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ENHANCED REVERSIBLE WATERMARKING OF MEDICAL IMAGES IN LOSSY ENVIRONMENT

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ABSTRACT

Medical image data now a day's exchange from one place to another place. Due to noisy channel and unintentional attacks, even a lossless reversible watermarking will remain no more lossless. So practically all the lossless methods are actually lossy, which reflects when images are restored reversibly. We have proposed algorithm based on histogram shifting and pixel mapping supported by k mean clustering which can recover the actual image from these lossy channels and is robust to unintentional attacks. We have performed all the embedding in the region of non interest to maintain the acceptability of the medical image.

KEYWORDS: Watermarking, Histogram, Pixel Mapping, IWT, K-Mean Clustering

INTRODUCTION

Digital media like picture, video, audio now a days, are used for reversible watermarking because it is a very effective medium to send and secure information from one place to another across the globe without disturbing the core content and quality of the carrier media. The method is useful for "copyright protection" as well as securing the content of the digital media. So these methods are very useful for protection in sensitive applications like medical and military applications. Researchers have developed a lot of very good methods for reversible watermarking which are lossless also, but the main point is that the carrier channels are not lossless. Therefore, any information sent across the communication channel cannot be lossless. So our main aim is to develop a reversible watermarking for medical application which can work in lossless and lossy environment both plus to handle some unintentional attacks also. For the medical data the main problem is that it contains some sensitive information which cannot be modified in any ways otherwise the medical image would be worthless. Researchers have done a lot of work in this direction also. Normally, all of them divide the image into two parts on contains the sensitive part and other contain the remaining part of the image. The remaining part of the image is used for watermarking and contains authentication purposes and the sensitive part will be reset after watermarking in the remaining part.

All the methods of reversible watermarking can be broadly divided into two parts from the aspects of the histogram. One is histogram rotation methods and other is the histogram constrained method. In the first part, the image is firstly divided into blocks and then two independent blocks are rotated against the centroid of the image. Because the neighbouring pixels in the image are linearly dependent and are correlated to each other, the method is robust against any change in the image information. The method also works well in case of compression attacks, whether intentional or unintentional, but it fails in the case of "salt and pepper" noise. In the histogram constrained method also, image in divided into blocks and modulated watermark is inserted into these blocks based on certain constrained. But these methods also fail

due to its instability and problem of pixel underflow and overflow in the image. So we have to proceed by taking these demerits into consideration. These days property based pixel mapping and statistical quantity histogram methods are very much popular among researchers, so we have also motivated to be proceed with these methods. We have fused these methods in our proposed algorithm. A brief introduction about these methods is given as under:

Property Based Pixel Mapping

These methods are very much useful in case of pixel underflow and overflow problem. In his method, after embedding watermark pixel change will be correlated with wavelet transform coefficient and thus will be controlled by these coefficients. For any possible underflow and overflow situations, these coefficients will settle down the problem.

Statistical Quantity Histogram

This method is very helpful to avoid unintentional compression attacks. In this method also we use wavelet transform coefficient to control the embedding process. We draw the histogram for the original basic image and do embedding block wise and record the histogram change if any. If there is any change in the histogram we set it as previous by applying histogram modification and stretching methods. We repeat the process until the last watermark embedding done. For the extraction process we use the k clustering mean method to extract the watermark.

Besides the above methods, we also take consideration of the human visual system for distortion management. We apply the above method in the non interested region of the medical image as interested region contains the sensitive part of the image.

PROPOSED WORK
Phase 1

- In the first phase of our work we have to calculate the statistical quantity histogram of the non interested part of the medical image. The method is done as per the following steps:

- Let the non interested part of the image contains n number of bits

- We divide the image into B number of blocks in the image part.

- Statistical histogram will be generated on each of these blocks by calculating average block intensity in each of the blocks.

- We record all of these averages block intensities (B) for the whole image, and calculate the frequency of each of these intensities (f).

- Denote the histogram in the set of pair (I, f) for each of the blocks. Thus we get a data pair as:

  $$H_{pair} = \{(I1, f_l)\ (I2, f_2) \ldots (I_i, f_i) \ldots (I_n, f_n)\} \tag{1}$$

- Let I_m and I_n are the maximum and next maximum intensities for the blocks.

WATERMARK EMBEDDING PROCESS

We arrange these intensities as in the following figure 1. In the following figure we have divided the image intensities of the blocks in the image into 5 parts as in the figure.
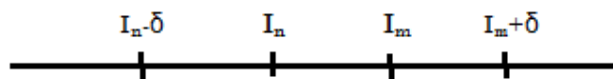
Figure 1

- To avoid the underflow and overflow problem of pixels during watermark embedding we use the following 5 formulae applied to each of the 5 parts:

$$W_E^i = \begin{cases} Wi - \delta - 1 \ if \ Wi \leq In - \delta \\ Wi - bi(\delta + 1) \ if \ In - \delta \leq Wi \leq In \\ No \ embedding \ if \ In \leq Wi \leq Im \\ Wi + bi(\delta + 1) \ if \ Im \leq \ Wi \leq Im + \delta \\ Wi + \delta + 1 \ if \ Wi \leq Im + \delta \end{cases} \tag{2}$$

W_i and W_E^i represent the average block intensity for ith block, before watermarking and after watermarking. b_i represents the binary bit 0 or 1.

Watermark Extraction: Watermark will be extracted as following:

$$B_x^i = \begin{cases} 1 \ if \ Wi \leq In - \delta \\ 0 \ if \ In - \delta \leq Wi \leq In \\ No \ extraction \ if \ In \leq Wi \leq Im \\ 0 \ if \ Im \leq \ Wi \leq Im + \delta \\ 1 \ if \ Wi \leq Im + \delta \end{cases} \tag{3}$$

B_x^i is the ith extracted watermark bit.

Phase 2

In this phase we compute the distortion after watermark embedding process. We would try to make the distortion under the human visual limits so that it cannot be observed. This relimit will be the function of three variables, resolution, brightness and texture sensitively in the image.

So the human visual limit say HVL can be represented as:

$$HVL = R(r, w) \ \beta(r, I, j)^{\Theta} \ Tx \ (r, i, j)^{0.2} \tag{4}$$

Where R (.) stands for resolution with resolution level r while w watermarking at pixel location (i, j)

β is the brightness change at pixel location (i, j)

Tx is texture change at pixel location (i, j)

Now watermark embedding in ith block is given by

$$W_E^i = W^i + fSb^i \tag{5}$$

Where $f = (W_E - W^*)/abs \ (W_E - W^*)$ (6)

Where $W^* = \min_{d\epsilon\{ln,lm\}}(We, d)$ (7)

And

$$S = \frac{g}{PXQ} \sum_{i=1}^{P} \sum_{j=1}^{Q} HVL(i, j) \tag{8}$$

This is an important equation where S represents the watermark strength, g is the global parameter PXQ is the size of the block.

WATERMARK EXTRACTION PROCESS

Watermark extraction process is the reverse of the watermark embedding process. But this is only when the channel of transmission is totally ideal and there is no loss in the channel i.e. the whole system is lossless. But in practical this is not possible as every channel is lossy. So we have to develop some effective method to develop the extraction algorithm. So while portioning part of the image block is done we will use the clustering algorithm against these problems. The whole extraction algorithm is shown in the following block diagram.
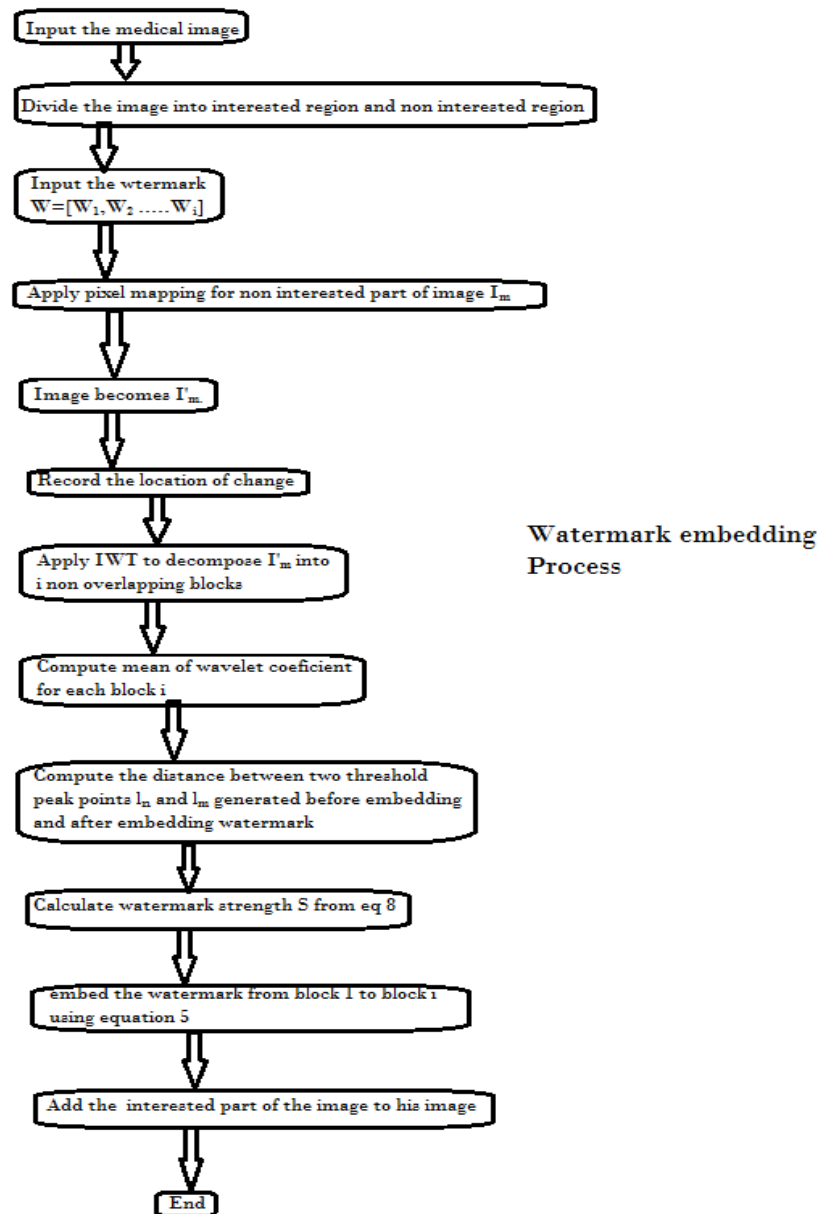

Figure 2: Watermark Embedding Process

Applying classification result watermark can be extracted by a slight modification in above equation 3 as following:

$$B_x{}^i = \left\{ \begin{array}{c} 0 \; if \; Wi \; belongs \; to \; class \; 1 \; and \; class \; 3 \\ 1 \; if \; Wi \; belongs \; to \; class \; 2 \end{array} \right\} \tag{9}$$

And watermark will be extracted using equation

$$W_x{}^i = W_E{}^i - fSb^i \tag{10}$$

```
Input the watermarked image
        ⇓
input the watermark strength S and location of
pixel change
        ⇓
Divide the image into sensitive part and non
sensitive part
        ⇓
Taking non sensitive part divide the image into i
non overlapping blocks
        ⇓
Compute weblet coeficient mean for each of the i blocks
        ⇓
apply k mean clustering on all of these i blocks
        ⇓
      x = 1
        ⇓
Extract watermark as equation 9          Watermark Extraction Process
        ⇓
      x = x+1
        ⇓
no  ◇ whether x = i
        ⇓ yes
apply equation 10 to recover wavelet coeficient
        ⇓
perform pixel mapping to recover non sensitive part of
the image
        ⇓
add sensitive part and non sensiive part to get
the original medical image
        ⇓
       end
```
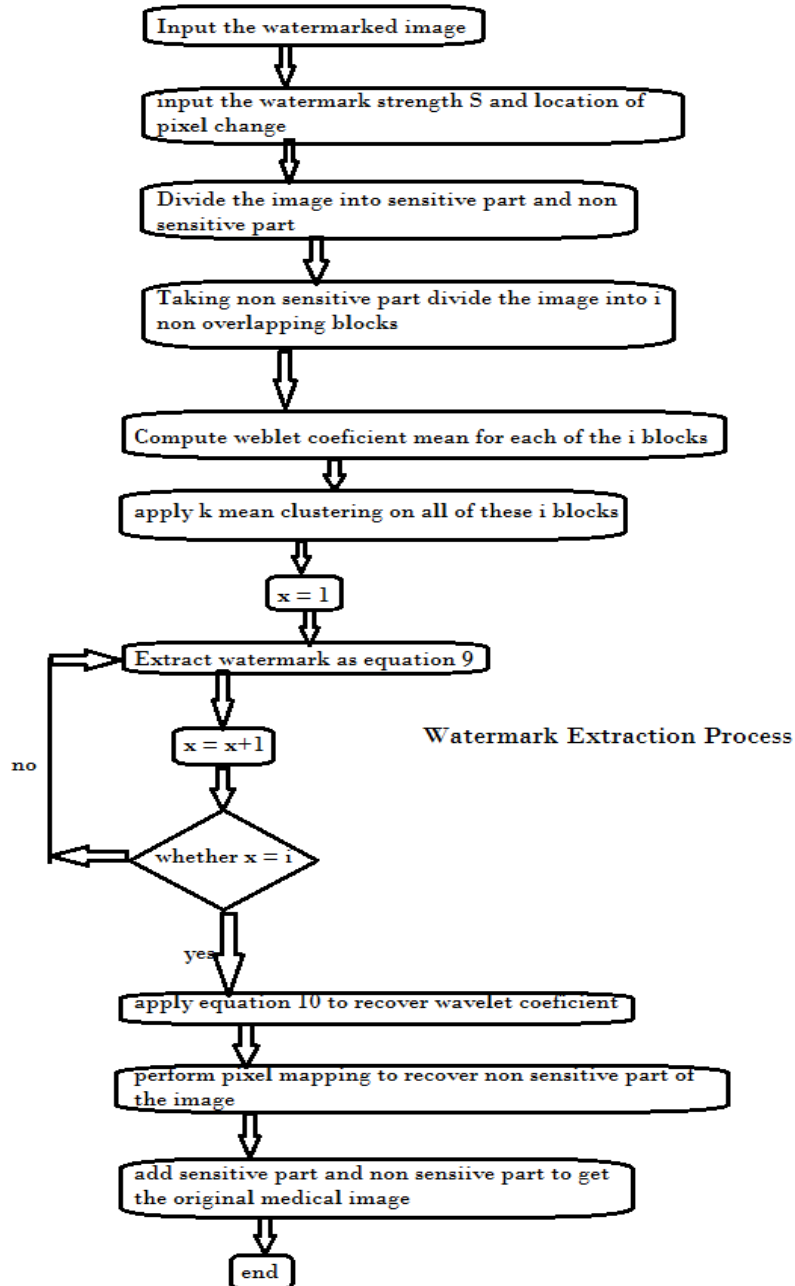
Figure 3 : Watermark Extraction Process

RESULTS AND DISCUSSIONS

In our experiment 20 normal images and 20 medical images have been taken and abobe algorithm have been tested under the following parameters:

- Effect of threshold on capacity and compression attacks:

  - Medical images gets more capacity for watermarking when increasing the value of threshold as comparison to narmal images because medical image pixels are more correlated than the pixels of normal images.

  - Medical images were found robust against JPEG2000 attack

- Effect of block size on capacity and compression attacks:

  - If block size is smaller, capacity were larger and vice versa

  - There is no effect on block size while JPEG 2000 attack

- Performance comparison with other classical methods:

  - Robustness was found better than classical methods

  - In terms of reversibility our method proves better

  - In terms of watermarking capacity it is better than classical methods

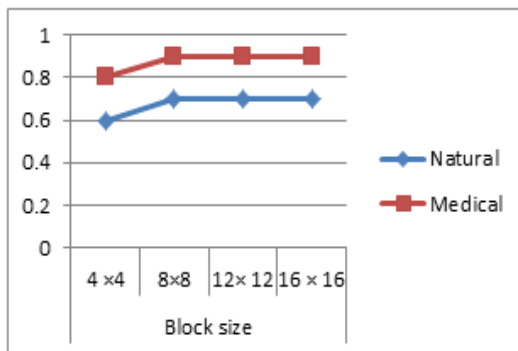 - In terms of run time complexity it is comparable to other methods.

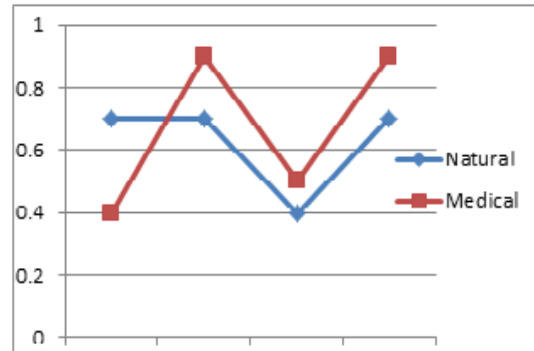**Figure 4 (a): Effect of Block Size**   **Figure 4 (b): Effect of JPEG 2000 Attack**

CONCLUSIONS

In our paper first we shall divided the medical image into 2 parts, sensitive region and non sensitive region. Taking non interested region we shall apply pixel adjustment to avoid underflow overflow problem. After we shall apply histogram shifting method followed by pixel masking method to rectify any possible distortion can occur during embedding process. After embedding we shall compile the sensitive part with this watermarked part of the medical image. During extraction process we again divide the image into two parts as in embedding process, apply pixel adjustment followed by k mean clustering to extract information even from the noisy channel, followed by pixel mapping and

histogram shifting. The method proves good against JPEG compression attacks in terms of capacity and block size. The method also works well in terms of performance, reversibility and comparable, in terms of complexity.

REFERENCES

1. Manish Madhava Tripathi, S P Tripathi, "Strict Attestation of Medical Image Watermarking", International journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 4, April – 2013.

2. Manish Madhava Tripathi, S P tripathi, "A Review of Medical Image Watermarking Schemes", International Journal of Engineering Research & Technology (IJERT),Vol. 1 Issue 10, December- 2012.

3. Manish Madhava Tripathi, S P tripathi, "Improved Watermarking and Recovery using Modulo DCT", TMU conference, TMU, Moradabad, 2014.

4. Du y., and Zhang T., "A reversible and fragile watermarking algorithm based on DCT", 2009 International conference on Artificial Intelligence, 2, pp.301-304.IEEE, 2009.

5. Manish Madhava Tripathi, S P Tripathi, "A Block based Reversible Medical Image Watermarking", International Journal of Computer Science and Information Technologies, Vol. 4(2) 2013, 306-311.

6. Abhishek Ranjan Pandey, Manish Madhava Tripathi, "Medical Image watermarking for Mobile Smart phones", International Journal for Innovations in Engineering, Science and Management, *3d capacity 2, Issue 11, November 2014.*

7. Mahesh Prasad Tiwari, Manish MadhavaTripathi, "Performance Analysis of Digital Watermarking Methods for Medical Images based on PSNR and MSE", International Journal for Innovations in Engineering, Science and Management, *3d capacity 2, Issue 12, December 2014.*

8. A. Wakatani, "Digital watermarking for ROI medical images by using compressed signature image", in Proc. 35th Hawaii International Conference on System Sciences, 2002, pp.2043-2048.

9. R S Yadav, Md R beg, M M tripathi, "Image Encryption Techniques: A critical comparison", International Journal of Computer Science Engineering and Information Technology Research, 2013, Vol 3, Issue 1, pp 67-74.

10. M M Tripathi, Mod Haroon, Minsa Zafar, Mansi Jain, "Maxillofacial Surgery Using X-Ray Based Face Recognition by Elastic Bunch Graph Matching", Springer Berlin Heidelberg, Book: Contemporary Computing, pp183-193.