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Histogram Shifting based watermarking approach for medical image authentication

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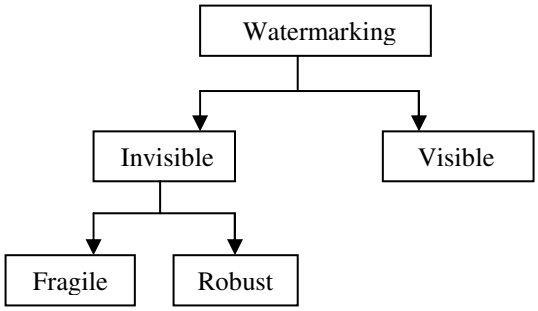
***Abstract* -- Digital Watermarking describes methods and technologies that hide information in digital media. Watermarking technique can be effectively applied to medical images. Watermarking technique has recently developed for medical image watermarking and it can be used to embed the patient information into medical image and can be efficiently extract back the information. This medical image watermark technique can avoid unnecessary modification by unauthorized person. In this paper Histogram Shifting based watermarking scheme is used for medical image watermarking and is simulated using MATLAB software. The proposed method provides performance metrics MSE and PSNR values better than existing methods.**

Key terms: **Image watermarking, Histogram Shifting based Watermarking, PSNR, MSE**

I. INTRODUCTION

Digital image watermarking is a method of embedding the data into the cover image or host image. The data which is to be embedded is called watermark. Watermark is the secret message that is embedded into host image, to keep the copyright information inside the host image and prevent it from any unauthorized modifications. There are two types of watermarking namely visible watermarking and invisible watermarking.



Visible watermarking as the name suggests, the secondary data is translucent when it is embedded into the primary image or host image. The watermark data is visible to viewer either in casual vision or careful look over. Invisible watermarking is that the data or information is embedded into host image and it is not visible to the viewer, since the alterations are made to pixel values. The watermarked image resembles the original image and the watermark data can be extracted with proper decoding. Watermarking can also be divided into four categories according to the type of data to be embedded as watermark content in the host image. They are namely Text watermarking, Image watermarking, Audio watermarking and Video watermarking. The embedding method can be spatial domain based or transform domain based. In spatial domain based watermarking method, the watermark content is embedded directly into the pixels gray values of the cover image. In the transform domain based or frequency domain based watermarking method the watermark content is embedded into coefficients of image transform. The image transform can be either of Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) or Discrete Wavelet Transform (DWT). With the different resolution levels, DWT can provide both space and frequency localization and so DWT is more effective when compared to other transform domain watermarking. But transform domain watermarking provides more invisibility than spatial domain watermarking. Christo Ananth et al. [3] proposed a system which uses intermediate features of maximum overlap wavelet transform (IMOWT) as a pre-processing step. The coefficients derived from IMOWT are subjected to 2D histogram Grouping. This method is simple, fast and unsupervised. 2D histograms are used to obtain Grouping of color image. This Grouping output gives three segmentation maps which are fused together to get the final segmented output. This method produces good segmentation results when compared to the direct application of 2D Histogram Grouping. IMOWT is the efficient transform in which a set of wavelet features of the same size of various levels of resolutions and different local window sizes for different levels are used. IMOWT is efficient because of its time

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effectiveness, flexibility and translation invariance which are useful for good segmentation results. Projection based complex wavelet transform is very much useful in denoising and edge detection. But in case of watermarking it provides less imperceptibility when compared to DWT. Hence DWT preferred over projection based wavelet transform.

Medical images or medical information (such as, CT scan, MRI Scan images etc.,) need to be more secure and reliable. The medical information should be secure and prevented from modification by unauthorized person and also replacement of one's report by others. These problems can be resolved by hiding the patient information in the medical images by watermarking approach, so that the doctor can diagnose the medical image and also it is more secure. When the medical image watermarking is done, a special care is needed, so that the medical content is not disturbed or lost. The patient information is embedded into medical image without disturbing the quality or original content of the medical image.

II. PROPOSED METHOD

In this paper, Histogram shifting based watermarking method is used for medical image watermarking. In the proposed method of watermarking, the patient details are embedded into medical image as watermarking content. The Histogram is calculated for the cover image. The watermark content is embedded into the region where the low frequency histogram values are present.

III.TECHNIQUES USED

A. Histogram Shifting Based Watermarking

An image histogram is a type of histogram that acts as a graphical representation of the colorness distribution in a digital image. It is used to represent the location of low frequency and high frequency content in the digital image. The watermark content should be placed in the low frequency values of the cover image, so that the original content of the cover image is not disturbed. The watermarking should be done in such a way that the watermarked image should resemble the original image.

B. Embedding Algorithm

The patient details are embedded into medical image as watermark content by watermarking as follows.

1. First the input image host image I and watermark image is read as input from the user.

2. The input image is divided into number of non overlapping sub blocks

3. The histogram is calculated for every blocks of the cover image, that is the high frequency and low frequency content distributions are calculated.

4. The block which contains the low frequency content of the image is choosed for watermarking. Choose the peak value a and lower value b. The values which are very closer or equal to b is considered to the low frequency value.

5. The pixel values of the watermark image are embedded into the block which contains the low frequency content of the image with the X-OR operation.

6. All the applied values of b are applied with X-OR function and it is assigned to a separate variable.

7. Then the pixel values of watermark content X-ORed with the previous XOR result. The watermark bits embedded into the low frequency component of the host image blocks one after the other.

8. The above step is repeated until all the bits of watermark content are embedded into the low frequency component of host image. Finally the watermarked image is now obtained rejoining all the blocks

C. Extraction Algorithm:

The watermark content or the patient detail is separated from the medical image or watermarked image by the following algorithm. The first four steps of embedding algorithm s repeated for the extraction algorithm.

1. The watermarked image is scanned as input image and it is divided into number of non overlapping sub blocks.

2. The histogram is calculated for all the sub blocks to find low frequency and high frequency distributions of pixel values.

3. The blocks which contain the low frequency content of the cover image and the pixels values of the watermark image are choosed for the extracting algorithm.

4. The watermarked pixels are extracted from the low frequency blocks of the watermarked image

5. Finally the watermark content is extracted from the watermarked image by XORed result.

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IV. EXPERIMENTAL RESULTS

The proposed method is simulated using MATLAB software. For the proposed Histogram Shifting based medical image watermarking, different medical images are taken as input images ie., host image. The patient details are stored as digital images. These digital images which contain the patient information are taken as the watermark image. The watermarking of patient information into the medical image is executed by the proposed Histogram shifting based medical image watermarking and the simulation results are given in following diagrams.

The performance metrics used to examine the performance of proposed method are Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR). MSE is used to find the similarity between the original image and watermarked image. As the MSE value is low it indicates that the similarity is high. The MSE for the host image and watermarked image can be computed by using following formula.

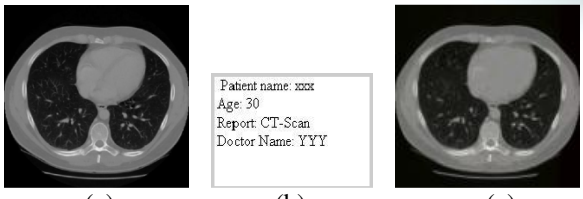
$$MSE = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\left(I(x,y) - I'(x,y)\right)^2 \quad (1)$$

Where I(x,y) is the original image
I'(x,y) is the watermarked image.

The PSNR is used to examine the visual quality of the watermarked image. PSNR is calculated by using the following formula.

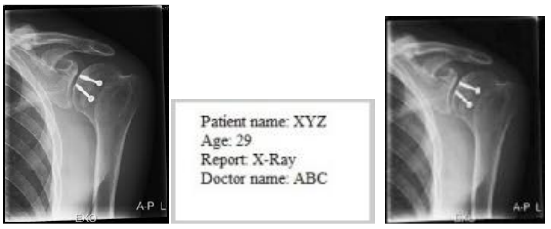
$$PSNR = 10\log_{10}\frac{\max^2}{MSE} \quad (2)$$

Where max=255, and MSE is Mean Squared Error. The simulation results are shown in the following figure.



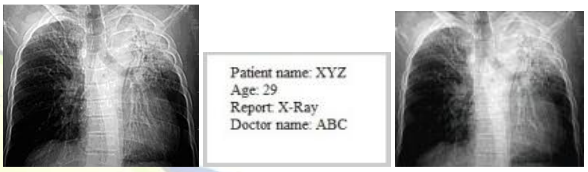
(a) (b) (c)

Fig 2. Simulation result 1 of DWT based medical image watermarking. (a) host image (b) watermark image (c) output watermarked image



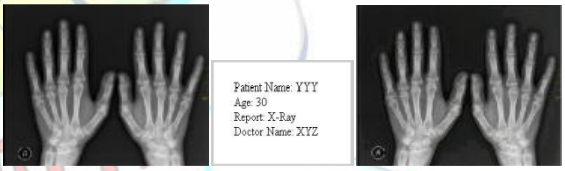
(a) (b) (c)

Fig 3. Simulation result 2 of DWT based medical image watermarking. (a) Host image (b) watermark image (c) output watermarked image



(a) (b) (c)

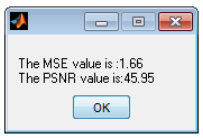
Fig 4. Simulation result 3 of DWT based medical image watermarking. (a) Host image (b) watermark image (c) output watermarked image



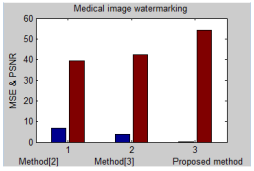
(a) (b) (c)

Fig 5. Simulation result 4 of DWT based medical image watermarking. (a) host image (b) watermark image (c) output watermarked image

The simulation results for different images are taken and their performance metrics are calculated. The calculated values are compared with previous methods and they are tabulated. Table 1 shows the comparison of MSE and PSNR of different methods and the proposed method for different input images.



(a) MSE & PSNR



(b) MRI images- Watermarking

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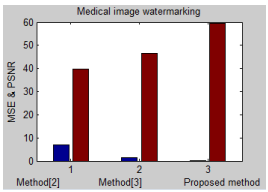
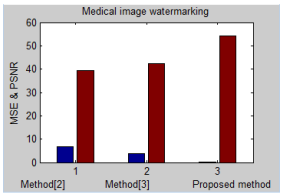


(c) X-RAY images



(d) CT scan images

Fig 6. Bar graph (a) Comparison of MSE and PSNR of different methods for CT scan images (b) Comparison of MSE and PSNR of different methods for MRI images. (c) Comparison of MSE and PSNR of different methods for X-RAY images (d) MSE & PSNR values

TABLE 1. COMPARISON OF MSE AND PSNR

Types of images	Method [2]		Method[3]		Proposed method	
	MSE	PSNR	MSE	PSNR	MSE	PSNR
CT scan images	6.81	39.83	3.09	43.23	1.66	45.95
MRI scan images	6.86	39.40	3.87	42.25	0.24	54.32
X-Ray images	6.93	39.60	1.47	46.45	0.073	59.49

V. CONCLUSION AND FUTURE SCOPE

In this paper, the hiding of patient details in medical images by using Histogram shifting based watermarking has been proposed for medical image authentication and watermarking has been effectively done. The proposed method is examined by the performance metrics MSE and PSNR. From the above simulation results, comparison table and the bar graph shown, it is clear that the proposed method provides MSE values 4 times lower than the existing methods and PSNR values are increased by 32%. When we use the transform domain based method along with histogram shifting based watermarking, it is expected to give the result with lesser execution time when compared to this method. The future scope is to perform transform domain based watermarking along with histogram shifting method for medical image authentication.

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