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# Multiple Image Watermarking Technique Based on Hybrid DWT-SVD and Artificial Neural Network

**[1]Mohananthini N and [2]Yamuna G**

[1]Research Scholar, Annamalai University, Tamil Nadu, India
mohananthinin0786@gmail.com
[2]Professor, Department of Electrical Engineering,
Annamalai University, Tamil Nadu, India

**Abstract:**

Multiple watermarking combines the advantages of single watermarking algorithms to create a sophisticated multiple watermarking scheme, which is efficient in terms of robustness and security. Multiple watermarks is to convey multiple sets of information designed to suit similar or differing objectives and is used to increase robustness with many different methods in which the embedded information is not easily lost. The primary intension of this research is to design and develop an efficient multiple-watermarking technique. The proposed multiple-watermarking technique makes use of Artificial Bee Colony Algorithm (ABC) based Hybrid DWT-SVD and artificial neural network. The understanding between the transparency and robustness is considered as an optimization problem and is removed by applying artificial bee colony algorithm. This technique is used to obtain the highest possible robustness without losing the transparency. The proposed ABC based embedding and extracting method of hybrid DWT-SVD watermarking is employed to avoid watermark exposure. In embedding process, multiple watermarks are fused using a fusing technique in to a single watermark and then it will be embedded. From the fused single watermark, multiple watermarks are extracted using extraction process. Multiple watermark strength is analyzed using artificial neural network. The reliability was tested with various attacks such as Intensity, Geometric and salt and pepper noise attacks.

**Keywords***:* Artificial Bee Colony algorithm (ABC), Discrete Wavelet Transform (DWT), Singular vale decomposition (SVD), Hybrid DWT-SVD, Transparency, Reliability, Security.

## 1.Introduction

Watermarking is the art of imperceptibly embedding a message into object. More than 700 years ago in Fabriano (Italy), paper watermarks appeared in handmade paper, in order to identify its provenance, format, and quality. Since the early 1990s, digital watermarking has applied similar concepts to multimedia contents (images, video and music) as a technological support to digital right management [1]. In recent years, watermarking has been an exciting topic and there have been many watermarking schemes proposed. Among these schemes, those requiring both the original data and the secret keys for the watermark bit decoding are called private watermark schemes. Those requiring the secret keys but not the original data are called public or blind watermark schemes [2]. Digital watermarking has attracted a great deal of attention recently from researchers focusing on academic investigations and practical applications. Techniques for processing watermarks in text, images, video and audio have become increasingly popular in recent years [3].

Digital watermarking is a technique that embeds data called watermark into a multimedia object such that watermark can be detected to make an assertion about the objects. It can be categorized as visible or invisible. On the other hand, invisible watermark is hidden in the object, which can be detected by an authorized person [4]. Digital watermarking has been used to increase medical image security, confidentiality and integrity. Watermarked medical images should not differ perceptually from their original counterparts. Digital data or images can be easily manipulated without leaving any trace of modification [5]. Digital watermarking provides a way of protecting the rights of the owner of a file. Even if the file is copied and then changed with minor alterations and transformations, the owner can still prove its original file [6]. The widespread use of digital networks for the communication of multimedia data has resulted in a recent spurt of research on techniques for digital watermarking [7].

Digital watermarking algorithms are composed of three parts, namely, watermark embedding algorithm, watermark extraction algorithm and watermark detection algorithm [8]. Digital image watermarking provides copyright protection to image by hiding appropriate information in original image to declare rightful ownership [9]. Digital Image watermarking is the process of embedding a digital signature into a digital image called watermark. Detection or extraction of this watermark at a later time enables data owners to make an assertion about the authenticity and ownership of their object [10]. The application of multiple watermarking technique also represents a solution to preserve the security of such data on the one hand, and the traceability of medical diagnoses made by doctors on the other hand [11].

## 2. Related Works

Shang-Lin Hsieh, et al. [12] presented a novel digital watermarking scheme for copyright protection against piracy of color images. Unlike traditional watermarking schemes that directly embed watermarks into host images, their proposed scheme encodes the watermark prior to watermark embedding in order to improve tolerance to attacks. The process has utilized the secret sharing scheme with the feature extracted from the host image by the discrete wavelet transform. Moreover, different from other watermarking schemes that require manual adjustment in the embedding scaling factors to embed the watermark, their proposed scheme can automatically calculate the scaling factor for different images while still preserving robustness and imperceptibility. K.Ganesan and Tarun Kumar Guptha [13] proposed a scheme using which more data can be inserted into an image in different domains using different techniques, which results in the increasing of embedding capacity. Their proposed scheme also has provided an extra level of security to the watermark image by scrambling the image before embedding it into the host image. Their experimental results shows that the proposed watermarking method results in almost invisible difference between the watermarked image and the original image and is also robust against various image processing attacks.

S. Radharani and Dr. M.L.Valarmathi [14] proposed a multiple watermarking technique which combined the wavelets based on texture properties to watermark copyright and authentication information inside a cover image. Experimental results proved that their proposed algorithm was efficient in terms of quality and further, the results also proved that storing watermarks using texture properties had also provided more robustness to their proposed technique. Vijaya Kumar. Kurapati, et al. [15] proposed a new robust watermarking technique for copyright protection based on Discrete Wavelet Transform and Singular Value Decomposition. The high frequency sub band of the wavelet decomposed cover image was modified by modifying its singular values. A secret key was generated from the original watermark with the help of visual cryptography to claim the ownership of the image. The ownership of the image will be claimed by superimposing of secret key on the extracted watermark from the watermark image. The robustness of their technique was tested by applying different attacks and the visual quality of the extracted watermark after applying these attacks was found to be good. It was also found that the visual quality of the watermarked image was undistinguishable from the original image.

Kiratpreet Singh and Rajneet Kaur [16] proposed a robust watermark scheme based on spatial domain by embedding the watermark image 14 times in RGB components at different locations order to achieve robustness against various geometric double attacks. Ibrahim Alsonosi Nasir and Ahmed b. Abdurrman [17] proposed a new color image watermarking scheme for copyright protection. It was based on embedding multiple watermark bits into the luminance component or the blue component of a color image in discrete wavelet domain. The extraction process does not require the original image. Experimental results show that their proposed scheme successfully makes the watermark perceptually invisible as well as robust to common signal processing and some geometric attacks.

A robust image watermarking scheme based on singular value decomposition (SVD) and discrete wavelet transform (DWT) with Artificial Bee Colony Algorithm is proposed in [19]. Previous ABC based watermarking algorithms have a major drawback of security and robustness. For solving this problem, the multiple watermarking technique makes use of Artificial Bee Colony Algorithm (ABC) based Hybrid DWT-SVD and artificial neural network is proposed. This paper is organized as follows; the proposed methodology for watermark embedding and extraction process is explained in section 3. The experimental results and discussion are presented in section 4. Finally, concluding remarks are given in section 5.

## 3. Proposed Methodology

The proposed work focuses on multiple-watermarking technique using artificial bee colony algorithm and artificial neural network. The proposed methodology are discussed as follows,

### *3.1.Watermarking Image Fusion Process*

Image fusion is the process of mixing information from two or more images of a scene in to a single composite image that is certainly more beneficial and is also far better with regard to visible conception or computer finalizing. The objective of image fusion is to combine supporting multi-sensor, multi-temporal and multi-view facts directly into one particular new image. The aim should be to decrease uncertainty and limit redundancy in the productivity while maximizing applicable facts certain with a software or even process. Consider if the composite watermark image size is 200*200; the 4 images to be watermarked are taken as 50*50 which will be equal to 200*200. Among the RGB values in the medical images, R value is taken in to account the remaining G and B values were added. Hence the image to be watermarked is made by means of composite watermarking 4 images. Then the watermarking process is carried out.

### *3.2. Discrete Wavelet Transform*

The DWT is similar to a hierarchical sub-band system where the sub bands are logarithmically spaced in regularity and signify octave-band decomposition. The proposed method 3-level wavelet decomposition is used. The Discrete Fourier Transform (DFT) is easy to handle the 2 dimensional images using the tensor product form of the orthogonal basis [18]. The image is divided into four sub bands using DWT. They are HL, LH, LL and HH sub bands. These four sub bands come up from separable functions of vertical and horizontal filters.

### *3.3. Singular Value Decomposition*

The SVD is a powerful matrix decomposition tool which has also been used in a variety of applications. From the viewpoint of linear algebra, a discrete image can be represented as a 2D matrix with nonnegative scalar entries. The SVD of an N×N image matrix F has a decomposition form:

$$F = U * S * V^T \qquad (1)$$

Where U and V are N×N orthogonal matrices, the superscript T denotes matrix transposition, and S is an N×N matrix containing singular values on the diagonal and zeros off the diagonal. The singular values ($s_i$) of F are arranged in a decreasing order $s_i > s_i+1$. Thus there is a notice of the fact that every image matrix can always have the well-known singular value decomposition (SVD) and can be regarded as a composition of a set of base images generated by SVD, and a thing further pointed out that, the leading base images (those corresponding to large singular values) are sensitive to the variations in an image.

### *3.4. Artificial Bee Colony Algorithm*

In proposed work, the understanding between the transparency and robustness is considered as an optimization problem and is removed by applying artificial bee colony algorithm. This technique is used to obtain the highest possible robustness without losing the transparency. ABC algorithm is a swarm based meta-heuristic algorithm which is enthused by the sharp foraging behaviour of the honey bees. It consists of three components namely, employed bees, onlooker bees and scout bees. The employed bees are coupled with the food sources in the region of the hive and they transfer the data to the onlookers about the nectar quality of the food sources they are exploiting. Onlooker bees are watching the dance of the employed bees inside the hive to pick one food source to exploit according to the data provided by the employed bees. The employed bees whose food source is abandoned become Scout and seek new food source arbitrarily. The number of food sources denotes the location of probable solutions of optimization problem and the nectar amount of a food source denotes the quality of the solution. The flow chart of artificial bee colony algorithm as shown in Figure 1.

### *3.4.1 Employed Bee Phase*

In the employed bee phase, new population parameters are generated using the equation below:-

$$V_{i,j} = x_{i,j} + \phi_{ij}\left(x_{i,j} - x_{k,j}\right) \qquad (2)$$

Where, $k$ and $j$ is a random selected index, $\phi$ is randomly produced number in the range [-1, 1] and $V_{i,j}$ is the new value of the $j^{th}$ position. Then the fitness value is computed for every new generated population parameters of food sources. From the computed fitness value of the population, best population parameter is selected i.e. the population parameter, which has the highest fitness value by applying greedy selection process. After selecting the best population parameter, probability of the selected parameter is computed using the equation (3).

$$P_j = \frac{F_j}{\sum_{j=1}^{d} F_j} \qquad (3)$$

where,

$P_j$ is the probability of the $j^{th}$ parameter.

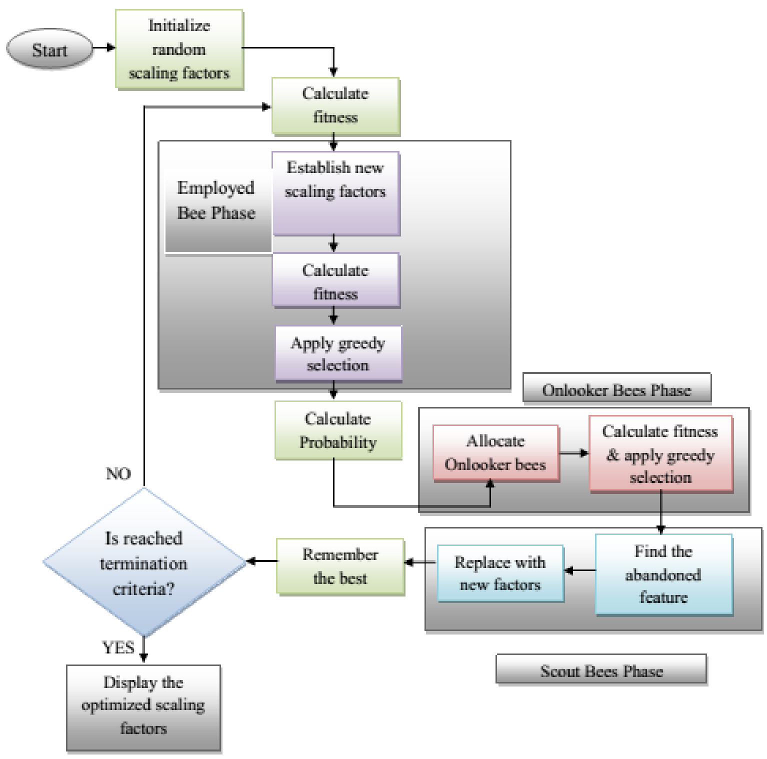


**Fig 1:** Flow chart of artificial bee colony algorithm

*3.4.2 Onlooker Bee Phase*

After computing the probability of the selected parameter, number of onlooker bees is estimated. Later on, generate new solutions $V_{i,j}$ for the onlooker bees from the solutions $x_{i,j}$ based on the probability value $P_j$. Then the fitness function is calculated for the new solution. Subsequently apply the greedy selection process in order to select the best parameter.

*3.4.3 Scout Bee Phase*

Determine the Abandoned parameters for the scout bees. If any abandoned parameter is present, then replace it with the new parameters discovered by scouts using the equation (3) and evaluate the fitness value. Then memorize the best parameters achieved so far. Then the iteration is incremented and the process is continued until the stopping criterion is reached. Finally, the optimized rules are discovered.

***3.5. Watermarking Scheme***

The DWT-SVD based watermark embedding and extracting process can be described as shown in Figure 2 and 3.

*3.5.1.Watermark Embedding*

Step 1. Input Original image and Fused Watermark image.

Step 2. Apply DWT to the input image and the fused watermark image. By applying DWT both the images are decomposed in to four sub bands HH, HL, LH and LL.

Step 3. Apply SVD to the LL band.

Step 4. The watermark image is embedded in the original image by means of the following formula:

$$S_{kj} = S_j + \alpha * S_k \qquad (4)$$

where,

$S_j$ = Approximation matrix of the original image.

$S_k$ = Approximation matrix of the watermark image.

$\alpha$ = Scaling factor

Step 5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.

Step 6. Apply Inverse SVD and apply Inverse DWT.

Step 7. Finally the watermarked image will be obtained

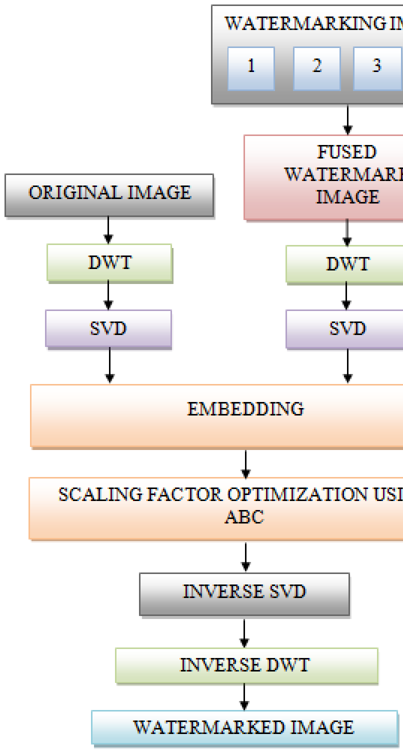



**Fig 2:** Architecture of the proposed watermark embedding process

### *3.5.2. Watermark Extraction*

Step 1. Input Watermarked image.

Step 2. Apply DWT to the watermarked image. By applying DWT both the images are decomposed in to four sub bands HH, HL, LH and LL.

Step 3. Apply SVD to the LL band.

Step 4. The watermark image is extracted from the watermarked image and the original image by means of the following formula:

$$S_k = \left(S_{kj} - S_j\right) / \alpha \qquad (5)$$

Where,

$S_{kj}$ = Approximation matrix of the watermarked image.

Step 5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.

Step 6. Apply Inverse SVD.

Step 7. Finally the fused watermark image will be obtained.

Step 8. From the fused watermark image the watermark images are obtained.

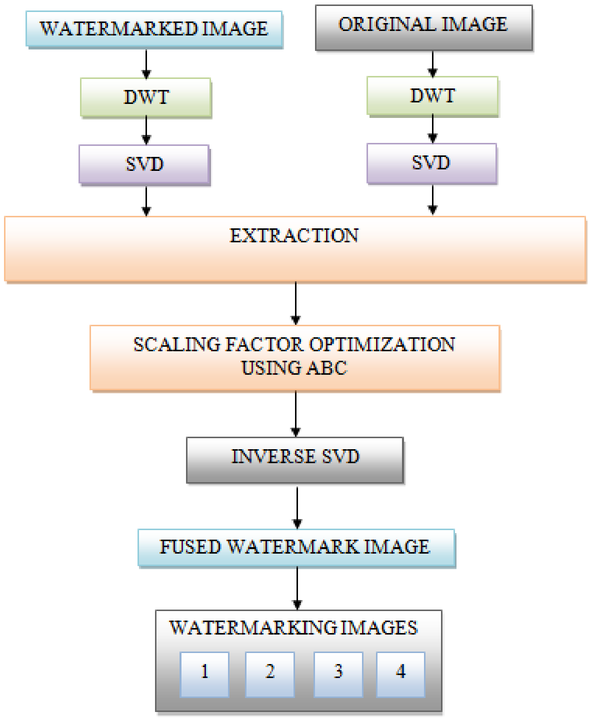



**Fig 3:** Architecture of the proposed watermark extraction process

### *3.6 Artificial Neural Network*

In proposed work Feed Forward Back Propagation Neural Network classifier (FFBNN) analyzes the multiple watermark strength using Levenberg-Marquardt algorithm. Neural network is a three-layer standard classifier with $n$ input nodes, $l$ hidden nodes and $k$ output nodes. It is examined, if the two hidden layers are used then one hidden layer is to associate every pair in one important unit and second is regarded as to be the real hidden layer after classifying the input data in the first hidden layer. For our proposed work, the input layers are the DCT coefficients of retrieved watermark, $HU_a$ Hidden Units and one output unit $f$. The structure of the FFBNN classifier is demonstrated in the following Figure 4.

#### *3.6.1 Neural Network Function Steps*

Step 1. Calculate the DCT coefficients for the four retrieved watermark images.

Step 2. Set weights for every neuron's except the neurons in the input layer.

Step 3. Generate the neural network with the extracted coefficients $\{C_1, C_2, C_3, C_4\}$ as the input units, $HU_a$ Hidden units and age $f$ as the output unit.

Step 4. The calculation of the proposed Bias function for the input layer is,

$$X = \beta + \sum_{n'=0}^{H_{NH}-1} w_{(n')} C_1(n') + w_{(n')} C_2(n') + \dots + w_{(n')} C_4(n') \quad (6)$$

The activation function for the output layer is calculated as

$$Active\,(X) = \frac{1}{1+e^{-X}} \tag{7}$$

Step 5. Identify the learning error as given below.

$$LE = \frac{1}{H_{NH}} \sum_{n'=0}^{N_{NH}-1} Y_{n'} - Z_{n'} \tag{8}$$

where,

$LE$ - learning rate of FFBNN.

$Y_{n'}$ - Desired outputs.

$Z_{n'}$ - Actual outputs.

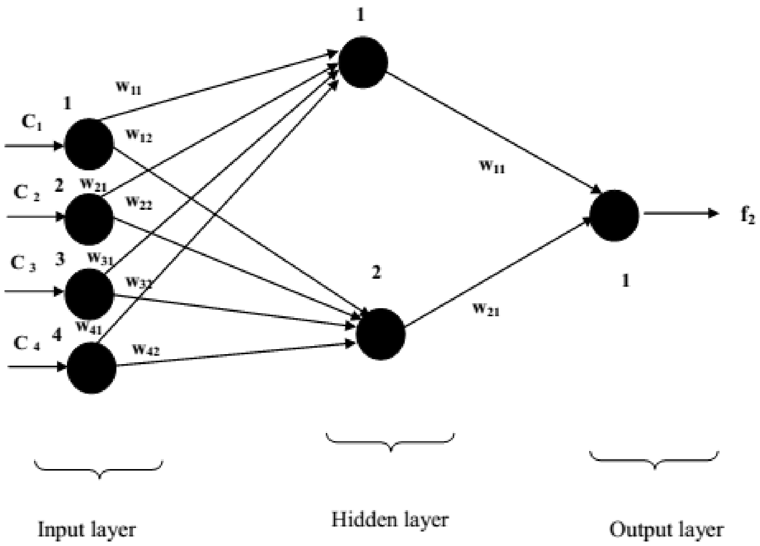



**Fig 4:** Structure of FFBNN classifier for the proposed work

### *3.6.2 Neural network training using Levenberg–Marquardt algorithm*

The training of the neural network was done in the hidden layer using LM (Levenberg–Marquardt) algorithm. Levenberg–Marquardt algorithm also known as the damped least-squares (DLS) method provides a numerical solution to the problem of minimizing a function, generally nonlinear, over a space of parameters of the function. These minimization problems arise especially in least squares curve fitting and nonlinear programming. The performance index is calculated using the following equation:

$$F(W) = E_r^T E_r \tag{9}$$

Where,

$E_r$ is the error, Therefore, the performance index is

$$F(W) = \sum_{p=1}^{p} \left[ \sum_{n=0}^{h-1} (d_n - a_n)^2 \right] \tag{10}$$

Where,

W refers to the weights of the network
$d_n$ refers to the desired value of the $n^{th}$ output and the $p^{th}$ pattern
$a_n$ refers to the actual value of the $n^{th}$ output and the $p^{th}$ pattern

The weights were calculated using the following equation

$$w_{t+1} = w_t - \left(J_t^T J_t + \mu_t I\right)^{-1} J_t^T E_t \tag{11}$$

Where,

I is identity unit matrix
m is a learning parameter
J is Jacobian of m output errors with respect to n weights of the neural network.

The error gets minimized to a minimum value using LM algorithm and the neural network is well trained for performing the testing phase. In the testing process, the DCT coefficients are given to the well trained neural network to check whether the testing data will predict the maximum watermarking strength. Then the result of the neural network $(s)$ is compared with the threshold value $(\tau)$. If it satisfies the threshold value it denotes high watermarking strength. The four watermark images were divided in to two categories, they are resistive and non-resistive. The images which will be above the threshold value will be denoted as resistive and below the threshold value denoted as non-resistive.

### *3.7 Attacks applied to the watermarked image*

The Implementation and Analysis of attacks to the watermarked image is shown below. The Attacks applied to the watermarked image are

- Intensity attack
- Geometric attack
- Salt and pepper noise attack

#### *3.7.1 Intensity attack*

It's a type connected with attack by which attacker transform the intensity on the watermarked picture to weaken the watermark data.

- photographic negative (using imcomplement function)
- gamma transformation (using imadjust)
- logarithmic transformations (using c*log(1+f))
- contrast-stretching transformations (using 1./(1+(m./(double(f)+eps)).^E)

#### *3.7.2 Geometric attack*

These kinds of attacks can easily attacks the actual pixels associated with image for attacking. Like pixels transferring, scaling associated with image, rotation of image without higher image changes. The goal of these kinds associated with attacks is actually degrade the quality of watermark. The Range of geometric attacks lies between 0.2 and 0.5.

#### *3.7.3 Salt and pepper noise attack*

This can be a type regarding attack where monochrome pixels present in the image as a noise.

Outside of all above we will find so various attacks including resizing, popping, scaling, sharpening, JPEG compression etc. which affects the quality of watermark photograph and watermark far too. The effect of these all attacks can be analyzed with the help of MATLAB operates specially regarding this goal. For examine the criteria firstly assault the image with all of these attack. From then on recover the actual watermark details from attacked image. Compare the excellent of watermark image recovered by non-attacked along with recovered by attacked image. Thus anyone can examine the robustness of criteria against these attacks.

## 4 Results and Discussion

The original image used as colour image and the watermark images used in the proposed work are medical images. The proposed methodology will be implemented in MATLAB. The original image is given in Figure 5. The watermark images are given in Figure 6.

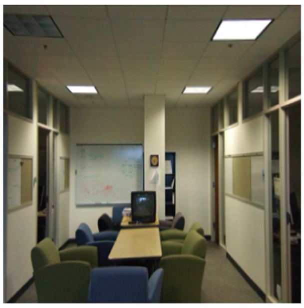


**Fig 5:** Original Image

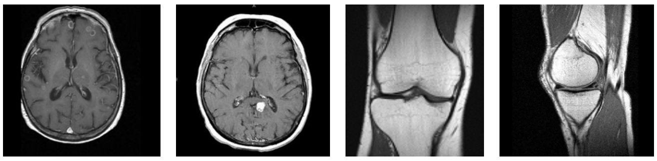


**Fig 6:** Watermark Images

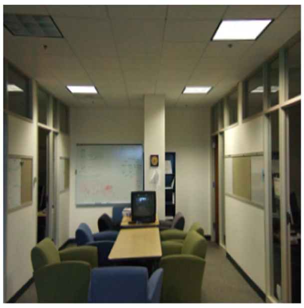


**Fig 7:** Watermarked Image

The watermarked image is given in Figure 7. The Watermarking images which were retrieved from the watermarked image are given in Figure 8.

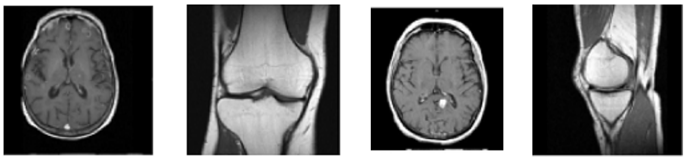


**Fig 8:** Retrieved watermarking Images

### *4.1 Evaluation of Results*

The quality of the system is evaluated using the quality metrics. The quality metrics calculated in our proposed methodology are PSNR, NC and SDME.

#### *4.1.1 PSNR (Peak Signal to Noise Ratio)*

PSNR is the logarithmic value of ratio between signal and noise. It is expressed in decibels. The PSNR value is calculated using the following equation

$$PSNR = 10 \log_{10} \left[ \frac{255^2}{MSE} \right] db \qquad (12)$$

$$MSE = \frac{1}{n.n} \sum_{i=0}^{i=n-1} \sum_{j=0}^{j=n-1} \left( I(i, j) - W(i, j) \right)^2 \qquad (13)$$

Where

MSE = Mean square error
I (i,j) = Pixel values of the original image
W (i,j) = Pixel values of the watermarked image

#### *4.1.2 NC (Normalized cross Correlation)*

The Normalized Cross-Correlation (NC) is calculated using the following equation

$$NC = \frac{\sum_{i=1}^{i=n-1} \sum_{j=1}^{j=n-1} W(i, j).W'(i, j)}{\sqrt{\sum_{i=1}^{i=n-1} \sum_{j=1}^{j=n-1} (W(i, j))^2} . \sqrt{\sum_{i=1}^{i=n-1} \sum_{j=1}^{j=n-1} (W'(i, j))^2}} \qquad (14)$$

Table 1 shows the scaling factor and PSNR values of before and after optimization. From the table it is proved that optimization improves the PSNR values.

**Table 1:** PSNR values of before and after optimization

| **Images** | **Before optimization using ABC** | | **After optimization using ABC** | |
|---|---|---|---|---|
| | **Scaling Factor Values** | **PSNR Values** | **Scaling Factor Values** | **PSNR Values** |

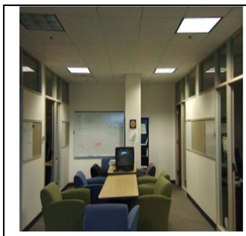
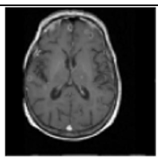
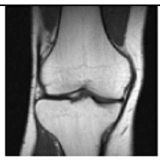
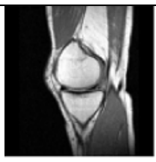
| | | | | |
|---|---|---|---|---|
|  | 0.8092 | 32.124 | 0.9954 | 33.769 |
|  | 0.9241 | 32.197 | 0.4617 | 33.801 |
|  | 0.8344 | 31.451 | 0.2165 | 32.582 |
|  | 0.571 | 33.980 | 0.5841 | 34.713 |
|  | 0.819 | 31.186 | 0.7346 | 33.576 |

Table 2 represents the NC values with and without optimization for the original and the watermark images.

**Table 2:** NC values before and after optimization

| **Images** | **Normalized cross correlation Values** | |
|---|---|---|
| | **Without optimization using ABC** | **With optimization using ABC** |
| Original Image | 0.9421 | 0.9487 |
| Watermark Image 1 | 0.9314 | 0.9654 |
| Watermark Image 2 | 0.9576 | 0.9712 |
| Watermark Image 3 | 0.9487 | 0.9533 |
| Watermark Image 4 | 0.9601 | 0.9871 |

### *4.1.3 SDME (Second Derivative like Measurement)*

The Second Derivative like Measurement (SDME) is an enhancement measure based on the concept of second derivative. The Second Derivative like Measurement is calculated using the following equation

$$SDME = -\frac{1}{K_1 K_2} \sum_{m=1}^{k_1} \sum_{l=1}^{k_2} 20 \ln \left| \frac{I^{l,m}{}_{\max} - 2I^{l,m}{}_{cen} + I^{l,m}{}_{\min}}{I^{l,m}{}_{\max} + 2I^{l,m}{}_{cen} + I^{l,m}{}_{\min}} \right| \qquad (15)$$

Where,

Imax are the maximum values of the pixels.
Imin are the minimum values of the pixels.
Icen is the center pixel value of each block.

Table 3 represents the SDME values for the original and the watermark images before and after optimization.

**Table 3:** SDME values before and after optimization

| **Images** | **SDME Values** | |
|---|---|---|
| | **Without optimization using ABC** | **With optimization using ABC** |
| Original Image | 0.7644 | 0.8589 |
| Watermark Image 1 | 0.8492 | 0.8856 |
| Watermark Image 2 | 0.7658 | 0.8245 |
| Watermark Image 3 | 0.9305 | 0.9457 |
| Watermark Image 4 | 0.7218 | 0.8509 |

**Table 4:** Performance metrics of applying different types of attacks

| **Attacks** | **Performance Metrics** | | |
|---|---|---|---|
| | **Mean SDME** | **Mean NC** | **Mean PSNR** |
| Intensity Attack Range 25 | 0.8487 | 0.9421 | 32.1264 |
| Intensity Attack Range 50 | 0.8247 | 0.9296 | 30.3454 |
| Salt and pepper noise at the variance of 0.02 | 0.8506 | 0.9581 | 32.786 |
| Salt and pepper noise at the variance of 0.02 | 0.8321 | 0.9406 | 31.324 |
| Geometric Attack Range 0.2 | 0.8402 | 0.9438 | 33.003 |
| Geometric Attack Range 0.5 | 0.8256 | 0.9299 | 31.945 |

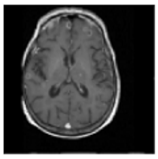
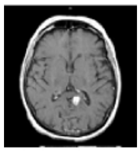
Table 4 shows the performance metrics of applying different types of attacks. Mean PSNR value represents the average PSNR values of the original and the four watermark images. Mean NC value represents the average NC values of the original and the four watermark images. Mean SDME value represents the average SDME values of the original and the four watermark images. Table 5 shows the DCT coefficients of the retrieved watermark images.

**Table 5:** DCT coefficients of the retrieved watermark images in Neural Network

| Retrieved Watermark Images | DCT Coefficients Values |
|---|---|
| Watermark Image 1 | 0.2351 |
| Watermark Image 2 | 0.5378 |
| Watermark Image 3 | 0.3303 |
| Watermark Image 4 | 0.3582 |

Table 6 represents the resistiveness analysis of multiple watermarking strength using feed forward back propagation neural network. For this process, the watermarked image can be divided in to 4 blocks such as 2 equal sized blocks horizontally and 2 equal sized blocks vertically. These 4 blocks are represented as position 1, 2, 3 and 4 respectively. By this process we can identify which block or position has high resistiveness while watermarking through open network. These image blocks and its corresponding retrieved watermarks are given as the input for ANN to identify the resistiveness.

**Table 6:** Resistiveness analysis using neural network

| **Watermark images** |  |  |  |  |
|---|---|---|---|---|
| **Position 1** | Non Resistive | Non Resistive | Non Resistive | Non Resistive |
| **Position 2** | Resistive | Non Resistive | Resistive | Resistive |
| **Position 3** | Resistive | Resistive | Non Resistive | Resistive |
| **Position 4** | Non Resistive | Non Resistive | Non Resistive | Resistive |

### *4.2 Comparison to existing Method*

From Figure 9 it is clear that the performance of our proposed method was higher when compared to the existing method [14].

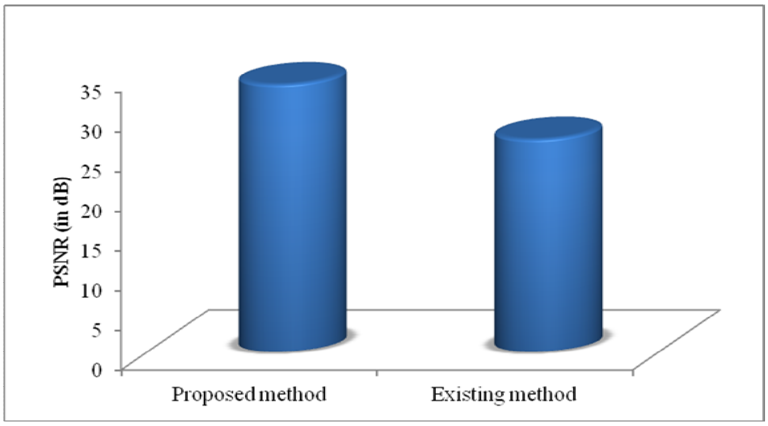



**Fig 9:** Comparison graph of proposed method and existing method

**Table 7: Comparison during attacks**

| Attacks | Proposed Method | Existing Method [19] |
|---|---|---|
| Crop | 0.8701 | 0.8465 |
| Histogram Equalization | 0.8995 | 0.8852 |

The proposed methodology performance is compared with the existing method [19]. The robustness of the watermarking scheme is analyzed based on two different attacks such as image cropping and histogram equalization. The values are listed in Table 7, it is evident that the robustness performance of our proposed method is superior to existing method.

### *4.3 Application Proof*

The confidentiality and security can be achieved using medical image watermarking. The patients report can be hidden inside the medical image without being seen by unauthorized persons. The watermarking can prevent the patient's information and images from being tampered. A medical image contains Region of interest (ROI) along with Region of non interest (RONI). ROI is sensitive region regarding medical image using which in turn doctors perform exact medical diagnosis and decide treatment as a result. Utilization of classical watermarking techniques may build the distortion within ROI along with consequently your diagnosis benefit of image may become lost. Therefore, only RONI needs to be used intended for watermark embedding. The actual ROI of image may be selected interactively through medical image. Excluding this kind of selected location, the watermark is embedded. The physician can utilize different options to decide on ROI interactively. As a result, ROI along with RONI regarding image must be separated prior to watermark embedding. The actual watermark is embedded using pixels regarding RONI along with watermarked image is built.

## 5 Conclusion

Multiple image watermarking was done by using ABC based Hybrid DWT-SVD and artificial neural network. The approximation matrix of image in DWT domain was modified with SVD in order to embed the singular value of watermark to the singular value of DWT coefficient. The proposed embedding and extracting method ABC based hybrid DWT-SVD watermarking is employed to avoid watermark exposure. In embedding process, multiple watermarks were fused using a fusing technique in to a single watermark and was embedded and then the single watermark was extracted from the watermarked images. From the fused single watermark, multiple watermarks were extracted is the extraction process. Then the watermarking strength was analysed using artificial neural network. The quality was assured using the quality metrics such as PSNR, NC and SDME. Our proposed method has achieved better performance metrics values. It is higher when compared to the existing method. Thus the performance measures calculation showed that our proposed method is efficient.

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**Mohananthini Natarajan** received her B.E. (Electrical and Electronics) Degree from Annai Mathammal Sheela Engineering College, Namakkal, Tamil Nadu, India in 2007. She received her M.E. (Applied Electronics) Degree from Anna University, Chennai, Tamil Nadu, India in 2009. She has published technical papers in national and international conferences and journals. Her current research areas are digital image processing, information security and optimization.

**Yamuna Govindarajan** received her B.E. (Electronics and Communication) Degree from the Regional Engineering College, Trichy, Tamil Nadu, India in 1987. She received her M.E. (Power Systems) Degree from Annamalai University in the year 1991. She received her Ph.D Degree in Electrical Engineering from the Annamalai University in the year 2010. She has published many technical papers in national and international conferences and journals. Currently, she is working as Professor in the Department of Electrical Engineering, Annamalai University, Tamil Nadu, India. Her areas of interest are digital signal processing, digital image processing and information security.