VOL. 14, NO. 23, DECEMBER 2019 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DIGITAL IMAGE-IN-IMAGE WATERMARKING FOR COPYRIGHT PROTECTION AND AUTHENTICATION

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ABSTRACT

The internet is an outstanding distribution and sales channel for digital assets, but copyright compliance and content management can be a challenge. If you distribute electronic images, be it online or CDs and other portable media, you are risking digital piracy. These days, digital images can be utilized - with or without consent everywhere. For the consent of the person's authentication and copyright, in this paper a digital image watermarking is proposed. The suggested digital watermarking is a method which allows a person to add invisible copyright images or notices or text messages to image and documents. In this paper, a invisible watermarking is proposed for authentication and copyright protection. This mechanism calculates the checksum for watermark and embedded within the original image at random pixels. This mechanism does not disturb the original image quality and key factors. So that intruder or unauthorized person does not identifying hiding information. From the results of the experiment, it is also observed that proposed method not only produces the quality watermarked images but also produces the quality check sum that will used for authentication.

Keywords: internet, authentication, copyright protection, digital assets, digital piracy, digital watermarking, check sum.

1. INTRODUCTION

Manipulations and flawless copying is subordinated with the magnificent multimedia processing software and the far-anchoring coverage of the interconnected systems. A consistent advancement in terms of storage and retrivalsegements has smoothened in relation with large-scale multimedia repository applications. Exploitation and wild misuse of these technologies and facilities has thrown a challenge of impending threats to multimedia security management on a general basis, and multimedia copyright protection and content integrity verification in specific [1, 2].

Cryptography has a tremendous and extended record of program to information and multimedia security. The option of not providing coverage to the media if encrypted has restricted the feasibility of its prevalent usage. Digital watermarking technique has been proposed as a panacea as a counter to these challenges in the previous decade. The small amount of the thought of digital watermarking is to embed a small amount of indiscernible highly confidential information in the multimedia so that it can be extracted later for the purposes of asserting copyright, controlling duplicity, broadcast and authenticating, confirmation of content integrity etc [3, 4].

1.1 Background

Innumerable number of watermarking schemes has been advised for various applications**.** It is anticipated from an embedded watermark to be resistant in terms of for copyright-related applications, the embedded watermark is expected to be immune to various sorts of malevolent and non-malevolent manipulations in a little purview, until the content tends to be worth in terms of monetary relevance or spare able in conditions of perceptual quality. Therefore, watermarking schemes for copyright related applications are robust [1, 2], i.e. they are made to ignore or continue to be insensitive to manipulations. Conversely, in medical, forensic, and intelligence or military applications where content integrity and source authentication are a significant matter, more emphases are put on the strategies' capacity for discovering forgeries and impersonations. Therefore, plans of this type are usually fragile or semi-fragile and are designed to be intolerant to manipulations [3, 4]. The embedding is a common indulger and incurs distortion to this content even if a watermark was created to be undiscernible to the users. Petty modifications and trivial chages in the content are not acceptable. Reversible watermarking schemes have been proposed to clear the watermark in order to recover the original media after passing the authentication process in the recent years. Digital watermarking completely vary across applications [5, 6]. The key requisites are minimum distortion, maximum capacity, and high security. Getting along with all the three requirements concurrently is not worthy as trade-offs are made to whoop up the balance for every specific application every now and then. In many applications where original media is unavailable at the watermark decoder, blind detection of the watermark without the prior understanding of the initial is desirable.

1.2 Literature survey

The present literature of the watermarking is presented in this section.

Tuncer T [7] proposed another probabilistic picture confirmation strategy. Disorganized pseudo irregular number generators, another watermark arrange which like neural system, modulo based watermark installing capacities, modulo based watermark extraction capacities, alter recognition calculation and perceptual hash based picture recuperation calculation are used for making another probabilistic picture verification strategy.

Jianzhong Li *et al.*, [8] presented new image watermarking method QDCT, SVD and watermark is CGH. U matrix is modified by inserting CGH with SVD and used different embedding strength factors.

Salah Mokhnache *et al.*, [9] propose a joined watermarking plan of pictures in view of discrete Transforms. DWT permits the deterioration of the picture after multi - determination examination in sub groups by methods for progressive sub-samplings of the picture to let a refined detachment of the low-recurrence parts with a specific end goal to frame a less touchy addition space. In the other hand, the DCT is portrayed by a partition impact of the high frequencies, from the low frequencies and the normal frequencies, giving hence the likelihood of utilizing a scope of frequencies incorporating coefficients with a high level of vitality.

Ridhima Sharma [10] displayed a picture verification conspire in view of computerized watermarking utilizing grouping. In this they utilized a mix of DCT and bunching together with picture scrambling strategy. DCT is utilized shape watermark implanting process and Fuzzy C-Means is utilized for bunching. To enhance the security of the proposed Watermarking, Arnold Transform is utilized that scrambles watermark before installing it in to the cover picture.

Bhattacharjee, T. and Maity, S.P [11] proposes, a picture in-picture correspondence method as SIS for dynamic quality access control combined with information hiding. The hidden picture is divided into few clamor like shadows of diminished size. These are then implanted into a gathering of host pictures to create stego pictures.

Priyanka *et al.*, [12] proposed another strategy that depends on the recurrence space which is known as the SVD-DWT-DCT alongside Kalman separating. Examinations are made in the before accessible and additionally the new proposed strategy. It is seen through the trial comes about that the new proposed strategy gives better outcomes.

Xiao D *et al.*, [13] propose another advanced watermarking calculation in encoded picture in light of compressive detecting estimations and 2-D DWT. In this calculation, compressive detecting is received for encryption, and watermark is inserted in the certain positions. It expand the watermark implanting limit.

Cui L *et al.*, [14] utilize basic movement parts of system as the first vector video. Right off the bat, haphazardly select a few edges from the vector video edges to install the watermarking data. Besides, the 2D DWT and pseudo 3D DCT change is picked as the handling mode to process vector video outlines in the preparing of change space. Also, utilizing the log polar facilitate change and particular esteem disintegration process vector video to get a paired arrangement.

Parah SA *et al.*, [15] presented another high limit and reversible information concealing plan for e-human services applications. The plan has been assessed for perceptual impalpability and alter location ability by subjecting it to different picture preparing and geometric assaults.

Hu WC *et al.*, [16] proposes viable picture falsification identification conspire that recognizes an altered closer view or foundation picture utilizing picture watermarking and alpha mattes. In the proposed strategy, part tint distinction based unearthly tangling is utilized to acquire the forefront and foundation pictures in light of the got alpha matte.

Chen HK and Chen WS [17] proposed a GPU-quickened visually impaired and vigorous watermarking way to deal with the 3D polygon networks based on the geometry picture change and picture watermarking, which performs watermark implanting and identification based on the geometry picture got from a circular parameterization of the information work.

Maity HK, Maity SP [18] proposes FPGA based VLSI engineering of RCM-RW calculation for advanced pictures that can fill the need of media validation progressively condition. The proposed design permits a 6-arrange pipelining procedure to accelerate the circuit task. Ali M *et al.*, [19] connected DE calculation to adjust the tradeoff amongst strength and subtlety by investigating numerous scaling factors in picture watermarking. Above all else, the first picture is divided into squares and the squares are changed into DCT space. After that watermark is installed by changing particular qualities with the solitary estimations of the watermark.

Das C *et al.*, [20] presents a novel visually impaired watermarking calculation in DCT area utilizing the connection between's two DCT coefficients of contiguous squares similarly situated. One DCT coefficient of each square is changed to bring the distinction from the nearby square coefficient in a predetermined range.

Makbol NM [21] proposed another strong and secure computerized picture watermarking plan that can be utilized for copyright insurance. The plan utilizes the whole number wavelet change and SVD. The dark picture watermark pixels esteems are inserted specifically into the particular estimations of the 1-level IWT decayed sub-groups.

Makbol NM and Khoo BE [22] present another picture watermarking plan in view of the RDWT and the SVD. The plan accomplished a huge limit because of the repetition in the RDWT space and in the meantime protected high impalpability because of SVD properties.

Zheng P *et al.*, [23] talk about the usage of WHT and its quick calculation in the encoded space, which is especially appropriate for the applications in the scrambled area for its change lattice comprises of just numbers. At that point by altering the relations among the contiguous change coefficients.

2. DIGITAL WATERMARK

Traditional paper watermark is the best juxtapose to describe a digital watermark. Attribution of proof authenticity is the basic objectivity of implying traditional watermarks. Holding up to a light with intent to notice is the only manner to observe the mark. Digital water marks are put into the similar images in a manner that a computer can sense the content that is imperceptible to the eye. A Digimarc digital watermark posesses note formulated with information about the creator or distributor of the image, or even about the image itself. The intention behind using a digital watermark is to communicate copyright information about a graphic for reducing the copyright infringement [24, 25].

2.1 Reasons to digitally watermark images

There are several reasons for using digimarc digital watermarks [26]. One is straightforward pride of authorship--the same cause that artists signal their artwork. Digital photographs are mainly at risk of lack of authorship, as visible by way of the avalanche of photographs posted daily on the world extensive internet, few of thembaresome reference to the photographer or illustrator. All the related motives are equally keen; a digimarc watermark conveys the rights and call of the copyright holder pertaining to the image. The consumer would fast approach the photo writer or distributor to license the work or commission extra work in terms of that image. Normal, digital watermarking gives creators and distributors of images three fundamental benefits:

- Appealing of copyright and safeguard the value of the images
- A continuous monitoring about the usage of images on the Web.
- Generate incremental revenue by embedding an ad in every image.

2.2 Types of digital watermarks

Techniques of watermarking and Watermarks can be divided into various classified in different methods [27]. Watermarking strategies may be categorized into 4 classes consistent with the sort of document to be watermarked as follows:

- Text Watermarking
- Image Watermarking
- Audio Watermarking
- Video Watermarking

Multiple methods enable watermarking in the spatial domain in the case of imagery. Frequency domain is the substitute to spatial watermarking

The advanced watermarks can be isolated into three unique writes as takes after.

- Obvious watermark[28]
- Undetectable-Robust watermark [29]
- Elusive delicate-Fragile watermark [30]

Obvious watermark [28] is an auxiliary translucent overlaid into the essential picture. The watermark shows up observed to a casual watcher on an intent observation. The undetectable robust [29] watermark is insert in this sort of way that changes made to the pixel esteem is perceptually not additionally seen and could be recuperated just with significant translating instrument. The elusive delicate watermark [30] is implanted in a sort that any control or alteration of the picture may manage or ruin the watermark.

2.3 Applications of digital watermarks

Obvious watermark: Visible watermarks can be utilized as a part of following cases [31].

- Visible watermarking for improved copyright assurance the substance proprietor is concerned that the picture check be utilized for business reason by means of media web
- Visible watermarking used to demonstrate possession firsts
- Invisible strong watermarks discover application in following cases [32, 33].
- Invisible Watermarking to distinguish misused pictures
- Invisible Watermarking as proof of possession
- Invisible Watermarking for a reliable camera: images are enthralled with the assistance of virtual computerized camera for a thereafter incorporation in news articles.
- Invisible Watermarking to identify variation of pictures put away in a computerized library

2.4 Watermarking for copyright protection

In case you distribute electronic images, whether it's over the internet or CDs and other portable media, you are risking virtual piracy. Actually digital images without your understanding or consent.

Your picture graphs are your intellectual assets. So it is disheartening to look images you made co-opted by means of a person else, and it's now not always smooth to show it's your images which have been swipped, specially stay even pictures. The internet multiplies the capacity for photograph piracy, it's so simple to make an unlawful reproduction, proper-click on image, or definitely click on-and-drag to the computer desktop. No copier darkroom is required.

2.4.1 Digital protection [34, 35]

Photographers who publish photographs ought to look into an updated version of darkroom era tool: the digital watermark. Numerous organizations provide software that embeds images with marks undetectable to naked eye. Visible simplest with special viewing software, a number of these watermarks may even be ferreted out through web- searching software. Digital watermark software program alters the actual pixels in an image.

2.5 Watermarking for authentication [36, 37]

Current advanced symbolism verification strategies are fundamentally in view of cryptographic ideas and computerized marks. Those plans productively shield the insights from change amid transmission, yet they give no wellbeing following transmission. For the reason that certainties longed for these plans to complete the confirmation is split away the records, an assailant can

VOL. 14, NO. 23, DECEMBER 2019 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

genuinely change the insights, recalculate the fresh out of the box new message process or advanced mark, and connect them on the whole. Without comprehension of the interesting actualities or of the bona fide validation realities, it is difficult to challenge the genuineness of the changed computerized picture. Be that as it may, on the grounds that the estimation of advanced pictures depends on its substance material, the picture bits can be adjusted to insert codes without changing the significance of its substance.

3. METHODOLOY

Watermark embedding unit and watermark detection and extraction units are the two different parts of watermarking system. An example of embedding unit is represented in Figure-1. The plain picture is gone through a perceptual examination hinder that decides the degree of the pixel that can be modified so the subsequent watermarked picture is correct like the first. This considers the human eye affectability to changes in level territories and its moderately high resilience to little changes in edges. After this supposed perceptual-maskhas been registered, the data to be covered up is formed by this veil and spread everywhere throughout the first picture.

This spreading strategy is like the interleaving utilized as a part of different applications including coding, for example, minimal plate stockpiling, to avoid harm of the data caused by scratches or residue. For this situation, the principle purpose behind this spreading is to guarantee that the concealed data survives editing of the picture.

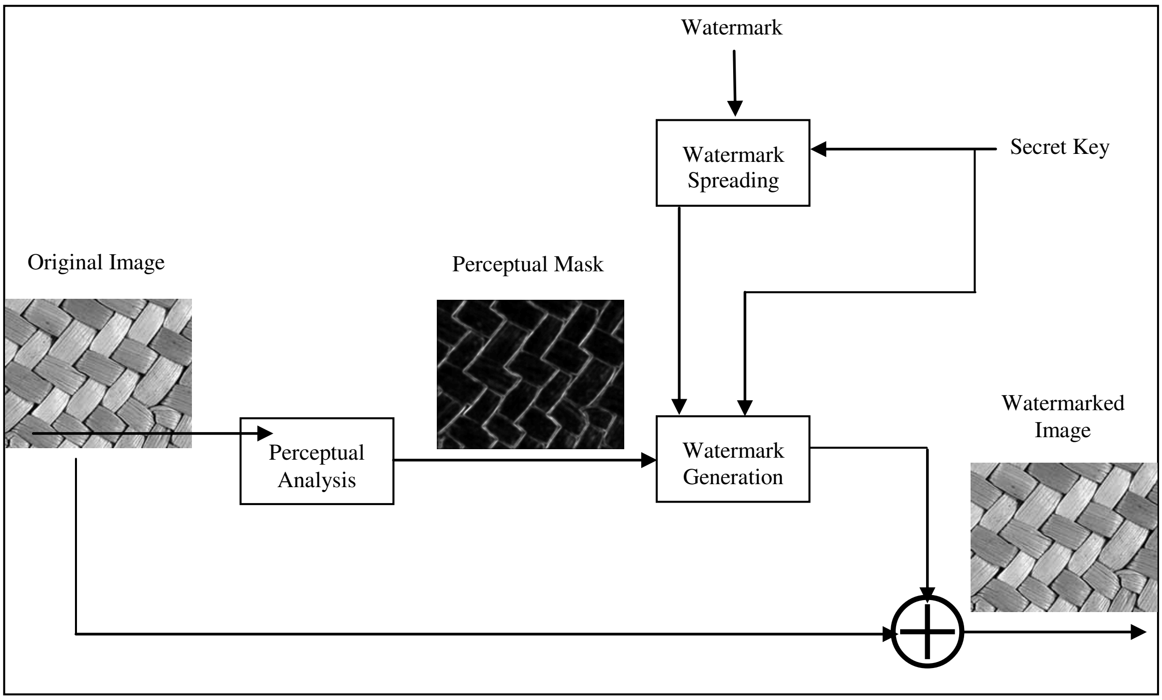

Figure-1. Watermark Insertion Unit.

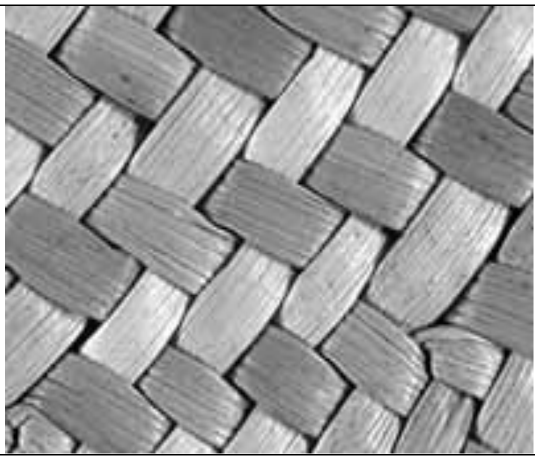	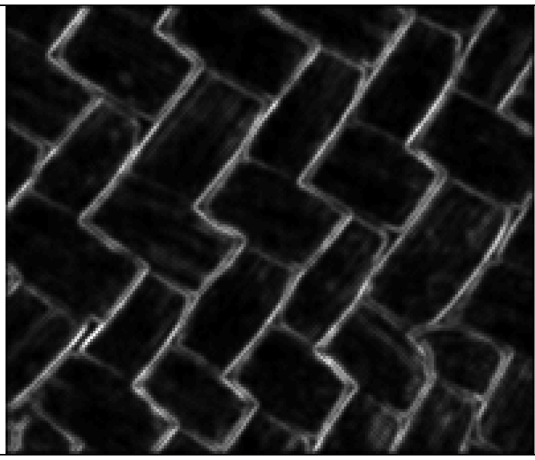
Figure-2. Original Fabric Image.	**Figure-3.** Perceptual Mask.

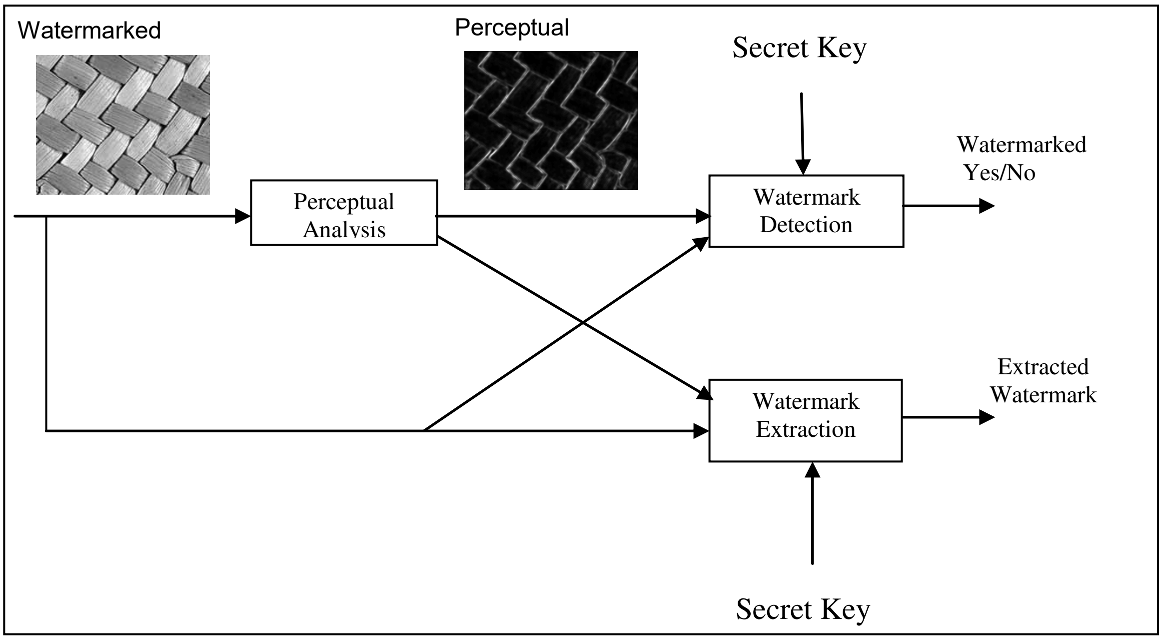

Figure-4. Watermark detection and extraction Unit.

The procedure in terms of spreading it clearly depends on the secret key, and it is obviously difficult to recover the hidden information if one is not in possession of this key. In fact, a similar technique is used in spread spectrum systems to extract the anticipated information from noise or other users. Additional key-dependent uncertainty can also be introduced in pixel amplitudes (recall that the perceptual mask imposes only an upper limit). The undertaking of adding watermark is to the first is last. Figure-3 speaks to the perceptual veil that outcomes subsequent to dissecting the picture displayed in Figure-2. Higher force levels suggest that higher annoyances can be made at those pixels without distinguishable contortion. In this way, the higher limit zones for covering data relate to edges. These veils are figured by utilizing some clear outcomes on the working standard of the human eye in the spatial space. Dissimilar outcomes are acquired while dealing with different spaces.

Figure-4 represents the typical configuration of a watermark detection and extraction unit. Watermark detection involves deciding a certain image has been watermarked with a given key or not. Binary output is produced through that watermark detector. Extraction of the concealed information would be only possible only after the presence of the watermark has been correctly detected

Watermark embedding process and its related steps are depicted in ALGORITHM 1 and the process of extraction is provided in ALGORITHM 2 which is also illustrated in the block diagrams shown in Figures 5 and 6.

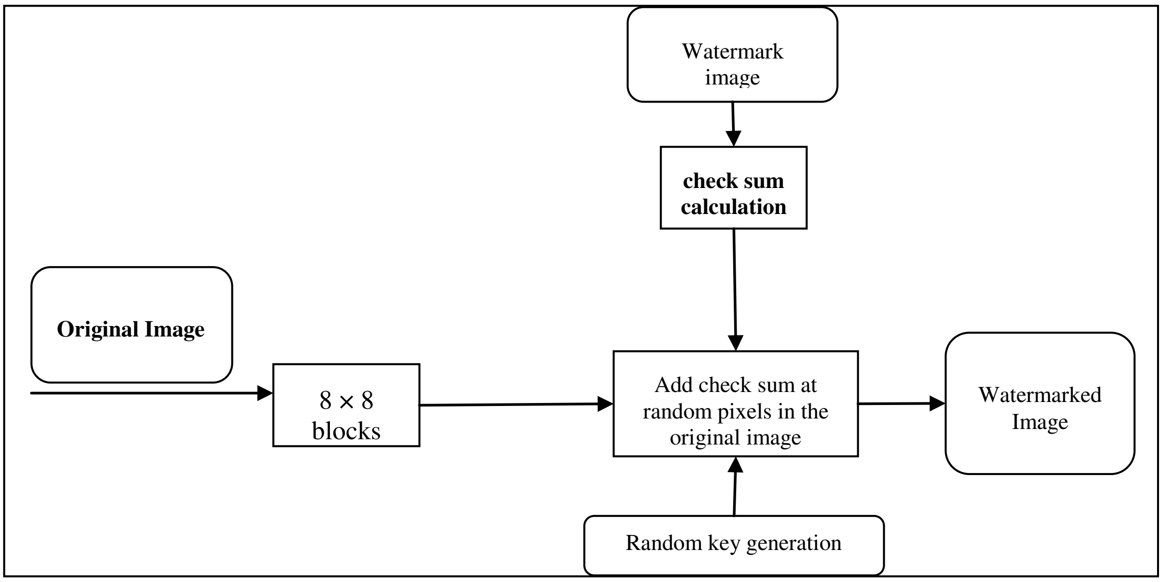

Figure-5. Watermark Insertion Unit.

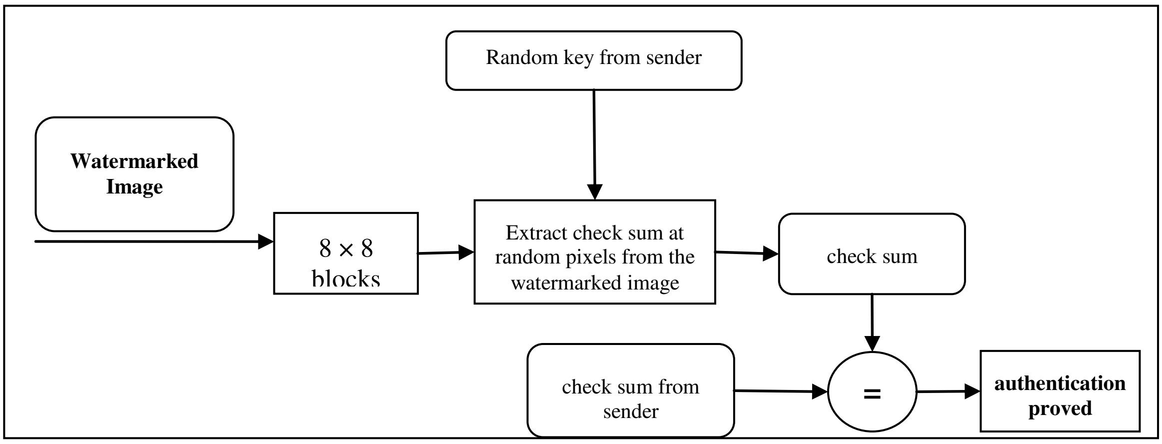

Figure-6. Watermark Extraction Unit.

ALGORITHM 1:		Watermark insertion process
Input	:	Original Image (is denoted by *f(x,y))* ,watermark Image (is denoted by *w(x,y))*
Output	:	Watermarked Image
/* Main */		
Original and watermark image is read		
Original and watermark image size is read		
Original and watermark image is splitting into 8 × 8 blocks		
random_number(f(x,y).size);		
for i←0 to 63 block of original image		
begin		
check_sum_cal(w(x,y).size, i);		
orginal_image_block=orginal_image_block[random_number[i]] ∪ check_sum		
end for		
combine_all_original_image blocks;		
construct_original_image;		
/*random number generator*/		
random_number(integer f(x,y))		
begin		
for i' ← 0 to f(x,y).size		
begin		
random[i']←java.random(i');		
end for		
end random_number;		
/*check sum calculation */		
check_sum_cal(integer w(x,y))		
begin		
for i'' ← 0 to w(x,y).size		
begin		
mean=$\frac{\sum_{i''}^{w(x,y)} i''}{w(x,y).size}$		
end for		
check_sum=$mean mod w(x,y).size$		
end check_sum_cal;		

ALGORITHM 2:		Watermark extraction process
Input	:	Watermarked Image (is denoted by *f'(x,y))*, check_sum[], random_number(), watermark Image(id denoted by w(x,y))
Output	:	check_sum
/* Main */		
		Watermarked image is read
		Watermarked image size is read
		Watermarked image splits into 8 × 8 blocks
		for i←0 to 63 block of Watermarked image
		begin
		check_sum_1[i]=extract_check_sum[i].at(random_number[i]);
		end for
		for i←0 to check_sum[].size
		begin
		if (check_sum_1[i]= check_sum[i])
		authentication_proved;
		else
		authentication failed;
		end-if
		end-for

4. EXPERIMENTAL RESULTS

The experiments for the digital watermarking insertion and extraction system is performed by using the Java. In this paper we consider original_image.jpg and watermark_image.jpg is considered for testing. These images are given as input to our watermark insertion process called algorithm 1, it gives the watermarked image called watermark_image.jpg. The watermark_image.jpg is given as input to proposed watermark extraction called algorithm 2. Sample of 16 original images (size 256 × 256) are shown in Figure-7. Sample of 16 watermarks (size 16 × 16) are shown in Figure-8.

VOL. 14, NO. 23, DECEMBER 2019 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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Figure-7. Original images of size 256 × 256.

A	B	C	D	E	F	G	H
I	M	N	P	K	L	S	W

Figure-8. Watermarks of size 16 × 16.

The original_image.jpg and watermark_image.jpg examples are shown in Figure-9, watermarked_image and extraction process is shown in Figure-10.

original_image.jpg

watermark_image.jpg

Figure-9. Image-In-Image Watermarking Insertion Process.

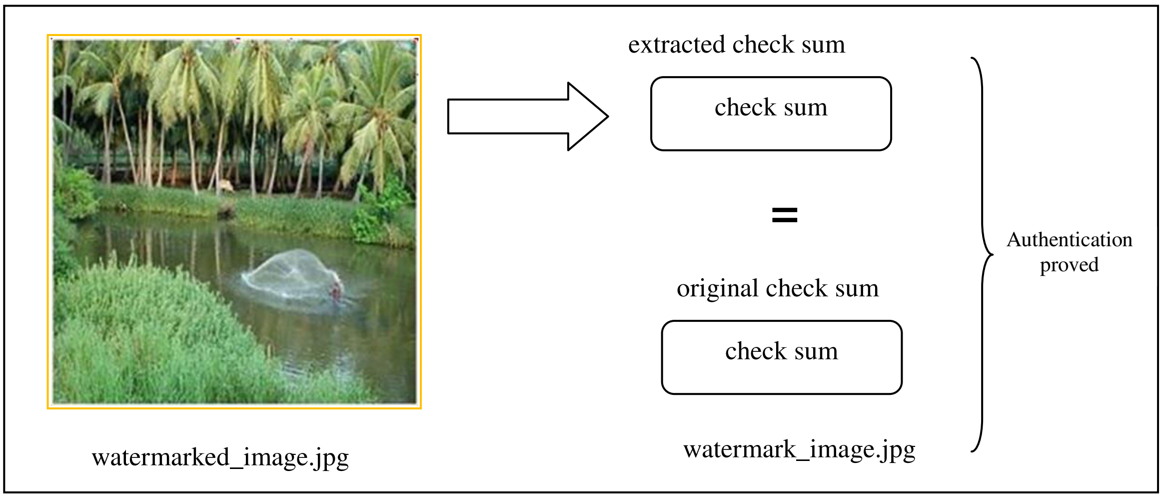
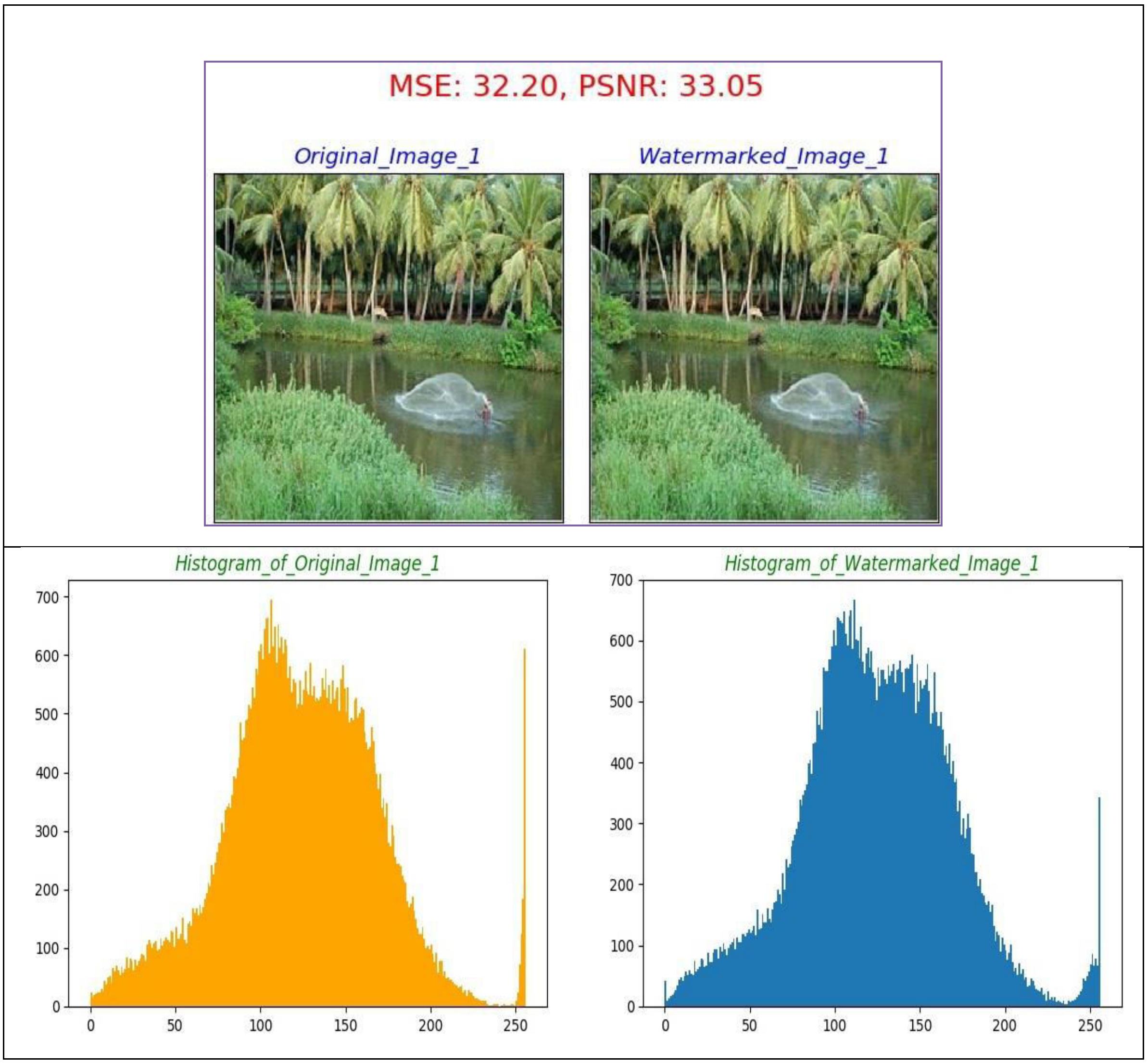
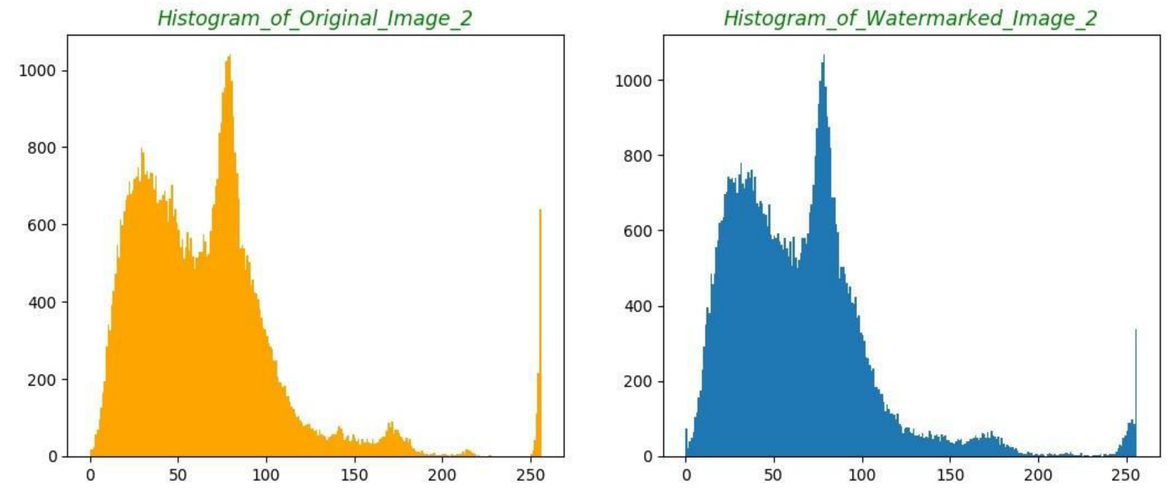


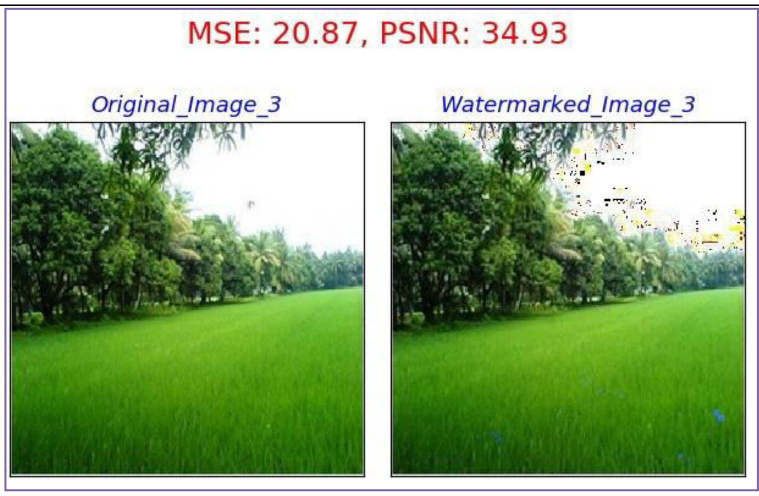
Figure-10. Watermarking extraction Process.

Original, Watermarked images, their histograms and their corresponding MSE and PSNR values are shown in Figure-11.




MSE: 24.23, PSNR: 34.29
Original_Image_2
Watermarked_Image_2


Histogram_of_Original_Image_2
Histogram_of_Watermarked_Image_2
0 200 400 600 800 1000
0 50 100 150 200 250


MSE: 20.87, PSNR: 34.93
Original_Image_3
Watermarked_Image_3

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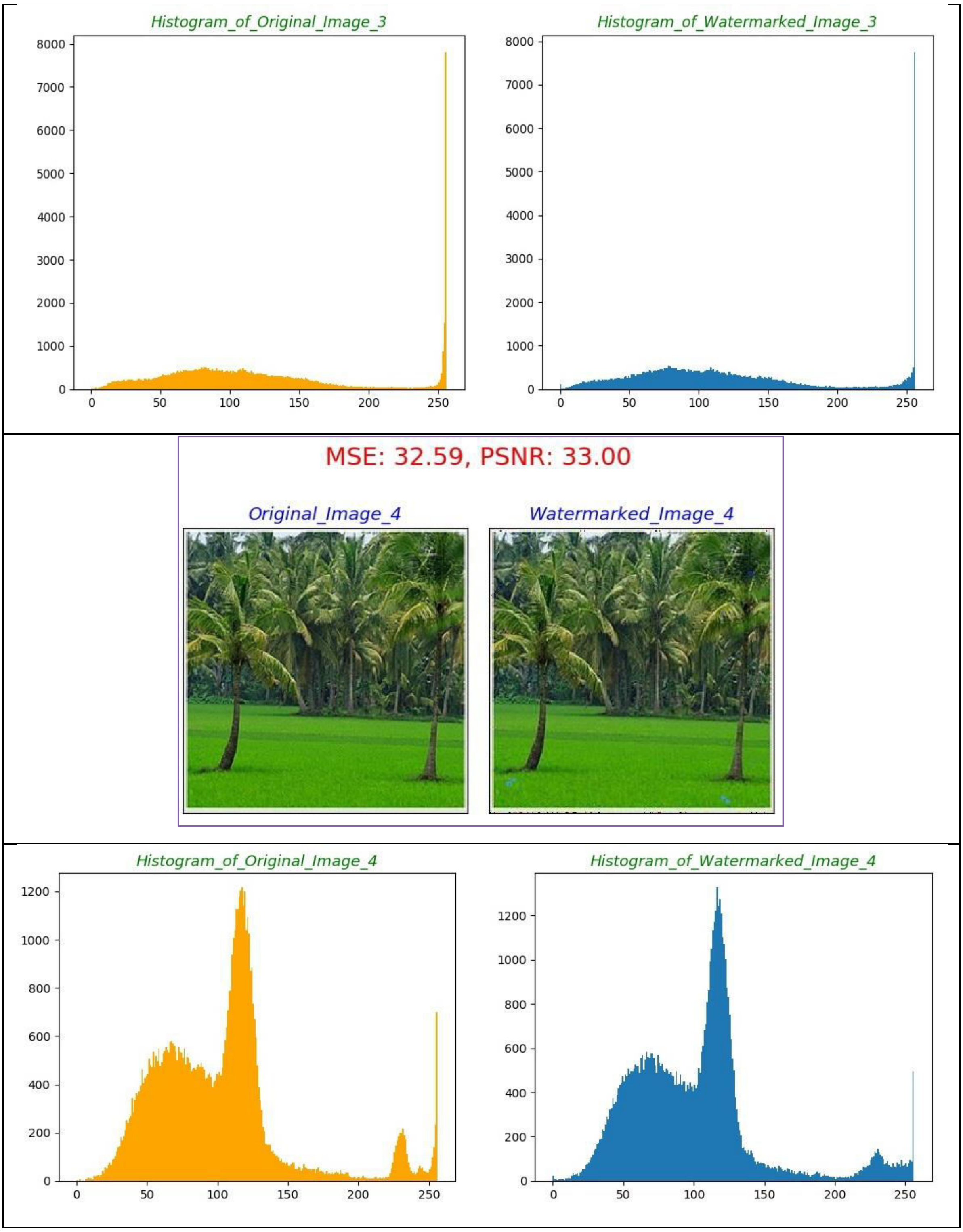
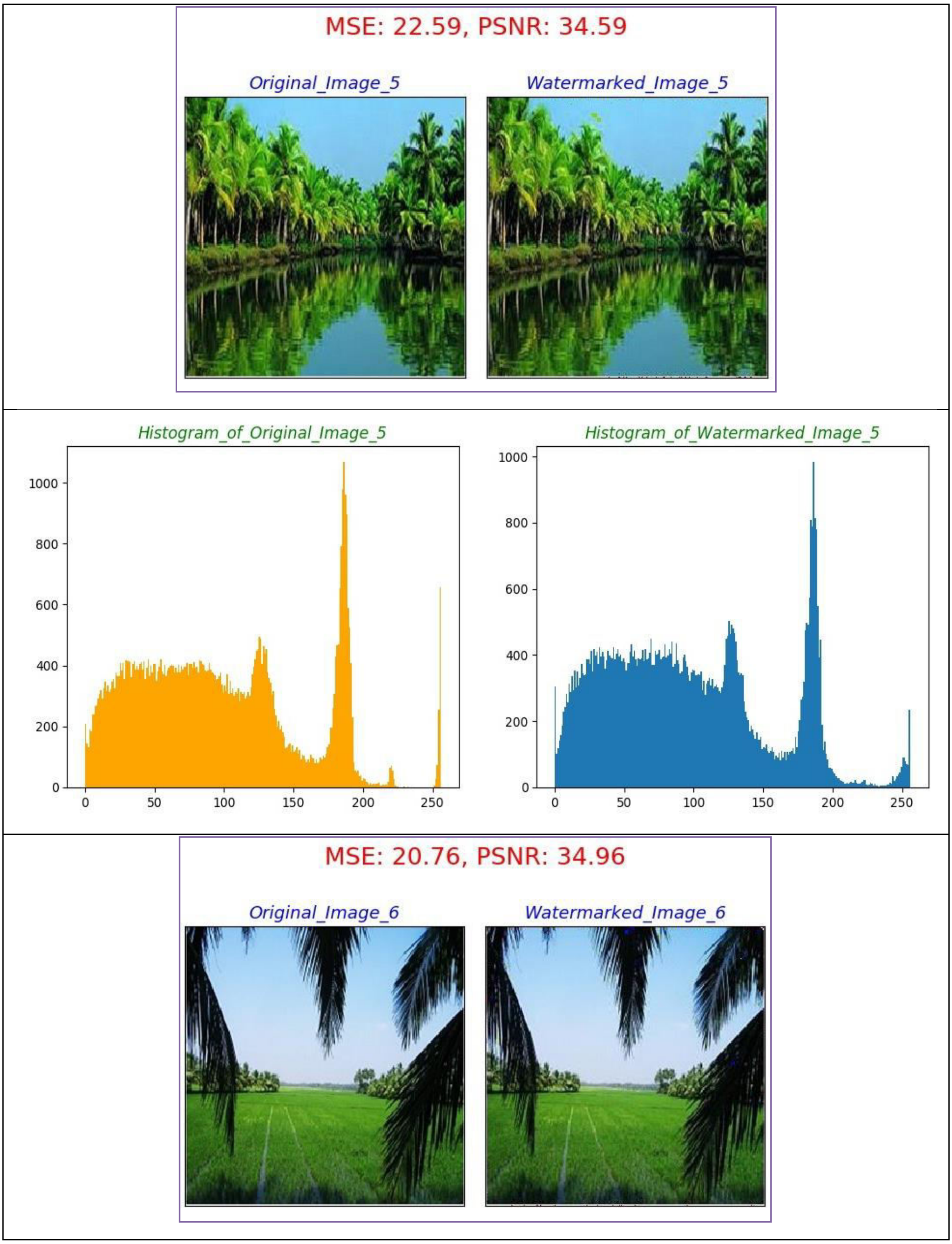
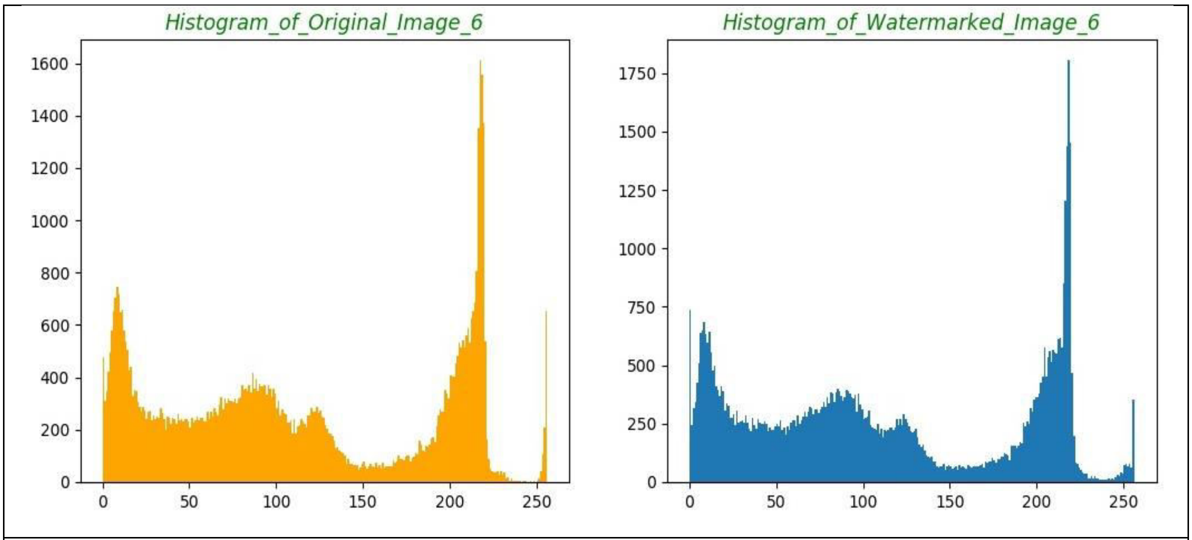
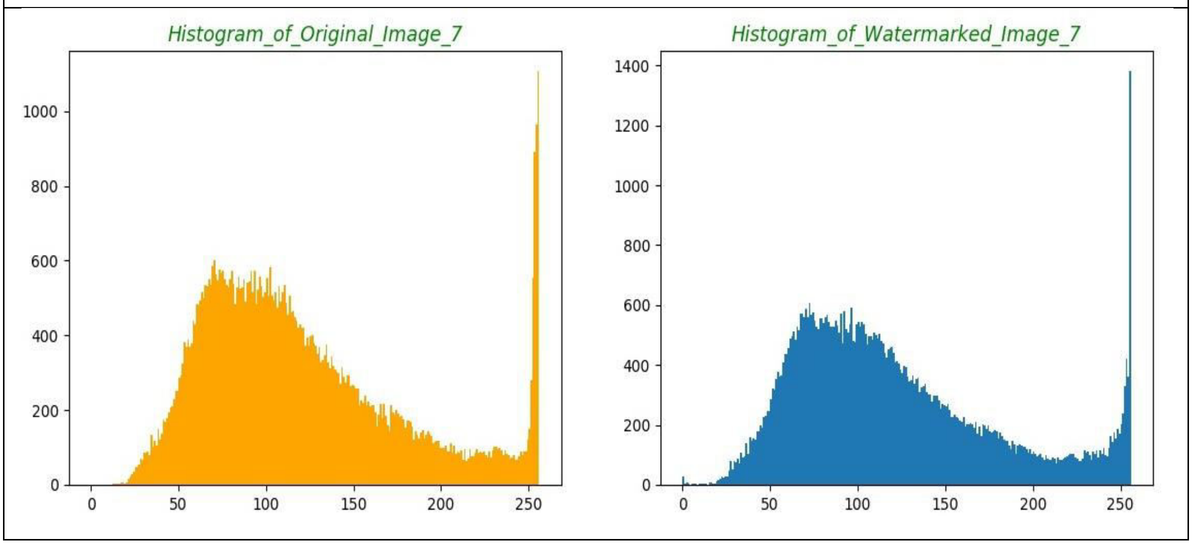



MSE: 22.59, PSNR: 34.59
Original_Image_5
Watermarked_Image_5
Histogram_of_Original_Image_5
Histogram_of_Watermarked_Image_5
0
200
400
600
800
1000
0
50
100
150
200
250
MSE: 20.76, PSNR: 34.96
Original_Image_6
Watermarked_Image_6


Histogram_of_Original_Image_6
Histogram_of_Watermarked_Image_6


MSE: 24.60, PSNR: 34.22
Original_Image_7
Watermarked_Image_7


Histogram_of_Original_Image_7
Histogram_of_Watermarked_Image_7

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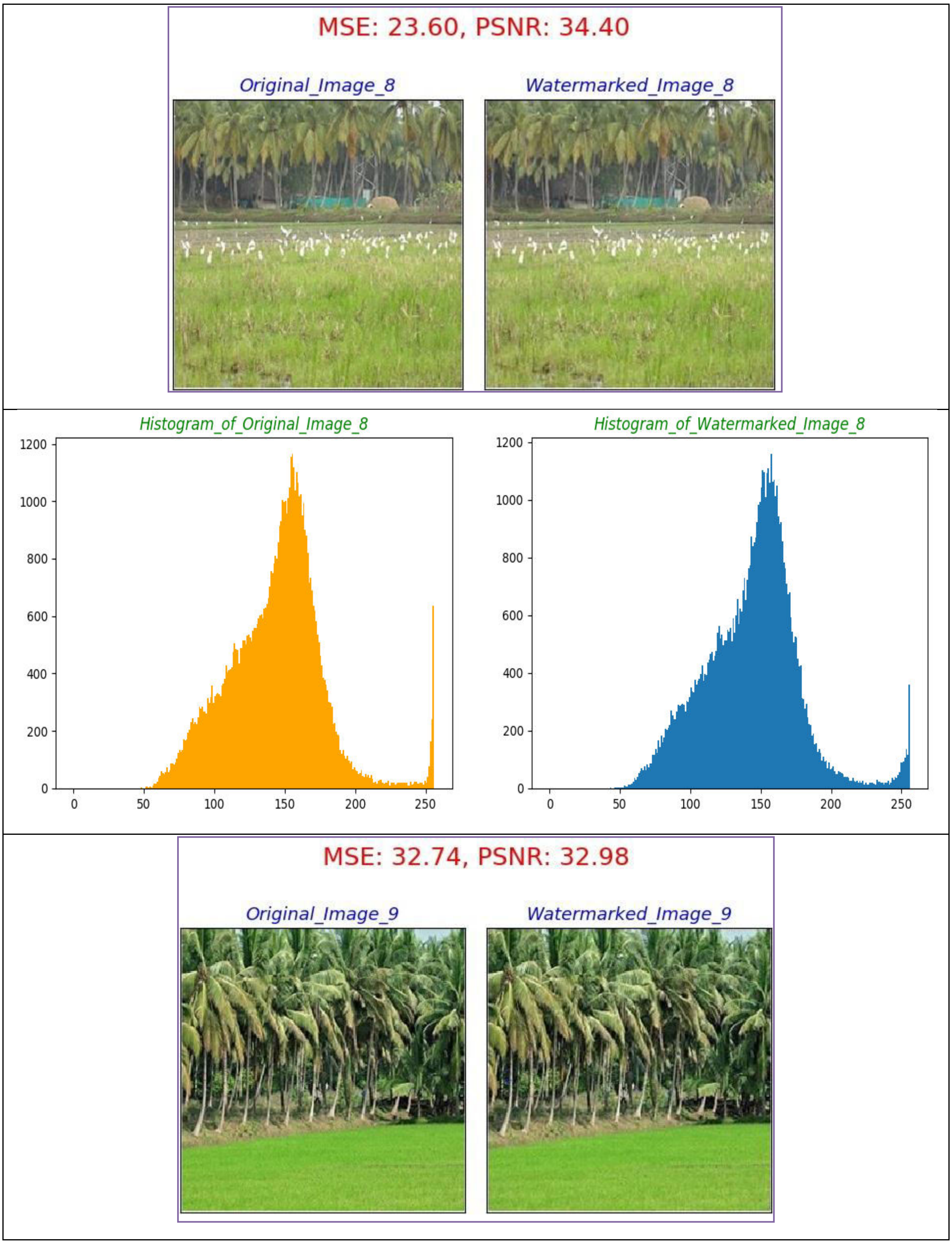
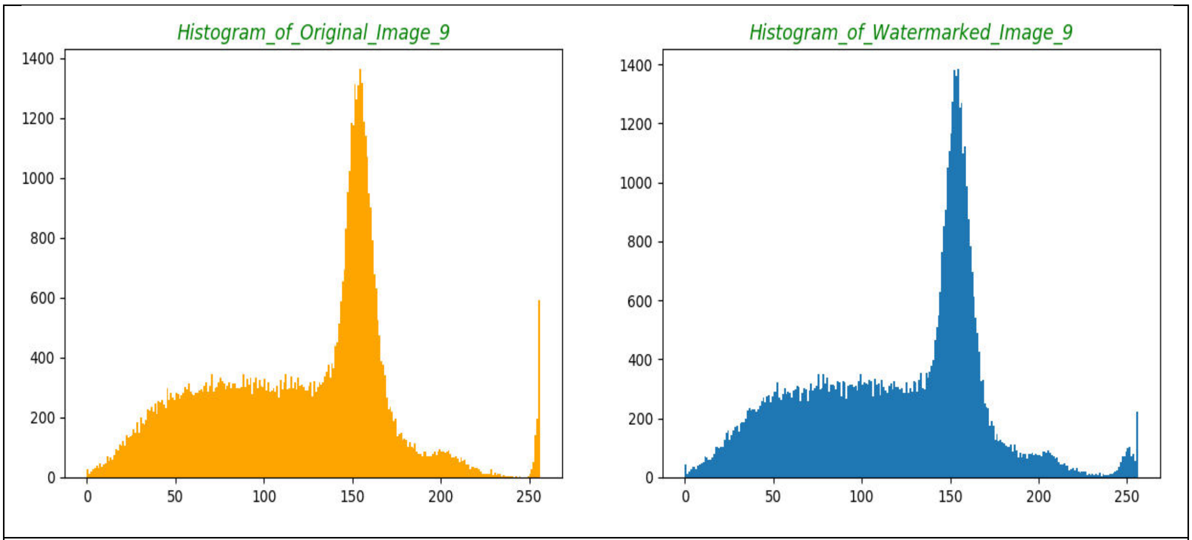
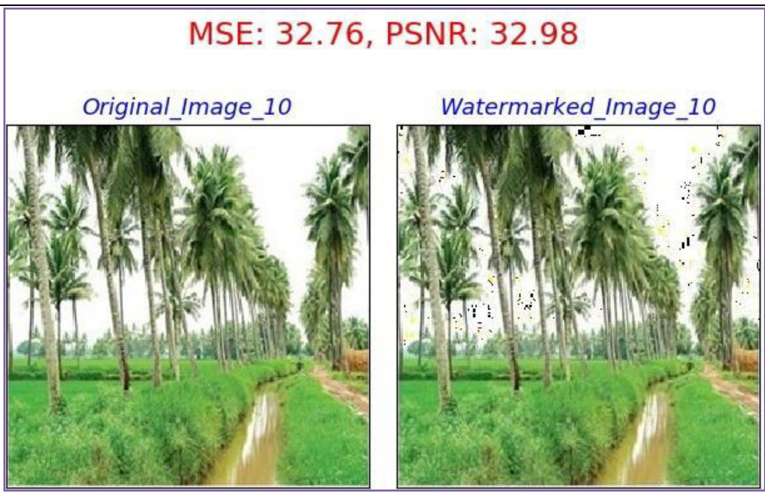
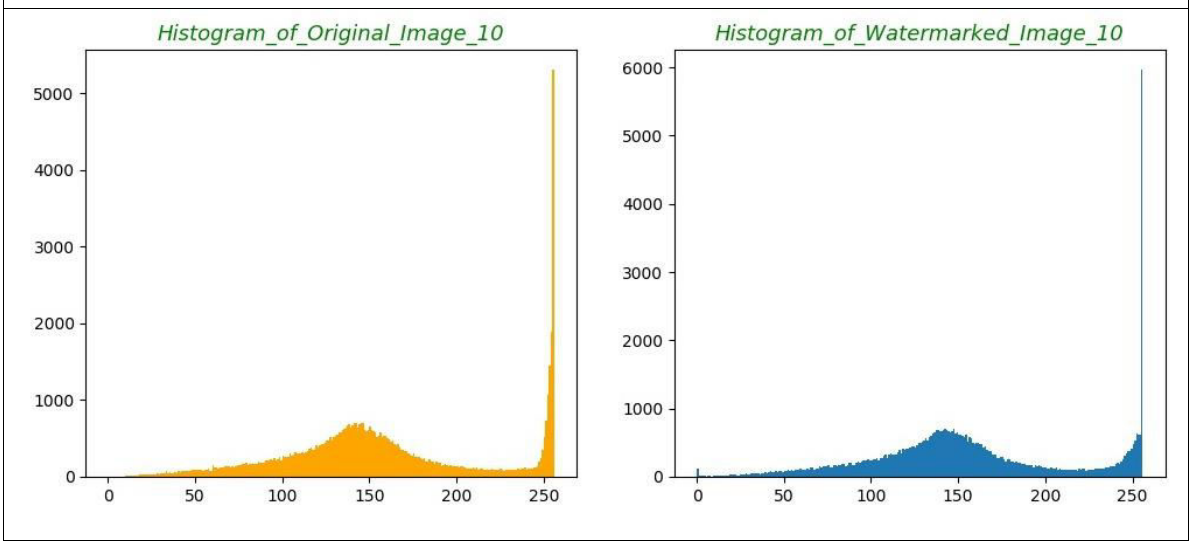



Histogram_of_Original_Image_9
Histogram_of_Watermarked_Image_9


MSE: 32.76, PSNR: 32.98
Original_Image_10
Watermarked_Image_10


Histogram_of_Original_Image_10
Histogram_of_Watermarked_Image_10

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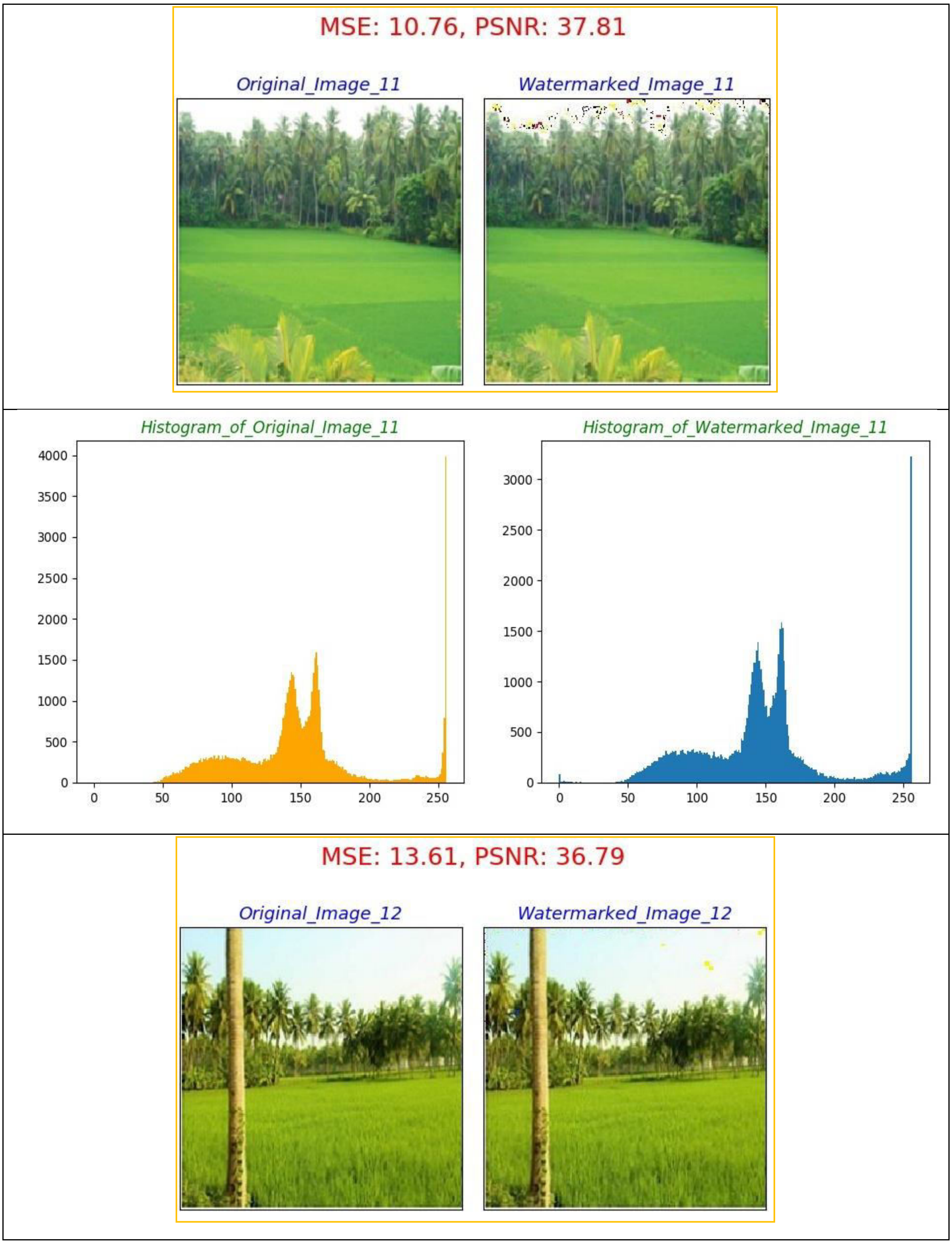

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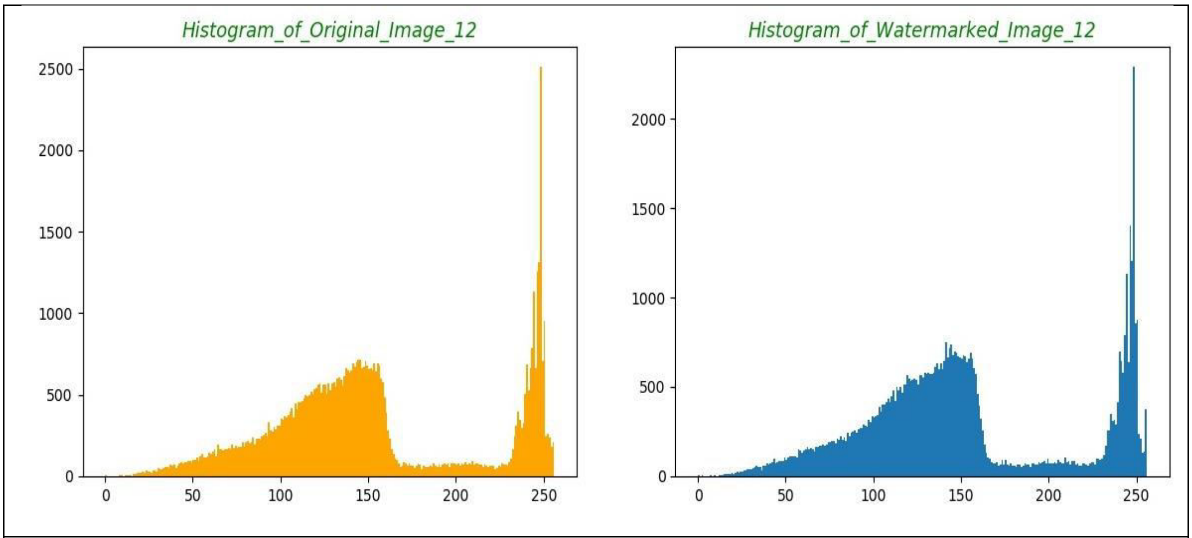
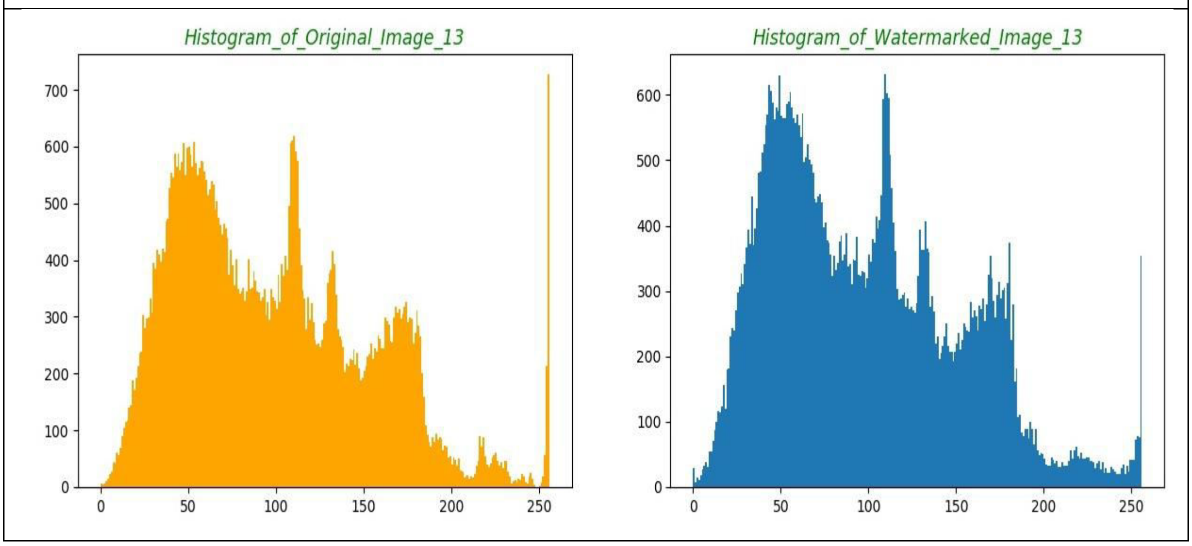
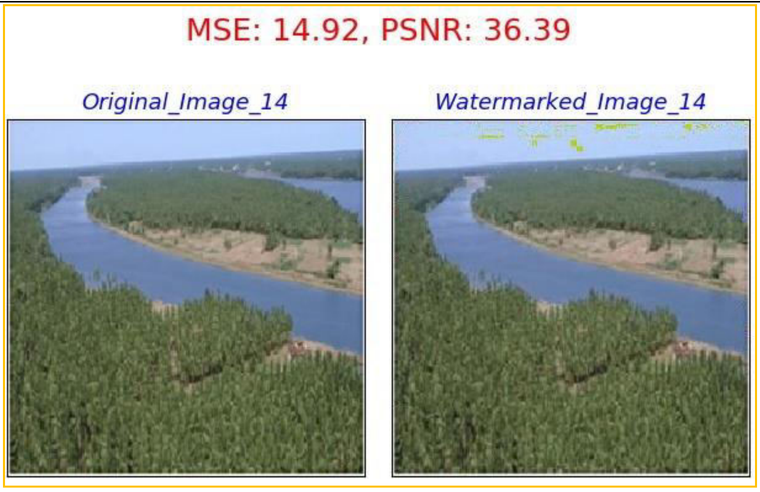
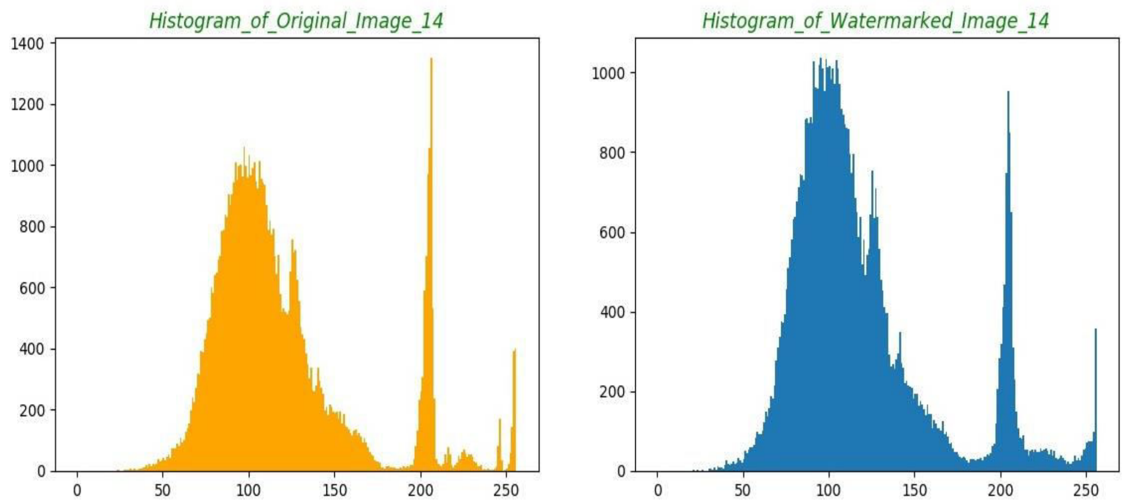
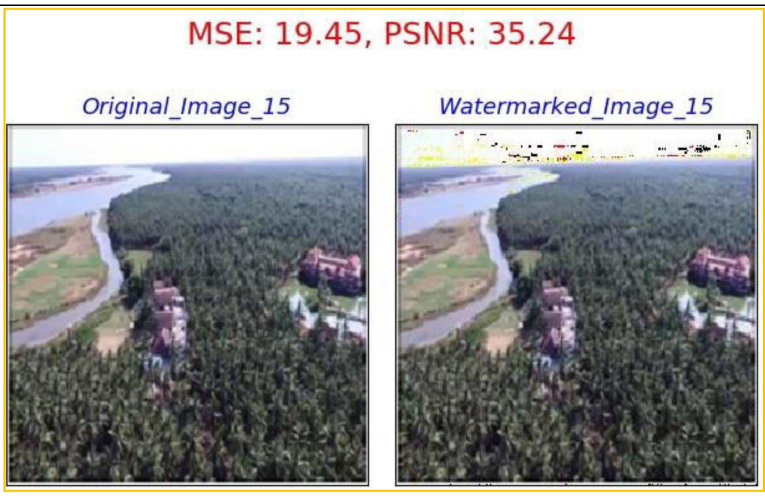





MSE: 14.92, PSNR: 36.39
Original_Image_14
Watermarked_Image_14


Histogram_of_Original_Image_14
Histogram_of_Watermarked_Image_14


MSE: 19.45, PSNR: 35.24
Original_Image_15
Watermarked_Image_15

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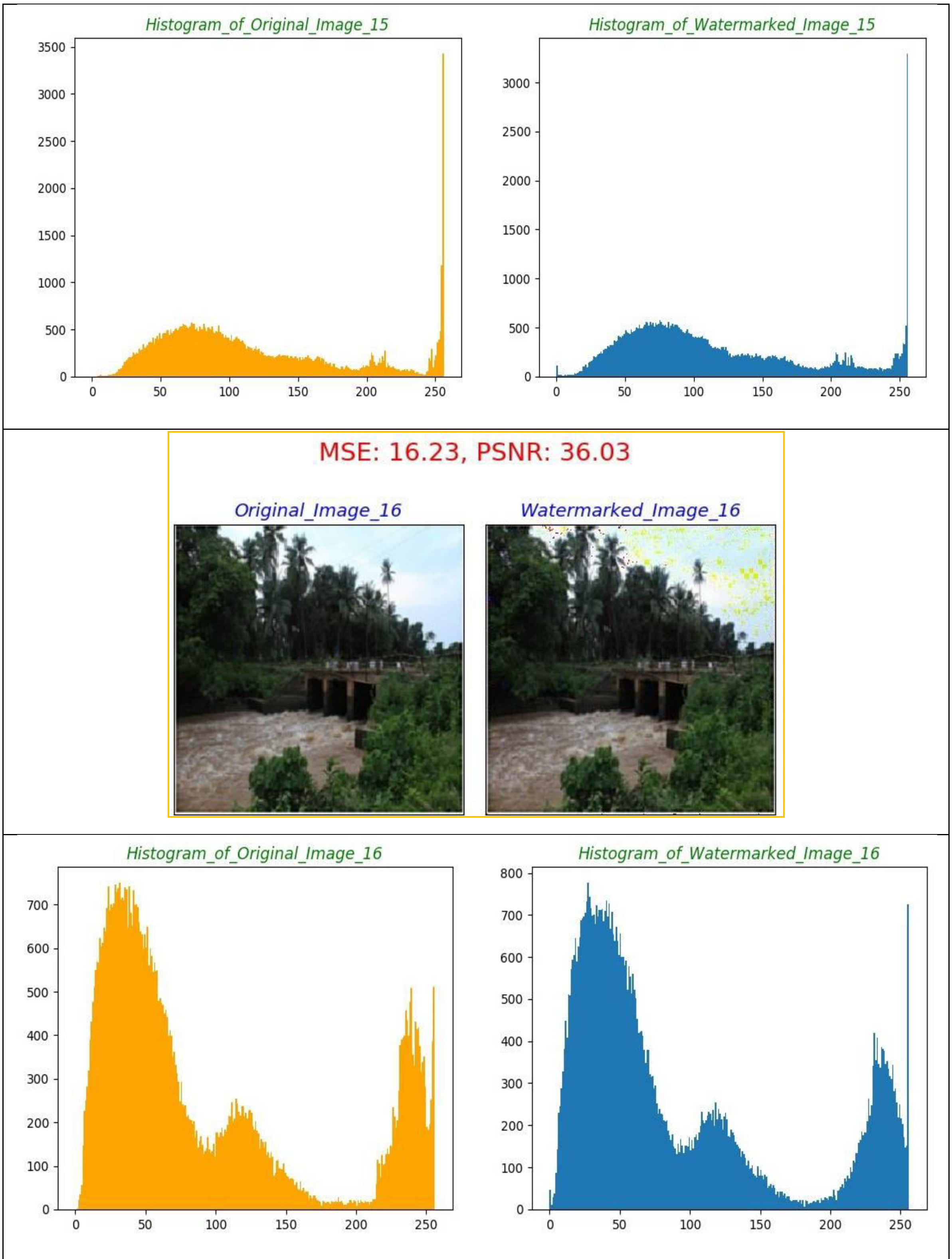

Figure-11. Orignal, Watermarked Images, their histograms and its MSE, PSNR values.

Table-1. MSE and PNSR measures of different Original and Watermarked Images.

	MSE	PSNR
Original_1 vs Watermarked_1 Images	32.2	33.05
Original_2 vs Watermarked_2 Images	24.23	34.29
Original_3 vs Watermarked_3 Images	20.87	34.93
Original_4 vs Watermarked_4 Images	32.59	33
Original_5 vs Watermarked_5 Images	22.59	34.59
Original_6 vs Watermarked_6 Images	20.76	34.96
Original_7 vs Watermarked_7 Images	24.6	34.22
Original_8 vs Watermarked_8 Images	23.6	34.4
Original_9 vs Watermarked_9 Images	32.74	32.98
Original_10 vs Watermarked_10 Images	32.76	32.98
Original_10 vs Watermarked_11 Images	10.76	37.81
Original_10 vs Watermarked_12 Images	13.61	36.79
Original_10 vs Watermarked_13 Images	12.48	37.17
Original_10 vs Watermarked_14 Images	14.92	36.39
Original_10 vs Watermarked_15 Images	19.45	35.24
Original_10 vs Watermarked_16 Images	16.23	36.03

Table-1 represents the MSE and PSNR values of Original and Watermarked Images. Figure-12 has shown the line graph for MSE values, Figure-13 has shown the line graph for PSNR values and Figure-14 has shown the line graph for MSE vs PSNR values. From the Figure-14 and values of Table-1, we clearly observed that MSE values are smaller when compared to PSNR values for all the samples.

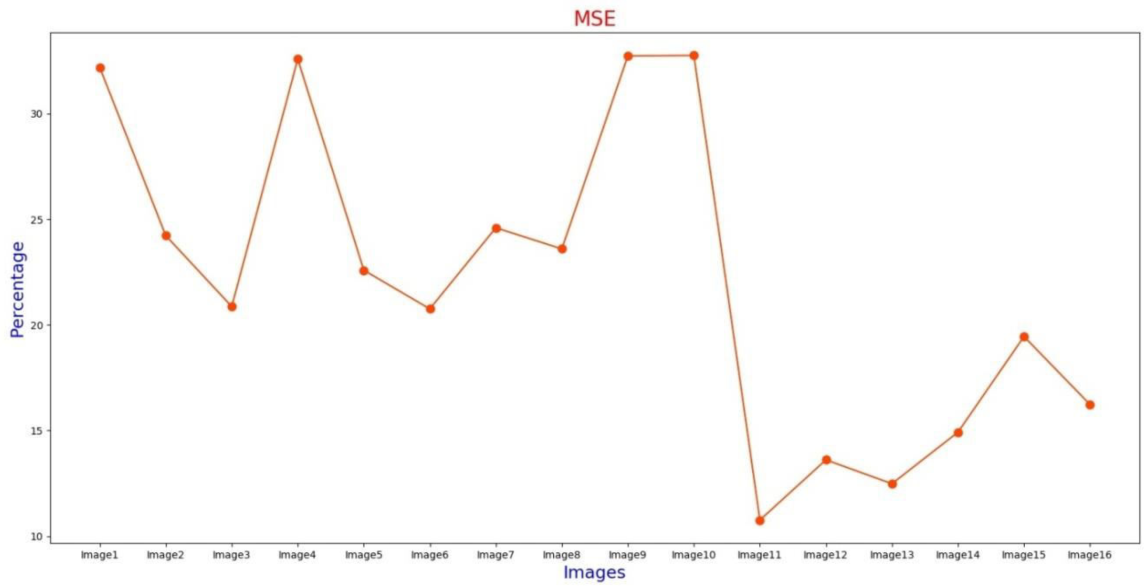

Figure-12. MSE values line graph.

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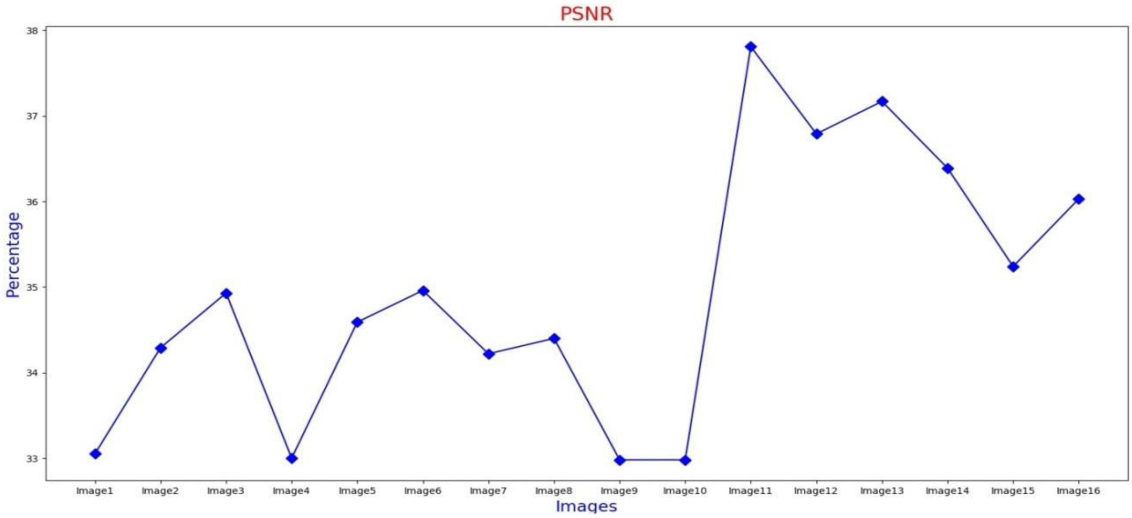

Figure-13. PSNR values line graph.

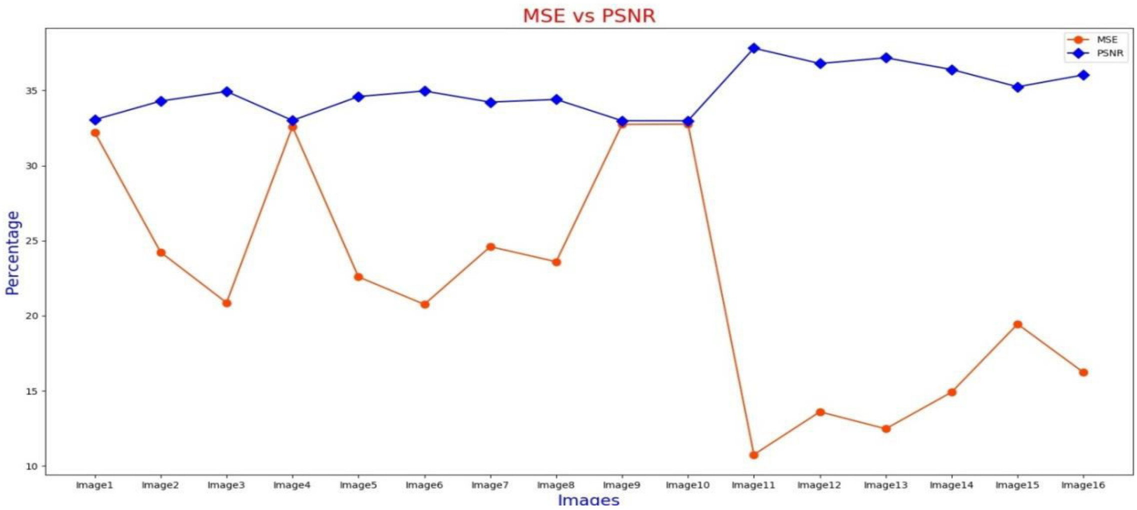

Figure-14. MSE vs PSNR values line graph.

5. CONCLUSIONS

The present paper can be used to protect and providing security and authentication to the images. It mainly uses the image as well as text embed in the original image at random pixels in source. In receiving end, the embedded image and text can be retrieved; these are compared with original embedded text and image which are send through secured channel to recipient. If they both are matched then that can prove the security, authentication, otherwise security and protection are failed. As a future work a better and secure mechanism can be used to generate the watermark without using the self-authentication.

REFERENCES

[1] Devi B. P., Singh K. M., Roy S. 2016. A copyright protection scheme for digital images based on shuffled singular value decomposition and visual cryptography. Springer Plus. p. 1091.

[2] Rani A., Raman B. 2016. An image copyright protection scheme by encrypting secret data with the host image. Multimedia Tools and Applications. pp. 1027-42.

[3] Liu XL, Lin C. C., Yuan S. M. 2016. Blind dual watermarking for color images' authentication and copyright protection. IEEE Transactions on Circuits and Systems for Video Technology.

[4] Su P. C., Kuo T. Y., Li M. H. 2017. A practical design of digital watermarking for video streaming services. Journal of Visual Communication and Image Representation. pp. 161-72.

[5] Wang J. T., Chang Y. C., Lu C. W., Yu S. S. An OFB-Based Fragile Watermarking scheme for 3D polygonal meshes. International Symposium on

Computer, Consumer and Control (IS3C). pp. 291-294.

[6] Khor H. L., Liew S. C., Zain J. M. 2016. Parallel digital watermarking process on ultrasound medical images in multicores environment. Journal of Biomedical Imaging.

[7] Tuncer T. 2018. A probabilistic image authentication method based on chaos. Multimedia Tools and Applications. 1-8.

[8] Li J., Lin Q., Yu C., Ren X., Li P. 2018. A QDCT-and SVD-based color image watermarking scheme using an optimized encrypted binary computer-generated hologram. Soft Computing. 22(1): 47-65.

[9] Mokhnache S., Bekkouche T., Chikouche D. 2018. A Robust Watermarking Scheme Based on DWT and DCT Using Image Gradient. International Journal of Applied Engineering Research. 13(4): 1900-7.

[10] Sharma R., Singh J. 2017. Image Authentication Technique Based on Digital Watermarking using Clustering. International Journal of Advanced Research in Computer Science. 8(5).

[11] Bhattacharjee T., Maity S. P. 2017. An image-in-image communication scheme using secret sharing and M-ary spread spectrum watermarking. Micro system Technologies. 23(9): 4263-76.

[12] Kumar P., Tiwari R. G. 2017. Novel Technique to Create a Secure Medical Image Watermarking. International Journal of Computer Applications. 166(10).

[13] Xiao D., Chang Y., Xiang T., Bai S. 2017. A watermarking algorithm in encrypted image based on compressive sensing with high quality image reconstruction and watermark performance. Multimedia Tools and Applications. 76(7): 9265-96.

[14] Cui L. 2017. Robust Animation Zero Watermarking Based on Visual Cryptography and Complete Complementary Code. In Advances in Computer Science and Ubiquitous Computing 2017 Dec 18 (pp. 60-65). Springer, Singapore.

[15] Parah S. A., Ahad F., Sheikh J. A., Bhat G. M. 2017. Hiding clinical information in medical images: A new high capacity and reversible data hiding technique. Journal of biomedical informatics. 66: 214-30.

[16] Hu W. C., Chen W. H., Huang D. Y., Yang C. Y. 2016. Effective image forgery detection of tampered foreground or background image based on image watermarking and alpha mattes. Multimedia Tools and Applications. 75(6): 3495-516.

[17] Chen H. K., Chen W. S. 2016. GPU-accelerated blind and robust 3D mesh watermarking by geometry image. Multimedia Tools and Applications. 75(16): 10077-96.

[18] Maity H. K., Maity S. P. 2014. FPGA implementation of reversible watermarking in digital images using reversible contrast mapping. Journal of Systems and Software. 96: 93-104.

[19] Ali M., Ahn C. W., Pant M. 2014. A robust image watermarking technique using SVD and differential evolution in DCT domain. Optik-International Journal for Light and Electron Optics. 125(1): 428-34.

[20] Das C., Panigrahi S., Sharma V. K., Mahapatra K. K. 2014. A novel blind robust image watermarking in DCT domain using inter-block coefficient correlation. AEU-International Journal of Electronics and Communications. 68(3): 244-53.

[21] Makbol N. M., Khoo B. E. 2014. A new robust and secure digital image watermarking scheme based on the integer wavelet transform and singular value decomposition. Digital Signal Processing. 33: 134-47.

[22] Makbol N. M., Khoo B. E. 2013. Robust blind image watermarking scheme based on redundant discrete wavelet transform and singular value decomposition. AEU-International Journal of Electronics and Communications. 67(2): 102-12.

[23] Zheng P., Huang J. 2012. Walsh-Hadamard transform in the homomorphic encrypted domain and its application in image watermarking. In International Workshop on Information Hiding 2012 May 15 (pp. 240-254). Springer, Berlin, Heidelberg.

[24] Joshi A. M., Bapna M., Meena M. 2016. Blind Image Watermarking of Variable Block Size for Copyright Protection. Proceedings of the International Conference on Recent Cognizance in Wireless Communication & Image Processing. pp. 853-859.

[25] Deshpande P., Sharma S. C., Peddoju S. K. 2016. Data Storage Security in Cloud Paradigm. Proceedings of Fifth International Conference on Soft Computing for Problem Solving. pp. 247-259.

[26] Niu P. P., Wang P., Liu Y. N., Yang H. Y., Wang X. Y. 2016. Invariant color image watermarking approach using quaternion radial harmonic Fourier moments. Multimedia Tools and Applications. pp. 7655-79.

[27] Giri K. J., Bashir R. 2017. Digital Watermarking: A Potential Solution for Multimedia Authentication. Intelligent Techniques in Signal Processing for Multimedia Security, Springer International Publishing. pp. 93-112.

[28] Agarwal H., Sen D., Raman B., Kankanhalli M. Visible watermarking based on importance and just noticeable distortion of image regions. Multimedia Tools and Applications. pp. 7605-29.

[29] Albalawi U., Mohanty S. P., Kougianos E. 2016. A new region aware invisible robust blind watermarking approach. Multimedia Tools and Applications. pp. 1-35.

[30] Thanh T. M., Iwakiri M. 2016. Fragile watermarking with permutation code for content-leakage in digital rights management system. Multimedia Systems. pp. 603-15.

[31] Santoyo-Garcia H., Fragoso-Navarro E., Reyes-Reyes R., Cruz-Ramos C., Nakano-Miyatake M. 2017. Visible Watermarking Technique Based on Human Visual System for Single Sensor Digital Cameras. Security and Communication Networks.

[32] Srivastava, Rashmi. 2017. Dwt based Invisible Watermarking on Images.

[33] Qian Q., Wang H. X., Hu Y., Zhou L. N., Li J. F. 2016. A dual fragile watermarking scheme for speech authentication. Multimedia Tools and Applications. pp. 13431-50.

[34] He C. 2016. Research of Web Resources Protection Based on Digital Watermarking and Digital Signature. In International Conference on telligent Networking and Collaborative Systems (INCoS). pp. 294-297.

[35] Sun J. , Lin J., Zhang L., Liu S., Zhao Q., Liu C., Liang K. 2016. Lossless and High Robust Watermarking of Electronic Chart for Copyright Protection. International Conference of Young Computer Scientists, Engineers and Educators, Springer Singapore. pp. 441-452.

[36] Giri K. J., Bashir R. 2017. Digital Watermarking: A Potential Solution for Multimedia Authentication. Intelligent Techniques in Signal Processing for Multimedia Security, Springer International Publishing. pp. 93-112.

[37] Nematollahi M. A., Vorakulpipat C., Rosales H. G. 2017. Security Enhancement of Digital Watermarking. Digital Watermarking, Springer Singapore. pp. 191-203.