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Medical Image Watermarking by Histogram Shifting and Group Search Algorithm

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Abstract— Health of living being depends on diagnosis of diseases and symptoms. Diagnoses of medical images were done by the medical specialist, but availability of such practitioner is rare. So reports were sharing plays an important role. This paper work on the validation of medical images. To validate a medical image watermarking was done by embedding in DWT low frequency region. Coefficient from the Group Search optimization algorithm was used for the embedding of watermark. Suitable coefficient values were used for histogram shifting for embedding of secret data. This process help in improvement of the watermark embedding that can be minimizing the cover value losses. Experiment was done on real dataset of breast cancer. Result shows that proposed model has improved the SNR value of embedded image by 72.09% as compared to comparing models.

Index: Genetic algorithm, Image Processing, Information Embedding, Information Extraction, LSB, MSB.

I. INTRODUCTION

When working in a medical field, different kinds of medical images are frequently sent to other locations for the purpose of obtaining a physician's opinion regarding a diagnosis from a remote location and also for the purpose of archival-based applications. Various forms of multimedia are utilised throughout the process of internet-based image transfer of medical data. Concentration is required in order to defend (cover) the medical image against attacks from the outside. In addition, medical imaging enables the creation of a directory of normal anatomy and physiology, which paves the way for the possibility of abnormality detection [1]. Even if the organs and tissues have been removed, it is common practise for them to be revealed, and these techniques are regarded more as a component of pathology than medical imaging. The term "medical imaging" refers to a wide range of radiological imaging techniques, some of which are as follows: X-ray radiography; fluoroscopy; magnetic resonance imaging (MRI); medical ultrasonography or ultrasound; endoscopy; elastography; tactile imaging; thermography; medical photography; and nuclear medicine functional imaging techniques, such as positron emission tomography (PET) and single-photon emission computed tomography [2, 3, 5].

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During the transmission of medical images, watermarking is utilised to ensure patient confidentiality. The process involves embedding significant information over a host medical image in order to provide authentication, information hiding, tamper proof data, and other similar features. Coatrieux et al., 2009 [4]. When it comes to the watermarking process, confidentiality, authenticity, and dependability are considered to be the most important factors. The process of watermarking can primarily be divided into two categories: visible watermarking and invisible watermarking. The use of an invisible watermark is a secure strategy to prevent watermarking attacks [5].

Researchers from a variety of fields have developed a wide variety of watermarking algorithms for medical images, the majority of which are based on either the spatial domain technique or the frequency domain technique. Zhou et al. [6] proposed a watermarking scheme for the spatial domain that could be used to verify the authenticity and integrity of digital mammography images. In order to validate the reliability of DICOM ultrasound images and ensure that they are genuine, Zain et al. [7] have proposed a new method of watermarking based on the spatial domain. X. Guo and colleagues have come up with a method of lossless watermarking that is based on difference expansion. The values of neighbouring pixels are computed and used in the process of embedding several bits in the RONI region.

II. RELATED WORK

A multipurpose medical image watermarking scheme is presented by the authors in [8]. This scheme offers copyright and ownership protection, tamper detection/localization (for ROI (region of interest) and different segments of RONI (region of non-interest)), and self-recovery of the ROI with 100 percent reversibility. In addition, this scheme protects against tampering. In the beginning, the LZW (Lempel-Ziv-Welch) algorithm is used to compress the recovery information of the ROI of the host image. Following that, a transform domain based embedding mechanism is utilised in order to incorporate the robust watermark into the host image. In addition, the 256-bit hash keys for the ROI and eight RONI regions (i.e. RONI-1 to RONI-8) of the robust watermarked image are generated with the help of the SHA-256 algorithm. An approach to fragile watermarking that is based on LSB replacement is used, and after the compressed recovery data and hash keys have been combined, they are subsequently embedded into the segmented RONI region of the robustly watermarked image.

The author of [9] presents a new blind fragile-based image watermarking scheme in the spatial domain. This scheme combines the well-known Weber Descriptors (WDs) and the Arnold algorithm with the Speed Up Robust Features (SURF) descriptor. It offers a useful method for improving the image quality and reducing the time complexity required for maintaining medical data integrity. To begin, the image containing the watermark is jumbled up by using the Arnold chaotic map. In the second step, the SURF technique is applied to the Region of Interest (ROI) of the medical image. After that, the blocks surrounding the SURF points are chosen so that the watermark can be inserted. At long last, the watermark is encrusted and then extracted with the help of WDs.

In the article [10], the author presents a blind multipurpose image watermarking scheme for the protection of copyright and ownership, image authentication, and image restoration. In order to achieve the multipurpose nature, two distinct types of watermarking strategies, namely robust and fragile, are utilised. IWT is used to insert a watermark that is encrypted into the host image in order to perform the Robust watermark insertion (Integer wavelet transform). After that, a method known as least

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significant bit replacement, which is based on the 9-base notation, is applied in order to embed the fragile sequence alongside recovery information in a controlled manner of randomization.

An effective encryption model for medical images is suggested in the work that the [11] author has contributed. The six-dimensional hyperchaotic map (SDHM) is suggested as a method for recovering the hidden keys. To begin, a standard medical image is split into three channels, which are labelled red, green, and blue respectively. These channels can be diffused with the use of secret keys. In the final step, the channels that are encrypted are concatenated to produce the final encrypted medical image. When analysing the standard medical images, extensive experiments are performed to draw conclusions. In addition, comparisons are carried out between the proposed SDHM and other techniques by taking a variety of performance metrics into consideration. An analysis of comparisons reveals that the proposed SDHM achieves astonishingly better performance than the various encryption models that are currently in use.

In the work described in [12], a three-tiered security system is implemented in addition to robust and reversible watermarking. Both the region of interest (ROI) and the region of non-interest are important diagnostic components of a medical image. These are referred to respectively as the region of interest and the region of non-interest (RONI). To begin, in ROI Reversible data embedding, which embeds payload data in a reversible manner into to binary image, due to the fact that physicians consider it to be important for making a diagnosis. During the watermarking process, the ROI image does not undergo any changes as a result. The second step in RONI is called "Robust watermarking," and its purpose is to make the system resistant to a wide variety of attacks, both intentional and accidental. Within the region of interest (ROI), the Haar wavelet is used to perform a two-level decomposition, and a watermark containing the patient's information is incorporated into the LH1 and HL1 sub bands. After some time has passed, the two watermarked images are merged together to produce a single watermarked image. Thirdly, the resulting image goes through additional processing with the help of an AES algorithm, which results in the output image being in an unreadable form. Offering a very high level of security.

III. Proposed Methodology

In this section, the proposed model GSOMIW (Group Search optimization based Medical Image Watermarking) was detailed with a running example of where input image is pre-processed and feature extraction is done for the purpose of hiding secret data. The steps of the proposed methodology are shown in Figure 1. The explanation of each block in figure 1 is presented in the order that it appears in the figure. The steps of data extraction were also detailed in the section.

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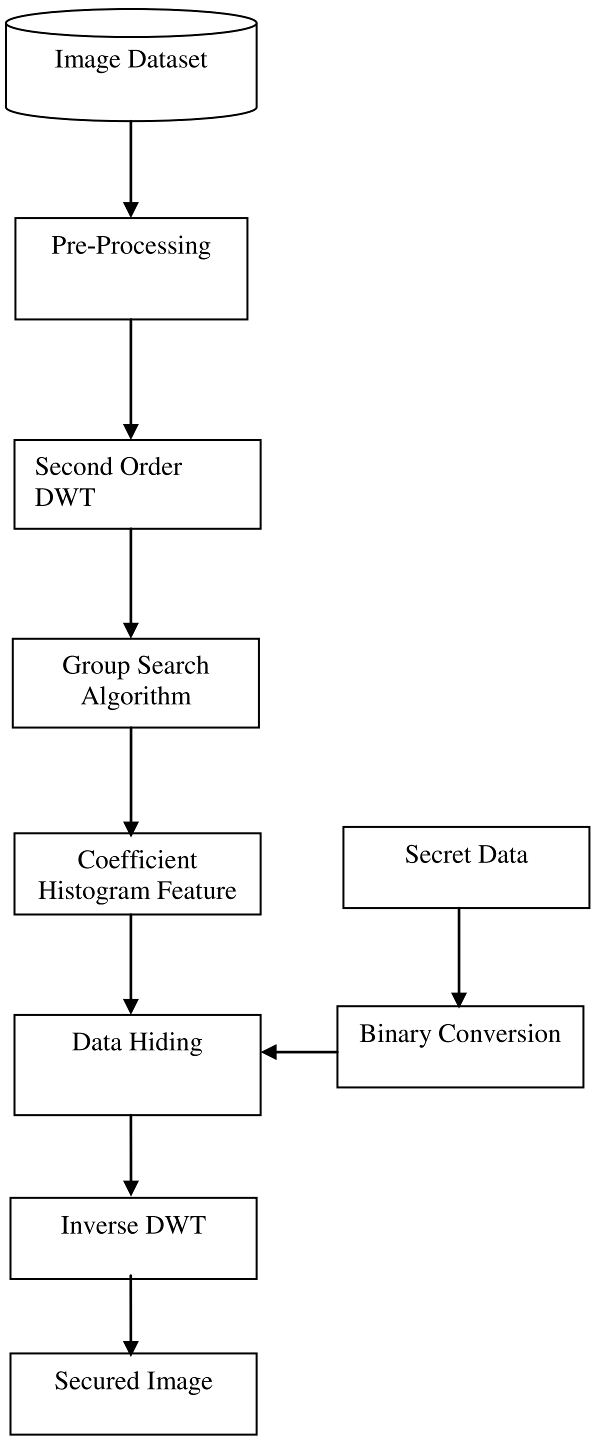

Fig.1 Block diagram of proposed work.

Input Image Pre-Processing

The work accepts input images of any dimension that are provided by the user. This work is suitable for both two- and three-dimensional image representations. In the case of three dimensions, only one set of the matrix—namely, red, green, and blue—is used to hide the data. Next, the image was converted into a pixel range that went from 0 to 255. Therefore, if the image that was in HSV format was converted to RGB format first [13]. The input image I is then pre-processed according to the working environment into the image matrix Ip, where Ip is a two-dimensional representation of the image.

Image DWT Feature Extraction

Within the scope of this work, the DWT frequency feature was implemented. Figure 2 demonstrates the detail steps of DWT, which are shown in the context of work that has an embedded watermark in the LL region of the image [14]. After filtering the image rows with a low pass filter, this block of the image is obtained by passing the same data through the low pass filter again, but this time the columns are filtered for the analysis [15]. Because this version of the image does not contain any edge information, it is referred to as an approximate version of the image. This block contains the flat region of the image.

Genetic Algorithm

The DWT coefficients extracted from the image are then converted into a matrix with a single dimension. Clusters of transformed vector values were created, one of which was suitable for data hiding while the other was unsuitable for data hiding. In order to cluster the vectors, the model made use of genetic algorithm.

Generate Members

Group search finds the food to eat where searching member is at any of three state first is producer, second is scrounging and third is ranging. Hence in this algorithm population is group and pixels set present in group is member (Chromosome). Out of various food sources available some random sources were point by the member. Representation of this population is shown in eq. 1.

$$GM \leftarrow Gaussian\_Feature\_Set(m, f,)$$

Where in Eq. 1 m is number of member in the population/group, f is number of features. In order to generate random food source point Gaussian function was used.

Producing

Evaluation of various food point identify by the members was done in this step of the model. In terms of genetic algorithm this step is fitness evaluation function. Producer selection is done in this step as per fitness values. Algorithm 1 gives the fitness value of different members. Members vector pass in the fitness function for finding the Euclidian distance function. This distance summation value is fitness parameter in the work.

$$F_m = \sum_{i=1}^{e} \sum_{j=1}^{coeff} \text{Euclidian}(C_j, GM_{i,m}) \text{-----Eq. 4.1}$$

Above eq. 1 gives an fitnesss value F_m in the population. Where Coeff is coefficient values.

Scrounging (Crossover) Scroungers

Producer finds the good food points and other member in the p group is considers as the scroungers. All scroungers join the food source search by the producer. So producer stop searching the food source in this iteration and other members change their food pint as per producer. This change is termed as crossover operation in the group. To understand this let P is producer, M_m is m^{th} member in population then change occur at random feature position as per producer feature state.

$$M'_m[1\ r] \leftarrow M_m[1\ r] + P[1,r]$$

New food point obtained from the crossover operation. Where r is random position value range from 1 to f. One more step is to check that new food point is better food source or not. For this evaluate its fitness value as done. Better food source were point by the member.

Ranging (Mutation) Rangers

Each group member except producer participate in this step of algorithm. As ranger will find new food point as by there random behavior hence producer not help them. Member modify the state of the feature at some random position. This change of state gives new food location in the search space to the members. Flip operation were perform in the step of algorithm.

$$M'_m[1\ r] \leftarrow \text{Flip}\ (M_m[1\ r])$$

New member food search point need to check as done in scrounging phase. Food point having better fitness value is consider as the final member food point in current iteration.

After sufficient number of iterations algorithm stops to get the feature set that has good coefficient cluster center values. These cluster center gives two group of coefficient first is suitable for embedding and other is not used for embedding.

Image Histogram

In this step coefficient obtained after genetic algorithm for hiding data is consider for histogram estimation of the image. In this work histogram works at one bins. Histogram of each value in the data hiding vector is the cunt of its presence.

Data Hiding

Histogram shifting is obtained by manipulating the peak value with zero presence value, but this make one limitation that

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number of data hiding bits are less. So in order to increase the number of position in the image proposed work has include other peak of the histogram for increasing the hiding capacity. Here histogram shifting is done for hiding each bit of the data. This shifting means replacing peak pixel value with its corresponding zero pixel value.

Extraction steps

In this extraction steps receiver can extract data and image. Preprocessing and DWT feature extraction steps are same as done in data hiding step. Further input to the work is Key that is cluster center obtained from the genetic algorithm obtained during data hiding process. As per key coefficient values were cluster into data hiding and non data hiding group. As per low and peak value frequency replacement of low value was done by peak frequency values. As per low and high value sequence obtained in the coefficient vector binary secret data is extract.

VI. EXPERIMENT AND RESULTS

This section exhibits the experimental assessment of the proposed procedure for the protection of the picture. All calculations and utility measures were executed by utilizing the MATLAB apparatus. The tests were performed on a 2.27 GHz Intel Core i3 machine, outfitted with 4 GB of RAM, and running under Windows 7 Professional.

Dataset

Collect the data from: Similarly breast cancer disease mage watermarking was done where images have dimension of 224x224 [20].

Result

PSNR values of embedded images shows in table finds that proposed GSOMIW model has reduces the image losses while embedding as compared to previous model. It was obtained that use of group search optimization algorithm has increase the work performance of the watermarking.

Table 1 Comparison of watermarking algorithms based on PSNR values.

Breast Cancer Testing Images	GSOMIW	Previous Model [18]
B1_Image	103.07	23.2095
B2_Image	102.837	16.6442
B3_Image	102.756	17.9964
B4_Image	102.806	17.6165
B5_Image	103.111	20.1855

Table 2 Comparison of watermarking algorithms based on SNR values.

Breast Cancer Testing Images	GSOMIW	Previous Model [18]
B1_Image	57.7591	20.2531
B2_Image	57.2503	13.4068
B3_Image	56.8963	14.4847
B4_Image	57.2926	14.4561

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B5_Image	**58.1739**	**17.5916**

Use of Group Search Optimization for selection of DWT coefficient in histogram shifting has increased the work performance of SNR parameter of the model. It was found the from table 2 that SNR value was increases by 41.43 as compared to existing model proposed in [18].

Table 3 Comparison of watermarking algorithms based on MSE values.

Breast Cancer Testing Images	GSOMIW	Previous Model [18]
B1_Image	0	310.551
B2_Image	0	1408.2
B3_Image	0	1031.43
B4_Image	0	1125.71
B5_Image	0.163086	623.063

MSE values of embedded images shows that proposed GSOMIW model has reduces the image losses while embedding as compared to previous model. It was obtained from table 3 that use of group search optimization algorithm has increase the work performance of the watermarking. Histogram shifting for embedding of secret information has drastically reduced the MSE values.

Table 4 Embedding time (Seconds) based data hiding models comparison.

Breast Cancer Testing Images	GSOMIW	Previous Model [18]
B1_Image	0.0421722	0.1273355
B2_Image	0.0149683	0.1273355
B3_Image	0.0040996	0.1106615
B4_Image	0.00667451	0. 355023
B5_Image	0.0517706	0.1432116

Use of Group Search Optimization for selection of DWT coefficient in histogram shifting has decreased the work watermark extraction time in seconds. At extraction side group search optimization algorithm was not need to execute.

V. Conclusions

Digital Image plays an important role in day to day life for different purposes, area, etc. Medical diagnosis also takes advantages of images for consultation purpose. But network may affect the image data that need to verify that image is original or not. This paper has developed a group search optimization genetic algorithm based signature embedding for image stenography. Paper has done whole embedding process in low frequency region of image. Experiment was done on real dataset. Result shows that PSNR value was improved by 83.78db, similarly SNR value was improved by 41.43 as compared to [18]. In future scholar can developed a model that protect image from geometrical attacks.

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