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INVESTIGATION OF HYBRID TRANSFORM FOR BIOMEDICAL IMAGE WATERMATKING AND EXTRACTION USING FAST ICA

CT-SVD based Image watermarking

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Abstract : This work reveals the application of beyond 5th generation communication for e – health care image watermarking. Now a day there is a lack in multimedia image processing over the communication protocols due to its data security, speed of propagation. For data security, healthcare images are encrypted as a watermarking mechanism and data transfer rate is effectively achieved by incorporating proper network protocol. By comparing with other ideas this work aims with discretized images construction and then expand its studies for the continuous spectrum analysis. The work starts from encryption of e- healthcare data's by using contourlet Transform with Singular Value Decomposition technique, following the encryption of data, the embedded images are transformed through suitable communication network. By using webcrawler.com patients medical data such as CT, Ultrasound, MRI, retina,and mamography's of different size of pixels are examined, also watermark image of size 64x64 size is used for embedding purpose. Artificial Bee colony methods are applied for fitness selection among the population and hence the later solution is found to be fit among the search area. The extraction of watermark is performed using Fast ICA which has a special characteristics that it does not need the transforming process. Result indicates that the hybrid transform based on Artificial Bee colony algorithm for e- healthcare images is more robust against various kinds of attacks such as salt and pepper noise, median filtering and rotational attacks. Operating measurements such as PSNR and Normalized Correlation are also evaluated. Simulations are performed by using MATLAB software.

***IndexTerms*-Artificial bee colony, Contourlet, SVD, Fast-ICA,watermarking.**

I. INTRODUCTION

Now a days internet plays a vital role in day to day usage which is the sole responsible of interchanging customers data. Beyond this level of exchanging there is a tremendous chance of data reproduction without accessing the copyright. In order to protect data's from hacking community, data encryption and decryption with original key procedure has been introduced which is termed as watermarking algorithm. Watermarking follows the protocol of hiding digitalized data particularly e-healthcare data's into a digital text/video contents in order to safeguard the copyright data's and enhance the integrated solution. The main objectives of introducing watermarking technique is to reduce stakeholders/host/original image perceptibility, enhance more robust against various attacks, improve handling efficiency and protection. The technical term of watermarking is the steganography where the digital data's are hidden within the original data which may be image/video signal by interpreting visual tolerance of the host signal. Data hiding technique is best suitable for multitask applications (image, audio, video signal), normally the operation of watermarking is performed on three modes namely watermark creation, embedding of created objects with host data and decryption by using secret key. The different methods of watermarking encryption are partially based on Policy hidden, Universal based, Multi reason image, Square based outwardly disabled, Hyper-chaotic, Selective encryption technique with fragmentation and dispersion, Artificial Bee Colony based LSB etc.,

The selectivity of watermarking algorithm depends on the area of application's usually the subjective can be divided into 1. Protectivity (ie., to reach certain protection of data through the system integrity) and 2. Unsecured data storage(eg.,data base management system) also the subjective are achieved by finding without considering the basic properties of watermarking approaches namely Perception, Hiding strength, PSNR and Correlation index. Likewise, the detection of watermarking algorithm depends on Robustness, imperceptibility, error occurance factor etc., Without considering these properties and implementation area different studies are carried and evaluated by the researchers. There is a numerous vulnerable of data getting malfunctioned by the internet hackers if the watermarking properties are not followed stringently also the data get misused if the suitable algorithm is not

applied. Highly embedding duration of watermarking is suitable for highly encrypted data's and high visual similarities. Security error and problem in reliability arises if the collision resistance properties is not followed in watermarking.

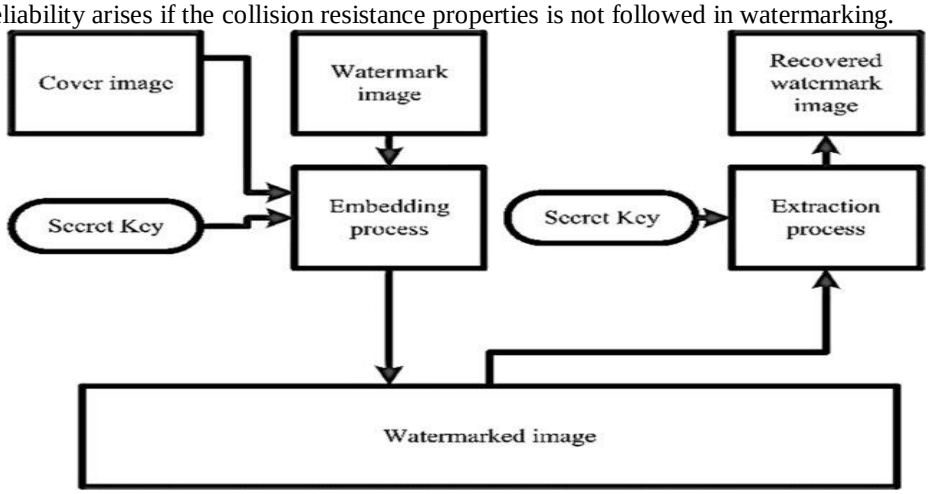


Figure 1BLOCK DIAGRAM OF WATERMARKING

The schematic development of watermarking as shown in Figure1 involves mathematical manipulations and sequential activity prediction. In this process the sequential activity determines the objective and properties of watermarking scheme depends upon the application scenarios. Systematic approach of watermarking has enormous advantages such as 1. Ability to produce rigid data of watermarked images 2. To find the ambiguity and irrelevant mapping of images 3. Provide digitalized data for analysis.

Enormous data's produced by e-healthcare system are transferred and utilizing such data brings impressible task of decision making, copyright regulations. Now-a-day's Communication of patient's historical data's through the available network protocol meet a major obstacles due to lack of security. In this paper use of Artificial Bee Colony Algorithm for watermark embedding and extraction using ICA is performed, the overall communication is done through B5G network. Thus the watermarked e-healthcare image will be shared through B5G/6G network and subsequently these shared images are stored in cloud computing server. Researchers studied many works dealing for image embedding recently, we introduce Artificial Bee Colony Algorithm over 6G communication network.

The important theme of this work are as follows

1.To develop the watermarking image using Contourlet transform-SVD.

2. Using Artificial Bee Colony (ABC) algorithm for fitness selection among set of population.

3. ICAML is used to decrypt the relevant data with the proper key handling.

4. Overall communications is performed through regulated network.

The overall paper categorized in the following manner. A literature review is elaborated in section-2. Section-3 depicts the watermarking scheme implemented using contourlet Transform.Section-4 explain the operation of Singular value decomposition. Section-5 detailed the workflow of Artificial Bee Colony Algorithm,section-6 illustrates the operation of watermark extraction using Fast- independent component analysis.Section-7 is framed for results obtained and comparison with other technique.

II. LITERATURE REVIEW

Recently there are n-number of digitalized images/videos are shared through communication network. Digital images hold the presence of its importance in all field such as biomedical, farming solutions, space technologies, Automobiles, Telemetry etc., Biological images reveals most of the important data's pertaining to patient health history which is very sensitive to the individuals are patient privacy data due to the rapid development of internet technology these secret data's can be hacked by the unknown person without having access permission. In order to protect the data's from various attacks different algorithm for watermarking is carried out by the researchers.

In 2020 Guozheng wu etal., examines the deep learning based image encryption and decryption network for Internet of Medical Things.Yi Ding, approaches the technique namely Cycle Generative Adversal Network(CGAN) for the leaning iterations to transfer the sensitive medical images from its host to the receiver area.

In 2019 Jianwei Feng etal., pointed out the importance of novel deep learning algorithm for sensing human activity and localized task management using wi-fi CIS. Also Wang designed a graphics processing unit(GPU) based homomorphism for encrypting the images to obtain rapid results. In 2021 XiataoYang etal., propose the data privacy preservation and integrity verification based on multi keyword searchable technique. For e-healthcare multimedia images, it develops a secret key.In 2020 Haded etal.,suggested the joint watermarking-encryption-compression scheme for protection of biomedical images.It illustrates without the need of decryption or decompressing the method have its ability to grant access to image watermarking includes encrypted and compressed nature. In 2020 Han Qiu etal., develops a selective encryption algorithm merged with fragmentation and dispersion method for protecting the multimedia data security and copyright ownership when both clouds server and secret keys are known. He suggested the user-centered design for controlling cloud based data access. In 2019 Jiang etal.,introduce homomorphic encryption(SHE) for single instructions multiple data with fewer overheads for encryption. In 2022 Arpit Jain eta., outlined the multimedia image watermarking over G network for securing the sensitive data. In 2009 Khaled Loukhaoukha and Jean-Yuves chorinard suggested the importance of singular value decomposition and lifting wavelet transform for image hiding techniques. In this research work the transformation of image is performed using 2level lifting wavelet transform selecting the subband signal and reverse lifting wavelet transform is applied. Singular value estimation is deployed during embedding process finally the images reconstructed. In 2012 Sushma G.Kijgir and Manesh Kokre illustrates the lifting wavelet transform and singular value decomposition for image hiding technique. In this work,energy of subband signal is compered to the calculated Q-value, if the corresponding energy is chosen for higher level in order to proceed embedding process. It has a merit over DWT .In 1998 Jain and Koch express the study of interest on the image watermarking extraction.In 2010 Liu and Zhao suggested video watermarking based on one dimensional discrete fourier transform and random transformations without altering spatial information of host data the algorithm produces the temporal data of the watermarked video information/sequence. Watermark data embedded in the host information is in the form of fence-shaped using

the random transform domain with highest temporal frequencies which is used for further analysis. The different locations of the video sequence has been adapted sequentially has improved the robustness and reliability of overall tecchniques. In 2015 saju etal, suggested Contourlet based image watermarking and decrypted the image using Independent Component Analysis, the result provides more robust and high similarity index against various attack.

III. CONTOURLET WAVELET TRANSFORM

The enhanced features of contourlet is derived from Discrete Wavelet Transform. DWT analysis component is written as

$A_i[m,n]=(A_i+1(m,n)*h[-m]) \downarrow 2$ (1)

$B_i[m,n]=[(A_i+1(m,n)*g[-m]) \downarrow 2$ (2)

Similarly synthesis component is written as

$A_i+1[m,n]=[(A(m,n) \uparrow *h[m]+(Bi(m,n) \uparrow 2)*g[m]]$ (3)

Where the symbol * represents convolution operator, $\downarrow 2$ and $\uparrow 2$ ilustrates the downward sampling and upward sampling which depends on the dimension of signal components, In (i) Ai explains approximation component and in (ii) Bi represents detail components. The main disadvantage occurred in discrete wavelet transform such as (i)smoothening of contour information (ii) Absence of detailed directional signals.

Contourlet Transform based image watermarking possess more robust and stable when compared to other transformation technique. It smoothens the edge of images and performs better noise reduction factor. Also singular value decomposition proves its performance in terms of stability and efficient against various watermarking attacks. Because of the factor that modification is singular values does not affect the image quality, SVD plays a vital role in image watermarking. In the proposed system e-healthcare image watermark embedding is performed using contourlet transform integrated with SVD. Watermarking is important role in the field of biotelemetry in order to authenticate patients historical data preserved in the storage device. The stored data during telemetry process undergoes several attacks performed by the digital hackers. In order to improve the watermarking robustness and visualization difficulties it is incorporates the essential of transformation process. In this paper contourlet transform is used for watermark embedding for copyright the telemetry images. In image processing the selection of contours and detailed information is derived by implementing the process of Contourlet Transform.

Contourlet Transform produces high quality images and also create the image in different ways/multipronged. With this nature, contourlet transform has the ability to derive the boundary/outline of the image and its detailed frequency component effectively. On comparing with other transformation process contourlet produce images with multiple scale in different direction using basis function. The process of contourlet transform is initiated by properly selecting the edge points and then choosing the edge points to create contour segment. There are two banking structures/filter used in contourlet transform as in fig.2 namely Laplacian Pyramidal banking filter and directional banking filter where LPBF is used for selecting the point discontinuities and DFB is used for converting point discontinuities into a linear component respectively. Hence the process named as contour.

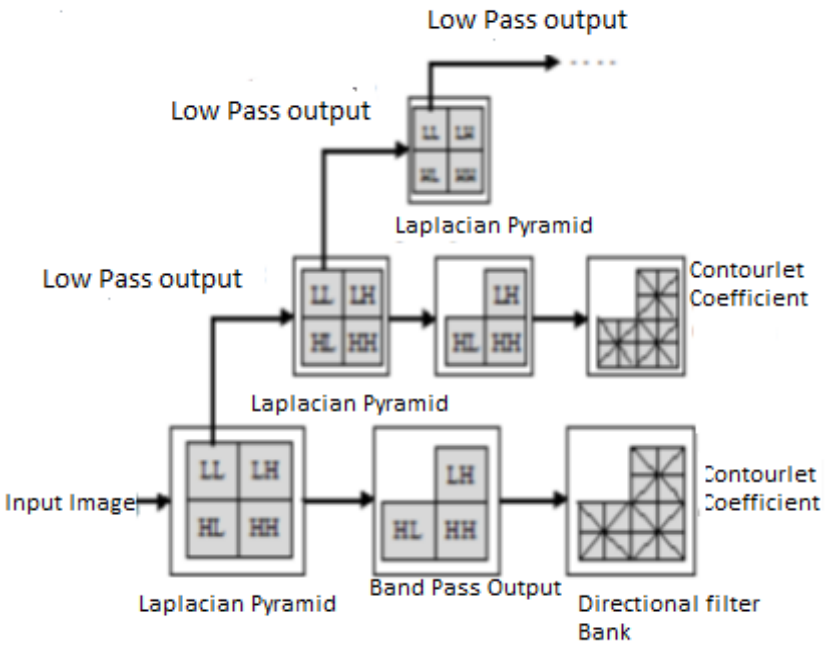


Figure 2 Contourlet Transform Decomposition

In this paper contourlet Transform is applied for embedding the watermark in a selected subband frequency with specified decomposition level. At the end user the embedded watermark issues validation of original image without any distortion introduced by various attacks. In this paper contourlet transform is used to improve imperceptibility and high PPI without altering the robustness. Due to recent development of digitalized system there is n-numbers of malicious attacks are possible to extract the secret message without ownership. Here various attacking scenarios such as salt and pepper, median filtering and rotational attacks are applied to the watermarked images and using contourlet transform the factor of robustness is examined. Examination validates the parameters of Similarity index, Normalized correlation, Bit Error Rate, Peak Signal to Noise Ratios are evaluated and compared with the DWT, CT, DWT-SVD algorithms.

IV. SINGULAR VALUE DECOMPOSITION

Before SVD in a linear algebra performs the objectives of factorizing the given image/signal component into three matrices components. By conversion SVD has the potential to deliver the dimensional and theoretical information of the signal in a linear transformation ie.,single energy is located from the mixture level, singular value decomposition produces more stable and robust for

dividing the image structure into a set of linear non dependent components,so each components have singular energy. Also SVD produces a minimum coefficient from a set of maximum energy signal.Beyond these conversion SVD is more suitable for image processing applications such as coding, enhancement and noise reduction. Image watermarking utilizes the advantages of singular value decomposition for hiding the contents in singular energy inspite change occurring in large set of signals. Singular value decomposition follows the step of finding out the eigen value decomposition.Let B be the matrix representing transformation matrix which performed with Y namely vector quantity to introduce a another vector quantity BY.$[B]_{ij}$ or bij represents the energy particles present in the matrix B with i^{th} row and j^{th} column.Suppose if B is nxp matrix vector and C is pxm matrix vector, the resultant output is BC which is nxm matrix vector represented as

$$[D]_{ij}=D_{ij}=\sum_{k=1}^{p} b_{ik}C_{kj} \quad (4)$$

For 2D space space the rotational vector matrix is

$$B=\begin{matrix} COS(\theta) & -\sin(\theta) \\ \sin(\theta) & -\cos(\theta) \end{matrix} \quad (5)$$

The above vector quantity in (iv) rotates the vector with respect to its origin by an angle(theta). For stretching of matrix in two dimensional quantity which is represented as,

$$C=\begin{matrix} L & 0 \\ 0 & 1 \end{matrix} \quad (6)$$

The above matrix stretching along the x-components by a factor L without altering Y-component. There is no change in its direction, only affects the magnitude. It also shows that all the vectors doesn't have this properties and the specialized vector quantity is termed as eigen vector of A and their associated scalar value λ is known as eigen value of given matrix A. Hence the product nxn of variable matrix is mentioned as in

$$Au= \lambda u \quad (7)$$

Where λ is known as scalar value. Which is termed as eigen value of A and u is the corresponding vector.

By the principle of singular value decomposition the actual matrix component is splited into three matrices.

U represents pxp orthogonal nature as in

$$U=[U_1\ U_2\ U_3\ldots\ldots\ldots\ldots U_{r+1}\ldots\ldots\ldots\ldots U_p] \quad (8)$$

Column vectors Ui for i-1,2……p for orthogonal form as in

$$U_i^t = \begin{cases} 1\ldots\ldots\ldots..i=j \\ 0\ldots\ldots\ldots..i\neq j \end{cases} \quad (9)$$

Matrix V represents qxq orthogonal matrix as

$$V=[V_1\ ,V_2\ ,V_3\ldots\ldots\ldots..V_r,V_{r+1}\ldots\ldots\ldots..V_q] \quad (10)$$

Column vectors Vi, for i=1,2……q form an orthogonal matrix.

By stretching eigen values concept, it reveals the foundation of singular value decomposition. Thus SVD diagonalized a single energy which is located in a singular values contains the overall detailed energy level of images. In linear algebra, SVD achieves best stability and energy efficiency for dividing the sets of image signals into linear isolated components, each components representing its energy level ie., SVD compress maximum energy signal into a minimal energy signal/coefficients. Because of its energy conversion property SVD is most suitable for image processing applications such as image compression, feature extraction, filtering and coding. In case of image watermarking singular value decomposition is applied to hide the images effectively since the watermark image was destroyed if it is available in large values. As stated above, SVD converts the actual matrix M into three matrices.

From the equation of vector Vi for i=1,2….q form an orthogonal set.

$$v_i^t V = \begin{matrix} 1\ldots\ldots\ldots..i=j \\ 0\cdots\cdots\cdots..i\neq j \end{matrix} \quad (11)$$

S is an pxq diagonal matrix with singular values (SV) on the diagonal. The matrix S can be shown as follows

$$S=\begin{matrix} \sigma_1 & 0\ldots\ldots\ldots0 & 0\ldots.. & 0 \\ 0 & \sigma_2\ldots\ldots\ldots0 & 0\ldots. & 0 \\ 0 & 0\ldots\ldots\ldots..\sigma_r & 0\ldots\ldots. & 0 \\ 0 & 0\ldots\ldots\ldots.. & 0\ldots & 0\ldots\ldots.0 \\ 0 & 0\ldots\ldots\ldots\ldots0 & \sigma_{r+1} & 0 \\ 0 & 0\ldots\ldots\ldots\ldots & 0\ldots\ldots & \sigma_q \end{matrix} \quad (12)$$

S=diagonal(σ_1, $\sigma_2\cdots\cdots\sigma_q$) satisfies $\sigma_1 \geq \sigma_2 \geq \cdots\cdots. \sigma_r \cdots\cdots.. \geq \sigma_q \geq 0$

From the above expression in (xii) it clearly denotes that the diagonal elements of S is the singular energy level of M, the column element in vector U is the left element of matrix M and column element of V is termed as right vectors of the matrix M.Each singular component indicating the light intensity or luminence of layer with a equivalent vectors representing the overall geometrical size.

In SVD process image compression does not happen inspite the detailed component of image is represnetd for the initial singular values. By proceeding the SVD there is an advantage of showing the image with reduced dissimilarities on comparing with the host image. SVD possess a specified features like energy deduction, least square algorithm, matrix inverse and multi variant progression.

Some of the SVD properties enhance with applications in watermaking are listed below

i. Large energy signals can be represented by a singular values
ii. More robust singular values even there is a alteration to the picture.
iii. High noise reduction ratios of singular values

4. **Artificial Bee colony Algorithm**

Artificial bee colony is based on the behavioral nature of honey bees. It classifies into three division namely employed bees, onlooker and Scout. In 2005 Dervis Karaboga illustrates the importance of artificial bee colony algorithm in coherent with honey bees character. Like particle swam optimization the algorithm uses control variables like the population size, number of iterations etc., ABC is an optimization technique that follows population based analysis where the single element is mentioned as localization that is perturbate by the bees with respective time based that found their sources of food with huge amount and finally

with greatest nectar, Karaboga illustrate the foraging properties of honey bees. The analogy of optimized problem is related to the food available in the localized are and the fitness outcome is related to the nectar quantity in the origin.

The process of ABC is achieved by employed bees, onlookers and scouts. In its operations half of the populations is covered by employed bees while the other half is maintained by onlookers. Assume the nectar amount of food origin is equal to the size of employed bees populations. After abandoning the random search is performed by the scouts which is the food origin. ABC offers high speed of operation and accuracy when compared to SIMPSA, NESIMPSA, GA, ANTS etc., ABC execution is too simple in comparison with available algorithm Zou et al.,in2011 illustrate the handling capacity of ABC for multi objective solution where all optimization solutions are food source, all bees are behave like onlooker bees, in absence of employed bees and scouts.

In the process of ABC optimization, there is an utilization of additional memory which store the past vector output obtained from the searching procedure. In each generations outer logged food origin is selected in a helter-skelter way continue with origin identification and determines the present origin. By the way of memory usage after finding the origin arbitrarily the best fit to the population is sorted out and stored.

For producing the new solution onlooker bees is initialized with proper learning iterations. All the bees selecting a vector of m-size without following the manner and choosing the best fit from the external memory. By using the below expression the best fit of the population is determined as .

$$V_{ij}=X_{ifm}+\Phi(m)(EA_{kfm}-X_{ifm}) \quad (13)$$

Where k represents the solution of index ie., k=(1,2…..p)

P denotes the number of solution available in the external memory.

F_m shows the permutation for the first integer population selected in a random manner 1:n and

f(m) indicates the element of xi to be iterated from the memory.

The searching potential of external memory is outlined by ΦIj generates the random number lies between (0 2) after obtaining the optimized solution for the problem, the best fitness parameter is identified. Then the greedy mechanism is selected to determine the best solutions to be entered in external archieve. After certain iterations the data storage in external memory has been reduced due to the continuous iterations of the problem, this effect has been reduced by using congesting distance. To identify the crowding distance sorting in ascending order of the population is follow. Usually the distance of crowd is mentioned as a algebraic sum of individual population distance to the respective objectives. Normalization is performed for the objectives in prior to determine the crowding distance.

Some of the formulas to be used in ABC algorithm is as follows:

The best food source is computed by using the fitness functions Fitness=MSE

After executing the fitness value the iteration is said to be 1.

Following the best food origin employed bee phase will start.

Optimized source of food is obtained by employed bee as follows:

$$S_{ij(new)}=S_{ij}+\Upsilon(S_{ij}-S_{kj}) \quad (14)$$

S_{ij} indicates the j-th fitness of i-th iteration.

S_{ij}(new) optimized solution for S_{ij}

S_{kj} denotes the adjacent bee of S_{ij}

Υrepresents the integer [-1 1].

From the optimized source of food,the better fit is chosen the greedy process as

$$P_i=\left(\frac{Fitness-i}{\sum_{n=1}^{N}(\text{fitness})}\right) \quad (15)$$

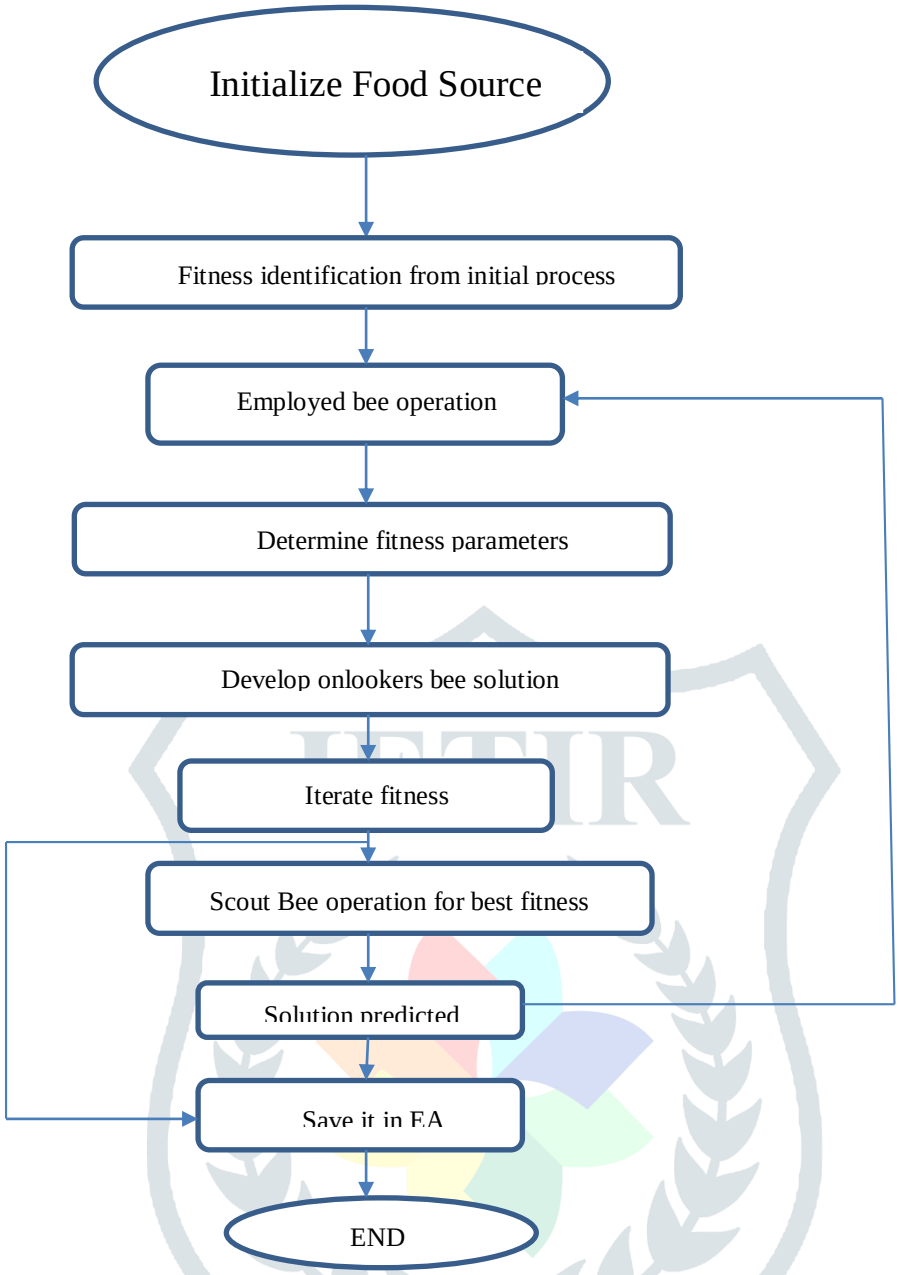


Figure.4 Flow chart for ABC algorithm

5.FAST ICA

Blind source separation is well performed by using Fast ICA.It has the ability to remove the independent source of signals from the linear combination of independent signals.Let $S_1,S_2……S_n$ be the independent signal of n-components and their corresponding mixture component is given by $x_1,x_2……x_n$

To represent vector notation the above equation is given by

$$x\text{-}As \tag{16}$$

where A represents square matrix of size nxn mixing components.The process of separating individual components or otherwods unmixing matrix is determined by calculating the weighing matrix W which is defined as the reciprocal of the matrix A and is given by

$$S=Wx \tag{17}$$

The algorithm of fast ICA has been extended to different process such as sensor dominant, Source dominant,wit additive noise,complex variant and mixed components,convoluted signals etc.,The implementation of ICA plays a major impact on signal processing,Image processing,audio/speech processing,Image authentication and telecommunication.Orthonormalization is performed in each step symmetrically with the detemintion of unmixed components in parallel.The weighing matrix is executed by using the formulae

$$W^{+}=g(wz)Z^{T}\text{-}diag(g^{'}(wz)1_N]w \tag{18}$$
$$W=(w^{+}w^{+T})^{-0.5}w^{+}$$

The iteration will stop till it converge.

ie., $1\text{-}min(abs(diag(W^{T}W_{o1d})))<€$ (19)

Where € is a constant.

The above iteration leads to the constant value which is the unit matrix mentioned as $W^{SYM}(Z)$.

To achieve similar image restoration fast ICA will achieve its convergence at a low level of iterations.The speed of convergence depends on model size, rule followed and on the data length.One or more mixed components say (U_k,U_l) are very near to

$(U_k + U_l)/\sqrt{2}$ and $(U_k - U_l)/\sqrt{2}$ (20)

In this case U_k and U_l represents the desired solution.In between two operatimized solution the saddle point is located which differs in their order

$\hat{U}k' = \frac{\hat{U}k + \hat{U}l}{\sqrt{2}}$ and $\hat{U}l' = \frac{\hat{U}k - \hat{U}l}{\sqrt{2}}$ respectively.

.

So, $\hat{U}k' and\ \hat{U}l$ representing the approximate value.

The optimized solution is chosed by maximizing the Fast ICA symmetrically criterian in the initialization Process.

$C(\widehat{Uk,Ul})=[G(\hat{U}_k^T)1_{N/N-G}]^2 +[G(\hat{U}_l^T)1_{N/N-G}]^2$ (21)

In the above expression G_o=E[G(ε)]

ε is a standard normal random variable

In case of non linearity "tanh" so,G(x)=logcosh(x) and G_o=0.3746

One or two additional iterations are needed if the saddle point test is showing as positive.

The separation quality of Fast ICA is specified by identifying the dependent k^{th} signal from the presence of I signal.This identification ability of Fast ICA is possible if the known sources are available due to the probability of iteration the obtained sources are arranged in sorted manner so as to fit with the original source signal. The obtained sources can be represented as

$$\hat{U} = \widehat{W}(z) * Z$$
$$= \widehat{W}(z)\hat{C}^{-1/2}AD^{1/2}U$$
$$=GU \quad (22)$$

Where $G=\widehat{W}(z)\hat{C}^{-1/2}AD^{1/2}$ and $\widehat{W}(z)$ represents $\widehat{W}(z)U(Z) or\ \widehat{W}^{SYM}(Z)$ also G shows the matrix of independent component if A=D=I Then it is known as gain matrix.

The similarity Index reflection of k^{th} signal is represented as follows

$SIR_k = \frac{E[Gkk2]}{E[\sum_{k=1}^{d} Gik2]}$ (23)

With reference to the orthogonal matrix of decorrelated signal the obtained estimator signal ($\hat{U}$) may vary, this is due to the reason that the recursion that guides the algorithm will follow the ralationshipequivalent to Z,W^+, and W replacing by QZ,W^+Z^+ respectively where Q mentions arbitrary unit matrix. Then its output is given by

$\hat{U}=W*Z$

$=WQ^{-1}QZ$ (24)

Because of the above reason the gain matrix G and its similarity index reflections are independent component of matrix A. From the view of above discussion of equivalent property, the recursion of decorrelated data can be represented as

$Z=R^{-1/2}U$ (25)

Here $R=\frac{1}{N}UU^T$ and hence the gain matrix is given by

$G=\widehat{W}(z)R^{-1/2}$ (26)

From the equation it is clearly shows that the gain matrix and SIR is dependent on the signal U.

6. Results and Discussion

The proposed CT-SVD image watermarking is applied on CT, Ultrasound, Magnetic Resonance Imaging, Opthalmascope, Mamography images of size 736*749,1024x768, 1600x954, 651x509, 1000x749 respectively based on the selection criteria of Artificial Bee Colony optimization(ABC) illustrated in the corresponding chapter. Contourlet-SVD procedure is applied for embedding the watermark for copyright protection which is illustrated in chapter 3 and chapter 4.A watermark image of size 128x128 namely a hand signal is used to embed with the original image. Table-1 illustrates the effect of indexing factor on the selected images,in this work the indexing value of 0.3 is optimized to obtained proper embedding. The normalized correlation was computed after applying the attack for retrieved data's. A few example of retrieved watermarks and their corresponding NC's are shown in the figure. This proposed scheme are not disturbed by an external hackers during transmission through communication network. Depending on the selection of coefficient the effect of tampering and cropping does not have impact on the watermarking image. CT-SVD based watermarking images have more robust if median filtering attacks are made.

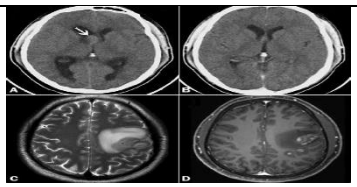
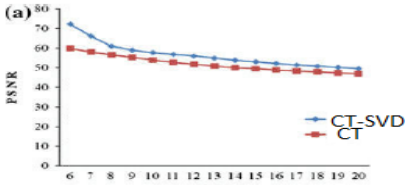
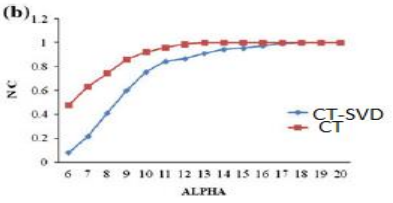
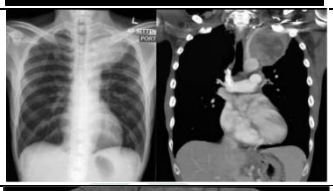
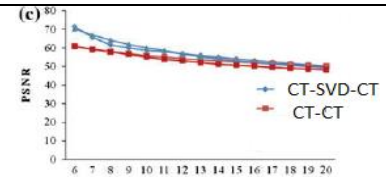
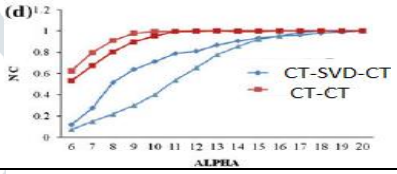
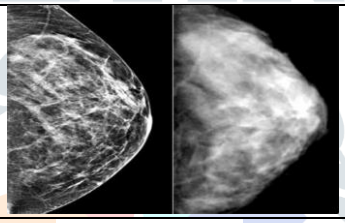
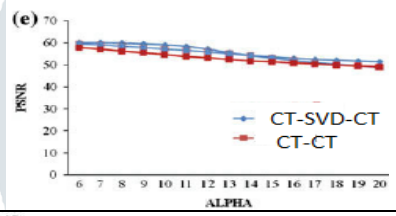
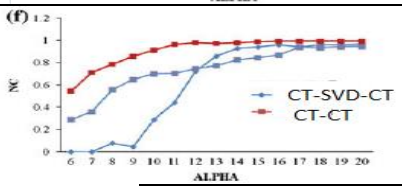
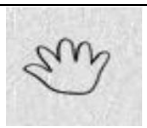
SOURCE	IMAGE SIZE	IMAGE	EFFECT ON PERCEPTIBILTY AND ROBUSTNESS
COMPUTER TOMOGRAPHY	736*749		
ULTRASOUND	1024*768		
MAGNETIC RESONANCE IMAGING	1600*954		
OPTHALMASCOPE	651*509		
MAMOGRAPHY	1000*749		
WATERMARK	128x128		

Table 1Performance evaluation of a watermarking

Parameters	CT-SVD	CT
RETRIEVD WATERMARK ALPHA PSNR NC	 20 50.6 1	 18 51 1
RETRIEVD WATERMARK ALPHA PSNR NC	 22 51.4 1	 16 54.8 1
RETRIEVD WATERMARK ALPHA PSNR NC	 24 51.66 0.99	 17 54.1 1
RETRIEVD WATERMARK ALPHA PSNR	 20	 16

NC	50.5 0.97	53 0.99

Table.2 Robustness Attack

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