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# An SWT-SVD based Image Watermarking Approach

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***Abstract:** Digital watermarking is a method of hiding a message related to a digital signal (i.e. an image, song, video) within the signal itself. Watermarking has a number of uses in security, authentication and registration purposes. Image Watermarking is a widely sought after research area and many researchers have done extensive study on various aspects of digital image watermarking. Out of those techniques DWT based techniques are quite popular. One of the drawbacks of the DWT based method is that it lacks translational invariance. Stationary Wavelet Transform overcomes this drawback and thus has been used in this research work. In this research work a comparative analysis of DWT-SVD and SWT-SVD technique has been presented. A comparative study of results in terms of PSNR has been presented to give analyse the performance of the three methods.*

## I. INTRODUCTION

Watermarking has been in use since time immemorial, in the form of watermarks found initially on paper for document authentication and on currency notes to provide fake note detection. .There has been an increase in the research on Digital Watermarking owing to an increase in the digital services like multimedia, telecommunication and internet. With the growing usage of these technologies and the ease with which multimedia data such as image, video, songs etc. can be transferred from one device to other device has also led to a threat of it being copied and forged to appear altogether different using tools which are easily available. In such a scenario it is very important to have certain mechanism for digital data copyright protection and authentication. Watermarking provides a solution to this problem. Watermarking as has been understood by this research is an act of embedding some form of data inside or over another piece of data or information. For example, the official documents in a University or college, generally come with a Logo or name watermark in the text document. Thus, its gives an authentication that the particular document has been issued by the University and an authentic document of the University. Likewise, there are other examples of watermark. Another such example can be an image or video where the watermark data can be hidden inside the original content. Based on the visibility of the watermark, it can be divided into two types visible watermark or invisible watermark. The example of document watermarking with university logo is an example of visible watermarking. In case of image, video or song, invisible watermarking is used. Several techniques and methods have been proposed and implemented in the past years to perform digital watermarking in multimedia data. In this research paper, Digital Image Watermarking is of particular interest. There are various techniques like LSB substitution method, Pixel Value Differencing, Quantization index modulation etc., in the spatial domain. In frequency domain there are different methods which use the Discrete Cosine Transform and Discrete Wavelet Transform techniques to achieve the watermarking. In this paper a novel algorithm has been proposed and implemented which uses a SWT based approach to perform Watermark Embedding and Extraction. The Wavelet domain gives a frequency domain analysis of the available signal and divides it to low frequency and high frequency sub bands. The Stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform DWT. Translation-invariance is achieved by removing the down samplers and up samplers in the DWT and up sampling the filter coefficients.The section II gives a literature review followed by the proposed implementation framework in Section III. Section IV gives the analysis and result and finally Section V gives the Conclusion.

## II. RELATED WORK

There are numerous digital image watermarking techniques in various domains which are broadly categorized as [2]:

*1)* Spatial domain based watermarking techniques
*2)* Transform domain based watermarking techniques

In spatial domain of watermarking, the secret information is directly embedded in pixel values of the image or in other words pixels are directly altered to store secret messages. These techniques are very simple but have greater impact then other techniques on the resultant image reducing visual perceptibility.

Transform domain steganography techniques are the most complex way to embed the secret data in the cover image.

An image in digital form is made up of high and low frequency components. Digital image can have smooth and edge (sharp) areas. Smooth areas represent low frequency whereas high frequency is represented by edge or sharp areas of the cover image. Changes done in low frequency areas can easily be visible to human eyes. So it is not possible to embed equal amount of secret information in all the regions. It has number advantages over the spatial domain methods of steganography such as it is more robust against compression, image processing and cropping and these methods are less prone to attacks [3].

Spatial domain based watermarking techniques are rarely preferred over transform domain based watermarking techniques because the watermark placed by them can be easily destroyed and modified by the attackers.

Least Significant Bit (LSB) substitution algorithm is one of the simplest form of algorithm in which LSBs of the cover image( the image inside which secret message is to be hidden), is modified according to the secret message. It is simple yet effective technique of embedding secret data into images. The bits in a pixel vary from 8 bits in case of Gray scale images to colored RGB images which use 24 bits to store color information where 8 bits each is used for  for Red, Green and Blue components. This method can achieve high embedding capacity but this algorithm is sensitive to image manipulations such as cropping, scaling and rotations, lossy compression and addition of noise. Edge and texture masking of cover image to determine the number of bits of LSBs for data embedding, Adaptive LSB algorithm based on brightness, optimized LSB algorithm using cat swarm and genetic algorithm are some other methods based on LSB substitution.

Pixel Value Differencing is another technique that sub divides the cover image into non overlapping blocks consisting of two connecting pixels. This technique uses an algorithm where the difference between two connected pixels is altered. High difference in the cover image pixel values, allows more changes. The area in which pixel exists over the whole image is used to decide the hiding capacity of this technique for example if edge area is chosen then the difference is high, between the connecting pixels, where as in normal areas, difference is low. So, ideal choice can be to select edge areas to embed the secret message that has more embedding capacity. Watermarked or stego image obtained by this technique has better quality and has better imperceptibility results [4].

Grey Level Modification technique the data is mapped by applying some modifications to the grey values of the image pixels. This technique doesn’t hide or embed data, instead it map the data by using some mathematical functions. Set of pixels are selected for mapping using this mathematical function. It uses the concept of odd and even numbers for mapping the data in cover image. High hiding capacity and low computational complexity are some advantages of this technique [5].

In frequency domain watermarking, the cover data is considered as communication medium. The watermark is considered as a signal that is passed through this medium. In frequency domain watermarking the cover medium is converted to frequency domain before adding the watermark. After the insertion of the watermark, the medium is inversely transformed to get the watermarked medium in the spatial domain. The watermark inserted in the frequency domain ensures high level of security. The watermark is spread in such a way that the position of the watermark in not known. Moreover, watermark destruction brings severe degradation to the watermarked medium.

The most popular methods in this domain are DCT and DWT. Nowadays a number of researchers have focused their research on these two methods. Cox proposed a non-blind watermarking technique. The technique is based on using spread spectrum for inserting a watermark in DCT domain [6]. A Gaussian random sequence is used as a watermark. The watermark is inserted imperceptibly in a spread spectrum-like fashion. The technique proposed was robust to majority of geometric and common signal processing attacks like compression, analog-to digital and digital-to-analog conversion etc. But the major limitation of the technique is that it requires the original image to register it against the transformed watermarked image. Harrak et al. proposed a watermarking technique in [7].

In wavelet based methods an image is decomposed into different sub-bands. A wavelet based watermarking technique is proposed. In this technique every watermark bit is embedded in various frequency bands. The technique spread the watermark information in large spatial regions of the cover medium. The technique is able to survive the frequency based attacks for example removing the high frequency areas through low-pass filter, and the removal of high-pass details in JPEG compression. The technique is also resistant against the time based attacks like rotation and pixel shifting. This technique is not imperceptible because of using a fix watermarking level for the whole image.

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According to Lai et.al [8], the main objective of developing an image-watermarking technique is to satisfy both imperceptibility and robustness requirements. They proposed a hybrid image-watermarking scheme based on discrete wavelet transform (DWT) and singular value decomposition (SVD) in which the watermark is not embedded directly on the wavelet coefficients but rather than on the elements of singular values of the cover image's DWT subbands. Experimental results illustrate that the proposed approach is able to withstand a variety of image-processing attacks.

Bhagyashree et. al [9], propose a new singular value decomposition (SVD) and discrete wavelet transformation (DWT) based technique for hiding watermark in full frequency band of color images (DSFW). The quality of the watermarked image and extracted watermark is measured using peak signal to noise ratio (PSNR) and normalized correlation (NC) respectively. It is observed that the quality of the watermarked image is maintained with the value of 36dB. Robustness of proposed algorithm is tested for various attacks including salt and pepper noise and Gaussian noise, cropping and JPEG compression.

Another hybrid watermarking technique has been presented by Ramakrishnan et. al[10]. The authors have used singular values of Wavelet Transformation’s HL and LH sub bands to embed watermark. Further to increase and control the strength of the watermark, they have used a scale factor. An optimal watermark embedding method is developed to achieve minimum watermarking distortion. A secret embedding key is designed to securely embed the fragile watermarks so that the new method is robust to counterfeiting, even when the malicious attackers are fully aware of the watermark embedding algorithm. Experimental results are provided in terms of Peak signal to noise ratio (PSNR), Normalized cross correlation (NCC) and gain factor to demonstrate the effectiveness of the proposed algorithm. Image operations such as JPEG compression from malicious image attacks and, thus, can be used for semi-fragile watermarking.

## III. MOTIVATION

Discrete Wavelet Transform (DWT) Wavelet domain is a promising domain for watermark embedding. DWT is an orthogonal transform similar to the Discrete Cosine Transform that can be used for the audio and video compression, speech recognition, feature extraction, finger print, watermarking and many other applications in biomedical engineering [8]. This is a frequency domain technique in which firstly cover image is transformed into frequency domain and then its frequency coefficientsare modified in accordance with the transformed coefficients of the watermark and watermarked image is obtained which is very much robust. In single level decomposition, DWT decomposes image hierarchically,

providing both spatial and frequency description of the image. It decompose an image in basically three spatial directions i.e.,horizontal, vertical and diagonal in result separating the image into four different components namely LL, LH, HL and HH. Here first letter refers to applying either low pass frequency operation or high pass frequency operations to the rows and the second letter refers to the filter applied to the columns of the cover image. LL level is the lowest resolution level which consists of the approximation part of the cover image. Rest three levels i.e.,LH, HL, HH give the detailed information of the cover image [9].

## IV. NETWORK MODEL

The embedding algorithm for DWT-SVD based watermarking is shown in Figure

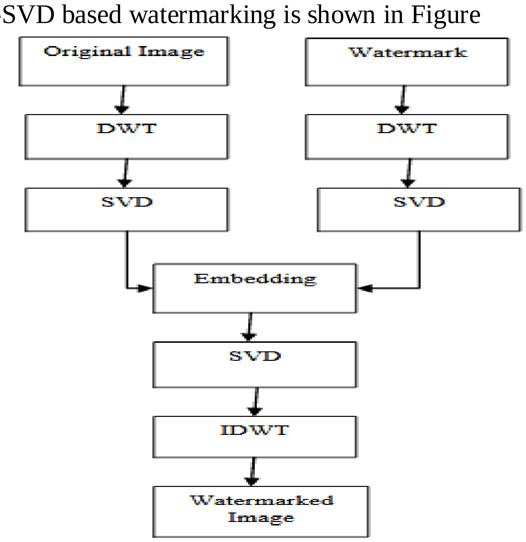


Figure1 showing embedding algorithm for DWT-SVD based watermarking

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The extraction algorithm for DWT-SVD based watermarking is shown in Figure

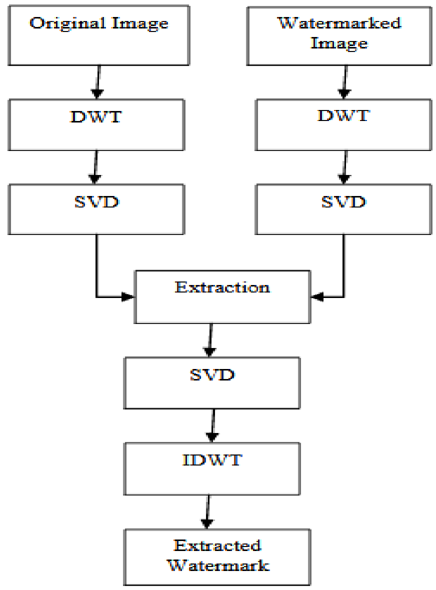


Figure 2 showing extraction algorithm for DWT-SVD based watermarking

## V. PROPOSED WORK

The proposed method uses Stationary Discrete Wavelet Transform to decompose the input medical image into various frequency bands i.e. LL, HL, LH, and HH band.The Stationary wavelet transform is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform. Translation-invariance is achieved by removing the downsamplers and upsamplers in the DWT and upsampling the filter coefficients by a factor of $2^{(j-1)}$ in jth level of the algorithm. The SWT is an inherently redundant scheme as the output of each level of SWT contains the same number of samples as the input – so for a decomposition of N levels there is a redundancy of N in the wavelet coefficients The same procedure is applied to the watermark image and the corresponding 2-D SWT bands are obtained. This again gives the frequency sub-bands for the watermark image. Thereafter SVD (Singular value Decomposition) method is applied on the LL sub-bands in both the input image and the watermark image. The singular values thus obtained are multiplied according to following equation:-

$$S_{new}= S_i + \alpha^* S_w \qquad (1)$$

Where $S_i$ and $S_w$ are the singular values of the input and watermark image respectively, and α is the scaling factor. The flowchart for the embedding procedure is shown in Figure 3. The image used is true-color RGB image and the watermark image used is also a true-color image of the size.

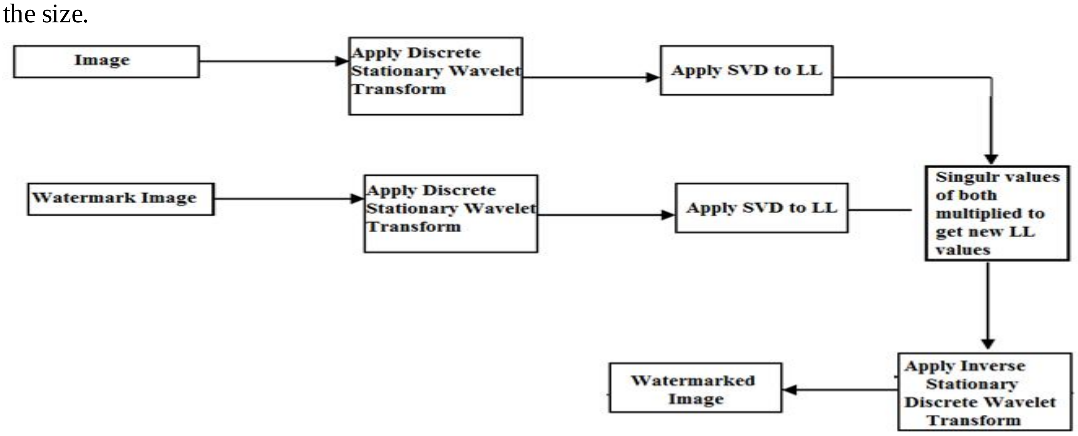


Figure 3: Watermark Embedding Flowchart

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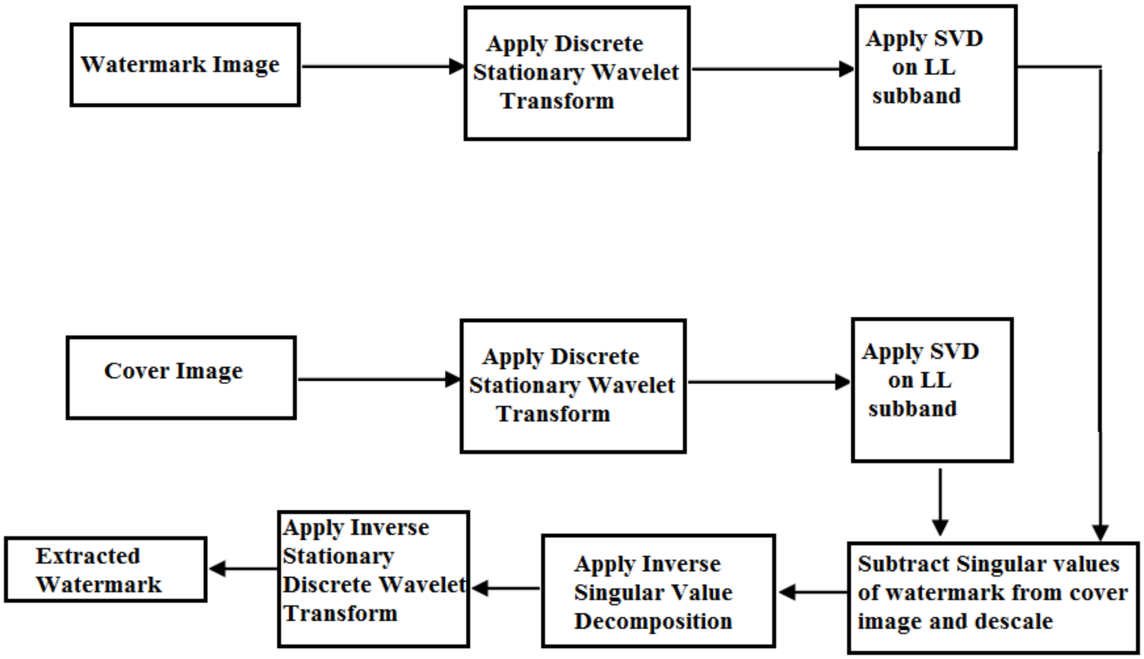


Figure 4: Watermark Extraction Flowchart

*A. The Embedding Algorithm Is Given As Below*

*1)* Step 1: The original N*N image is transformed into sub-bands using single level 2-D SWT.
*2)* Step 2: SVD is performed on LL sub-band of decomposed RGB original image, given by following equation:

$$S= USV^T \quad (2)$$

*3)* Step 3: The watermark of size M*M RGB image is transformed into sub-bands using single level 2-D SWT.
*4)* Step 4: SVD is performed on LL sub-band (on RGB components) of decomposed RGB watermark image i.e., T

$$SW= U_w S_w T_w \quad (3)$$

*5)* Step 5: After performing SVD on both original and watermark images, the resultant watermark image is then embedded with the original image using the scale factor (α), given by equation 1.
*6)* Step 6: Inverse SVD is performed on embedded image.
*7)* Step 7: Finally, inverse 2-D SWT is performed to produce the watermarked image.

*B. The Extraction Algorithm Is Given As Below*

1) Step 1: The original N*N image is transformed into sub-bands using single level 2-D DWT.
2) Step 2: SVD is performed on LL sub-band of decomposed original image.
3) Step 3: The watermark of size M*M image is transformed into sub-bands using single level 2-D SWT.
4) Step 4: SVD is performed on LL sub-band of decomposed RGB watermark image,
5) Step 5: The watermarked image (output of embedding) is transformed into sub-bands using the single level 2-D SWT.
6) Step 6: SVD is performed on LL sub-band of decomposed RGB watermarked image.
7) Step 7: Then the extraction is applied to the resultant SVD image using the same value of scale factor (α).
8) Step 8: Inverse SVD is applied on resultant image after extraction.
9) Step 9: Finally, inverse 2-D SWT is performed to get the extracted watermark image.

## VI. PERFORMANCE EVALUATION

Extensive experiments have been performed on a number of images to analyse the working of the algorithm. Several standard test images such as boat, baboon, Lena, peppers, couple, cameramen etc. are referred to in the present research work for watermark embedding and watermark detection. The technique is not limited to the use these cover images but we have used them as they are standard images widely used by other researchers working on image watermarking research area.

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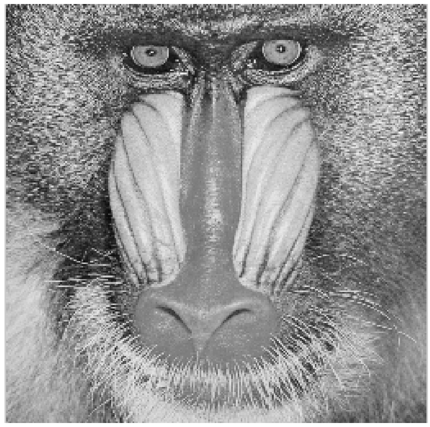

Figure 6: Cover Image(Baboon)

Figure 7: Watermark Image

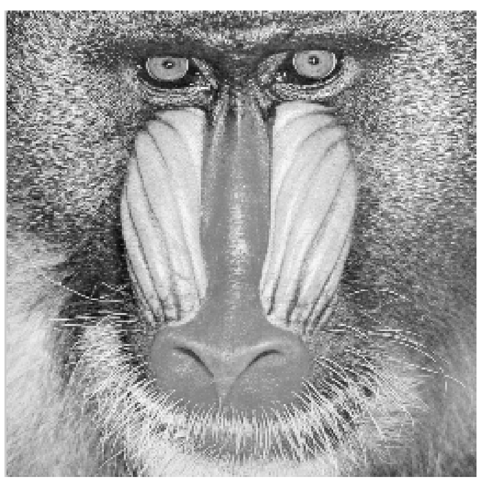

Figure 8: Watermarked Image

Figure 6 shows the original image of lena which is a coloured image of size 256x256. Figure 7 shows the watermark image of boat which is of the same size, which is to be hidden watermarked. Figure 8 shows the Watermarked Image which is same in appearance to the original image. There is no perceptual distortion in the watermarked image which shows the high visual imperceptibility of the proposed technique.

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Figure 8: Extracted Watermarked Image

TABLE I: Comparison of PSNR values for Lena Image by varying alpha

| Alpha | DWT-SVD | SWT-SVD |
|---|---|---|
| 0.01 | 76.2096 | 103.1904 |
| 0.02 | 60.8586 | 89.6181 |
| 0.03 | 52.6066 | 81.6083 |
| 0.04 | 49.4157 | 75.8780 |
| 0.05 | 45.9157 | 71.4172 |
| 0.06 | 43.1116 | 67.7861 |
| 0.07 | 40.8654 | 64.7078 |

Table I shows a comparative analysis of results with DWT-SVD method and the proposed SWT-SVD method. There is slight improvement in the PSNR values as compared to DWT-SVD method under similar conditions, which proves that stationary wavelet transform improves the performance characteristic.

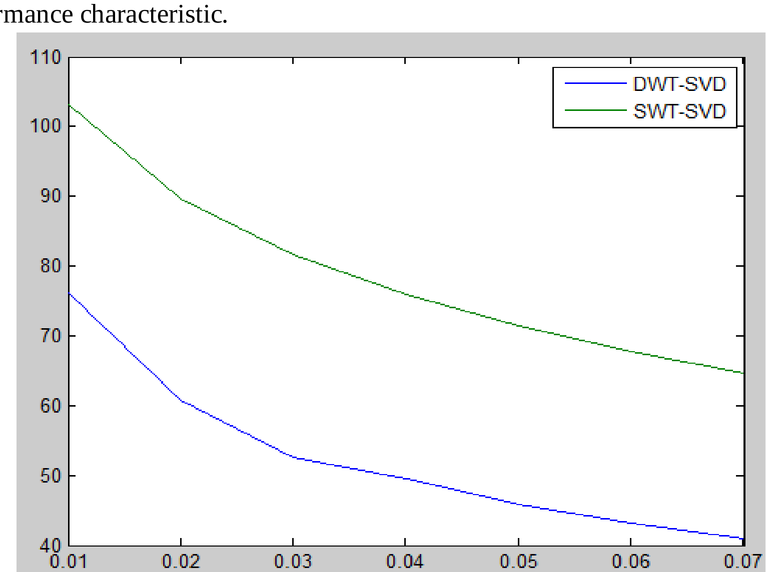



Figure 9: Graphical Comparison

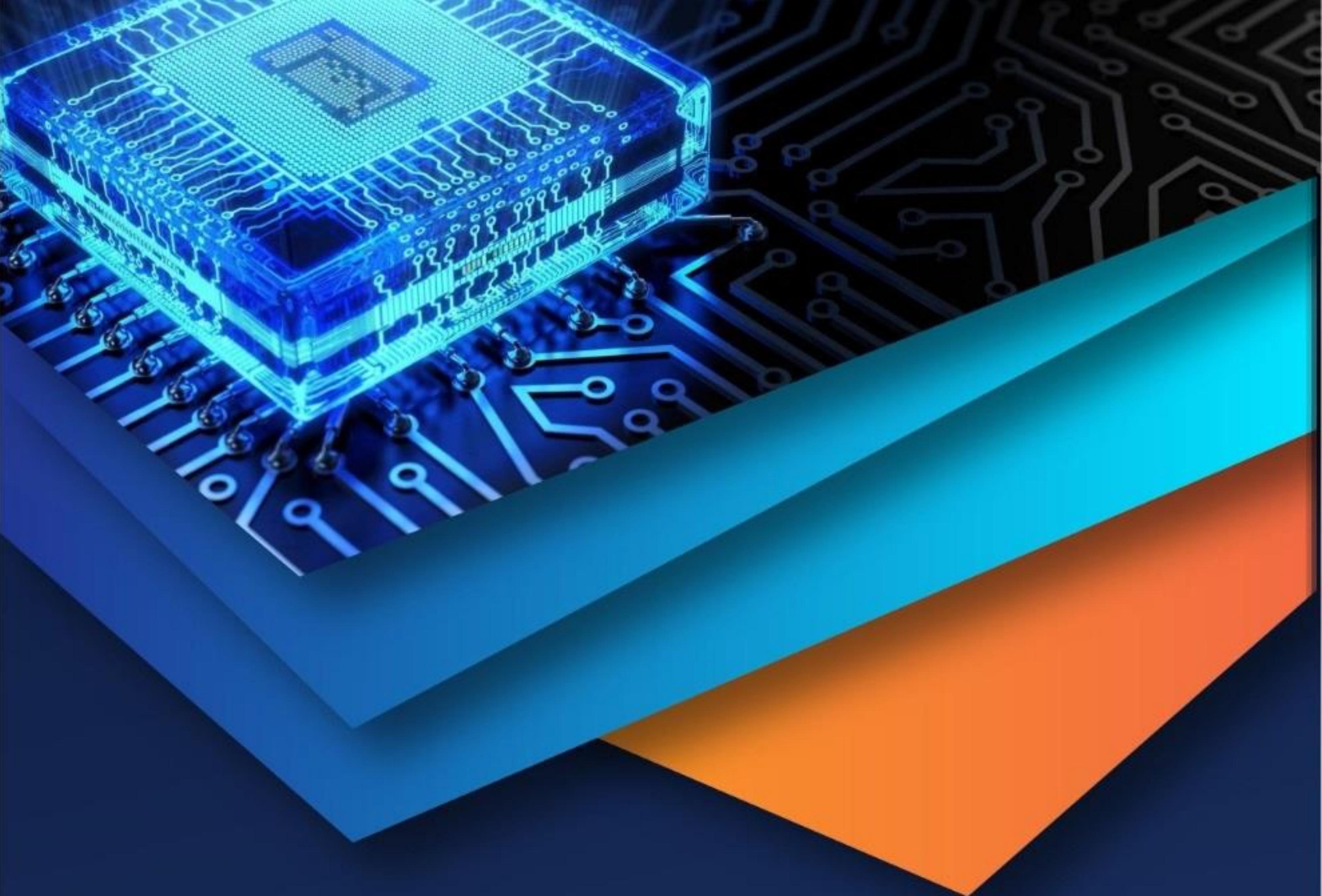
A graphical comparison between the two techniques is as shown in above, which shows a decrease in Peak Signal to Noise Ration(PSNR) values with the increase in scaling factor alpha.

## VI. CONCLUSION

A novel algorithm for image watermarking has been proposed in this research work. The algorithm is based on Stationary Wavelet Transform technique and uses Singular Value Decomposition method. Thus has been named SWT-SVD. A comparative analysis of DWT-SVD and the proposed SWT-SVD algorithm has been presented. The suppression of translation invariance in the SWT method improves the performance of the watermarking algorithm as is visible in the improved in the PSNR values as compared to the DWT-SVD method

## REFERENCES

[1] Neha Narula, Deepak Sethi, and Partha Pratim Bhattacharya," Comparative Analysis of DWT and DWT-SVD Watermarking Techniques in RGB Images", International Journal of Signal Processing, Image Processing and Pattern Recognition,Vol. 8, No. 4 (2015), pp. 339-348.
[2] Nidhi Bisla, Prachi Chaudhary," Comparative Study of DWT and DWT-SVD Image Watermarking Techniques", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 6, June 2013.
[3] C.P.Sumathi, T.Santanam and G.Umamaheswari," A Study of Various Steganographic Techniques Used for Information Hiding", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.4, No.6, December 2013.
[4] Dipesh Agrawal and Samidha Diwedi Sharma," Analysis of Random Bit Image Steganography Techniques", International Journal of Computer Applications (0975 – 8887) International Conference on Recent Trends in engineering & Technology – 2013.
[5] Abbas Cheddad, Joan Condell, Kevin Curran and Paul Mc Kevitt," Digital Image Steganography: Survey and Analysis of Current Methods", Signal Processing, Volume 90, Issue 3, March 2010, Pages: 727-752\
[6] Anil Kumar and Rohini Sharma," A Secure Image Steganography Based on RSA Algorithm and Hash-LSB Technique", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 7, July 2013.
[7] Ramadhan Mstafa and Christian Bach," Information Hiding in Images Using Steganography Techniques", 2013 ASEE Northeast Section Conference, Norwich University, March 14-16, 2013.
[8] C. C. Lai and C. C. Tsai, "Digital Image Watermarking Using Discrete Wavelet Transform and Singular Value Decomposition," in IEEE Transactions on Instrumentation and Measurement, vol. 59, no. 11, pp. 3060-3063, Nov. 2010. doi: 10.1109/TIM.2010.2066770
[9] S. Kapre Bhagyashri and M. Y. Joshi, "All frequency band DWT-SVD robust watermarking technique for color images in YUV color space," 2011 IEEE International Conference on Computer Science and Automation Engineering, Shanghai, 2011, pp. 295-299. doi: 10.1109/CSAE.2011.5952684.
[10] ISO/IEC 14495-1, ITU T.87, "Information technology - Lossless and near-lossless compression of Continuous tone still images," 1999.
[11] M. J. Weinberger, G. Seroussi, and G. Sapiro, "LOCO-I: A low complexity, context-based, lossless image compression algorithm," in Proc. DCC'SG, (Snowbird, Utah, USA), pp. 140-149, Mar. 1996.
[12] S.Ramakrishnan, T.Gopalakrishnan, K.Balasamy," SVD Based Robust Digital Watermarking For Still Images Using Wavelet Transform", CCSEA 2011, CS & IT 02, pp. 155–167, 2011.
[13] Chun-Hsiang Huang, Chih-Hao Shen & Ja-Ling Wu," Fidelity-Controlled Robustness Enhancement of Blind Watermarking Schemes Using Evolutionary Computational Techniques", Volume 3304 of the series Lecture Notes in Computer Science pp 271-282
[14] Min-Jen, T., & Jung, L ,"The quality evaluation of image recovery attack for visible watermarking algorithms", Paper presented at the Visual Communications and Image Processing (VCIP), 2011 IEEE, (2011, 6-9 Nov. 2011).
[15] M. Kim, D. Li and S. Hong, "A Robust Digital Watermarking Technique for Image Contents based on DWT-DFRNT Multiple Transform Method", International Journal of Multimedia and Ubiquitous Engineering,Vol.9, No.1 (2014), pp.369-378.

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