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An Effective and Safe Method for Digital Image Watermarking That Uses RDWT Algorithms with SVD and Firefly

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Abstract : Digital watermarking is the process of concealing digital copyright information in digital content, to enable copyright protection and stop unauthorized distribution. The process of undetectable digital data embedding in the host audio stream is known as digital audio watermarking. One of the best approaches for embedding a picture into another image is image watermarking. Despite the fact that there are several methods available for watermarking SVD, Firefly is the most effective method for achieving the greatest outcomes. Watermarking is generated by SVD, and firefly aids in both encryption and watermarking. The most effective method for creating safe watermarks is to combine cryptography and watermarking. While there are several scaling factors that can be applied to fireflies, multiple scaling factors are used in this study. This study measures the Structure Similarity Index Measure (SSIM). Furthermore, the watermarked image undergoes standard processing methods such as sharpening and smoothing, and is subsequently encrypted using Firefly.

Keywords: Water marking, DWT, SVD, SSIM

I. Introduction

The internet is now widely utilized worldwide. Given how easy the data may be copied, communication of the data must be secure. This paper uses firefly algorithms and SVD to prevent plagiarism. These algorithms can implement this copyright with ease. There are numerous techniques and methods available for watermarking and encryption, but the ideal method should be precisely extracted and decrypted again. Although watermarking and related articles were first introduced in 1979, this field of study only began to receive significant attention in 1990. Although there are many benefits to data digitalization for consumers worldwide, it is quite easy for digital data to be altered and lose its authenticity [1].

The water marking technology is employed to safeguard copyright. The phrase "watermarking" refers to the common practice of leaving a visible watermark on paper. It was applied to the forgery of banknotes and books. Watermarking is a technique used to transmit hidden information and change the substance of a text by switching around the alphabet's places. Watermarking first appeared in use as a money anti-counterfeiting tool in the eighteenth century, and it was also applied to other papers. This method preserves security by converting the original image to a watermarked version. Every watermarking technique must be applied in order to obtain a watermarked image [2], [3]. Water marking techniques can be used under certain guidelines, and these guidelines can be altered based on the needs of various applications, including security, robustness, and imperceptibility.

Imperceptibility: Imperceptibility is the capacity to distinguish between an image that has been watermarked and the original image. The user has no control over the audio or picture in this.

Robustness: The watermark cannot be removed, even if the computational theory underlying it is understood. This implies that the watermark is able to be eliminated by someone with greater expertise in the embedding process.

Security: The watermark needs to be resilient to assaults that try to expose the contained data directly. Without the secret key or password, no one can alter, conceal, decode, or erase the watermark.

II. Block description

Figure 1 illustrates the fundamental procedures that must be followed. Where the extracted and watermarked image is located. The process of embedding an image with a signature secured in it is shown in figure below.

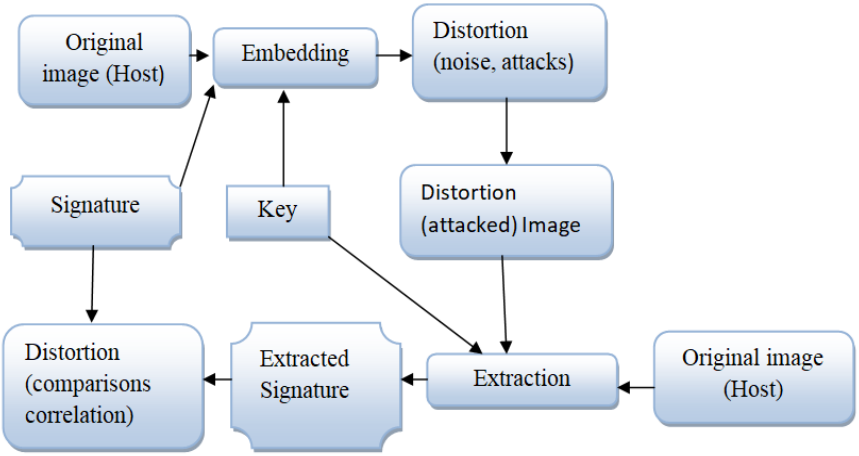

Figure.1. Block diagram

As seen in figure 1, two images are regarded as the original picture and the host image, also known as the embedding image. Using the SVD approach, the host image is integrated into the original image to create an embedded or watermarked image [4]. Additionally, the firefly algorithm is utilized in cryptography to secure this watermarked image. SVD and the firefly algorithm work together to produce optimum, encouraging outcomes.

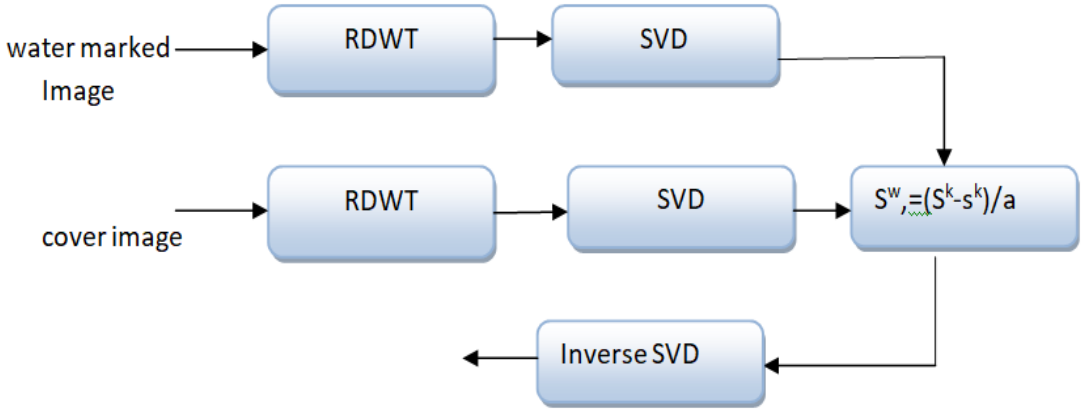

Figure.2. Block diagram of SVD

The image is watermarked using redundant discrete wavelet transform (RDWT) and SVD, as seen in figure 2. The illustration illustrates how SVD and RDWT are combined for the cover image as well as the source image. The primary actions to take are

- RDWT
- SVD
- Firefly Process
- ISVD

RDWT (Redundant Discrete Wavelet Transform)

RDWT is the key methodology. DWT and RDWT are comparable; however, although the HH part in RDWT is separated into four segments as illustrated in figure 3, the LL part in DWT is further divided into four pieces. Instead of using low frequency, high frequency is used to maintain the information [5].

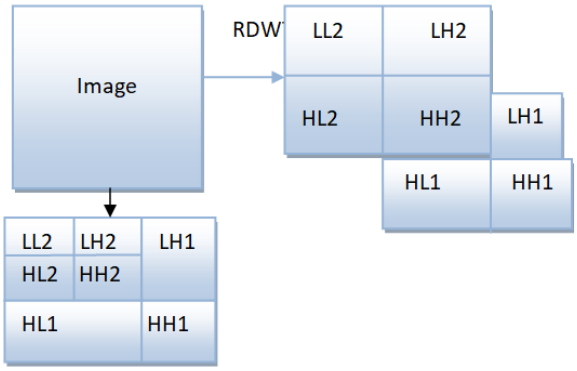

Figure.3. RDWT levels

RDWT of image is segmented as showed in Figure 3

- HH 2 (High - High)
- HL 2 (High - Low)
- LH 2(Low - High)
- LL 2 (Low - Low)

HH2 is further segmented in to second level as

- HH 1 (High - High)
- HL 1 (High - Low)
- LH 1 (Low - High)
- HH 2 (High - High)

SVD (Singular Value Decomposition)

The SVD comes from linear algebra, wherein 3 matrices, such as the orthogonal matrix U, the diagonal matrix S, and the transfer of the orthogonal matrix V, can be obtained by analyzing the rectangular matrix A [6]. In order to obtain a variety of associations among the primary data, this approach combines associated variables into a set of uncorrelated ones [7]. Another way to see a digital image is as a matrix of scalar entries that are not negative. If A is a rectangular picture with a size m x n (m ≥n), then SVD can mathematically represent it as follows:

A = USVT

Here:

U is an m × n orthogonal matrix

A is an m × n matrix

V is an n × n orthogonal matrix

S is an n × n diagonal matrix

The SVD involves a few steps, like:

- ❖ First, the SVD transformation can be represented as a square or rectangle because memory capacity is not defined in this process [8].
- ❖ Secondly, SVD aids in improving accuracy and reducing memory restrictions.
- ❖ Thirdly, the larger single values in SVD preserve the majority of an image's energy and also fend off attacks. As a result, single values are less impacted when a generic picture watermark is applied, which strengthens the inserted watermark's resilience [9].
- ❖ Finally, algebraic properties lead to singular value decomposition.

The image would roughly stay the same even after the watermark was added if the aforementioned conditions were met [10]. This would prevent even little variations in the single values from having an impact on the image.

Firefly Algorithm

The fire fly process is also known as a meta heuristic system, which indicates that higher-leveltechnique or heuristic designed for finding, generating, or selecting a heuristic that gives us a better solution for an optimization issue. This is particularly useful when working with incomplete data, data with imperfect information, or very

limited computational capacity.The firefly' flashing lights serve as the main source of inspiration for this program. All that the fireflies are solutions or values that are created at random. The two fundamental elements that these solutions address is“attractiveness” and “brightness”. Because these two factors are directly related to one another, appeal rises with brightness but falls with increasing distance [11], [12]. This could also imply that a firefly with more brightness will draw the attention of other fireflies, and that a firefly will begin to move randomly in the absence of a brighter firefly [13], [14]. It is inversely quadratic proportional to area square when taking into account the fundamental physical principle of light intensity.

Results and Discussion

As seen in pictures 6, 7, 8, 9, and 10, the process states that host image is watermarked on original image. Beginning with original, watermarked, host, encrypted, and decrypted images.

Fig 7 Original Image

Fig 8 Watermark Image

Fig 9 Watermarked Image

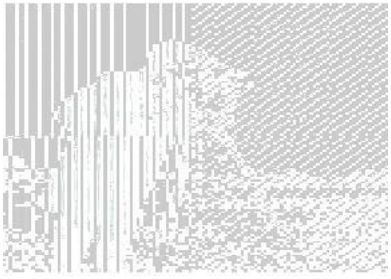

Fig 10 Firefly Image

Fig 11 Extracted or Decrypted Image

Performance Matrices: The audio signal's Mean Square Error can be calculated using the formula below: Audioread('original.wav') for [y1, Fs1]; audioread('watermarked.wav') for [y2, Fs2]; (Both files are available on the CD-ROM that is connected.) Given that there are 2097152 samples in total, the MSE equals

Mean square error(MSE)

It's a process that calculates the average of the errors to estimate an unknown quantity. In this case, the original and filtered photos are represented by the maximum MSE value, however the filtered image with the lowest value has greater quality. This measurement is helpful in determining the overall performance of the image and provides information on the preservation of individual characteristics. This enables us to compare our damaged image with the original image's true pixel values.

$$MSE = \frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[g(i,j) - f(i,j)]^2$$

Peak to signal ratio

It is the proportion of a signal's maximal potential power to power-corrupting noise. The improved quality of the image that was reconstructed is shown by a greater PSNR. In terms of a logarithmic decibel scale, PSNR is stated. A higher PSNR value in this case indicates greater filtered image quality. In order to contrast the effects of picture enhancement techniques on this image quality, measurable measurements have been devised. This compares to determine whether specific algorithm yielded the superior outcomes.

$$\text{PSNR} = 10\ \text{Log}_{10}(\frac{p}{RMS})\text{dB}$$

The result is 0.0123. The following table displays the mean square error and PSNR for three different music classes.

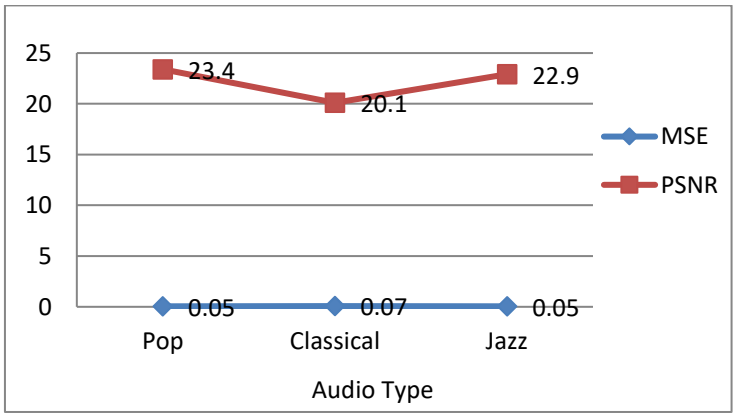

Figure.10. Quality matrix for MSE and PSNR

Robustness is an advantage that accounts for the slight increase in the MSE value over the base strategy. This is because invisible watermarking is obtained by embedding in S matrix domain via the SVD transformation.

Conclusion

This work uses DWT and SVD Transformation for watermarking. However, there are two ways to watermark

audio: in the frequency domain or the temporal domain. The temporal domain is highly sensitive to encoding, noise addition, downsampling, and echo in all of its manifestations. For this reason, the transform domain is where the audio watermarking method is most frequently used. The embedded content must be secure, resistant against tampering, inaudible, and statically undetectable. This work presents a method of embedding watermarks using discrete wavelet transformations and singular value decomposition. The watermark values are incorporated into the singular values of SVD Transformation. The suggested watermarking method is blind, meaning that in order to extract the watermark, the original, unmarked audio must be present at the recipient.
The research on SVD using RDWT and the firefly method is the subject of this paper. With the appropriate encryption and decoding, the image is recovered.

References

[1] A. K. Yadav, R. Roy, R. Kumar, C. S. Kumar and A. P. Kumar, "Algorithm for de-noising of color images based on median filter," 2015 Third International Conference on Image Information Processing (ICIIP), Waknaghat, 2015, pp. 428-432.

[2] A. P. Kumar, N. Kumar, C. S. Kumar, A. K. Yadav and A. Sharma, "Speech recognition using arithmetic coding and MFCC for Telugu language," 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, 2016, pp. 265-268.

[3] A. P. Kumar, R. Roy, S. Rawat, A. Sharma, "Telugu speech feature extraction by MODGDF and MFCC using Naïve Bayes classifier", International Journal of Control Theory and Applications, vol. 9, No. 21, Dec 2016.

[4] A. K. Yadav, R. Roy, R. Kumar, and A. P. Kumar, "Survey on Content based image retrieval and texture applications", International Journal of signal processing, image processing and pattern recognition.

[5] Kumar A.P., Roy R., Rawat S., Yadav A.K., Chaurasia A., Gupta R.K. (2018) Telugu Speech Recognition Using Combined MFCC, MODGDF Feature Extraction Techniques and MLP, TLRN Classifiers. In: Pant M., Ray K., Sharma T., Rawat S., Bandyopadhyay A. (eds) Soft Computing: Theories and Applications. Advances in Intelligent Systems and Computing, vol 584. Springer, Singapore

[6] Vaka Murali Mohan., R. Kanaka Durga, Swathi Devathi, K. Srujan Raju "Image processing representation using binary image; grayscale, color image, and histogram" 2nd International Conference on Computer and Communication Technologies - IC3T 2015, during July 24 -26, 2015 at CMR Technical Campus, Hyderabad, Telangana, India, Advances in Intelligent Systems and Computing book series (AISC, volume 381) Volume 1, pages 353-361.

[7] Kanaka Durga Returi., Vaka Murali Mohan, Y. Radhika "A Novel Approach for Speaker Recognition By Using Wavelet Analysis and Support Vector Machines" 2nd International Conference on Computer and Communication Technologies - IC3T 2015, during July 24 -26, 2015 at CMR Technical Campus, Hyderabad, Telangana, India, Advances in Intelligent Systems and Computing book series (AISC, volume 379) Volume 1, pp 163-174.

[8] Kanaka Durga Returi and Radhika Y "An Artificial Neural Networks Model by Using Wavelet Analysis for Speaker Recognition" Proceedings of Information Systems Design and Intelligent Applications, Second International Conference on INformation systems Design and Intelligent Applications (INDIA - 2015), Advances in Intelligent Systems and Computing book series (AISC, volume 340) Issue 2, pp 859 – 874

[9] Dr. kanaka durga returi, dr. radhika & dr. vaka murali mohan "digital image pixel processing and 2d-convolution" gedrag & organisatie review - issn:0921-5077, volume 33 - 2020 (jan - march), pages 123-130

[10] VK Sharma, AP Kumar , "Continuous telugu speech recognition by joint feature extraction of mfcc, modgdf and dwpd techniques by pnn classifier", International Journal of Pure and Applied Mathematics,Vol. 118, No. 21, pp. 865-872, 2018

[11] Kumar A.P., Roy R., Rawat S., Chaturvedi R., Sharma A., Kumar C.S. (2018) Speech Recognition with Combined MFCC, MODGDF and ZCPA Features Extraction Techniques Using NTN and MNTN Conventional Classifiers for Telugu Language. In: Pant M., Ray K., Sharma T., Rawat S., Bandyopadhyay A. (eds) Soft Computing: Theories and Applications. Advances in Intelligent Systems and Computing, vol

584. Springer, Singapore

[12] AP Kumar, R Roy, S Rawat, P Sudhakaran, "Continuous Telugu Speech Recognition through Combined Feature Extraction by MFCC and DWPD Using HMM based DNN Techniques", International Journal of Pure and Applied Mathematics,Vol. 114, No. 11, pp. 187-197, 2017

[13] SS. Saravana Kumar, K. Umapathy, "Efficient Implementation of Downlink Resource Allocation in Wireless Networks with Inter-cell Interference", Journal of Advanced Research in Dynamical and Control Systems, November 2017, ISSN: 1943-023X, Volume 9, Special Issue 14, pp.2297-2312.

[14] R. Krishnamoorthy, K. Umapathy, "Design and Implementation of Micro strip Antenna for Energy Harvesting using Low Power Devices", IEEE International Conference on Electrical, Electronics, Information, Communication and Bio-informatics" (AEEICB 2018), February 2018.