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Image Steganography Using Least Significant Bit Technique

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***Abstract*—**In any communication, security is the most important issue in today's world. In this paper, steganography is the process of hiding the important data into other data, such as text, audio, video, and image. The interest in this topic is to provide availability, confidentiality, integrity, and authenticity of data. The steganographic technique that embeds hides content with unremarkable cover media so as not to provoke eavesdropper's suspicion or third party and hackers. In which many applications of compression, encryption, decryption, and embedding methods are used for digital image steganography. Due to compression, the nose produces in the image. To sustain noise in the image, the LSB insertion technique is used. The performance of the proposed embedding system with respect to providing security to secret message and robustness is discussed. We also demonstrate the maximum steganography capacity and visual distortion.

***Keywords*—**Steganography, LSB, encoding, information hiding, color image.

I. Introduction

WITH advancement in the digital communication technology and the growth of computer power and storage, the problems with ensuring individuals' privacy become important challenging. Due to the development of the internet, the most significant issues in networking are the security of data or information [3]. Steganography, coming from the Latin word *Steganos* that means roof or covered and *graphic* means are writing. Steganography is defined as the process of embedding the secret messages into another file such that no one else than receiver knows the present of secret messages. In cryptography technique which is also used for information hiding. Cryptography is defined as transferring the text or data onto transparent to non-transparent format for providing the security from third party access. It applies the encryption method to encrypt or convert the message for the non-readable format, but it does not hide the contents of messages.

Huge or large amount of data is easy to copy and destroy by the hackers through the internet. The purpose of steganography is that to detect the presence of covert data onto harmless looking media called to cover media that is text, audio, video, or digital images. The secret writing is the technique in which information is transferred or exchanged over the non-secured communication channel.

The main terminologies are used in steganography system are a cover image, secret image, embedding algorithm and secret key. The cover image is that the carrier of information in the form of video, audio, image, text and other digital media. The secret image is that the careers of secret information in the format of digital media from unauthorized person or hackers. The secret key is that key used to convert the plain text to cipher text or from cipher text to plain text. The secret key is that key which is used for embedding the extract the information that is only depending upon the steganography LSB technique.

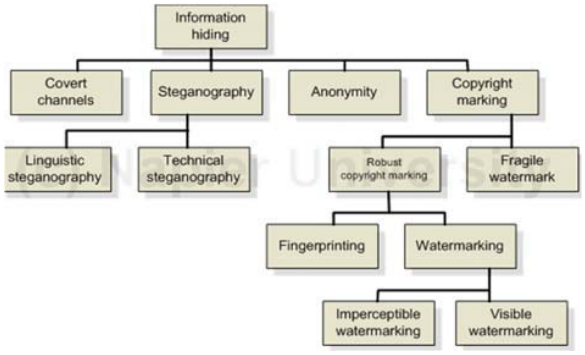

Fig. 1 Classification of data hiding methods

The substitution algorithm is those who are used to insert the hidden information about the cover image. In embedding algorithm, the one file is a club or adds into another file. The extracting algorithm is that which subtracts the secret message from cover message. In the steganography system, initially, sender may choose the specific cover image and also select the secret image or password which is hidden inside it.

The coding technique is that which converts the secret image of a highly-secured form that obtains the storage file. Then sender can send the stage file by email, chatting, or any other digital media. The Steganos file which contains the carrier message as well as the secret information. When the receiver receives the message, to decode the message by applying the extracting algorithm and same key or password is used by the sender.

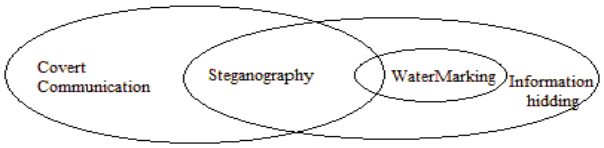

Fig. 2 Relationship between Steganography and other fields

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By applying the extracting algorithm, the stage file providing the cover image and secret message. Images are an effective way for the data hiding.

Steganography technique is divided into two categories such as spatial domain technique and Frequency domain technique [1]. The spatial domain algorithm is that which adjust the least bit of the pixel level of the cover image. In Frequency domain technique is that in which frequency coefficients are modified by the cover image that is discrete cosine transform (DCT), discrete wavelet transforms (DWT), discrete Fourier transform (DFT).

Fig. 2 shows the relationship between stenography and other fields. This shows that the steganography is correlated with cryptography and watermarking and the information hiding methods that are also used for secret communication.

II. Literature Review

The literature review shows the communication between sender and receiver secretly in which steganography uses the technique that is the Least Significant Bit (LSB). The various techniques are explained that are explained as: Ge Huayong et al. [2] focused on quickly developing of steganography and steganalysis. In information security, the comparison between steganalysis and steganography becomes the most important issue. For hiding the information, the digital images are mostly used as a cover image. The performance is calculated due to spatial domain embedding and transfer domain embedding techniques.

Harshitha K. M. et al. [5] discussed that the goal of combining both steganography and cryptography is that which provide higher security. They provide the integrity, non-repudiation, authenticity, and confidentiality to users. In which firstly secret message is encrypted with the use of encryption algorithm for secure communication and also use the secret key. In which LSB substitution technique is used for embedding and extraction methods that provide the much security for covert communication also. Monica Adriana Dagadita et al. [7] observed that spatial domain technique that applies the LSB insertion to embed data into the cover image. It processed parallel or serially by use of a guide to fast the data hiding process. The stage image provides efficient imperceptibility but less security for secret messages. Manoj Kumar et al. [6] proposed that on various images the data encryption standard is applied on it due to steganography technique. Encryption executes with the help of s-boxes and using two LSBs insertion information is embedded in the last stage. Jing Liu et al. [9] proposed the steganography method that provides very secure protection for private data in the medical system. This method mapped firstly cover image into a 1D pixel sequence by Hilbert filling curve after portioning into non-overlapping embedding units with three consecutive pixels. This method also uses adaptive pixel pair matches to embed digits into pixel value between the three pixels. To resolve the optimization problem, minimal distortion of the pixel turneries affected by data embedding can be produced.

P. Thiyagarajan et al. [10] computed a novel steganography technique that holds patient information inside a medical image using a key that is generated by 3 coloring problems. This technique is based on the reversibility as the original medical image is reconstructed after extracting from a stage image that contains the embedded data. Due to the embedding of patient information in the medical image the capacity and visual quality remains retained.

Ki-Hyun Jung et al. [12] presented the reversible data hiding technique in which after extracting the hidden data he can extract the cover image from the stage image without any disturbance. In this paper, a semi-reversible data hiding method is proposed to employ the interpolation and least significant substitution techniques. Before hiding the secret data for better quality and capacity, the interpolation technique is used to measure the rising and falling cover image. To embed the secret data LSB substitution is used. Palak Mahajan et al. [13] observed a joint application of encryption, embedding, and compression techniques digital image steganography. Due to compression technique, the noise is produced in an image. In order to sustain noise at lower levels in an image, she uses the LSB insertion technique that embeds the data or bits and inserted in last 2 LSB's of an image. In this paper firstly compressed the secret data after that encrypt the resulting bits. Those encoded bits are transferred into an image.

III. Background and Preliminaries

In this section, the main goal of providing the different aspects of authentic steganography technique is presented. These aspects are robustness, capacity, and imperceptibility. To provide the robustness, the steganography technique uses the encryption algorithm. The capacity can be increased or decreased according to the compression (lossy and lossless) technique, and the imperceptibility can be preserved due to the changes in embedding method at minimum amount [2].

JPEG-LS is used for JPEG images, and it is a lossless compression technique. This technique provides the low complexity lossless compression. It is efficient and very simple techniques that are used for preserving the quality of the images and compare the efficiency. For the encrypted images, im2double that is the image transformation function is used. The image transformation function that is im2double is needed to change and modify the image intensity values and other parameters to resize the data or information.

$$\text{EncryptImage} = K - \text{im2doubleS (originalImage)}$$

LSB Substitution is the method used for hiding information. Due to LSB Substitution method, secret bits are replaced with the least bit of the pixels with a cover image that is undetectable to human eyes. The LSB Substitution technique uses embedding and extraction processes. In the LSB Embedding process, the large amount of data or information is embedded into the cover image the data may be audio, video, text, and images [5]. In encryption, due to the substitution cipher, the bits of pain-text may be replaced with the bits of ciphertext, and the bits are in the form of letters, characters, and others.

The Least Significant Bit Technique is most widely used technique and known as LSB technique. It is divided into two

parts such as LSB replacement and LSB matching. In LSB replacement method the LSB bits of the cover image are replaced with the secret message of bits. In LSB matching method, the pixel values are incremented and decremented according to the secret bits. The LSB Insertion technique is common and popular embedded technique in which information is stored in the cover image. According to the size of an image, the quality of data or information is transferred into the cover image and bits of the secret image due to the LSB insertion. It simply works by rearranging cover image of a pixel having a least significant bit with the secret image that is to be hidden. For example, the letter S (01010011) can be hidden with the use of LSB insertion [4]. Pixel values before LSB insertion:

11000001	01001110	11110011
00110010	10101011	01100101
10000110	11111100	11001011

Pixel values after LSB insertion of 'S' will be:

1100000<u>0</u>	0100111<u>1</u>	1111001<u>0</u>
0011001<u>1</u>	1010101<u>0</u>	0110010<u>0</u>
1000011<u>1</u>	1111110<u>1</u>	11001011

With the LSB insertion to imperceptible for human eyes, altering the least significant bits of the stage image that will slightly change the color from the cover image that is the original image. The reason by imperceptibility is that minor changes in the color pixels between cover image and stage image by unit 1.

IV. Motivation

Reversible data hiding is the process in which after extracting the embedding messages, then the original image can be re-destroyed back through lossless compression. This technique is very useful for medical images, military and covert communication where hackers don't modify or steal the secret information except the sender and receiver. As per the literature surveyed so far a steganographic system should be capable of providing security, imperceptibility, robustness and capacity [8]. The main purpose of this technique is to higher security in the form of encrypted images. For encryption and decryption purpose LSB technique is used. The LSB substitution technique is used to find out the objectives of the proposed work is to formulate a steganographic system that will satisfy the following parameters:

- To provide the highest security for secret information.
- Image quality should not get degraded.
- Human eyes cannot easily distinguish between stage-image and original image.

V. Proposed Methods

In this paper, the Least Significant Bit Substitution algorithm is the process in which embedding and extracting methods are used. This algorithm is used for information hiding. The architecture of the proposed system is shown below:

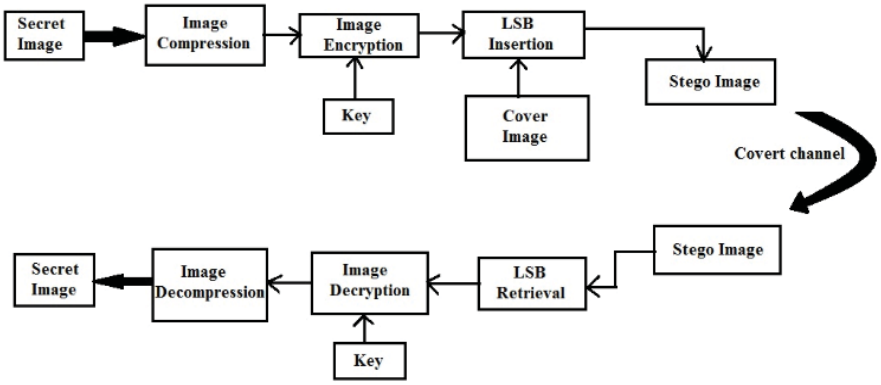


Fig. 3 The architecture of the Proposed Steganography System

In this paper, the purpose of the proposed system is to provide a strong steganography technique that accomplishes embedding capacity and high security while preserving imperceptibility and quality of the image [6].

A. Data Embedding Algorithm

B. Data Extracting Algorithm

The working of the proposed methodology is represented in Fig. 4. It provides a high capacity and robustness in the images that are firstly compressed. These are compressed by two methods such as lossless compression technique and lossy compression technique [9].

A. Data Embedding Algorithm

In the proposed technique, the data or information embedding technique is that in which a large amount of data can be embedded into the original image. It allows the user to choose the appropriate the image which is best suited for the cover image and less susceptible to the steganalysis attacks. The database is produced from which the best cover images are extracted. For embedding procedure initially, select the appropriate image from the database is known as a cover image.

First of all, load the original color image (RGB) and convert the RGB image to YCbCr [7]. Then, Support Vector Dimension (SVD) on any bit of an original image is applied. The Y band is

chosen to embed the watermark on an image and applied separately lower to lower, lower to higher, higher to lower, higher to higher to the watermarked images. The watermarked image is compressed by applying the lossless compression technique. The compressed image is produced then the substitution encryption algorithm is applying for that for encryption purpose.

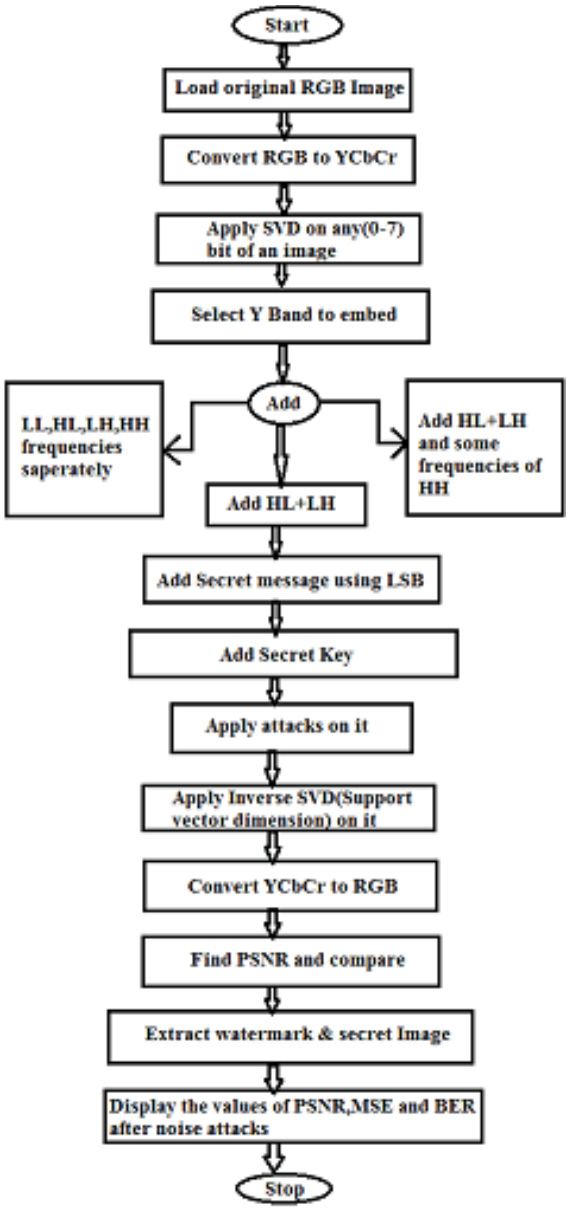


Fig. 4 The Proposed Approach

Store the original image which is affected by watermark that is staged or watermarked image. Add the secret image with the help of an LSB substitution technique. For encryption, a key is used which is created by the random generator. The image so produced is the watermarked image. The watermarked image and the key send to the receiver through the internet. The receiver receives the secret key very securely through the covert path. The embedding and extracting algorithm is explained as below:

Algorithm for Embedding Process:

Input: Original Image P, Key K, Secret Image S
Output: Watermark Image P'

Step 1: Select the appropriate original image P of size MxN from the database.
Step 2: Load the original color image (RGB).
Step 3: Convert RGB to YCbCr.
Step 4: Apply SVD on any (0-7) bit of an original image.
Step 5: Select Y band to embed the watermark:-
  5.1: Add to LL, HL, LH, and HH separately
  5.2: Add to (HL+LH) together
  5.3: Add to (HL+LH) and some frequencies of HH
Step 6: Store the position of the original image affected by the watermark.
Step 7: Add secret image using LSB technique.
Step 8: Add secret key.
Step 9: End.

B. Data Extraction Algorithm

The data extraction process is that which convert the cipher text into the plain text by using a secret key. Mapping the pixels into an image is known as an extraction method. The requirements for data extraction are watermarked image and the secret key [10]. For extraction process applies the inverse support vector dimension on watermarked image. With the use of a secret key, the decryption is done only. Then it transfers the YCbCr to RGB image, form and calculates the PSNR values of the original image and watermarked image. Extract the original and the watermark image. The quality of the image doesn't degrade while decompression. The human eyes can't detect easily. It provides the high security to the secret image that cannot alter by hackers or intruder easily.

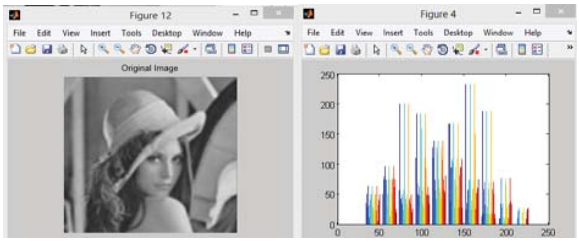
Algorithm for Extracting Process:

Input: Watermark Image P', Key K
Output: Secret Image S, original Image P

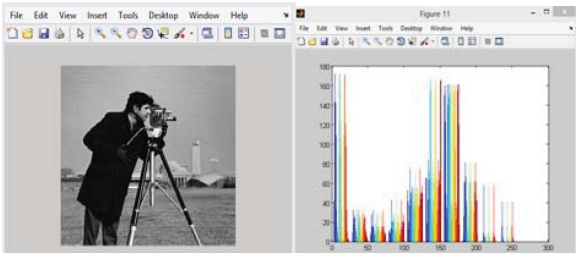
Step 1: Extract the watermarked image and choose any no of a few LSBs of Watermarked image.
Step 2: Apply Inverse SVD on the watermark image.
Step 3: Convert YCbCr to RGB.
Step 4: Find the PSNR fidelity measure between the original image and watermarked images.
Step 5: Extract secret and watermark images.
Step 6: Display the values of parameters PSNR, MSE and BER between cover image and watermark image and also represent the graphs of PSNR and MSE after noise attack.
Step 7: End.

VI. Experimental Results

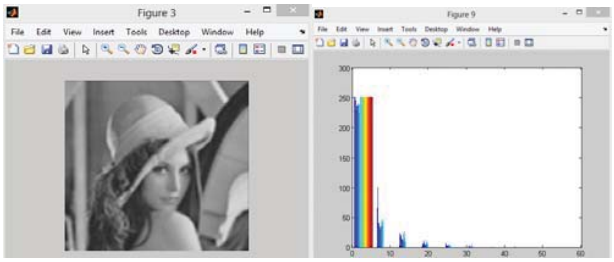
In this section represent the results of using proposed method cover image, hold the secret information inside it.



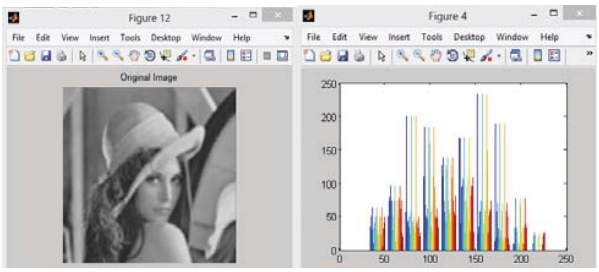
(a)



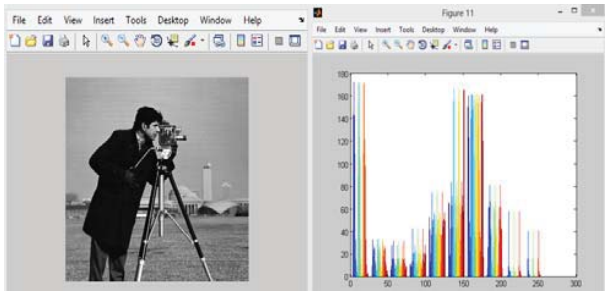
(b)



(c)



(d)



(e)

Fig. 5 Original Image (a), Secret image (b) and Watermark image (c) with their histogram (d) After Extraction the Original image and (e) Secret image with their histogram

Firstly, we choose the original image which is selected from the database. The original image and secret images are shown in Fig. 5 with their histograms. Naturally, the stage that means watermark is looking similar to the original image, but with the use of the histogram and visually looks like small changes due to the changes in the least pixel value of the image [13].

Steganography changes the pixel value during embedding process and after extraction process also. A minor difference between original and watermark images that why we use the steganography, cryptography and watermarking techniques that combined to provide much security for secret communication. The watermark image that means stage image which is produced by the encryption process. The different attacks are applied to it for analyzing the capacity of an image. The sharpened attack, contrast attack, and salt and pepper attacks are applied to the watermark image. Due to encryption process and decryption process, the quality of an image should be degraded to preserve the quality of the image we are applying the attacks on the stage image and find the parameters such as PSNR and MSE.

Due to the increase in the PSNR values and decrease in the MSE values, the image should be looking similar at the size and quality. The steganography has a very important factor which is Peak Signal to Noise Ratio (PSNR). The PSNR value shows the quality of an image that means if the image has higher PSNR values, that means the image has very good quality and similar to the watermark image, and if the values of PSNR are low then the quality should be degraded and looks very identical to the watermark image.

$$PSNR = 10 * \log(255^2/MSE)$$

TABLE I
PARAMETER VALUES OF PROPOSED METHOD

Features	Proposed
Security	High
MSE	Low
PSNR	High
Robustness	High
Imperceptibly	High
Payload Capacity	Medium

To evaluate the Peak Signal to Noise ratio then firstly we find the Mean Square Root Error (MSE) values. We find the muse, the value of the reconstructed image and if the image has a low MSE value that means there are lesser error ratios between original and watermark image. And if the image is having a high error ratio between original and watermark image [11]. The various attacks which are applied in the watermark image show the bar graphs in Figs. 6 and 7.

$$\text{MSE} = 1/\text{mn} \sum_{\text{i=0}}^{\text{m-1}} \sum_{\text{j=0}}^{\text{n-1}} [\text{f(x, y)} - \text{g(x, y)}]^2$$

The proposed technique is evaluated the various parameters such as high security and high robustness and high imperceptibility and lower MSE and High PSNR values. The

parameters are used for providing much security and unnoticeable the difference between original and watermarked image [12]. This is the best technique for covert communication for applying least bit significant technique (LSB) on the images.

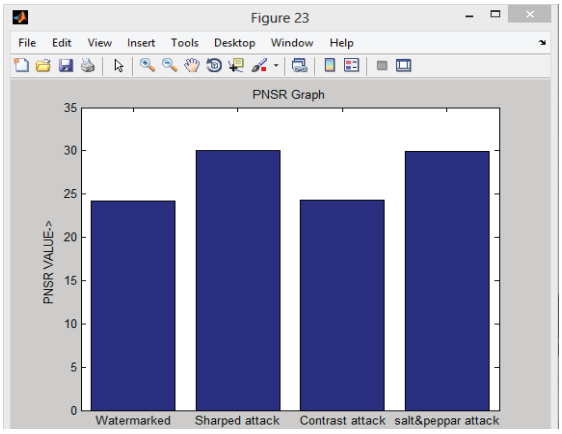


Fig. 6 PSNR between watermark, sharpened attack, contrast attack and salt and pepper attack

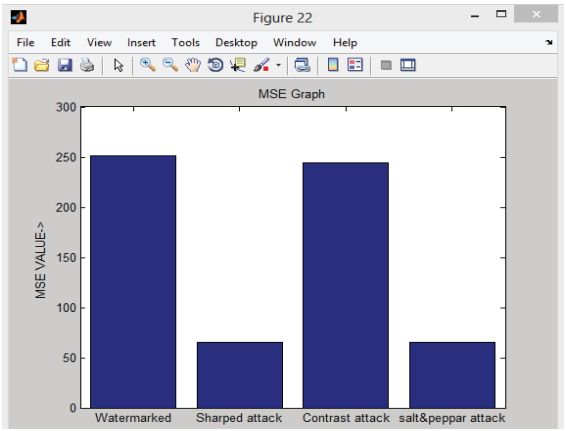


Fig. 7 MSE between watermark, sharpened attack, contrast attack and salt and pepper attack

VII. Conclusion

This paper explained the terms cryptography steganography and watermarking that are used for data hiding. In this paper, it successfully embeds the data into an 8-bit image. These are combined and become a powerful tool to which provide much security for secret communication. In this paper, we compute a technique that convert the RGB image to YCbCr and apply support vector dimension at least bit of the image on encryption side. On the decryption, side applies inverse support vector dimension at least bit of the image. Apply some attacks on the watermarked image that simply alter the bits of the secret image directly into the LSB plane of the original image that is the reason which is not easily noticeable by publicly. In this paper, the parameters which are evaluated such as PSNR, MSE, and BER that provides more precise results than the related work. For future work apply the new techniques for secret communication that provides much security.

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