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A Survey of ROI based Secured and Robust Medical Image Watermarking

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ABSTRACT*:* In medical field, It's common to transfer medical image and medical reports from one hospital to other hospital for diagnosis of the diseases. In that case the patient personal information and medical image plays a vital role while transferring over network. Because if a third party got those information and he intentionally cross change the information of multiple patients with wrong medical images, It's causes wrong treatment for all patients. So it's necessary to prevent information and medical image from third person i.e attacker. Medical image watermarking provide solution on this problem such as we hide the patient personal information and medical report inside the medical image as a watermark, so attackercannot get the information easily for cross change the information. Medical image clarity also plays an important role for diagnosis purpose,but after inserting watermark into medical image the quality of medical image degrades. for that ROI i.e region of interest and RONI i.e region of non interest technique is suitable to cut the actual sensitive area from medical image. Hide watermark into RONI using Combine version of Arnold transformation and RSA algorithm and create a watermarked medical image, it can't affect the quality of medical image as well as hide the patient information.

KEYWORDS: Watermarking, ROI & RONI, DWT, Arnold cat map, RSA algorithm.

I. INTRODUCTION

Digital watermarking is process of embedding secret information into digital signal, this term digital watermarking was first introduced in 1993. The secret information which we embed into digital signal is called as 'Watermark'. The digital signal may be image, audio, video or text file i.e. we can embed watermark inside image or video or text file[1][8].

There are two main categories of the Digital watermarking.

1) Visible watermarking
2) Invisible watermarking

1)Visible watermarking:

In visible watermarking the watermark which we embed into digital signal is easily visualize to human naked eyes.Visible watermarking is not secure because watermark information is easily detected by attacker. Fig 1 shows example of visible watermarking.

2) Invisible Watermarking:

In Invisible watermarking the watermark which we embed into digital signal is invisible, so the invisible watermarking is secure as compare to visible watermarking.fig 1 shows the example of invisible watermarking.

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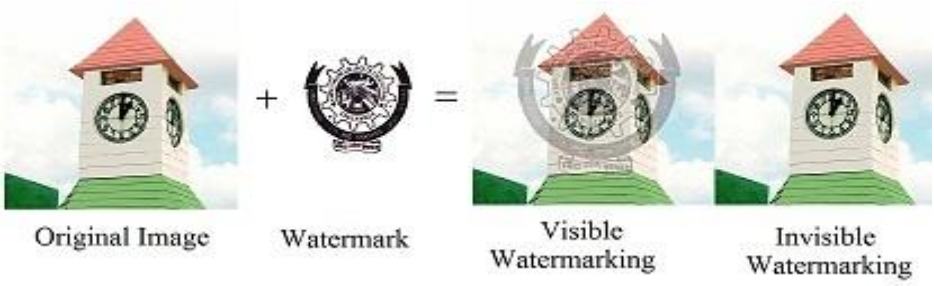

Fig 1: Watermarking

Digital watermarking consists of two main modules, Watermark embedding module and Watermark detection and extraction module. Digital watermarking algorithm have number of properties that the watermarking algorithm must have full fill, the properties are

1)Imperceptibility: The watermarked image looks like the original image after insertion of watermark and can't degrade the quality of original image.

2)Robustness: The watermarking algorithm must have capacity to survival of watermark against legitimate as well as illegitimate attack.

3)Security: It's must have secure i.e no one can extract the watermark from the watermarked image without having knowledge of embedding algorithm.

4)Capacity: The capacity of watermarking algorithm to hide maximum amount of information into digital signal.

5)Invertibility: The algorithm must retrieve the original image and original information i.e watermark without loss after extraction process[5].

Applications of digital watermarking:

1) Copyright protection.
2) Copy protection.
3) Broadcast monitoring.
4) Medical image etc.

II. SURVEY

Internet is mostly used in many applications such as online banking, teleshopping etc. Now a day's Internet is used to transfer medical data between different hospitals which are located at different geographical locations. Medical image and patient information is most important data which we share through public network. So that security to such sensitive data is a challenge for physician.Medical image watermarking provides way to share personal information of patient by hiding inside medical image by using invisible watermarking method.so that the attacker doesn't get the personal information till the brief idea of embedding algorithm.The security issue is solved by this method but after embedding watermark inside the medical image the quality of medical image is some how degrades.so it is risky to analyses of disease on such low quality image and he can't able to make right diagnosis due to quality of image,so its again challenge to provide security to information as well as maintain the quality of medical image. This challenge is solved by ROI based medical image watermarking, using this we embed information inside the medical image as well as it does not affect the actual interested area of medical image[1][2][7][10][11].

Watermarking done in two different domain namely spatial domain and frequency domain. Spatial domain watermarking hide watermark directly within the host data. Spatial domain watermarking is simple and easy to implement but fragile versus noise and various attacks, so it can't provide robustness and imperceptibility which mainly require to medical image. Frequency domain watermarking is also called as multiplicative watermarking. It provides better robustness as well as imperceptibility as compare to spatial domain watermarking[3][4].

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A. ***ROI and RONI segmentation :***

ROI i.e region of interest is most sensitive area into medical image, on the bases of ROI the physician make diagnosis of patient. And RONI i.e region of non interest is the area rather than ROI. If we embed watermark inside RONI then only quality of RONI is degrades it can't affect ROI from the medical image. we can separate ROI using different tools such as rectangular, ellipse shaped, polygon or with free hand to get actual sensitive area[2][3][4]. As shown in fig 2.

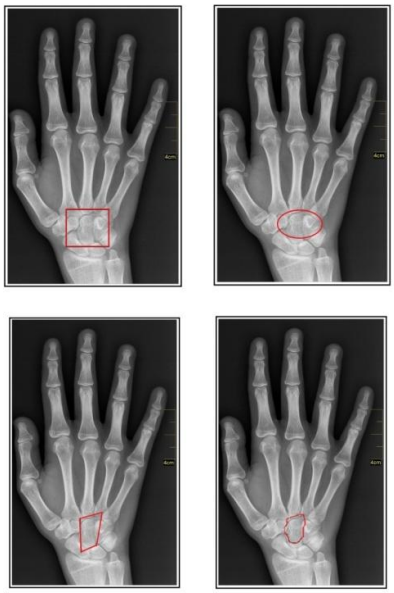

Fig 2:Segmentation of ROI and RONI

B. ***Discrete wavelet transform (DWT):***

Wavelet is mathematical function that distributes data into different frequency component. The basic concept for DWT is when host data pass through low pass and high pass filter, it decompose the host signal into low frequency part and high frequency part. DWT decompose host data i.e image into four multi-resolution non-overlapped sub-bands namely Approximate sub-band (LL), Horizontal sub-band (HL), Vertical sub-band (LH), and Diagonal sub-band (HH). Here HH,HL,LH are high frequency parts and LL is low frequency part. We decompose out image up to 3 levels. [3][5][6][12]as shown in fig 3.

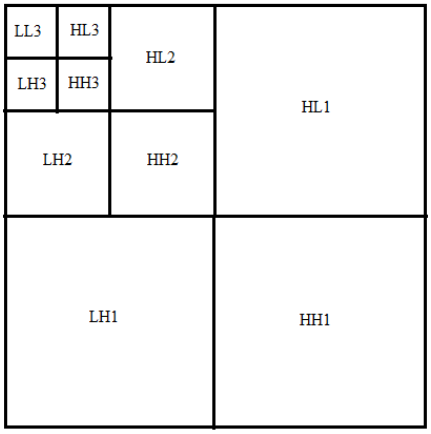

Fig 3: 3 level DWT decomposition.

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If we embed watermark into low frequency part it increase robustness but causes unacceptable image degradation which can not acceptable for medical image, so best area to embed watermark is high frequency parts i.e HL, HH, LH and Human eyes are not sensitive to high frequency parts. But diagonal sub-band (HH) include the texture and edges of the image hence we can't embed watermark into HH region. From horizontal sub-band and vertical sub-band human visual system (HVS) is more sensitive in HL i.e Horizontal sub-band so watermarking is done in HL region [3].

C. Arnold periodicity :

It is probability that the third person or attacker get the knowledge about the watermarking algorithm in that case he easily able to extract watermark from the medical image, in that case to provide security to watermark i.e the confidential information which we embed inside image is necessary.

Arnold periodicity is special property that shuffled information before embedding inside image and after extraction gives original information after specific number of iteration. Those specific numbers of iteration are called as 'Arnold periodicity'. Hence Arnold transform is used to provide security to watermark which we embed into the image[3][5][8][9].

D. RSA Algorithm:

RSA algorithm was described by Rivest, Shamir and Adleman, the letter RSA are initials of their surname.

RSA algorithm is based on Public-key cryptography i.e Use two keys ,every user having its two key one is secret key and other one is public key which is publicly known. Every User knows the public key of other user. On that bases If user A want to send information to user B at that time user A encrypt information with user B's public key and send it to user B. After receiving encrypted information at B. user B decrypt information with using his own secret key[5].

1. Choose two distinct prime numbers x and y.
2. Compute n=x × y.
3. Compute f (n) = (x-1)(y-1).where f is Euler's totient function.
4. Choose an integer e such that 1 < e < f (n), and
   gcd (e, f (n)) = 1.e is released as the public key exponent.
5. Determine d as d= e^{-1}(mod f (n)).d is kept as the private key exponent.
6. Public key (n, e), Secret key (n, d).
7. For encryption C=P^{e}(mod n)
8. For decryption P=C^{d} (mod n)

The Scramble watermark will encrypt with RSA algorithm and embed into RONI.It helps to provide security to watermark while transmitting throughMedical image.

III. EMBEDING AND EXTRACTION PROCESS

A. Embedding Algorithm:

1. Separate ROI and RONI parts from the host image i.e Medical image.
2. Save the removed ROI part and apply 3 levels DWT on RONI and select HL3 for embedding watermark.
3. Take patient confidential information as a watermark and apply Arnold transform on that information.
4. Encrypt that Arnold scrambled watermark with RSA encryption algorithm.
5. Embed that encrypted watermark inside the HL3, it generates pre-watermarked image.
6. Combine ROI into pre watermarked image,it generate the watermarked Medical image [3][4][5].
   (As shown in Fig 4)

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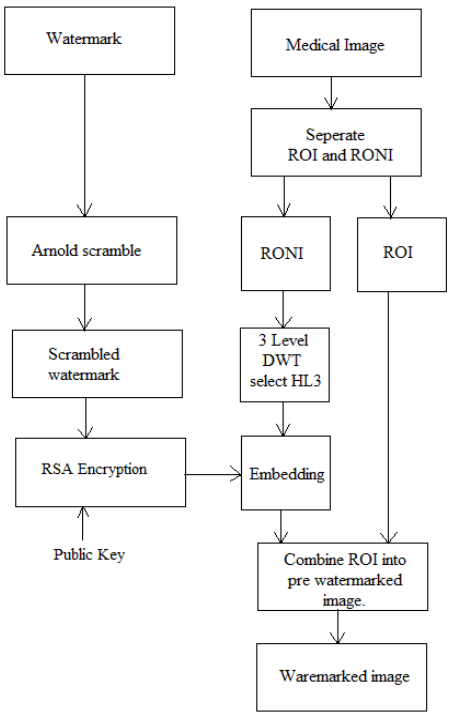

Fig 4: Embedding Process

B. ***Extraction Algorithm:***

1. Separate ROI and watermarked RONI from watermarked medical image.
2. Decompose RONI, it separate the plain RONI and watermarked from pre-watermarked image.
3. Combine ROI which is separate initially and plain RONI gives medical image for diagnosis.
4. Decrypt extracted watermark using RSA.
5. Apply Arnold transform iteration on watermark which decrypted from RSA algorithm it gives patient information [3][4][5].
   (As shown in Fig 5)

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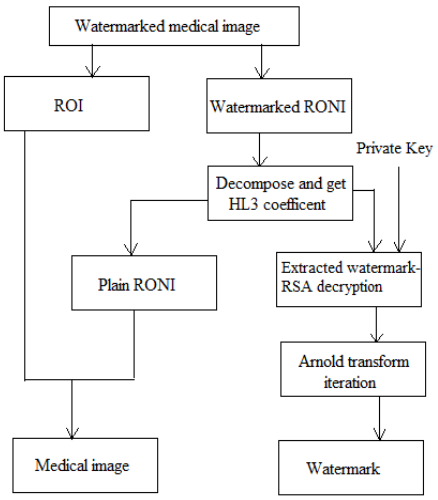

Fig 5:Extraction process.

C. *Performance evaluation metric*

The performance of watermarking is evaluated on Quality of watermarked image and robustness. The quality of watermarked image is measured by Peak signal to noise ratio (PSNR).

$$PSNR = 10\ log_{10} \frac{(G)^2}{\frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}[p(i,j) - p'(i,j)]^2}$$

Where M×N is size of image for PSNR, p(i,j) is pixel gray value of original image and p'(i,j) is pixel gray value of watermarked image. Extracted watermark quality i.e robustness is evaluated in term of Normalized cross-correlation (NC).This measures the similarity and difference between original watermark and extracted watermark. Value is generally in between 0 to 1.

$$NC = \frac{\sum_{i=1}^{N} o_i e_i}{\sqrt{\sum_{i=1}^{N} o_i}\sqrt{\sum_{i=1}^{N} e_i}}$$

Where N is number of pixel in watermark, $o_i$is original watermark and e_i is extracted watermark[3].

The PSNR value is calculated in decibel (db). As PSNR is greater than 30db then embedded cover is approximate to original cover. And NC value greater than 0.75 is acceptable. In our system PSNR value varies on bases of Image size. And correlation factor performance better than system Arnold scrambling without RSA. i.e system improves performance in case of security by using private and public key and by using combined Arnold and RSA technique the watermark get robust against various attacks such as rotation attack, Gaussian noise attack, Paper and salt noise attack.

D. *Multiplexer logic*

As growing of programmability and computational power of multi-core architecture system it helps to accelerate the process of watermarking for manipulate large amount of data.

In our system multiple tasks such as Arnold scrambling, DWT decomposition will be execute using SIMD i.e Single instruction multiple data parallel architecture. But, some of tasks such as separation of ROI and RONI are must perform separately for each and every Medical image.

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IV. CONCLUSION

It is a need of healthcare industry to transmit medical images from one geographical location with patient information. But security is essential factor. For that ROI based Digital Image Watermarking used to increased security levels and which embed watermark as well as producing exact recovery of original watermark for standard image. Good quality image and high security watermarking technique is necessary in Medical image which robust towards any attack. ROI is sensitive region of medical image using which doctor's analysis exact diagnosis and decide treatment, Use of classical watermarking techniques may create the distortion in ROI and consequently the diagnosis value of image may be lost, ROI of image can be selected interactively from medical image. Excluding such selected region, the watermark is embedded and Combined Arnold transform and RSA encryption technique is used for increasing security and robustness in medical image watermarking schemes.

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