

# Hybrid Non-Blind Color Image Watermarking

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## ABSTRACT

*Digital multimedia content has progressively becoming an important issue because image watermarking is identified as a foremost technology used in copyright protection. The main requirement for image watermarking is its imperceptibility and robustness. To achieve these requirements, a new approach for image watermarking based on singular value decomposition (SVD) and discrete wavelet transform (DWT) is proposed in this paper. Modification of the appropriate sub-bands leads to a watermarking scheme which positively preserves the quality. The additional advantage of the proposed technique is security, imperceptibility and its robustness against the most of common attacks. In this method, the singular values of DWT coefficients of B-plane are modified using different scaling factors to insert the singular values of watermark. The singular values of R, G, B planes of watermark are embedded into the three sub-bands LH, HL, HH of B-plane in host image. The proposed watermarking is realized by using MATLAB and evaluated by using performance metrics MSE, PSNR.*

**Keywords:-** Watermark, DWT, SVD, PSNR and MSE

## 1. INTRODUCTION

Digital data utilization along with the increased popularity of the internet has facilitated information sharing and distribution. Watermark, which is usually some information related to original data or the owner, is embedded in the original data; then the watermarked data is distributed throughout computer networks. Considering the applications of such systems, the watermark can be extracted from the media. Watermarking is the process of embedding a watermark into the host image, video or audio. To get more efficient output the watermark should be perceptually invisible & difficult to remove without affecting the image quality and should robustly resist to image distortions caused by attacks. The watermarking techniques can be classified into – Spatial domain techniques & Frequency domain techniques [1]-[2]. Spatial domain technique embeds the data by directly modifying the pixel values of the original image [3]-[4]. In Frequency domain technique, data will be embedded by modulating the coefficients of preferred transform. The most commonly used transforms are SVD, DWT, DCT & DFT. The transform domain techniques always give most robust output [5]. In few schemes, both watermark and host images are preprocessed in transformed domain to achieve high rigidity. In the literature, many schemes uses the SVD-DWT based embedding for gray scale image watermarking. The proposed scheme embeds the color watermark into color cover image. The color image is represented by Red (R), Green (G) and Blue (B) channels. Out of these three channels, change in the intensity of R channel is the most sensitive to human eyes whereas for B channel it is least sensitive [6]-[7]. Hence, in the proposed scheme the blue channel is considered for embedding. The wavelet transform of image gives four frequency sub-band coefficients. In image processing each subband is resistant to different types of attacks or transformations. For example, the low frequency subband coefficients are less robust to geometrical distortions and histogram equalization. In the proposed scheme the copy of the watermark is embedded into three subband coefficients which is hard to destroy the watermark even after the different types of attacks on the watermarked images. To improve the robustness of the scheme the watermark is embedded into different sub-band coefficients obtained from B channel of the color image.

## 2. DWT AND SVD TRANSFORMATIONS

In this section we discuss in brief the Discrete Wavelet Transform and Singular Value Decomposition of images [8]-[9].

### 1. Discrete Wavelet Transform

As one of the most glorious achievement in 20<sup>th</sup> century, DWT has become the most useful tool for image compression, processing and analysis. The basic idea is to multi-frequency decompose the image into subbands at different frequency and different space, then to process the coefficients of the subbands [10]. A DWT decomposes Image into four subbands: low frequency band (LL), horizontal detail band (HL), vertical detail band (LH), and diagonal detail band (HH). The image's energy is mainly focused on the low frequency band. The other three bands characterize the marginal information of the corresponding direction and have little energy.

**2. Singular Value Decomposition**

If a  $m \times n$  image is represented as a real matrix  $A$ , it can be decomposed as:

$$A = U S V^T$$

It is called a singular value decomposition of  $A$ . Where  $U$  is a  $m \times m$  unitary matrix,  $S$  is a  $m \times n$  matrix with nonnegative numbers on the diagonal and zeros on the off diagonal, and  $V^T$  denotes the conjugate transpose of  $V$ , an  $n \times n$  unitary matrix [6]. The nonnegative components of  $S$  represent the luminance value of the image. Changing them slightly does not affect the image quality and they also don't change much after attacks, watermarking algorithms make use of these two properties [7].

**3. PROPOSED SCHEME**

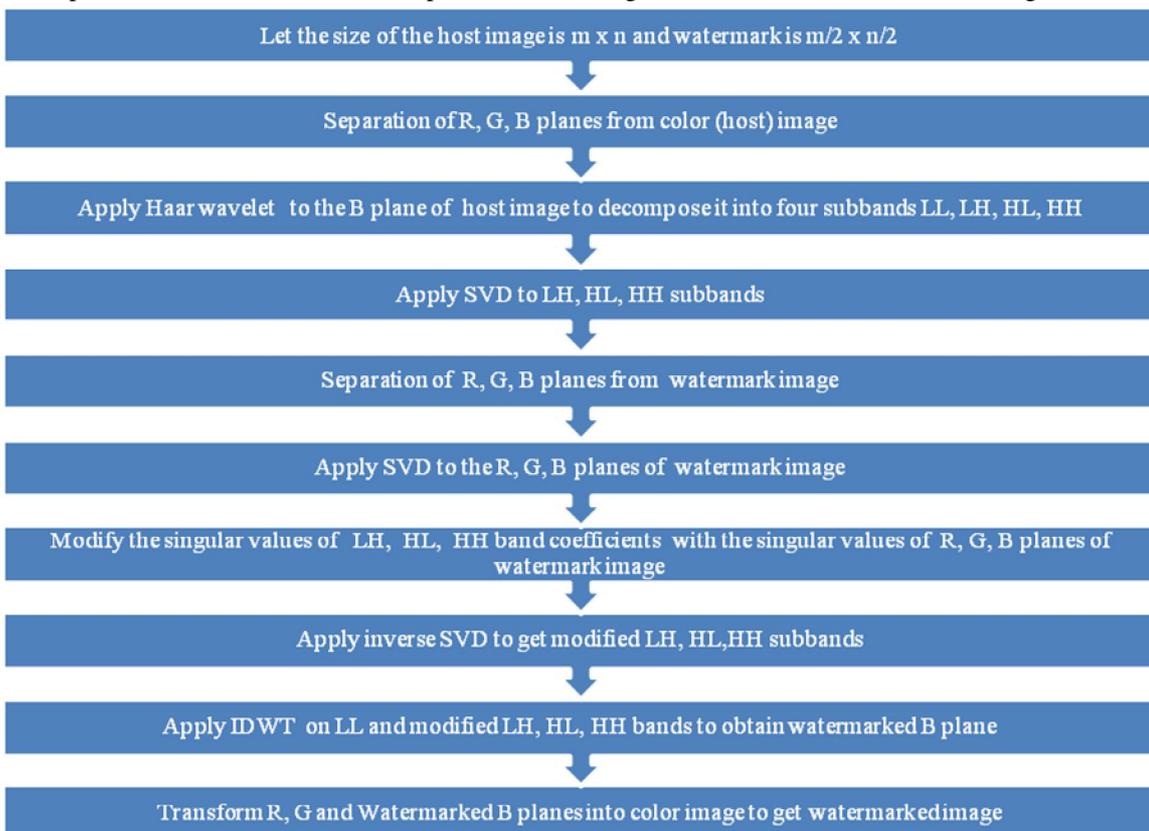
The proposed scheme is based on the idea of replacing the frequency coefficients of LH, HL, and HH with singular values of R, G, B planes of watermark image [10]. The watermarking procedures can be described as follows:

**Watermark Embedding:**

The proposed method uses the color image  $I$  of size  $m \times n$  as the host image and the color/ monochrome image  $W$  of size  $m/2 \times n/2$  as the watermark. The color image is transformed into R, G and B planes of size  $m \times n$ . Human eyes are less sensitive to change in the intensity of the B plane. So the B plane is chosen for watermark embedding. Then two-level DWT is applied on the B plane to generate subband coefficients LL, LH, HL, HH of size  $m/2 \times n/2$ . The SVD decomposition is applied on detail subband coefficients and R, G, B planes of watermark. The singular values of three planes of watermark are added to the subbands (LH, HL, HH) of the DWT transformed B plane using scaling factor  $a$ .

$$\lambda_i^l = \lambda_i + a \lambda_w \tag{1}$$

Now the inverse DWT is applied on the modified subband coefficients of B plane to achieve the embedded B plane. The embedded B plane is combined with R and G planes of host image to achieve watermarked color image.



**Figure 1:** Flowchart for Watermark Embedding

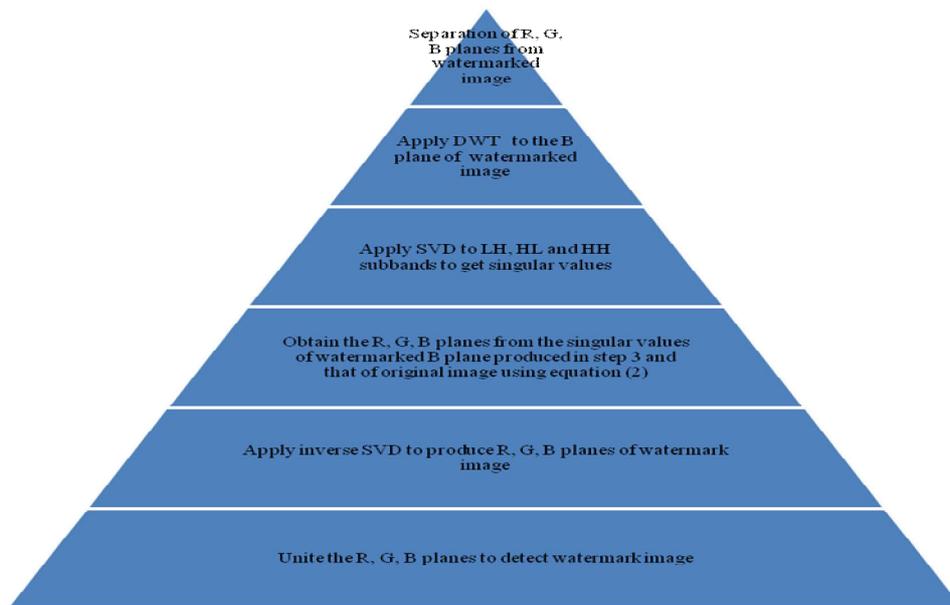
**Watermark Extraction:**

As non-blind watermarking technique uses the host image and watermark image to extract the Watermark, this extraction process uses the host image  $I$ , watermarked color image  $I'$  each of size  $m \times n$  and the watermark image  $W$  of size  $m/2 \times n/2$ . The original and the watermarked color images are transformed into R, G and B planes. On the B plane of the image  $I$ , DWT is applied to create subband coefficients LL, LH, HL, HH of size  $m/2 \times n/2$ . The SVD decomposition is applied to LH, HL, HH subbands. The singular values of R, G, B planes of watermark are extracted

from the (LH', HL', HH') of the DWT transformed B plane of color image and watermarked color image using scaling factor a.

$$\lambda_w = \frac{\lambda_i^l - \lambda_i}{a} \tag{2}$$

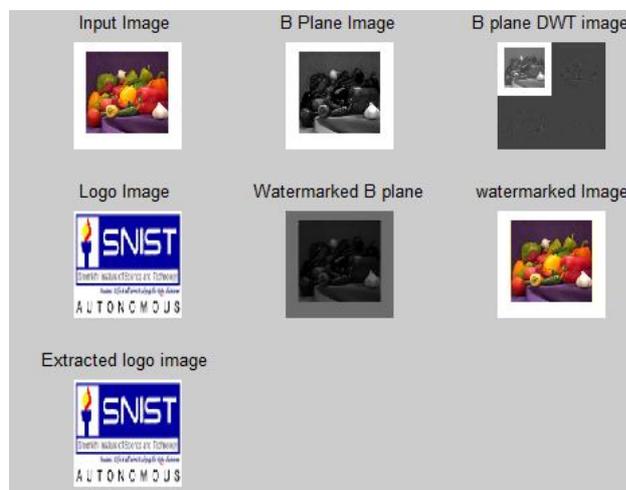
The extracted singular values of watermark are combined with other matrices of watermark to generate the watermark image. In this paper, we are using Mean square error (MSE) and Peak Signal to Noise Ratio (PSNR) to estimate the watermark imperceptibility [10].



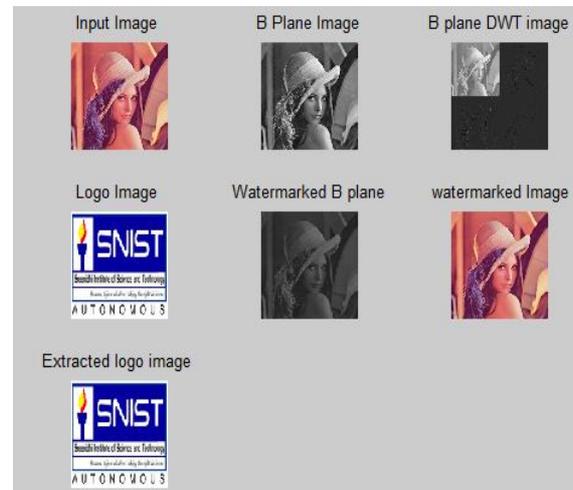
**Figure 2:** Flowchart for Watermark Extraction

**4. EXPERIMENTAL RESULTS**

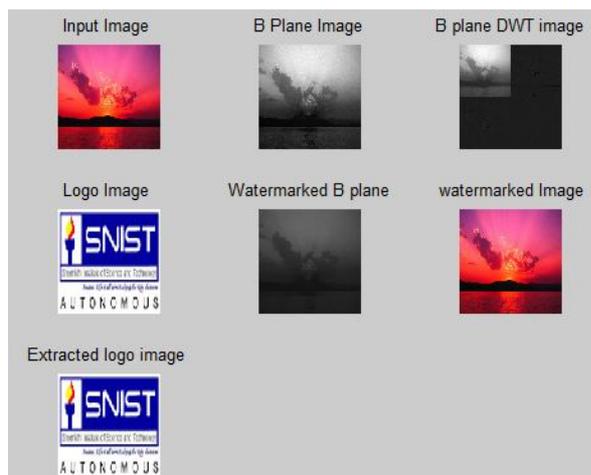
The proposed watermark scheme is tested on different types of images for various scaling factors. In our experiments 256x256 color images namely Lena, Peppers, Sunset, Balloon, autumn were used as shown in figures 3 – 7. 128x128 colour SNIST logo is used as a sample watermark. MATLAB is used for the implementation of the proposed algorithm. The following figures show input (host) image, extracted B plane, DWT domain of B plane, logo (watermark) image, watermarked B plane, watermarked image and extracted logo image for scaling factor of 0.01.



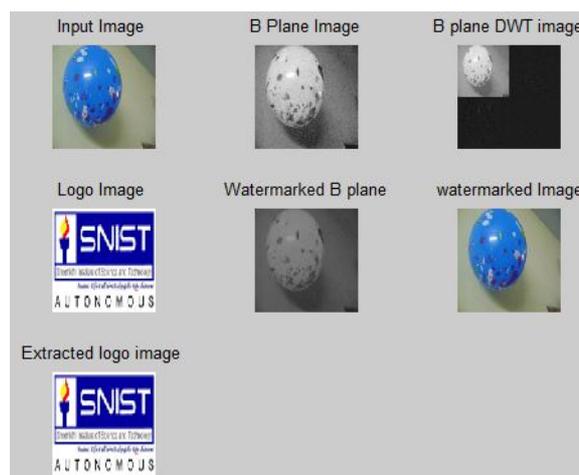
**Figure 3** Results of peppers image



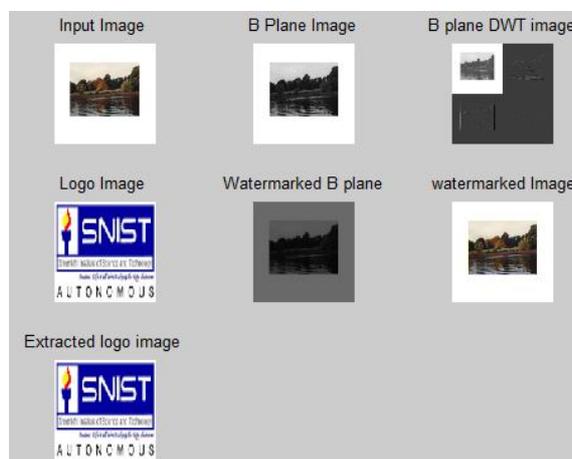
**Figure 4** Results of Lena image



**Figure 5** Results of sunset image



**Figure 6** Results of Balloon image



**Figure 7** Results of autumn image

To evaluate the performance of the proposed method, PSNR and MSE are used. From the observed results, PSNR and MSE are evaluated between host and watermarked images at various scaling factors as shown in Table 1, where we observe that the PSNR value decreases as scaling factor increases. Increased scaling factor gives large error between host and watermarked images.

**Table 1:** Performance results in terms of PSNR AND MSE

Scaling Parameter	Images	MSE	PSNR
0.01	peppers	0.1097	57.7293
	Lena	0.1589	56.1184
	sunset	0.1500	56.3707
	balloon	0.1586	56.1282
	autumn	0.0909	58.5457
0.03	peppers	0.5238	50.9390
	Lena	0.9475	48.3652
	sunset	0.9204	48.4911
	balloon	1.0393	47.9633
	autumn	0.4471	51.6270
0.05	peppers	0.9221	48.4831
	Lena	1.8017	45.5740
	sunset	1.7653	45.6625
	balloon	2.1232	44.8608
	autumn	0.7736	49.2458
0.07	peppers	1.2989	46.9951

	Lena	2.5606	44.0473
	sunset	2.5939	43.9913
	balloon	3.1734	43.1155
	autumn	1.0429	47.9482
0.10	peppers	1.8155	45.5408
	Lena	3.5505	42.6279
	sunset	3.7821	42.3535
	balloon	4.5513	41.5494
	autumn	1.3688	46.7673
0.50	peppers	5.0941	41.0601
	Lena	8.9300	38.6223
	sunset	10.6495	37.8575
	balloon	10.9652	37.7306
	autumn	3.2872	42.962
1.00	peppers	6.2729	40.1561
	Lena	10.8436	37.7791
	sunset	12.3519	37.2135
	balloon	12.4881	37.1658
	autumn	4.0283	42.0796

## 5. CONCLUSION

In this paper, A Hybrid technique has been introduced for colour image watermarking based on DWT and SVD. The singular values of watermark are added to the singular values of detailed coefficients of DWT domain of the original image. In simulation, we go through the different scaling factors to embed the watermark in different images of size 256x256. Here we observe that PSNR decreases and MSE increases with increased scaling factors. It has been observed that PSNR and MSE values of our proposed algorithm are better than those of SVD algorithm. The characteristics of SVD lead to the best performance of this algorithm in both security and robustness. Further research can be carried out with the singular values of watermark to be embedded in singular values of DCT coefficients of DWT domain.

## References

- [1] Potdar VM, Han S, Chang E, "A Survey of digital image watermarking techniques", Proceedings of *IEEE international Conference on industrial informatics*, 2005, pp. 709-716
- [2] Chandra D.V.S.; "Digital image watermarking using singular value decomposition", *Circuits and Systems 2002. MWSCAS-2002*, vol.3, 4-7Aug 2002, pp. 264-267
- [3] N. Nikolaidis and I. Pitas, "Robust image watermarking in the spatial domain", *Signal Processing*, Vol.66, No.3,pp.385-403, 1998.
- [4] R. Liu, T. Tan, "An SVD –based watermarking scheme for protecting rightful ownership", *IEEE Transaction on Multimedia* Volume 4, issue 1, March 2002 pp121-128.
- [5] S. Mallat,"The theory for multiresolution signal decomposition: the wavelet representation", *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 11, no. 7, pp.654-693, Jul.1989.
- [6] Q. Li, C. Yuan and Y.Z. Zhong, "Adaptive DWT – SVD domain image watermarking using human visual model", in *Proc. 9<sup>th</sup> Inst. Conf. Adv. Commun. Technol.*, Gangwon-Do, South Korea, 2007, pp. 1947-1951.
- [7] X.P. Zhang, K.Li comments on "An SVD-Based Watermarking scheme for Protecting Rightful Ownership", *IEEE Transaction on multimedia* Vol.7,no.2,2005, pp.593-594.
- [8] Chin Lai and Cheng-Chih Tsai,"Digital Image Watermarking Using Discrete Wavelet Transform and Singular Value Decomposition", *IEEE Transactions in Instrumentation and Measurement.*, Vol.59, no. 11, pp.3060-3063, Nov. 2010.
- [9] G. Bhatnagar and B. Raman, "A new robust reference watermarking scheme based on DWT-SVD", *Comput. Standards Interfaces*, Vol.31, no. 5,pp.1002-1013, Sep.2009.
- [10] E.Ganic and A.M.Eskicioglu,"Robust DWT-SVD domain image watermarking: Embedding data in all frequencies",in *Proc. Workshop Multimedia Security*, Magdeburg, Germany, 2004, pp. 166-174.