that require both protection control and respectability control of pictures.

These are the amalgamation of delicate and vigorous watermarking systems. Here, hearty watermarks are utilized for security control and delicate watermarks are utilized for the uprightness control of picture. A large portion of the therapeutic pictures contain two sections called return for capital invested and RONI. From determination perspective return on initial capital investment part is more vital. Care ought to be taken while concealing information into return for capital invested part with the goal that visual quality won't be corrupted. In the meantime any messing with return on initial capital investment must be recognized and the first return for capital invested must be recouped so as to evade misdiagnosis and retransmission of medicinal picture. The recuperation information of return on initial capital investment is by and large installed into RONI .When any alter is distinguished inside return on initial capital investment of got watermarked therapeutic picture the altered territory of return for capital invested is supplanted with the recuperation information inserted inside RONI.

In this paper, we propose a novel piece based delicate medicinal picture watermarking strategy to accomplish the accompanying targets.

(1) Checking whether the ROI is tampered or not.

(2) Recovering original ROI with zero loss, when it is tampered.

(3) Avoiding the process of checking ROI of watermarked medical image for the presence of tampers when the

ROI is not tampered.

(4) Avoiding distortion in ROI of watermarked medical image by not embedding any data inside ROI.

II. LITERATURE REVIEW

So far numerous square based watermarking procedures were produced for distinguishing altered regions inside return for money invested of medicinal pictures and recuperating unique return for money invested when any alter is identified inside it. Zain and Fauzi [2] proposed a plan, where the restorative picture is fragmented into 8×8 squares and after that a mapping is built up between the pieces for implanting the recuperation data of each square into its relating mapped piece. Afterward, each piece is additionally separated into four sub squares of size 4×4 and afterward a 9-bit watermark is produced for each sub square. The created 9-bit watermark of each sub piece is installed into LSBs of the initial 9 pixels of the sub hinder in the relating mapped square. At collector's end, the watermarked restorative picture is partitioned into squares of 8×8 size and after that the mapping between the pieces is ascertained as done in implanting method. Afterward, each square is additionally separated into four sub pieces of 4×4 size and after that a 2-level location conspire is connected for identifying altered pieces. This 2-level location plot recognizes altered pieces, where level-1 recognition is connected to sub squares of squares and level-2 discovery is connected to pieces. At the point when an altered square is distinguished, the comparing mapped piece is recognized and after that recuperation information implanted in mapped square is extricated.

This recuperation information is utilized to supplant the pixels in altered square. Significant disadvantages of this strategy are as per the following. (1) If both piece An and its mapped square B are altered then it won't be conceivable to recoup unique picture. (2) This strategy does not utilize any validation information for the whole restorative picture to check straightforwardly whether the picture is altered. In this way, all pieces in the picture must be checked consistently to distinguish the nearness of alters. This checking procedure prompts wastage of time when the picture isn't altered. (3) An altered square can't be recuperated with unique pixels of the piece as this technique utilizes normal of pixels inside the piece for recouping the pixels in the altered piece.

Wu et al. [6] created two piece based strategies. In the second strategy, JPEG bit-string of the chose return on initial capital investment is created and after that separated into settled length portions. Afterward, the medicinal picture is isolated into squares and after that hash bits are computed for each piece barring the piece with return for money invested. These hash bits are utilized as validation information of the squares. In each square of picture, hash bits of the piece and one portion of JPEG bit-string of return for money invested are both installed utilizing hearty added substance watermarking strategy. At that point all squares are consolidated to get watermarked restorative picture. At beneficiary's end, the watermarked therapeutic picture is partitioned into hinders as done in implanting technique.

From each piece, hash bits of the square and a section of JPEG bit-string are both extricated. For each piece, hash bits are computed and afterward contrasted with the separated hash bits with check whether the square is altered or not. On the off chance that the square with return for money invested is recognized as altered then the JPEG bit-string portions removed from all pieces are utilized to recuperate the return for capital invested. Disservices of this strategy are as per the following: (1) it isn't conceivable to get unique return for money invested as JPEG bit-string of return for money invested is utilized to recoup return for capital invested when it is altered and (2) this technique requires more computations to create recuperation information of return on initial capital investment and implant it into all squares of medicinal picture.

Chiang et al. [7] proposed two piece construct strategies situated in light of symmetric key cryptosystem and changed distinction development (DE) system. The main technique can recuperate the entire restorative picture, while the second strategy can recoup just return on initial capital investment of therapeutic picture. In the principal technique, the medicinal picture is partitioned into 4×4 measure squares and after that normal of each piece is computed. Afterward, the normal estimations of all squares are connected and afterward encoded utilizing two symmetric keys ?1 and ?2 so as to build the level of security. At that point, Haar wavelet change is connected to all pieces to recognize smooth squares. The encoded normal estimations of the considerable number of squares are installed in the distinguished smooth pieces. At the beneficiary's end, the inserted information is extricated from watermarked picture and after that decoded utilizing the keys ?1 and ?2 to get the normal estimations of all pieces. Afterward, normal esteems are figured for all pieces and after that contrasted with separated normal esteems with identify altered squares. At the point when an altered square is recognized the pixels in altered piece are supplanted with the separated normal of that square. The second strategy is the same as the principal technique aside from that the bits of pixels in pieces of return for capital invested are implanted rather than normal estimations of all squares in the whole picture.

Entanglements of these plans as per the following:

(1) The two strategies require more opportunity for installing information into therapeutic picture as all pieces of the restorative picture must be changed into recurrence area and afterward smooth squares must be recognized for implanting information and
(2) The two strategies are not utilizing any verification information for the whole return on initial capital investment or the whole picture to check straightforwardly whether the return for money invested or the whole picture is altered. Along these lines, all squares in the return for money invested or in the whole picture must be checked in a steady progression to distinguish the nearness of alters. This checking procedure prompts wastage of time when the picture isn't altered.

Liew et al. [3, 4] created two reversible piece based strategies. In the primary technique, the medicinal picture is portioned into two locales: return on initial capital investment and RONI.
Afterward, return on initial capital investment and RONI are partitioned into non covering squares of sizes 8×8 and 6×6, separately. At that point, a mapping is shaped between pieces of return for capital invested to insert recuperation data of each square into its mapped piece. Each piece in return for money invested is mapped to a square in RONI. This mapping is utilized to insert LSBs of pixels in a return for capital invested obstruct into its mapped RONI square. At that point, the method . In this paper, we proposed a novel strong restorative picture watermarking method for recognizing alters inside ROI of restorative pictures and recuperating unique ROI when fundamental. There is no implanting mutilation inside ROI of the produced watermarked medicinal pictures. The proposed technique precisely recognizes the nearness of alters inside ROI utilizing checksum and recoups the first ROI when it is altered. It gives heartiness to the watermark information which are implanted inside RONI. It can be utilized with therapeutic pictures of various modalities and sizes. It can be utilized with medicinal pictures whose pixels are spoken to utilizing either 8 or 12 or 16 bits. Future upgrade gives an extent of broadening the strategy so it can be utilized with the medicinal pictures whose ROI measure is huge.

III. PROPOSED METHOD

To achieve the above-mentioned objectives, we propose a novel medical image watermarking method. A medical image may contain several disjoint ROI areas in different shapes. Each ROI area is marked by a physician or by a clinician interactively and is represented by an enclosing polygon. The enclosing polygon is characterized by the number of vertices and their coordinates. In the present work, we consider medical images containing a single ROI, though the proposed method can be used with medical images containing multiple ROI areas.

The sender uses the following embedding algorithm and hides the ROI recovery data inside RONI.

EMBEDDING ALGORITHM

1) Segment the original medical image into two parts: ROI and RONI.
2) Calculate hash value of ROI using SHA-1 hashing technique and represent the hash value as h1.
3) Generate recovery data of ROI by collecting pixels of ROI and represent the recovery data as R.
4) Concatenate h1 and R to generate watermark 'w'.
5) Embed watermark 'w' into RONI using the following steps:
    a)   Divide RONI into 2×2 size blocks.
    b)   Repeat step c until all the bits of watermark 'w' are embedded into RONI.
    c)   Embed 4 bits of watermark 'w' into LSB and PLSB of two squint pixels of each block.
6) Represent the resulting image as watermarked image. The receiver uses the following extraction algorithm and identifies the tampers and recovers the original ROI.

EXTRACTION ALGORITHM

1) Segment the watermarked image into two parts: ROI and RONI.
2) Calculate hash value of ROI using SHA-1 hashing technique and represent the hash value as h2.
3) Extract watermark 'w' from RONI using the following steps:
    a)   Divide RONI into 2×2 size blocks.
    b)   Repeat step c until all the bits of watermark 'w' are extracted.
    c)   Extract 4 bits of watermark 'w' from LSB and PLSB of two squint pixels of each block.
4) Separate hash value 'h1' and recovery data 'R' from 'w'.
5) Compare h1 with h2. If they match then conclude that image is not tampered and use the image for diagnosis.
6) Otherwise, replace ROI with recovery data of ROI 'R'. Use the resulting image for diagnosis.

IV. RESULTS

Experiments are conducted on around hundred medical images of 8-bit, 12-bit, and 16-bit depth and of different modalities. The proposed method is developed on the assumption that the intruders generally try to modify only the significant part, ROI, in the medical images during their transmission. So, identifying changes inside ROI and recovering original ROI must be done before using the medical image for making diagnosis decisions. The proposed method can be used with medical images whose pixels are represented using 8 or 12 or 16 bits and with medical images of different modalities like CT scan, MRI scan, ultrasound, and so on. The RONI is not recovered exactly as LSBs of all pixels in RONI are set to bit 0 after extracting embedded data from them. This limitation does not affect the efficiency of the method as RONI of medical images is insignificant in the process of diagnosis decision making. It can only be used with medical images whose ROI size is small (up to 25% of the entire medical image). It is not robust against common attacks and image manipulation operations. This method can recover original ROI only when the RONI and border of the watermarked medical image are not attacked or modified by intruders. As intruders generally try to modify the ROI of the medical images during their transmission, this method emerges as a significant alternative in the field of medical image transmission.
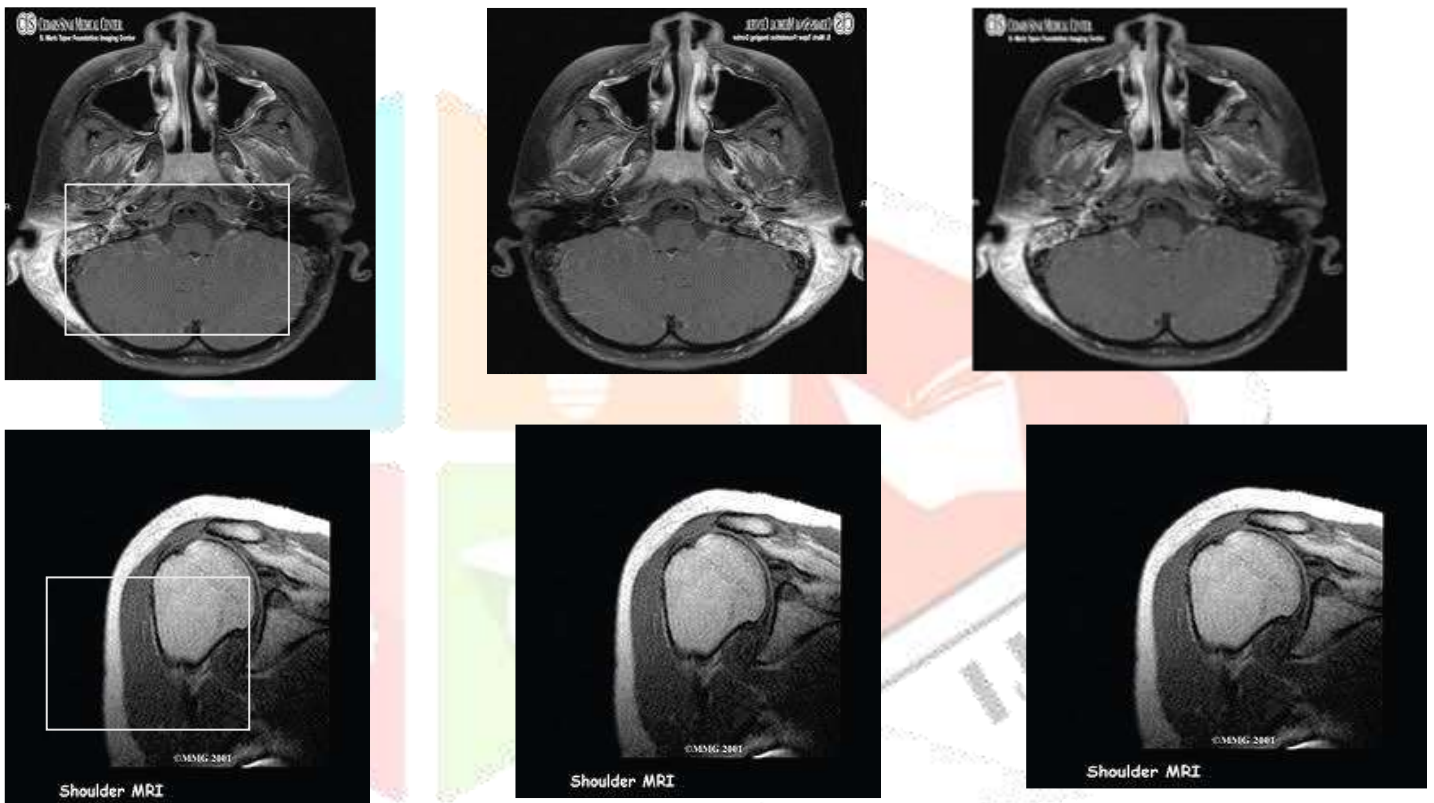

Fig-1: Original, watermarked, and reconstructed medical images. From top to bottom: CT scan and MRI scan images.

As shown in Figure 2, we induced some tampers into ROI of the watermarked medical images for testing the performance of the proposed scheme in terms of detecting tampered or modified areas inside ROI and recovering original ROI. The proposed method identified all the tampered locations inside ROI with 100% accuracy and recovered the original ROI with no loss as shown in next figure. In medical images, the LSBs of pixels inside RONI and border are zero. So, the LSBs of pixels in RONI and border are set to 0, after extracting the embedded data from them.
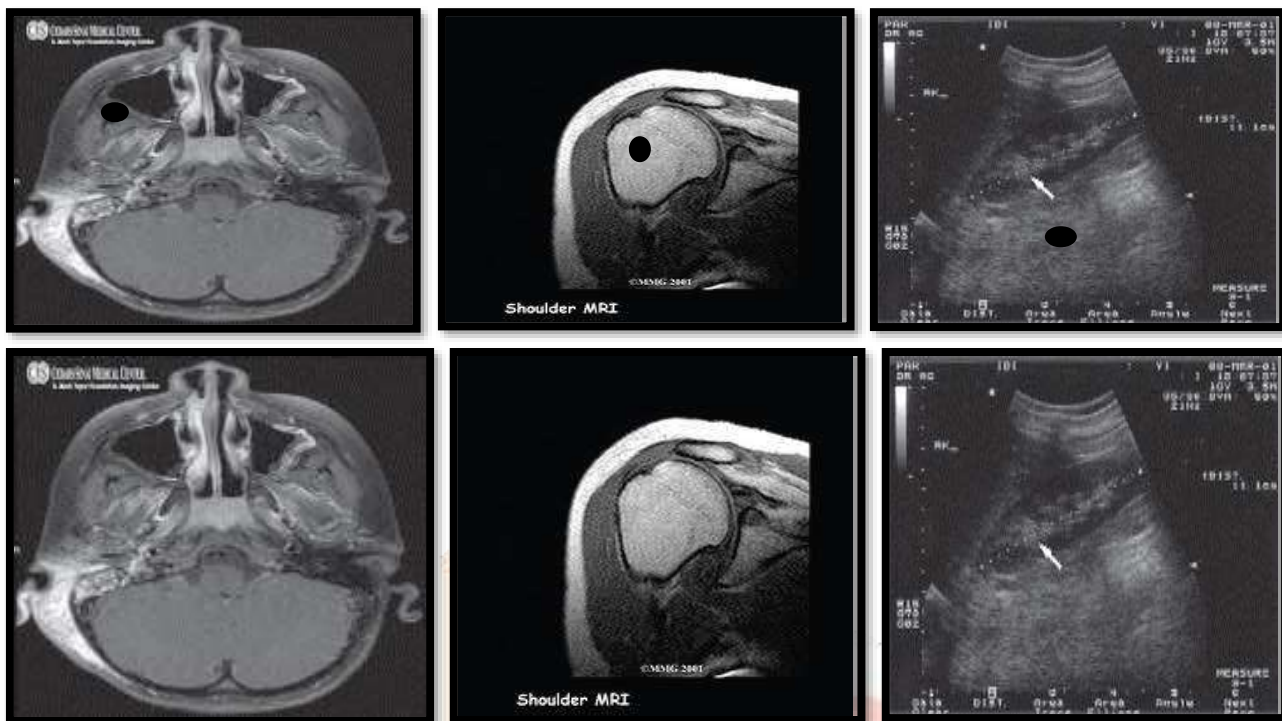
FIGURE 2 : WATERMARKED MEDICAL IMAGES (FROM LEFT TO RIGHT: CT SCAN, MRI SCAN, AND ULTRASOUND) WITH TAMPERS INSIDE ROI.

V.   CONCLUSION

In this paper, we proposed a novel hearty medicinal picture watermarking system for distinguishing alters inside return for money invested of restorative pictures and recouping unique return on initial capital investment when fundamental. There is no inserting contortion inside return on initial capital investment of the produced watermarked medicinal pictures. The proposed technique precisely distinguishes the nearness of alters inside return for money invested utilizing checksum and recoups the first return for money invested when it is altered. It gives strength to the watermark information which are installed inside RONI. It can be utilized with medicinal pictures of various modalities and sizes. It can be utilized with restorative pictures whose pixels are spoken to utilizing either 8 or 12 or 16 bits.

Future upgrade gives an extent of expanding the strategy so it can be utilized with the restorative pictures whose return for money invested measure is huge.

VI.   REFERENCES

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