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Performance comparison of Image watermarking using wavelet transform for different colour component of cover image

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Abstract -The Performance of the DWT based watermarking technique has been established by many researchers. The embedding performance is highly different on the disturbance in the colour components of a cover image. In this paper, the performance of watermarking on embedding side and recovering side has been demonstrated with use of red green and blue part of image separately. The performance comparison in terms of RMSE, PSNR and normalized cross correlation coefficient has been given. The effect of embedding gain is established for all these parameters are given in the paper.

Keywords: Watermarking, DWT, wavelet families, PSNR etc.

I. INTRODUCTION

The image is an effective media for information exchange. There are different copywriters has been used for the images and video. The protection of images and video is essential for these type of copywriters. The watermarking is an important technique for prevention the copywriters. Watermarking is the process that embeds data called a watermark into a multimedia object such that watermark can be detected or extracted later to make an assertion about the object. Watermarking is either "visible" or "invisible". Although visible and invisible are visual terms watermarking is not limited to images, it can also be used to protect other types of multimedia object. A Watermarking is adding "ownership" information in the multimedia data to prove the authenticity. This technology embeds a secrete data, an unperceivable digital code, namely the watermark, carrying information about the copyright status of the work which is to be protected. Continuous efforts are being made to device an efficient watermarking schema, the techniques proposed so far not having robustness to all attacks on the multimedia and multimedia data processing operations. Considering the enormous financial implications of copyright protection, there is a need to establish a globally accepted watermarking technique. Digital audio, video, and images are increasingly furnished with distinguishing but imperceptible marks, which may contain a hidden copyright notice or serial number or even help to prevent unauthorized copying directly.

Based on object- Text Watermarking: Watermark is embedding into text file.

Image Watermarking: Watermark is embedding into image.

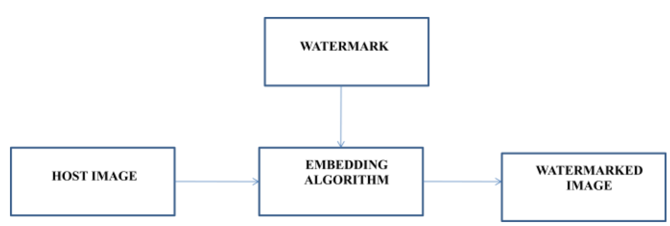

Fig: - 1. Schematic Flow of Image Watermarking

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II. SYSTEM MODEL

In this section Watermarking is a method used to embed "secret" information into an original image by engaging different approaches. This can be visually identified on the images or not. The following method was used to embed the data into the plain image using MATLAB.

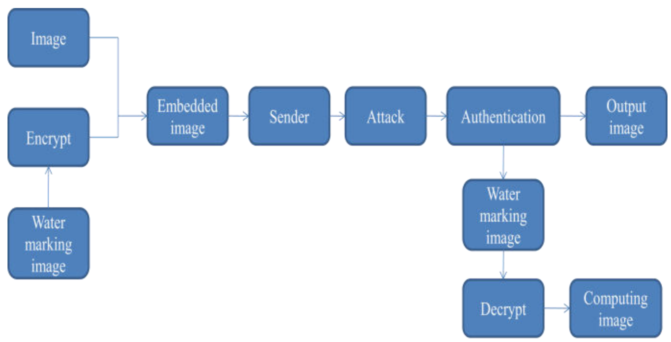

Fig: 2.Watermarking System

III. PREVIOUS WORK

In 2011 Manjit Thapa introduce an algorithm for digital image watermarking technique based on singular value decomposition; both of the L and U components are explored for watermarking algorithm. This technique refers to the watermark embedding algorithm and watermark extracting algorithm. The experimental results prove that the quality of the watermarked image is excellent and there is strong resistant against many geometrical attacks [1].

In 2012 Seema presented robustness and imperceptibleness of the algorithm, a new embedding and extracting method with DWT-SVD is proposed. The approximation matrix of the third level of image in DWT domain is modified with SVD to embed the singular value of watermark to the singular value of DWT coefficient. The proposed embedding and extracting method was employed to accelerate the hybrid DWT-SVD watermarking and to avoid the leak of watermark. This hybrid technique leads to optimize both the fundamentally conflicting requirements. The experimental results show both the good robustness under numerous attacks and the high fidelity. The time needed to perform the program is greatly decreased [2].

In 2013 N.A.Mosa presents the hybrid image watermarking algorithm for color images based on Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT). The cover image is converted from RGB color space into YCbCr color space, then the luminance component is partitioned into non-overlapping blocks of pixels according to the number of bits of the original watermark; and DCT conversion is performed for each block separately. After DCT transformation, the DWT is performed and vertical component, LH is taken out for embedding the watermark. Finally, the watermark information is embedded using new mathematical formula. Simulation results show that this method is imperceptible and robust with respect to a wide variety of conventional attacks like noise addition, filtering, cropping and JPEG compression [3].

In May 2013 Sangeeta Madhesiya introduced, a Digital Watermarking Algorithm based on DWT-DCT-Singular Value Decomposition and Arnold Transform is proposed. The DCT-SVD based method is very time consuming while the process of SVD-DWT-DCT and Arnold Transform method is found to be very fast and this new method was found to satisfy all the requisites of an ideal watermarking scheme such as imperceptibility, robustness and good capacity. This method can be used for authentication and data hiding purposes [4].

In May 2014 Manpreet Kaur presented the protection and illegal redistribution of digital media has become an important issue because of popularity and accessibility of the internet now days by people. Digital watermarking is used to protect the information against the illegal distribution in the form of images, videos and audios. Digital image watermarking technique is the process of embedding watermark in the form of image that contains the special information and then it detect and extract that special information. The robustness, copyright protection, fidelity, capacity and some more are essential requirements of watermarking schemes so that they can handle several types of image processing attacks. This paper reviews different aspects and techniques of digital image watermarking for protecting digital contents [5].In 2014 RAVIKANT S. MENDEGAR et al presented, a Digital Watermarking Algorithm based on Arnold, DWT and SVD is proposed. The DCT-SVD based method is very time consuming while the process of SVD-DWT and Arnold Transform method is found to be very fast and this new method was found to satisfy all the requisites of an ideal watermarking scheme such as imperceptibility, robustness and good capacity. This method can be used for authentication & data hiding purposes and the mentioned objectives have been achieved.

The use of this scheme can be extended to various video formats like .avi, .flv, .mp4, .3gp etc and watermark can be embedded on black-white as well as on color videos and also to solve the problems regarding frame ambiguity [6].

In November- 2015 Namrata R. Deshmukh presented that this watermarking system can keep the image quality as well as it is robust against many common image processing Operations of filer, sharp enhancing, adding salt noise, image compression, image segmentation and so on. This algorithm has strong capability of embedding single and anti-attack.

IV. PROPOSED METHODOLOGY

Discrete Wavelet Transform (DWT)

Wavelet transform decomposes an image into a set of band limited components which can be reassembled to reconstruct the original image without error. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four non-overlapping multi-resolution sub bands, a lower resolution approximation image (LL1), horizontal (HL1), vertical (LH1) and diagonal (HH1) detail components. The process can be repeated to obtain multiple scale wavelet decomposition. The information of low frequency district is an image close to the original image. Most signal information of original image is in this frequency district. The frequency districts of LH, HL and HH respectively represents the level detail, the upright detail and the diagonal detail of the original image. According to the character of HVS, human eyes are sensitive to the change of smooth district of image, but not sensitive to the tiny change of edge, profile and streak. Embedding the watermark in the higher level sub bands increases the robustness of the watermark. However, the image visual fidelity may be lost, which can be measured by PSNR. With the DWT, the edges and texture can be easily identified in the high frequency band .Therefore it's hard to conscious that putting the watermarking signal into the big amplitude coefficient of high-frequency band of the image DWT transformed. Then it can carry more watermark signal and has good concealing effect.

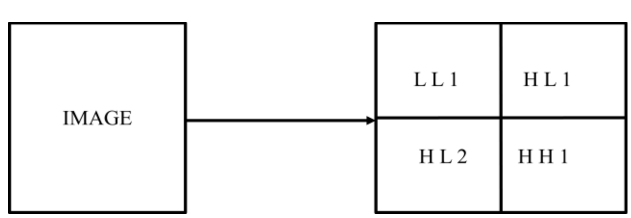

Fig: 3. Single level DWT

Watermarking Embedding Process

In the proposed approach, the embedded watermark must be invisible to human eyes and enough robust to some image processing operations. Before insertion, the host image color system (RGB) is converted to another color space (YCbCr) and then the histogram of the color values is calculated to find out the high pixel values in the host image. YCbCr is not an absolute color space; it is a way of encoding RGB information. The actual color displayed depends on the actual RGB colorants used to display the signal. Therefore a value expressed as YCbCr is only predictable if standard RGB colorants are used. Since the watermark is added to the luminance, the RGB color space of the image should be converted to YCbCr color space. The Y component is used later to embed the watermark. As in the spatial domain the color space of the original image is converted form RGB to the YCbCr system. And then the Y (Luminance) channel which is adequate with a visual system is chosen to add the watermark data.

RGB Color Spaces Some of researches have used RGB color space for watermark embedding. First R, G, B planes are separated by using equations 1, 2, 3 and either one of these planes or combination of two can be used for embedding.

R = image (: ; : ; 1)
G = image (: ; : ; 2)
B = image (: ; : ; 3)

But, RGB color space is complex in describing the color pattern and has redundant information between each component [5]. Since Pixel values in RGB color space are highly correlated, RGB color space is converted into YUV or YIQ color spaces.

B. YUV Color Spaces Here, RGB color space is converted into YUV Color space and then Watermark is embedded. Initially color image is read and R, G, B components of original Cover Image are separated. Then they are converted into YUV color Space using following equations.

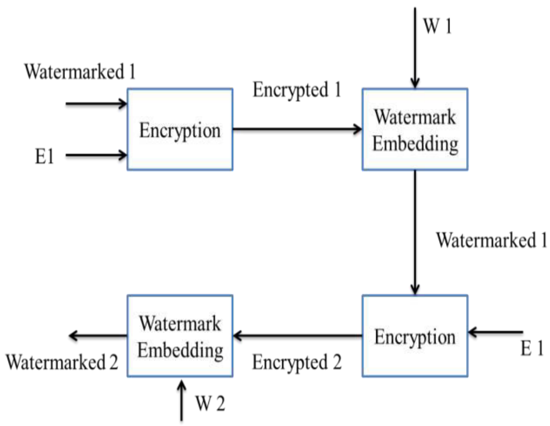

Fig: 4. Watermark embedding process

Watermark 1 – a binary image act as a watermark that embed in the main watermark.

Watermark 2 – a binary image act as main watermark. Cover Image – gray scale image to be watermarked.

E1 – key used for encrypting Watermark1

E2 – key used to encrypt watermarked watermark.

W1 – key used to embed encrypted binary watermark into the main watermark.

W2 – key used to embed encrypted watermarked watermark in Cover Image

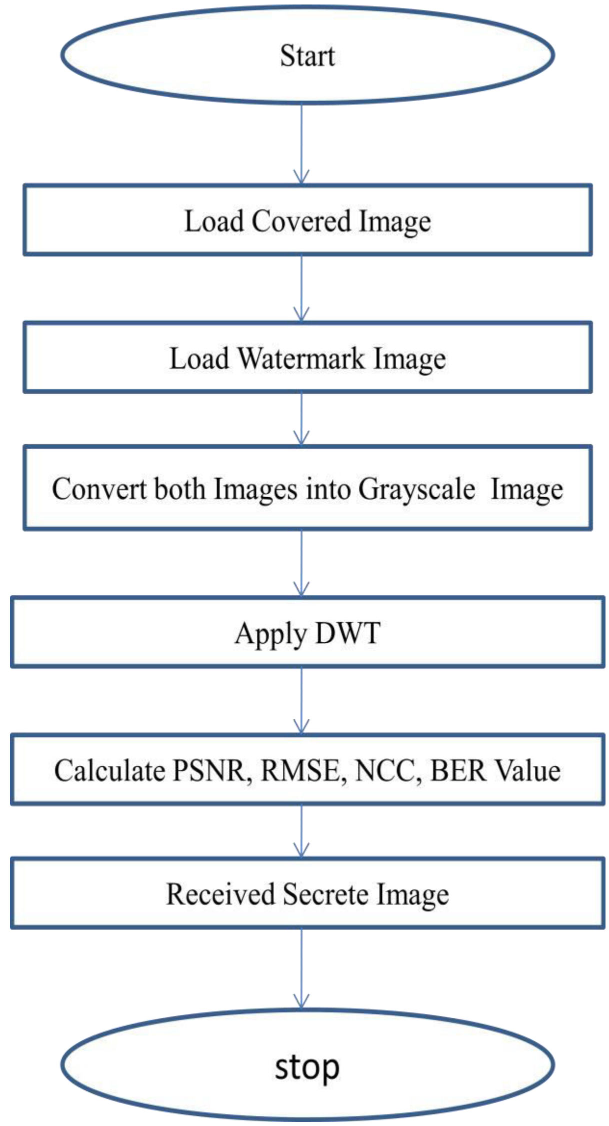

Fig: 5. Block Diagram of Watermarking Procedure

Proposed algorithm

1) Load the cover image (original image).
2) Load the watermark (secret) image.
3) Covert both images into grayscale images from step1 and2
4) Perform level watermarking using discrete wavelet transform.
5) Give the secret watermark key for the protection of the secret image.
6) Calculate the PSNR, RMSE, NCC, BER value of the image
7) Apply inverse DWT for the detection of watermark.
8) Receive the Secrete image.

V. SIMULATION/EXPERIMENTAL RESULTS

In order to authenticate the performance of the proposed technique, simulation is done on widest of cover images and watermarks using MATLAB12a. The cover image is of size 128X128 grayscale images as shown in figure and watermark is of size 64X64 as shown in figure. As indicated in figure 4 the watermark is divided into two shares after applying visual cryptography. This is represented as visual crypt watermark 1 and 2 respectively. The decrypted watermark 1 is the share 1 of the watermark extracted from the watermarked images. This is combined with the visual crypt watermark 2 to get the extracted watermark.

Fig:- 6. Original Image

Fig:-7. Original Image Convert to grey

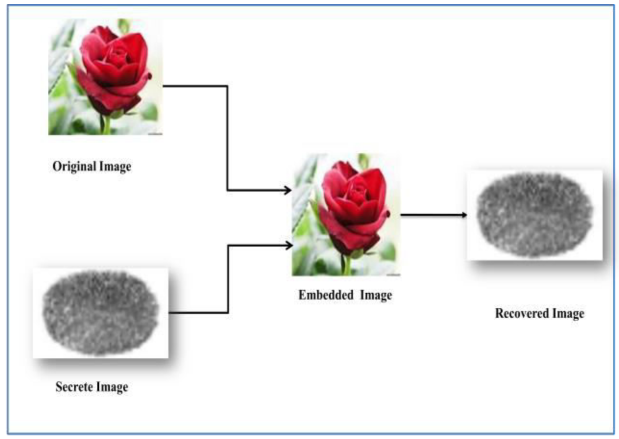

Fig:-8. Image Processing In Watermarking System

The results of RMSE, PSNR and NCC are given below:-

For testing the performance of our proposed watermarking schemes for gray scale images, we are using two standard test images, gray level test images of rose image [256x256] for cover images and for watermark we are using thumb image [64x64] pixel.
Quality of the watermarked image is calculated using peak signal to noise ratio (PSNR).

PSNR of an image can be calculated using the mean squared error.

$$\mathrm{PSNR} = 10\,.\log_{10}\frac{\mathrm{MAX}_1^2}{\mathrm{MSE}}$$

The recovered mean squared error (RMSE) between the original image and the watermarked image is given by:

$$\mathrm{MSE} = \frac{1}{mn}\sum_{\mathrm{i}=0}^{\mathrm{m}-1}.\sum_{\mathrm{j}=0}^{\mathrm{n}-1}[\mathrm{l}(i,j) - \mathrm{k}(\mathrm{i},\mathrm{j})]^2$$

where, $I(i\,,\,j)$ and $I'(i\,,\,j)$ denote the pixel value at position(i, j) of the original image I and the watermarked image I'. Both having sizes m x n pixels.

NC (Normalized correlation): We measure the similarity between the original watermark and the watermark extracted from the attacked image using the normalized correlation factor.

Normalized Correlation Factor is employed to evaluate the robustness of the algorithm. The Normal Correlation (NC) between the embedded watermark, W (i, j) and the extracted watermark W*(i, j) is given by:-

$$NC = \frac{\sum_{i=1}^{n} \cdot \sum_{j=1}^{m} w\,(i,j) * w\,(i,j)}{\sum_{i=1}^{n} \cdot \sum_{j=1}^{m} w^2(i,j)}$$

BER(Bit Error Rate):- It is the ratio that describes how many bits received in error over the number of the total bits received.

$$BER = \frac{P}{H * W}$$

Where, H= Height

And W = Width

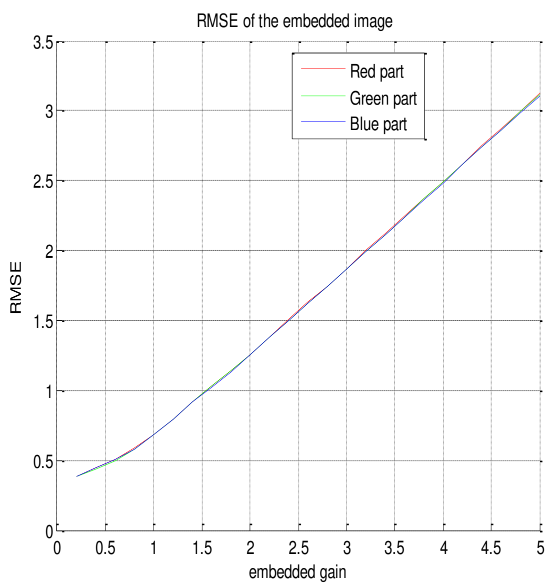

Fig: - 9. RMSE of the embedded image.

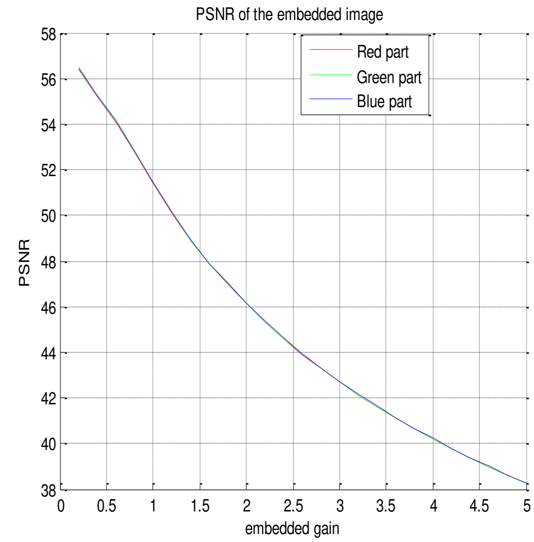

Fig: - 10. PSNR of the embedded image.

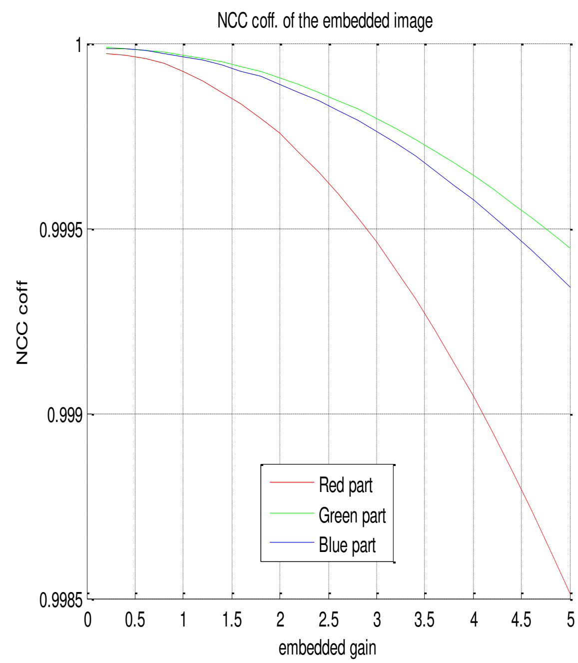

Fig: - 11. NCC of the embedded image.

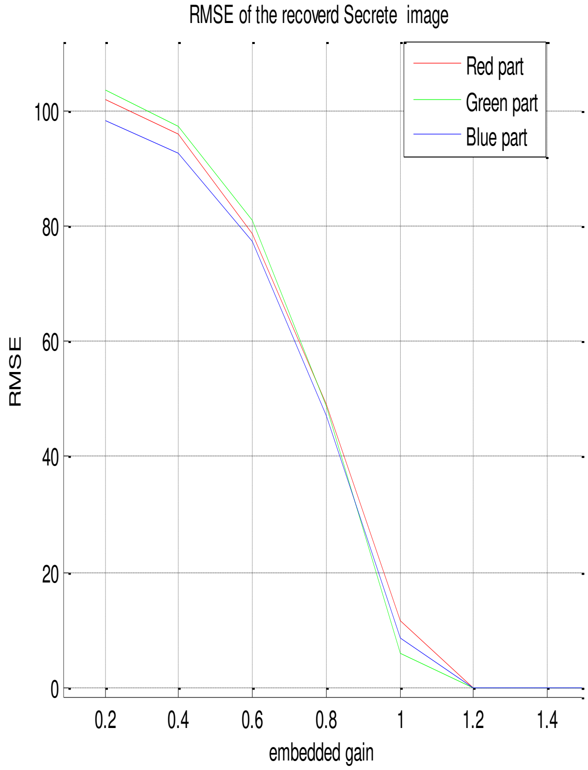

Fig: - 12. RMSE of the recovered secrete image.

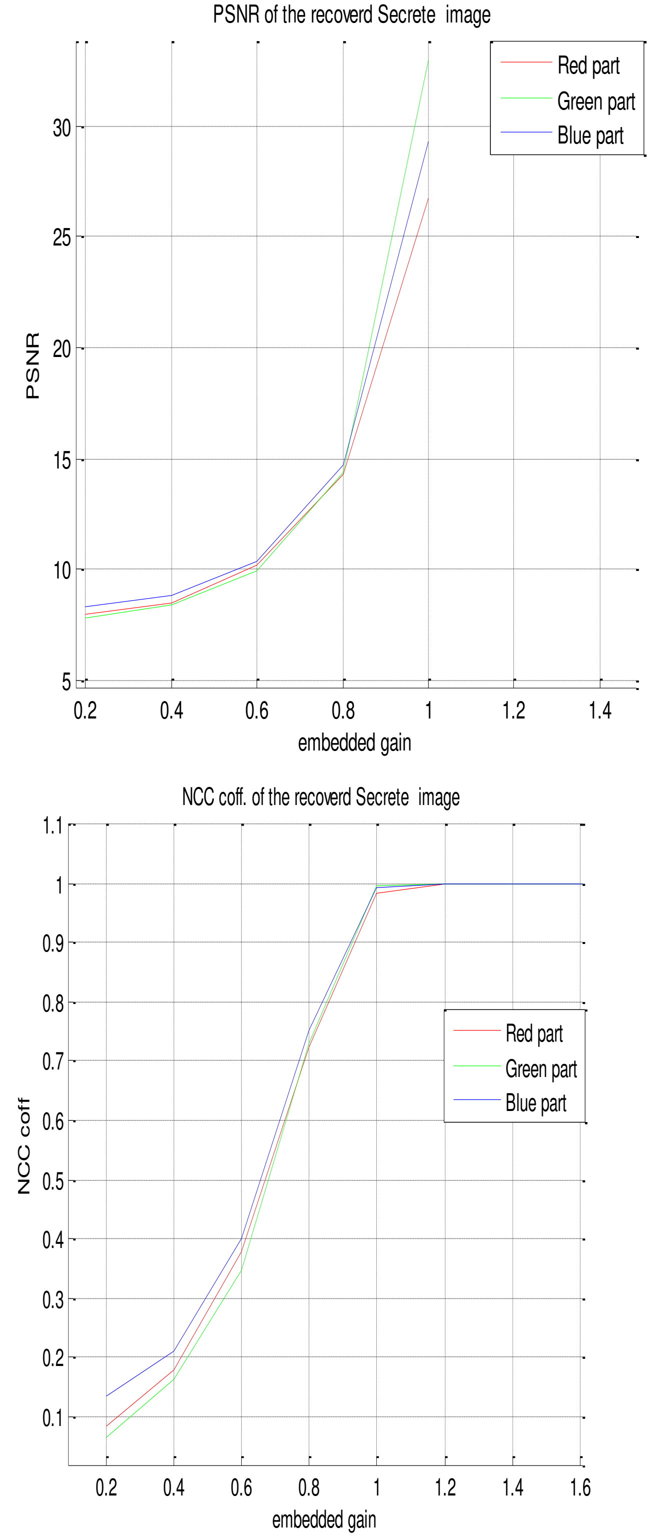

Fig: - 13. PSNR and NCC of the recovered secrete image.

The tables show RMSE, PSNR and NCC in embedded image and recovered secrete image for Red, Blue and Green Colour component. Tables are show RME, PSNR and NCC factor in less sensitive in green colour with compare red and blue.

TABLE 1. RMSE CALCULATE IN EMBEDDED IMAGE AND RECOVERED SECRETE IMAGE FOR DIFFRENT COLOUR COMPONENT

S. No.	Colour Component	Embedded Image		Recovered Secrete Image	
		E.Gain	RMSE	E.Gain	RMSE
1.	Red	0.385	0.3025	1.04	101.9
2.	Blue	0.384	3.064	0.75	98.2
3.	Green	0.381	4.700	0.50	103.5

TABLE 2. PSNR CALCULATE IN EMBEDDED IMAGE AND RECOVERED SECRETE IMAGE FOR DIFFRENT COLOUR COMPONENT

S. No.	Colour parameters	Embedded Image		Recovered Secrete Image	
		E.Gain	PSNR	E.Gain	PSNR
1.	Red	0.477	56.42	7.9	26.8
2.	Blue	0.488	56.44	8.3	29.35
3.	Green	0.499	56.52	7.8	32.95

TABLE 3. NCC CALCULATE IN EMBEDDED IMAGE AND RECOVERED SECRETE IMAGE FOR DIFFRENT COLOUR COMPONENT

S. No.	Colour parameters	Embedded Image		Recovered Secrete Image	
		E.Gain	NCC	E.Gain	NCC
1.	Red	0.84	0.97	3.80	0.994
2.	Blue	0.76	0.96	4.79	0.996
3.	Green	0.66	0.99	4.99	0.999

VI. CONCLUSION

In this paper, the simulation of the image watermarking technique has been discussed. The watermarking system has been implemented using wavelet transform of one colour part of image. In which performance of watermarking on embedding side and recovering side has been demonstrated. It has been observed that the green colour component is less sensitive to the watermarking. Hence green colour components is showing better performance in term of NCC of embedded image, PSNR and RMSE of the secrete image.

VII. FUTURE SCOPES

The green colour component is less sensitive to the watermarking for a particular case which may be explore for multiple images. However the embedding can be done local area of the colour components which may produce the more better results.

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