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Article

REVIEW OF BLOCK CHAIN MEDICAL IMAGE WATERMARKING APPROACHES: CASE STUDY DWT-SVD

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Abstract: - The exponential growth of medical imaging data necessitates the employment of data authentication techniques like watermarking and security algorithms. The fundamental overview of safe picture watermarking techniques is covered in this paper. Primarily based on wavelet domain, the singular value decomposition (SVD), the edge detection, as well as Block Chain (BC) based security. The paper's first contribution is an extensive analysis of medical image security methods based on edge detection (ED), Discrete Wavelet Transform (DWT), and associated singular values decompositions (SVD), as well as BC assisted security. For more resilience, the system diagram is described utilising BC-based watermarking. The purpose of this paper was to recognise recent challenges and future opportunities for researchers. The case study of the DWT-SVD based watermarking is presented at the end and performance is evaluated for different combinations of the watermark logos and the database images also considering the digital signature for multi-layer security framework. The RGB-DWT-SVD is evaluated for the various parametric cases with logo and signature embedding using Peak Signal-to-Noise Ratio (PSNR), mean brightness difference, and entropy variations. Various future design issues are highlighted based on evaluation and case study.
Keywords: Block Chain, Edge Detection, Encryption, Image Watermarking, SVD, Wavelet Transform,

1. Introduction

There was a significant amount of medical imaging information gathered throughout the COVID-19 and post pandemic. A secure and trustworthy technique needs to be created to safeguard their confidentiality and authenticate access to the right patient imagery database information. Given the number of false details and mis-understanding data may have chance of wrong diagnosis and a serious crime [1]. The technique of BC seems to represent an enormous amount of potential for protecting image data. The BC-based approach is reliable since resources are scarce [2]. A typical picture security method is the use of embedded watermarks. Medical watermarking is used to protect the validity of a patient's diagnostic data in addition to the current copyright. Utilising the limited ability of human vision to distinguish between different colours, watermarking technique is used. The person looking at the image is unconscious of a change in an image's medical properties since the eye corrects small deviations in those parameters instantly, making a watermark invisible. This study aims to develop a reliable watermarking method using BC safe encryption standards. There are many justifications for researching digital image watermarking.

Paper has aimed to identify the primary motivating factors underlying for watermarking recommendations for medical images. Medical imaging investigations are expanding at an exponential rate, necessitating the use of security measures and data authentication methods like watermarking. The watermark must be resistant to a variety of attacks, which includes as duplication, cropping, as well as noise. Because of this, it is still possible to improve security and effectiveness by making current watermarking methods even more effective. Due to the availability of reasonably priced medical imaging devices, such as mobile cameras, the use of digital imagery has expanded substantially. The security of 2D data must therefore be improved.

This is the right time to research on highly secure and ease of implement watermarking method which may take less memory requirement. The aim of paper is to identify the pro and cons of such methods for future researchers.

Contributions: There is wide range of image security methods available in literature. The initial contribution of paper is to present the extended review of the medical image security methods based on edge detection (ED), DWT, and SVD along with BC aided security. The system diagram is described using BC based watermarking for more robustness. Paper aimed to recognize the challenges and future scope for the researchers in recent times. The major contribution of paper is to present the comparative validation and case study of the DWT-SVD based watermarking methods using various combinations of watermark and the digital signatures based multilayer security. The performance is also compared with DWT-ED based approaches. Specific Magnetic Resonance Imaging (MRI), CT scan data is considered for the case study implementation. The fundamental block diagram of watermarking approaches at the transmitting ends is shown in the **Figure 1**. Several transformations are utilized to increase the resilience of the watermarking techniques, and different watermark insertion rules have already been created.

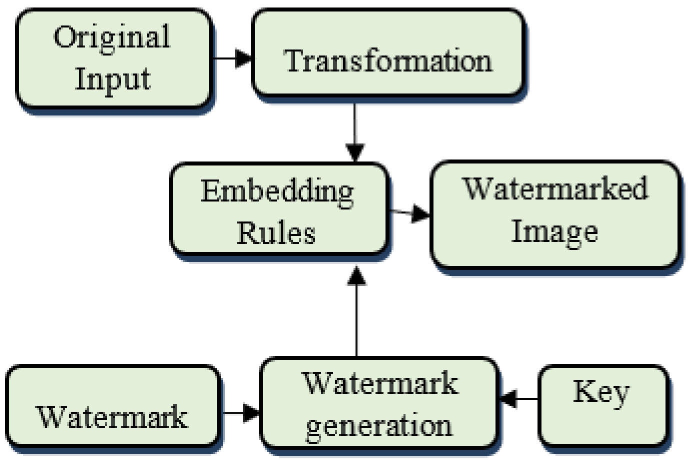


Fig. 1 Techniques for Basic Watermarking at Transmitter

Grouping of watermarking techniques as hidden watermarking provides data to audio, image, and video as digital data that cannot be recognised as anything else, although it is possible to find the concealed information. Typically, the data includes text or a logo that identifies the media's owner. A major use of invisible watermarking is in copyright protection systems, which are intended to stop or detect unauthorised copying of digital media. Several watermarking approaches have been introduced in the past to build a strong watermark. Invisible watermarking can be produced using magic morph and spatial domain techniques. **Figure 2** presents a general taxonomy of image security-based techniques.

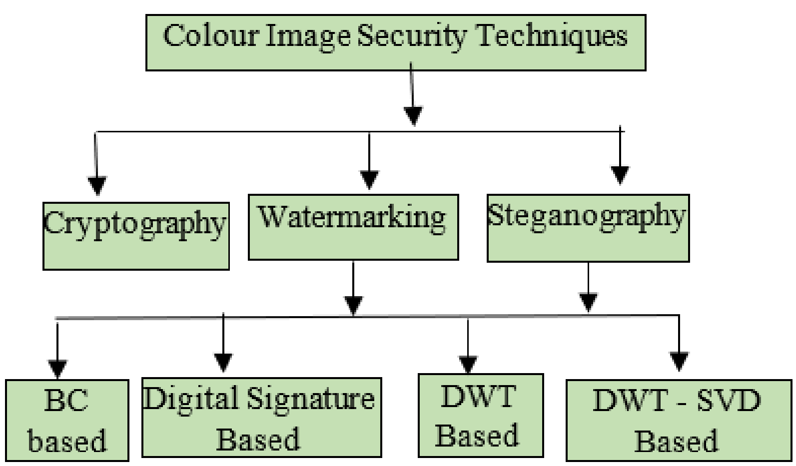


Fig. 2 Detailed classification of watermarking-based image security methods

2. Review of Related Works

Many watermarking methods were designed by the researchers. Every researcher tries to either improve the invisibility or robustness of the watermarking methods. This paper has presented the review of watermarking in three phases. Initially the ED based invisible watermarking approaches are reviewed. Since the accuracy and invisibility of watermark is sensitive to the high frequency features thus may have significant impact under noise. In the second pass the methods of BC based security for improving watermarking robustness are reviewed. The third and final phase extended survey of recent DWT-SVD based watermarking approaches are reviewed also considering optimization and security concerns.

2.1 Review of ED Watermarking

The gradient is given as a vector with a specific direction and magnitude that can be expressed mathematically as.

$$\nabla f = \left[\frac{\partial f}{\partial x}\ \frac{\partial f}{\partial y}\right] \quad magn(\nabla f) = \sqrt{\left[\frac{\partial f}{\partial x}\right]^2 + \left[\frac{\partial f}{\partial y}\right]^2} = \sqrt{{M_x}^2 + {M_y}^2} \qquad (1)$$

$$dir(\nabla f) = \left(\frac{M_x}{M_y}\right) \qquad (2)$$

There is two popular gradient based ED masks widely used as Prewitt and Sobel. Two basic components are measured by the Prewitt operator. Kernel Kx calculates the vertical edge component, while kernel Ky calculates the horizontal edge component. The expression |Kx|+|Ky| indicate the gradient's intensity in the current pixel.

$$K_x = [-1\ \ 0\ \ 1\ -1\ \ 0\ \ 1\ -1\ \ 0\ \ 1\,] \qquad (3)$$

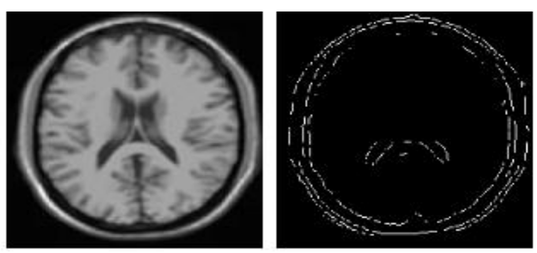
$$K_y = [\ 1\ \ 1\ \ 1\ \ 0\ \ 0\ \ 0\ -1\ -1\ -1\,] \qquad (4)$$

-1	-2	-1
0	0	0
1	2	1

X Gradients

-1	0	1
-2	0	2
-1	0	1

Y Gradients



a)Sobel mask gradients b) edge determination example

Fig. 3 An example of the Sobel mask and image edge determinatio

The Sobel based edge detector is essentially a negligible amount difference filter that averages the image in a direction perpendicular to the differentiation when the coefficients are odd. Sobel mask or detectors are similar to the Prewitt boundary detector, with the exception that the baseline operator is like a Gaussian, making it better at removing white noise Equation.4's simple gradient-based edge detection technique is described in detail. Finite differences can be used to approximate the gradient as follows: Ellinas et al. [1] employed edge detection and a watermarking technique to insert watermark data into selected groups of DWT coefficients. The contrast sensitivity function (CSF) of the DWT sub-band corresponding to edge coefficients was used to weight the watermark strength. They proposed DWT-based edge detection for watermarking and used the contrast sensitivity function to insert the watermark.

An imperceptible Healthcare Image Watermarking Architecture for Computerized Diagnostics of Retinal Pathologies inside of an eHealth Environment has been presented by B. Hassan et al [2]. Earlier Apeksha et.al [3] stated that goal of color watermarking is to assure data protection and imaging study verification. Watermarking technology takes use of human eye's limited ability to identify discrepancies. Because eye automatically corrects minor color changes in image. In order to provide invisibility, edge detection is commonly employed in watermarking methods. A robust watermarking technique based on wavelet-based edge detection was presented by John N. Ellinas et al. [1]. To determine the edge of a two-level DWT image, a Soble edge detection mask is utilized. On the detected edge picture, morphological dilation is performed with a 3x3 structuring mask, and then zero mean Gaussian noise is added as a watermark sequence.

Nilesh Rathi et al. [4] placed the watermark in the Discrete Hartley Transform (DHT) domain or the Discrete Cosine Transform (DCT) domain. The watermark is placed invisibly into the blocks of the original image, block by block. For robustness, the embedding technique employs block-based edge detection.

Surya Pratap Singh et al. [5] has presented the hybrid combination of DCT-DWT based watermarking. The watermark is embedded in the DCT transform domain and is expected to be robust. But method is useful for colour images.

Edge coefficients are formed after detecting the edges using Sobel edge detection by Ramanand et al. [6]. The distortions in the watermarked image are less noticeable in ED domain. Still there is scope to improve the robustness of the watermarking algorithm to make the watermark more secure.

2.2 Review of Block chain

Basically, the block chain is used after the watermarked images to secure the image against various attacks. The SHA 256 based encryption is used for securing the sequence of the blocks in shuffled form. The basic BC based system for watermarking is shown in **Figure 4**. Watermark is embedded in the image first and then BC based security is applied in encrypted form for robustness.

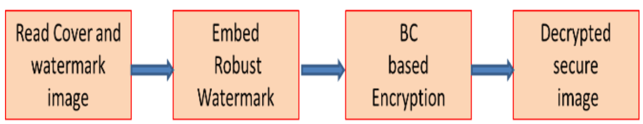


Fig. 4 system diagram of the BC based security framework

Block chain (BC) watermarking has indeed developed as a current safety trend to increase the reliability of encryption protocols [3]. The genesis blocks containing K bits are utilised in BC-based watermarking effective embedding units. They ought to be stronger and more secure like a consequence. The advantages of block chain with watermarking are combined in this work using DWT domains watermarking. Block chain has been employed in the banking and security sectors in recent years. R. Latypov et al. developed a new sort of watermark for graphic black and white papers. The use of a watermark in a document reduces document distortion. The watermarking adds another layer of security to BC database records comprising document scans [7]. I. B. Senkyire and Q.-A Kester suggest that forensic crime scene images be validated using watermarking and cryptographic BC [8].

The watermarking methodology, created by Mannepalli et al. [9] combines a BC and ED-DWT centred watermarking. The embedding technique for the medical photos has been created. However, there is a good likelihood of enhancing performance when it's under attack. Additionally, the reconstruction of an image's back has not been included. The framework can be expanded to include colour watermarking since Praveen only evaluated medical data in grey scale. There has been a considerable improvement in noise attack performance.

B Wang et al proposed to overcome the BC data expansion challenge, this framework integrates BC and zero-watermark technologies and employs an interplanetary file system. In addition, the image owner can authenticate the image and determine its copyright traceability [10]. Digital watermarking techniques and strategies have been covered by Raniyah Wazirali et al. in their work from 2021. Prerequisites and challenges for watermarking are also described in detail. The common architecture of the watermarking platform is also described in detail [11]. The strategy encounters a problem, though, because there are no trustworthy outside sources. Developing efficient reliable Blockchain Driven colour image watermarking employing DWT as well as local Features was addressed by Abhishek Tiwari et al. [12].

A perception hashing with block chain-(BC) based digital-copyright system was proposed by M. Zhaoxiong et al. [13]. Another method used to prepare the data is a convolution neural network (CNN). T. Jappie et al has goal of the research presented in this paper is to look at a different approach for returning data ownership and control to the rightful owners. The genuine owner will be able to ensure ownership and control of personal information. This new strategy will be to combine the Block chain-based technology along with Smart Contracts [14].

Zhaofeng, M. et al have demonstrated the DRM-Chain based on the BC for image security using the DCT and Human visual systems [15]. Although method is secure and robust, but overall, it seems computationally complex to implement on colour images. In recent years BC is widely used for securing crypto currency in banking sectors. Finally, the use of blockchain-based reversible watermarking scheme based on the application of integer wavelet transforms was introduced by A. Dey et al. [26].

2.3 Review of DWT-SVD based methods

Addanki et al. has developed an image watermarking method that uses digital signatures to use the YCbCR space as well as the DWT-SVD domain [16]. A host-coloured images was initially translated to YUV colour system by Y. He. et al. for watermarking [17]. The brightness component Y is then exposed to a DWT decompositions layer. The low frequency bands are then divided into blocks using a discrete cosine transform (DCT)), as well as SVD is carried out on every block. DCT-based watermarking techniques are more cumbersome.

Assini et al. [18] described a reliable watermarking technique that combines discrete wavelet transform (DWT), discrete cosine transform (DCT), and SVD in an effort to increase the security of medical images. This method aims to add a transparent picture watermark on a medical image. The third level of DWT coefficients are applied to the cover medical image, which is subsequently converted using DCT and SVD.

Pal et al. [19] investigated how support Vectors machines (SVM) along with Lifting Wavelet Transform (LWT), both methods were used for digital image watermarking upon medical images can be combined to provide a successful authentication framework. In this article, they first use SVM to distinguish the region of interest (ROI) against the Non-Region of the Interest (NROI) in the medical image. The NROI portion of the medical photo (Cover Image) is then provided with a watermark using LWT.

Thakkar et al. [20] suggested a blind image watermarking technique utilising (DWT) and (SVD). The ROI (region of importance) from a medical image is treated to DWT using this approach in order to get multiple frequency subsection bands for wavelet decomposition. The local features are used for watermarking. Zermi, N. et al [21] have exhibited a novel method in which the image is appropriately decomposed using DWT, allowing for very good correction during insertion. The three sub bands, LL, LH, and HL, are next subjected to an SVD that ought to permit for a preservation of the maximum energy of the used image while maintaining a stipulated minimum for singular values. Alshanbari S et al. [22] combined the concept of repetitive watermarking with the host image, and the suggested work focuses on further enhancing medical image watermarking. The principles components (PC)-are based on placement protects the system against ownership attacks. Fragile watermarking centred on LZW (Lemuel-Ziv-Welch) is used to disguise the ROI (region of interest) of images compressed to protect against purposeful tampering attempts.

Poonam et al [23] have proposes a hybridised method combining the discrete wavelet transformation (DWT) and the singular values based decomposition (SVD) for watermarking the digital images. But they have restricted to colour images only. Zhang and colleagues [24] proposed a safe and dependable dual-embedded watermarking technique has been suggested in conjunction with particle swarm optimisation (PSO) in their research. They claimed that utilising optimisation could increase robustness. The PSO is a probabilistic optimization method in nature.

Gunjal et al. [25] attempted to create an extremely secure and long-lasting image watermark system based upon the multi objective evolutionary optimisation (MEO). Optimisation might enhance PSNR and normalised correlation. Anirban Bose [26] and colleagues have studied to provide an image embedding approach for a sparse watermark based on the singular values of previously determined wavelet sub-band coefficient of digital images. The dictionary learning (DL) based methodology was used to generate the sparse watermark picture. Paresh et al [27] have presented a distributed as well as peer-to-peer (P2P) applications are proliferating in modern Internet of Things (IoT) contexts, and cyber-attacks are constantly evolving new strategies to breach consumer privacy and safety. Block chain, a decentralised cryptography-based technology in order is a promising element of IOT security within manufacturing, healthcare, financial supply chain, authentication and authorization, e-governance, defence, higher education, banking, and trade. Ramanand et al [28] implemented a robust watermarking using edge detection in 2D double density discrete wavelet transform. R Radha Kumari, et al [29] in the early stages of their study, the Bear Smell Search Algorithms (BSSA) educates the Deep Beliefs Networks (DBN). The embedding stage follows, and it employs the combination of the DWT-SVD based hybrid transform domain approach for watermarking. T. Ma et al. [30] have used QR code images for watermarking demonstration.

The work presented by Eldaoushy along with colleagues [31] was successful hybrid digital photo watermarking solution. This procedure consists of two steps of SVD. The embedding stage is completed first, using SVD, followed by block-based SVD (B-SVD). Approach aids the robustness, but optimal block size and block selection is an issue. Kumar, S et al [32] have recently presented the good survey of the watermarking methods for the multimedia databases. Shweta Wadhera [33] have presented the extended study of the various recent watermarking approaches. Several application areas have been offered, including medical, distance education, military, and electronic voting systems. The resilience, imperceptibility, security, and watermark capacity are examined for the image watermarking uses. Deron Rodrigues et al [34] have presented the fusion approach for medical multi model images. These images are used as data base in this manuscript as used by Deron. Similarly, authors in Sanoj Kumar, et al [35] have proposed the PSO in combination to FrQWT transform for watermarking. The CT and PET images are fused. These images are used in this manuscript as the input database. S. Kashifa, et al [36] have provided an overview of the digital picture watermarking technique, the categorization of digital image watermarking schemes, as well as the research issues in this sector. Om Singh et al. [37] provide an overview of block chain watermarking.

Transform-domain watermarking has seen improvements in robustness, such as with the use of DWT-SVD. In addition, the quaternion based SVD watermarking in a recent approach with hybrid attacks was introduced by Arun Kumar Patel and Prabhat Patel [38], and the algorithm demonstrated high robustness properties. The use of blockchain-based reversible watermarking scheme based on the application of integer wavelet transforms was introduced by A. Dey et al. [39].

3. Challenges and Findings

The most suitable application of watermarking is for the protection of ownership. If there are many claims to ownership, the creator of the original work may prove their ownership by acquiring the watermark information from the watermarked object. Digital watermarks are frequently used to authenticate and copyright-protect data, codes, or signal interpretation legends. To recognise or track the development of human diseases, several medical apps use a range of medical imagery. The data from medical imaging must therefore be kept safe. Based on the literature and related assessment provided here, the following are the difficulties for future research.

1. For watermarking, the conventional DWT-SVD decompositions were frequently utilised. However, these coefficients are susceptible to variations in the noise. As a result, these approaches' watermarking performance needs to be improved.
2. It is necessary to address the security risks that medical pictures may encounter during routine medical procedures. Therefore, wavelet domain secure watermarking must be designed for greater robustness.
3. The invisibility for photos with big edges and strong edge fluctuations, like in the case of the Barbara image, may be impacted by existing watermarking techniques using edge detectors and image dilation. Consequently, the proposed embedding rule needed to be improved.
4. Secure encryption-based watermarking is now in high demand. Using BC based encryption may achieve the task better. But execution is bit challenging.

4. Proposed DWT-SVD Methodology

In this paper basic hybrid method of the DWT-SVD based approach and its combination with multilevel authenticating layers is proposed. The block representation of the basic proposed DWT-SVD based methodologies and the validations of model are given in the Fig. 5. It can be observed from the **Figure 5** that watermark embedding is taken in the Red Green Blue (RGB) domain as parallel processing.

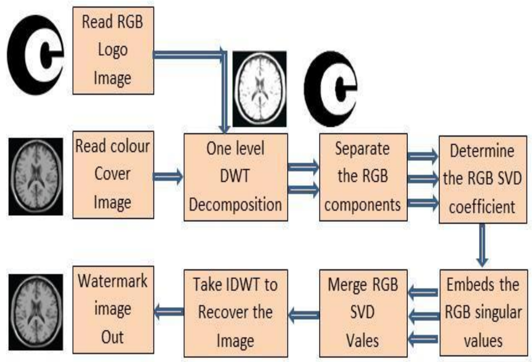


Fig. 5 proposed block diagram of the EGB based DWT-SVD based colour Image Watermarking.

In the proposed DWT method since SVD decomposition is implemented in separate RGB domain thus it is essential using scaling factor alpha to maintain the invisibility of the watermark. The scaling factor is set to 0.1 in this study, and which is nearly optimum and gives the good result. It is required to design the adaptive scaling algorithm as per images. The BC based security is usually recently being used and is applied as encryption standard over the watermarked images. As shown in highlighted box in Figure5.

The BC is applied to transmit or store the watermarked images over channel and database respectively. The SHA based encryptions are employed for the implementation of the BC security in watermarking literature. The flow chart of the proposed case study is presented in the **Figure 6**. It is clear from the flow chart. The DWT decomposition is given by the mathematical equation as given in the equation (5)

$$I = I\mathrm{LL} + \mathrm{L}\, I\mathrm{LH} + I\mathrm{HL} + I\mathrm{HH} \qquad (5)$$

The SVD value are merged using the watermark scaling law as

$$\mathrm{SWat} = \mathrm{Sim} + f * \mathrm{Sw} \qquad (6)$$

Where f is the scaling factor to maintain the invisibly.

The equation (6) is implemented in RGB domain separately in parallel.

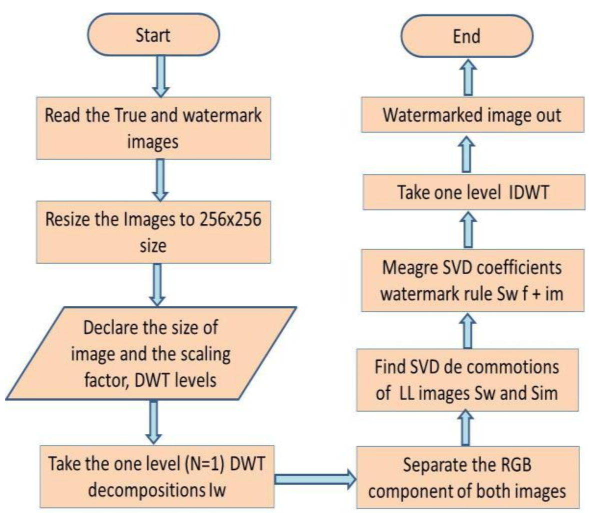
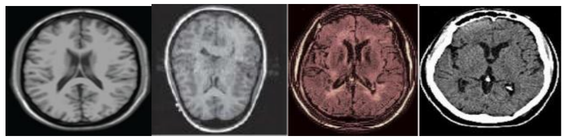


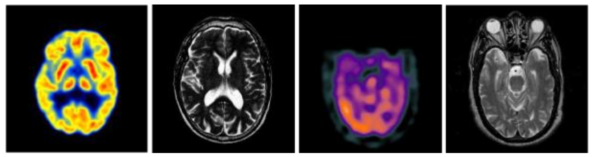
Fig. 6 the sequential Flow chart of the proposed RGB based DWT-SVD methodology a case study.

5. Case Study of DWT-SVD Watermarking

In this paper a specific case study is presented for the demonstration of the accuracy of the DWT-SVD based watermarking. The **Figure 7** and **Figure 8** may conclude that images are from multi modalities and having rich set of features.



a)**CT image 1, b) database-MRA image, c) Deron image 1, d) Deron CT image**



e) **medical-15-A PET f) medical-15-B CT g) medical-36-A PET d) medical--36-B CT**

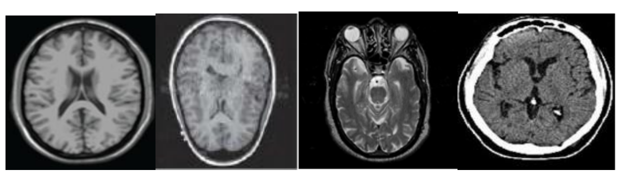
Fig. 7 Multi-modality database images used for the Case study and analysis of the DWT-SVD based medical watermarking

a)**Copyright2 watermark, b) PES Logo Watermark, c) Digital Signature**

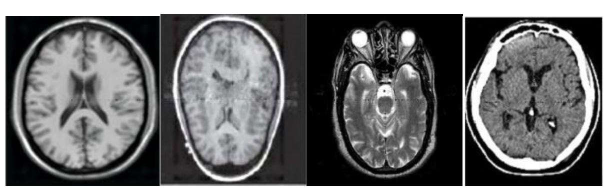
Fig. 8 the watermark and the signature image used for the case study

The images are considered from the reference papers Deron [34] and X. Li, [35]. The most common copyright2 image is used as watermark. The digital signature image is produced in real time and stored as image. It is proposed to resize all images to 256 x 256 sizes before being processed.

In order to qualitatively evaluate performance of the DWT-SVD based RGB watermarking approach the qualitative results for Grey base RGB medical images with qualitative differences are presented in **Figure 9**. The images are considered to have significant content differences and edge variations. It can be observed that there is slight change in contrast after watermarking and low information in difference images justify the invisibility of the approach. The PSNR is calculated between the true image and the watermarked images. The higher PSNR value is obtained with proposed approach.



a) **CT image, b) Database MRA image1 c) medical--36-B CT, d) Deron CT image**



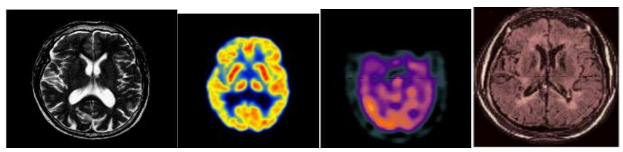
PSNR= 41.3800, PSNR= 41.0500, PSNR=50.2000, PSNR=59.1200

e) Respective Watermarked images Column wise

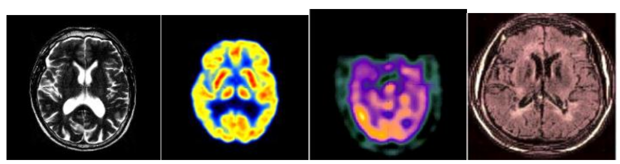
f) Respective Difference of true and watermarked images column wise

Fig. 9 case study outcomes for Grey base RGB medical images with qualitative differences for evaluation

The case of water marking for colour input multi model images is shown in the **Figure 10**. It can be clearly observed from the figure that the brightness change is observed in the DWT-SVD case with the colour image watermarking concept. It is because of the merging of the SVD values of the true image and watermark. This is the major limitation of the approach to be addressed in future.



a)**True colour images input**



b) **Respective column wise Watermarked images for the copyright2 watermark**

Fig. 10 results of the true colour multi-modality images watermarking using the EGB DWT-SVD approach.

5.1 Quantitative Evaluation of Limitations and Challenges

In this section the Quantitative evaluation in terms of parametric values is carried out to identify the limitations of the basic case study of the RGB colour medical image watermarking. It is clear from the parametric comparison of the various multi-modality images that RGB DWT-SVD method offers a significantly higher PSNR value of average of 49.88875. Therefore, for the watermarking it is suggested to prefer over other methods like ED based watermarking or DWT watermarking. But simultaneously there are some serious issues to be addressed in the near future. These issues are brightness variations and entropy changes. The large variation on the mean brightness is offered by the method. The average mean brightness variation for images is around 10.8 which are on higher side for medical images.

Table 1. Quantitative Evaluation of parameters for watermarked images using DWT-SVD

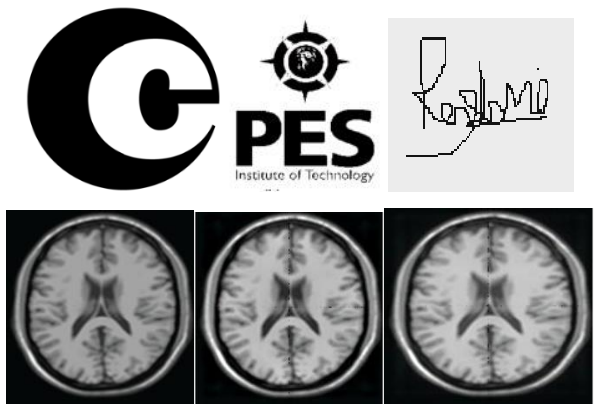
Images	**PSNR**	**Mean Brightness (MB)**		**Entropy**	
		Original	**Watermarked**	**Original**	**Watermarked**
CT image	41.3800	85.5212	97.8170	6.7052	7.0897
Deron image 1	43.8400	67.7879	80.3912	7.1842	7.3366
Medical-15-A PET	50.2000	39.7727	49.7162	4.9529	5.1496
Medical-15-B CT	45.9000	29.1078	37.3087	3.9537	3.9678
Medical-36-A PET	64.3500	30.7473	40.0477	4.4212	4.9231

Medical--36-B CT	53.2700	44.8924	53.4177	3.9603	3.6123

It is also observed from the Table 1 that entropy is even reduced form the true image case especially for colour images as in Deron image 1 and the Medical--36-B CT case. This shows the loss of the information. Thus, there is significantly an effort is required to research in future to improve the structural correlation. And maintain the relative information closer.

Another evaluation of the study is presented for the comparison of parameters for the two watermarks logos and with signature image cases. As shown in Table 2. It is It is clear from the Table that using individual signature may reduce the PSNR value. While in case of Medical--36-B CT image the entropy is even less resulting loss of information for copyright 2 log case.

The mean bright ness variations are highlighted for maximum variation cases as yellow text in Table 2. It can be seen that for PES Logo and signature case the MB varied around difference of 20.



PSNR = 41.3800 PSNR=60.8300 PSNR = 25.6000

Fig. 11 Example of watermarking for two different logo and signature images

.

Table 2. Comparison of parameters for three cases of logos including signature image.

Images	Watermark Images	PSNR	Mean Brightness (MB)		Entropy	
			Original	Watermarked	Original	Watermarked
Deron image	Copuright2	43.8400	67.7879	80.3912	7.1842	7.3366
Medical--36-B CT		53.2700	44.8924	53.4177	3.9603	3.6123
Deron image	PES logo	61.9900	67.7879	86.0525	7.1842	7.5761
Medical--36-B CT		80.7700	44.8924	57.0249	3.9603	4.0292
Peron image	Signature	25.2100	67.7879	87.7257	7.1842	7.6412
Medical--36-B CT		28.8300	44.8924	58.0116	3.9603	4.1655

Thus, overall case study makes it clear that still there are many issues to be addressed with the DWT-SVD watermarking although lots of work is already done.

6. Conclusions and Future Scope

This document provides a basic review of safe picture watermarking approaches primarily centred on security that is built on Blockchain (BC), the SVD, the wavelet domain, and edge detection. The first contribution of the paper is a comprehensive analysis of edge detection (ED), discrete wavelet transform (DWT) and associated singular values decompositions (SVD), as well as BC aided security, based medical image security techniques.

The system diagram is described using BC-based watermarking for increased resilience. The paper aimed to present the Case study of DWT-SVD based watermarking to identify current difficulties and promising future directions for scholars. The performance is assessed for various combinations of the watermark logos and the database images, taking into account the digital signature for multi-layer security framework. The case study of the DWT-SVD based watermarking is provided at the conclusion. It is concluded that average mean brightness variation for images is around 10.8 which are on higher side for medical images. Also, the PSNR is significantly higher with RGB DWT-SVD. The PSNR is reduced in case of digital signature using individual case.

Thus, overall lot of improvement is required to be assess in the future. Entropy of the image is raised while the watermark's invisibility is preserved. For more sturdiness, the combination of the logo and the signature is used. Paper has established the potential for the varied optimizer and watermarking in the future.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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