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# Embedded Secret Data in Images Using Wavelet Transform and Steganography

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***Abstract: The art of passing information in a manner that the very existence of the message is unknown is known as steganography. The detection of steganographically encoded packaged is called steganalysis. In this paper a steganographic technique using Discrete Wavelet Transformation (DWT) and Watermarking for transmitting pictures is proposed.***

***Now I apply the DWT on images like as $2^i$ scaling parameters. In this $2^i$ scaling applied on first column and next rows I am using totally 4 steps that is $2^1$, $2^2$, $2^3$, $2^4$. Process of the encryption in my project is I apply DWT-IDWT on cover image. After I get the wavelet transformation image, it is the input of the steganography technique that is cover –image. Next embedded the secrete data in to cover-image and also apply the watermarking on that image. Finally we get the stego-image. This image is encrypted image. Process of the decryption technique is apply the dewatermarking on stego-image. Finally we get the secrete image.***

***Keywords: DWT, LSB, Watermarking***

## I. INTRODUCTION

For many years Information hiding has captured the imagination of researchers. Two basic methods of information hiding are cryptography and steganography. The term steganography means "cover writing" and cryptography means "secret writing". These techniques are used to address digital rights management, protect information, and conceal secrets. Information hiding techniques provide an interesting challenge for digital forensic investigations. The message is encrypted before transmission and decrypted at the receiver side with the help of a key. Nobody, except the one having the key, can determine the content of the key. The message is called the plain text and the encrypted form is called the cipher text . The information is protected at the time for transmission. However, after decryption, the information becomes unprotected and it can be copied and distributed.

In steganography, the message is embedded into the digital media rather than encrypting it. The digital media content, called the cover, can be determined by anybody; however, the message hidden in the cover can be detected by the one having the true key. The message stays in the message after the receiver gets the data. This allows steganography to protect the embedded information after it is decrypted.

There are many applications that exploit the ability of steganography to hide secret message in the form of text, imagery, or any other digital signal. Applications for such a data-hiding scheme include in-band captioning, covert communication, image tamper proofing, revision tracking, enhancing robustness of image search engines and smart Ids (identity cards) where individual's details are embedded in their photographs. This work aims to present an efficient steganography technique in image files. The most common steganographic techniques in digital images focus on spatial domain methods-which generally use a direct least significant bit (LSB) replacement technique- and frequency domain methods such as discrete cosine transform (DCT), Fourier transform (FT), and discrete wavelet transform (DWT).

In this paper, we have introduce Discrete Wavelet Transform(DWT) which can be considered as generalization of Wavelet transform (WT), it was initially one of the most frequently used tool in signal processing. This paper presents a new method for data hiding into the discrete wavelet coefficients of the cover image in order to maximize the hiding capacity overcome the drawback.

In this paper a novel steganographic technique using Discrete Wavelet Transform for transmitting pictures is proposed. In this paper using fourth level wavelet decomposition in horigantal as well as vertical. It is more security than remaining levels of wavelet decompositions.

## II. LITERATURE SURVEY

***DISCRETE WAVELET TRANSFORM:***

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited

duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process. Wavelets are created by translations and dilations of a fixed function called mother wavelet. This section analyses suitability of DWT for image watermarking and gives advantages of using DWT as against other transforms.

### 2.1.1 Characteristics of DWT

The wavelet transform decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal. Hence wavelets reflect the anisotropic properties of HVS more precisely. Fig. 1 shows DWT decomposition of an image using three level pyramid.

1. Wavelet Transform is computationally efficient and can be implemented by using simple filter convolution.
2. With multi-resolution analysis, image can be represented at more than one resolution level. Wavelets allow image to be described in terms of coarse overall shape and details ranging from broad to narrow.
3. Magnitude of DWT coefficients is larger in the lowest bands (LL) at each level of decomposition and is smaller for other bands (HH, LH, HL).
4. The larger the magnitude of wavelet coefficient, the more significant it is.
5. Watermark detection at lower resolutions is computationally effective because at every successive resolution level, less no. of frequency bands are involved.
6. High resolution sub bands help to easily locate edge and textures patterns in an image.

### 2.1.2 Advantages of DWT

The suitability of wavelet transform for image watermarking can be considered because of following reasons.

1. Wavelet transform can accurately model HVS than other transforms like Discrete Fourier Transform (DFT) or Discrete Cosine Transform (DCT) . This allows higher energy watermarks in regions where HVS is less sensitive.
2. Wavelet coded image is a multi-resolution description of image. Hence an image can be shown at different levels of resolution and can be sequentially processed from low resolution to high resolution.
3. Visual artefacts introduced by wavelet coded images are less evident compared to DCT because wavelet transform doesn't decompose image into blocks for processing. At high compression ratios, blocking artefacts are noticeable in DCT as against wavelet transformed images.
4. DFT and DCT are full frame transform. Hence, any change in the transform coefficients affects entire image except if DCT is implemented using a block based approach. However DWT has spatial frequency locality. It means it will affect the image locally, if watermark is embedded.
5. Another advantage is that current image compression standard JPEG 2000 is based on wavelet transform.

### 2.1.3 Discrete Wavelet Transform in One Dimension:

Like the fourier series expansion, the wavelet series expansion of a continuous variable into a sequence of coefficients. If the function being expanded is discrete the resulting coefficients are called the Discrete Wavelet Transform(DWT).

For Example if $f(n)=f(x_0+n\Delta x)$ for same $x_0,\Delta x$, and n=1,2,3,….,M-1, the wavelet series expansion coefficients for f(x) become the forword DWT coefficients for sequence f(n);

$W_\Psi(j_0, k)=1/\sqrt{M}\sum_n f(x)\Psi_{j0,k}(n)$

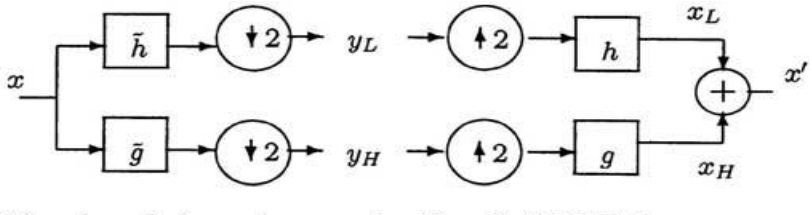
$W\psi(j, k)=1/\sqrt{M}\sum_n f(n)\psi_{j,k}(n)$

The $\Psi_{j0,k}(n)$ and $\psi_{j,k}(n)$ in the equation are sampled versions of basis functions $\Psi_{j0,k}(x)$ and $\psi_{j,k}(x)$ .

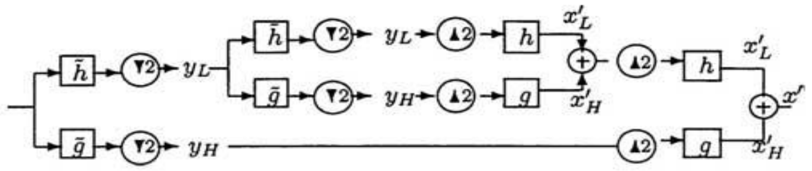
For example, $\Psi_{j0,k}(n)= \psi_{j,k}(x_s+n\Delta x_s)$ for some $x_{s,}\ \Delta x_s$ and n=1,2,3...., M-1. Thus , we employ M equally spaced samples over the support of the basis functions. in accordance equation the complementary inverse DWT is

$f(n)=1/\sqrt{M}\sum_k W_\Psi(j_0,k)\Psi_{j0,k}(n)+1/\sqrt{M}\sum_\infty\sum_k W\psi(j,k)\psi_{j,k}(n)$

The transform itself is composed of M coefficients, the minimum scale is 0, and the maximum scale is J-1.



Signal analysis and reconstruction in 1D DWT.



Signal analysis and reconstruction in two-level 1DDWT

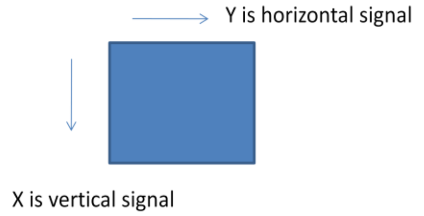
 

### 2.1.4 Discrete Wavelet Transform in Two Dimensions

The one-dimensional transforms of the previous sections are easily extended to two-dimensional functions like images. In two dimensions, a two-dimensional scaling function, $\Psi(x,y)$, and three two-dimensional wavelets, $\psi^H(x,y)$, $\psi^V(x,y)$, and $\psi^D(x,y)$, are required. Each is the product of two one-dimensional functiona. Excluding products that produce one-dimensional results, like $\Psi(x)\psi(x)$, the four remaining products produce the separable scaling function

$\psi(x,y)=\psi(x)\psi(y)$

and separable, "directionally sensitive" wavelets




$\Psi^H(x,y)=\Psi(x)\psi(y)$

$\Psi^V(x,y)=\psi(x)\Psi(y)$

$\Psi^D(x,y)=\Psi(x)\Psi(y)$

These wavelets measure functional variations-intensity variations for images along different directions:

$\Psi^H$ measures variations along columns(horizontal edges)

$\Psi^V$ responds to variations along rows(vertical edges)

$\Psi^D$ corresponds to variations along diagonals.

Given seperable two-dimensional scaling and wavelet functions, extension of the 1-D DWT to two dimensions is straightforward. We first define the scaled and translated basis functions:

$\Psi_{j,m,n}(x,y)=2^{j/2}\Psi(2^jx-m,\ 2^jy-n)$

$\Psi^i_{j,m,n}(x,y)=2^{j/2}\psi^i(2^jx-m,\ 2^jy-n)$, i={H,V,D}

Where index I identifies the directional wavelets previous three equations. Rather than an exponent, I is a superscript that assumes the values H,V, and D. The discrete wavelet transform of image f(x,y) of size M*N is then

$W_\Psi(j_0,m,n)=1/\sqrt{MN}\sum_{M-1}\sum_{N-1}f(x,y)\Psi_{j0,m,n}(x,y)$

$W^i_\psi(j,m,n)=1/\sqrt{MN}\sum_{M-1}\sum_{N-1}f(x,y)\psi^i_{j,m,n}(x,y)$, i={H,V,D}

f(x,y) is obtained via the inverse discrete wavelet transform

$f(x,y)=1/\sqrt{MN}\sum_m\sum_n W_\Psi(j_0,m,n)\Psi_{j0,m,n}(x,y)$

$+1/\sqrt{MN}\sum_{i=HVD}\sum_{j=j0}\sum_m\sum_n W^i_\psi(j,m,n)\psi^i_{j,m,n}(\qquad x,y)$

| | |
|---|---|
| **LL** | **LH** |
| **HL** | **HH** |

Fig: one-Scale Decomposition

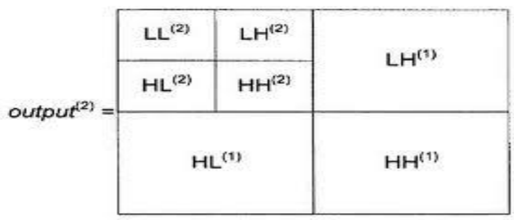



Fig: Two-Scale Decomposition

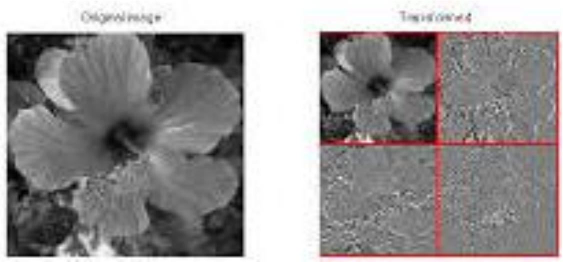


Fig: One-Scale Decomposition Example


Fig: Two-Scale Decomposition Example

## III. EXISTING SYSTEM:

A wavelet is a small wave which oscillates and decays in the time domain. The Discrete Wavelet Transform (DWT) is a relatively recent and computationally efficient technique in computer science. Wavelet analysis is advantageous as it performs local analysis and multi-resolution analysis. To analyze a signal at different frequencies with different resolutions is called multi-resolution analysis (MRA). Wavelet analysis can be of two types: continuous and discrete. In this paper, discrete wavelet transform technique has been used for image steganography. This method transforms the object in wavelet domain, processes the coefficients and then performs inverse wavelet transform to represent the original format of the stego object.

**2D wavelet decomposition:**

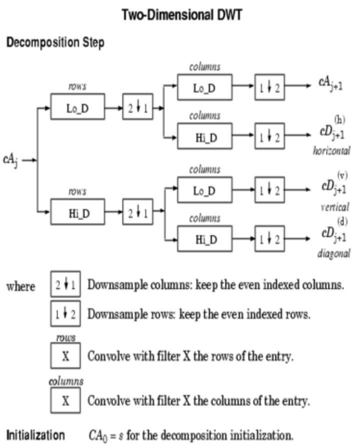
- The approximation and detail coefficients are computed in a similar way:

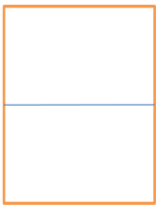
$$f^j_{k,l} = \int_{-\infty}^{\infty} 2^j \phi\left(2^j x - k,\, 2^j y - l\right) f(x, y)\, dx\, dy \quad d^{(S)\,j}_{k,l} = \int_{-\infty}^{\infty} 2^j \psi^{(S)}\left(2^j x - k,\, 2^j y - l\right) f(x, y)\, dx\, dy,$$

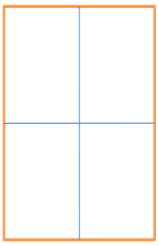
$$f^j_{k,l} = \sum_{n,m} h_{m-2k,n-2l}\, f^{j+1}_{m,n} \text{ and } d^{(S)\,j}_{k,l} = \sum_{n,m} g^{(S)}_{m-2k,n-2l}\, f^{j+1}_{m,n},$$

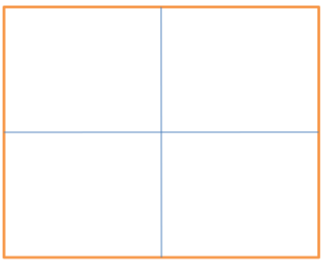
$$f^{j+1}_{k,l} = \sum_{n,m} h_{m-2k,n-2l}\, f^j_{m,n} + \sum_{n,m} g^{(I)}_{m-2k,n-2l}\, d^{(I)\,j}_{m,n} + \sum_{n,m} g^{(II)}_{m-2k,n-2l}\, d^{(II)\,j}_{m,n} + \sum_{n,m} g^{(III)}_{m-2k,n-2l}\, d^{(III)\,j}_{m,n}.$$

Subband Structure of Decomposition





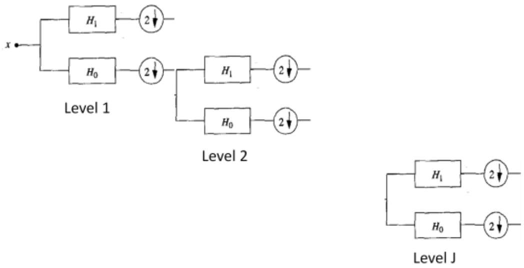


LL: Low pass filter vertical & horizontal
HL: horizontal high pass & vertical low pass filter
LH: horizontal low pass & vertical high pass filter
HH: high pass filter vertical & horizontal

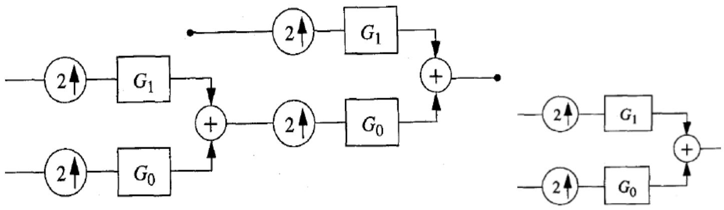
 

DWT(Discrete Wavelet Tranasform):

- We can construct discrete WT via iterated (subband) filter banks
- The analysis section is illustrated below




- And the synthesis section is illustrated here
- If is an orthogonal filter and , then we have an orthogonal wavelet transform.



Existing System process

- Steps
  - Read the cover image(I)
  - Calculate the size of I
  - Read the secret image(M)
  - Prepare M as message vector
  - Decompose the I by using Haar wavelet transform
  - embedded message M into decomposition image
  - Apply inverse DWT
  - Prepare stego-image to display

## IV. PROPOSED METHOD

In our proposed method, we used two processes. The first one is encoding and second one is decoding process. In encoding, we apply Discrete Wavelet transform. Apply DWT on the cover image in order to increase the security level. we apply the Inverse discrete wavelet transform (IDWT) and get the cover image, then the encrypted image is stegno-image. we apply the stegnography and watermarking on wavelet cover image. The decoding process is actually the reverse process of the embedding model.

### 1. Discrete wavelet transform

Wavelets are functions defmed over a fmite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function (t) as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The wavelet-based transform uses a I-D sub band decomposition process in which a I-D set of sample is converted into the low-pass sub band (Li) and high-pass sub band (Hi). Where I represents level of decomposition. The low-pass sub band represents a down sampled low-resolution version of the original image. The high-pas sub band represents residual information of the original image.

In 2-D sub band decomposition, the entire process is carried out by executing I-D sub band decomposition twice, fust in one direction (horizontal), then in the orthogonal (vertical) direction.

For example, the low-pass sub band (Li) resulting from the horizontaz direction is further decomposed in the vertical direction, leading to LLi and LHi sub bands. Similarly, the high pass sub band (Hi) is further decomposed into HLi and HHi. After one level of transform, the image can be further decomposed by applying the 2-D subband decomposition to the existing LLi subband. This iterative process results in multiple "transform levels". We refer to the subband LLi as a low-resolution subband and high-pass sub bands LHi, HLi, HHi as horizontal, vertical, and diagonal subband respectively since they represent the horizontal, vertical and diagonal residual information of the original image.

Now in this paper using the different type of DWT scaling factors that are $2^i$ scaling parameters are used in DWT-IDWT Wavelet Transform function. The 2D scaling function is

- The theories of Multiresolution analysis and wavelets can be generalized to higher dimensions.
- Scaling parameter

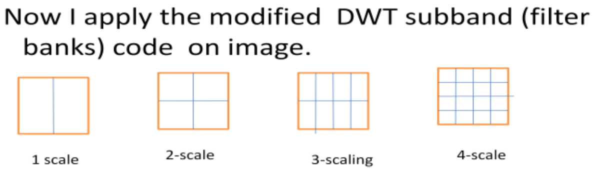
$$W_\Psi(j_0,x)=1/\sqrt{M}\sum_n s(n)\Psi_{j0,x}(n)$$

Where M is normalizing values

2D scaling function

$W_{\psi}(j_0,k1,k2)=1/\sqrt{N_1N_2}\sum_{n1=0 \text{ to } N1-1}\sum_{n2=0 \text{ to } N2-1}S(n_1,n_2)\psi_{j0,k1,k2}(n_1,n_2)$




**2. Implementation of modified steganography model:**

The following session describes the implementation of the encoding and decoding process clearly. The encoding process includes DWT, Arnold transformation, Alpha blending, IDWT and Stego image formation. The decoding process includes DWT, Arnold transformation, Alpha blending, IDWT and Secret image formation.

**Encoding Process:**

During encoding process that the cover image and secret image was reassigned by DWT transform on cover image. Next, IDWT was performed to reform the cover image. This secure stego image was transfer to any communication media. Next embedded the secrete image into wavelet cover image and as well as watermarking also. Now we get the stego image as encrypted image.

**3.3.1.1. Algorithm for encoding process:**

Step1: Preprocessing both the cover image(C) (N*N size) and secret image(S) (2N*2N size).
Step2: Perform a 2-D DWT-IDWT at level 1 of the image C (N/2 * N/2 size).
Step 3: Now we get CC wavelet C image
Step4:Applysteganographyand watermarking LSB algorithm on CC.
Step 5: Finally, get the 2-D DWT-IDWT Stego image.(SI).
Decoding process:
THE recover stego image and known cover image was reconstructed with the SI image. Apply dewatermarking in LSB position on SI image, now we extract the secrete image S.

**3.3.2.1. Algorithm for decoding process:**

Step1: Received the image SI.
Step2: Apply the dewatermarking technique on SI image.
Step3: finally we get the extracted secret image.

## V. EXPERIMENTS RESULTS:

**Encryption Resultants:**

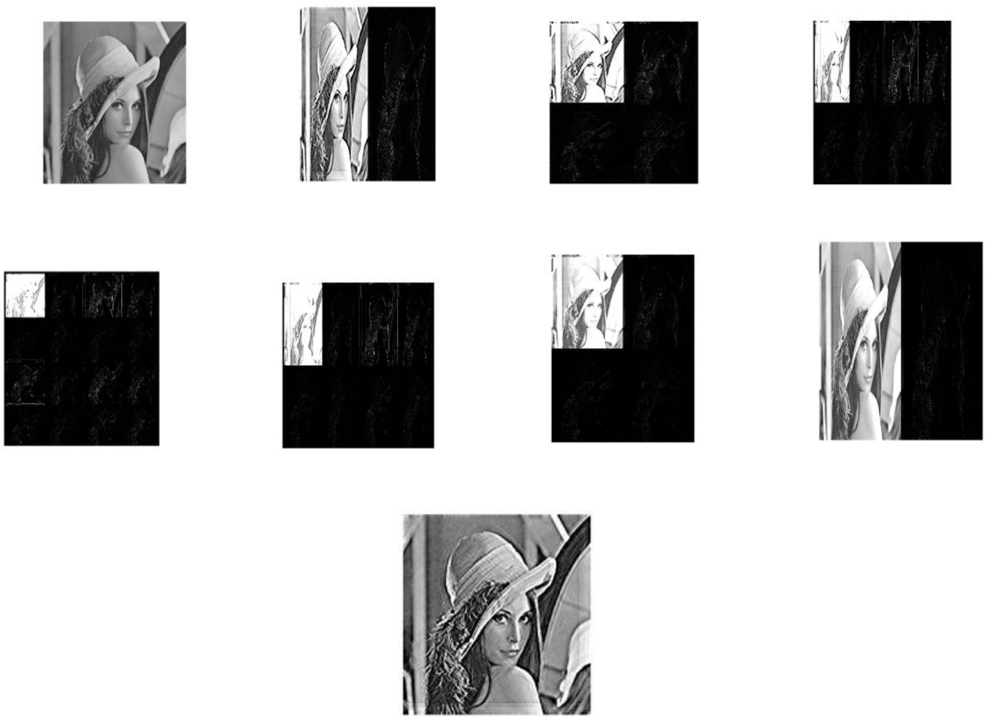
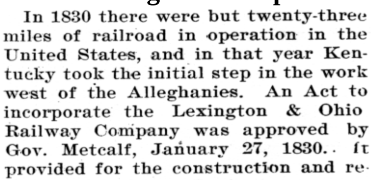


Fig: $2^i$ Scaling Resultents

**FIG: covered image with output of IDWT**



In 1830 there were but twenty-three miles of railroad in operation in the United States, and in that year Kentucky took the initial step in the work west of the Alleghanies. An Act to incorporate the Lexington & Ohio Railway Company was approved by Gov. Metcalf, January 27, 1830. It provided for the construction and re-

**FIG: secrete image**

**FIG: Watermarking with LSB encryption resultant image**

**Decryption Resultants:**

**FIG: encryption image**

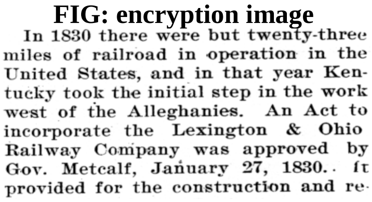


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**FIG: Extract Secrete image**

## VI. CONCLUSION

Wavelet transforms has been successfully applied to many applications. 2D DWTs are only capable of detecting horizontal, vertical, or diagonal details. This work is related with steganography technique using discrete wavelet transform domain. Wavelet domain is pretty new and efficient transform domain than previously used Fourier Transform. This method maintains the prime objective of steganography, which is the secrecy. It has been shown in results & discussion section that the stego image preserve the visible quality of original cover image. This method succeeds to keep intact the original image, after the extraction of embedded secret message. Hence this proposed method can be termed as successful new technique of image steganography.

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