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Research paper

A Decode Technique of MSI for Efficient Reconstruction Process

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Abstract

This paper presents a MSI (Modified Steganography for Image) decode technique for the perfect reconstruction process. Many algorithms are failing in decoding process due to the various reasons. In order to overcome those issues, an efficient decode process of MSI has been proposed in this paper presents. Basically, the MSI method can be classified into two parts of Encode and Decode. The segregation process for constructing the subbands,8-bit binary conversion process, Inverse substitution process and Decimal conversion process are doing an important role in MSI decode process. In addition, to measure the MSI decode performances, the standard parameters are used. This technique is designed mainly for the secret medical image transmission. The secret input image pixels should not be loss while transmitting over the network. In case of loss, it's very hard to retrieve the original secret image/date during the reconstruction process. This issue has been addressed by MSI decode process. In result, the original secret image can be restored 100% from this technique, the decode time is minimum than the conventional methods, the replica of the cover or known image can be obtained. However, the main advantages of this technique are easy to handle, more complex and strength than other methods, a perfect reconstruction without any loss and less execution time.

Keywords: *Decimal and binary conversion, decode process, steganography, medical image, cover image, secret image.*

1. Introduction

Johannes Trithemius has invented steganography method for preventing the intruder activities in 1949. It was one of the successful and popular techniques for hiding the secret data into known data. In addition, R. Karakış and his co-researchers had introduced a steganography method for medical applications in 2015.In their work, electro encephalogram (EEG) has used a secret image and magnetic resonance images (MRIs) were used as the cover image. This method had provided higher confidentiality for the patient information [2]. The authors have proposed an optical color image hiding algorithm based on Gerchberg-Saxton retrieval algorithm in Factional Fourier Domain (FFD) and they have done the numerical simulations to analysis the performances of this method [3]. SmitaAgarwal and Manoj Kumar had developed the reversible data hiding (DH) technique for encrypting medical images in 2017 and they have claimed that the technique was simple and powerful; it takes the less execution time than conventional [1]. The reversible data-hiding (RDH) scheme in the index tables of the VQ (vector quantization) compressed images based on index mapping mechanism has proposed by the Chuanqin team [4]. Chia-Chen Lin and his coordinators have introduced the RDH scheme for reducing the size of the VQ index table. The experimental results were indicating that, it provides an efficient DH and a high compression bit rate [7]. Manimurugan S and his Co-worker were developed various image hiding for different applications and he was also proved that his scheme is providing the high confidentiality, authentication and Integrity (CAI) [23-29]. Biswapati Jana has developed a DH scheme using the weighted matrix in 2016 [13]. Wen-ChungKuo and his teammates have proposed DH technique based on MSD (Modified Signed-Digit) and it was providing a better quality than 52 dB [5, 30-32].

Seung-Won Jung had proposed a post process algorithm of compressed domain lossless DH scheme for the JPEG compressed images. It extracts the filter coefficients from the bit stream and improves the quality of the decoded image using the wiener filter [6].

The ROI-based reversible DH scheme has developed for the encrypted medical images by the Yuling Liu teams [15]. The GuangyongGao and his research team has developed the DH technique with contrast improvement and tamper localization for the medical images.

It was achieving magnificent performance in terms of the quality of the image and tamper localization [24]. HongshengXu and et. al proposed an attack on double random phase encoding based image hiding method in 2014 [26]. ShahbazBadr andNoufal P have proposed an integrated DH and compression scheme (DH&CS) based on SMVQ and FoE in painting. The DH&CS scheme were merged into a single unit, which will upsurge the efficiency of the communication [21].
Xiang Wang, Jing Ding and Qingqi Pei have introduced DH scheme which will divide the cover image into equal size of the subbands.
In this scheme the pixel are ordering according to their values and it has achieved the better performances by modifying the max and min values of each subbandthan the current pixel value ordering based schemes while keeping distortion low [8].
Yang Yang, et.al had proposed RDH in medical images with improved contrast in texture part [17]. Le Wang, et.al proposed the computational ghost imaging (CGI) to have strong robust ness and high security based image hiding scheme. The watermark was encrypting with the configuration of a CGI system, and the random speckle patterns com pose a secret key [10]. Thai-Son Nguyen et.al had proposed a RDH system based on the Sudoku technique in 2015 [18]. Wen-Chung Kuo, et.al have proposed DH scheme based on multi bit encoding function and they have showed that their scheme was achieving good result than other DH schemes based on encoding function while upholding the suitable image quality [27].
In 2015, Chuan Qin et.al., proposed an effective RDH for the encrypted image with confidentiality protection for the image content. In this scheme, the receiver can be decrypted the encrypted data smoothly without any trouble using the own key [14]. ShaoweiWeng and his teammates have proposed a RDH based on flexible block-partition and adaptive block-modification strategy in 2016 and they stated that the method which they have proposed was better than the existing [16]. Chung-Chuan Wang, et.al had proposed a high capacity DH scheme for the binary images based on the block patterns. They have also examined the perceptual impact and then deliberated the robustness and security problems [19].
Tzu-Chuen Lu, et.al had proposed the reversible information hiding scheme which is using edge sensitivity detection based asymmetric histogram. It was providing the better image quality in multilevel embedding, particularly for the smooth images [20]. Jian Li, XiaolongLi and BinYang had introduced RDH scheme for the color images based on prediction error (PE) development and cross channel correlation.
The entropy of the PE was decreasing statistically, so the algorithm competency was increasing in terms of DH rate versus embedding distortion [22].As per the above study, there are many image hiding techniques have been proposed. However, every method has its own merits and demerits. In order to overcome the limitations of the conventional methods, this paper has been proposed a novel image decode technique. The entire paper has deals with the MSI decode process and its characteristics. The section-1 is discussing about the characteristics of different conventional methods and the proposed decode technique is discussing in the section-2. The section-3 describes the experimental results and discussion. Finally, the conclusion, acknowledgment and references have been discussed in the section 4, 5 and 6.

2. Proposed Decode Process of Image Hiding Technique

This section is describing the second stage of the proposed decode scheme. In the first stage, the given secret and cover images were encoded as a ‘stegano’ image$\sum_{i,j=0}^{m,n} ST_{(i,j)}$ and it has sent to the receiver/authenticated person as shown in Figure 2. In the second stage, the $\sum_{i,j=0}^{m,n} ST_{(i,j)}$is decoding by the proposed decode process for reconstructing the exact replica of the secret image as shown in Figure 1.

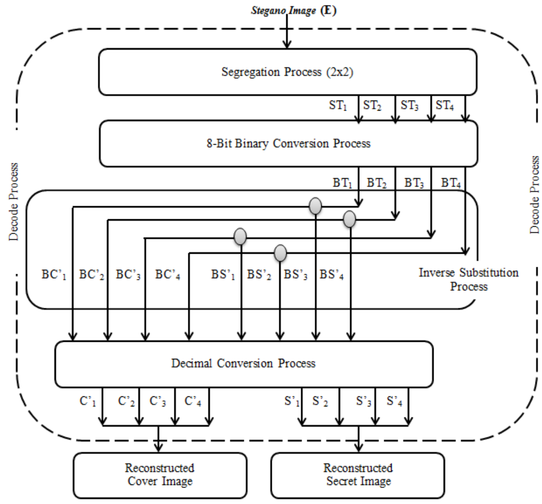

Fig.1: The proposed MSI technique decode process

Finally, the reconstructed secret image is validating by the standard parameters of Correlation coefficient (CC), CAI and error rate to confirm the truthfulness and quality of the rebuilt secret image. This decoding process has been classified into the segregation, 8-bit binary conversion, Inverse substitution and decimal conversion processes as shown in Figure 1.

The segregation process for constructing the subbands

The ‘stegano’ image $\sum_{i,j=0}^{m,n} ST_{(i,j)}$is dividing into the 2x2 equal sizes of the subbands of $\sum_{i,j=0}^{m,n} ST_{1\,(i,j)}, \sum_{i,j=0}^{m,n} ST_{2\,(i,j)}, \sum_{i,j=0}^{m,n} ST_{3\,(i,j)}$ and $\sum_{i,j=0}^{m,n} ST_{4\,(i,j)}$ as defined in equation 1.

$$\sum_{i,j=0}^{m,n} ST_{(i,j)} = \sum_{i,j=0}^{m,n} ST_{1\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{2\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{3\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{4\,(i,j)} \quad (1)$$

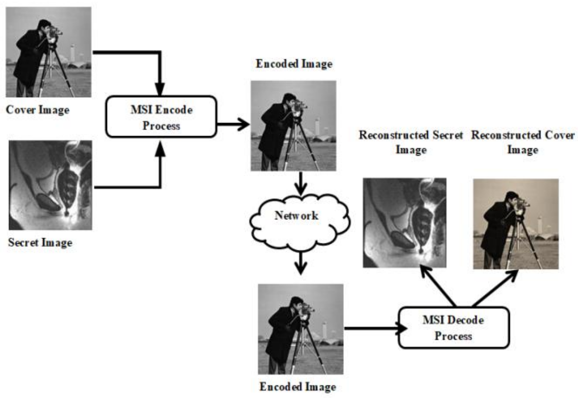

Fig. 2: Overview of the MSI decode process

8-bit Binary conversion process

The split subbands of $\sum_{i,j=0}^{m,n} ST_{1\,(i,j)}, \sum_{i,j=0}^{m,n} ST_{2\,(i,j)}, \sum_{i,j=0}^{m,n} ST_{3\,(i,j)}$ and $\sum_{i,j=0}^{m,n} ST_{4\,(i,j)}$ pixels are converting into the 8-bit binary value as given in equation 2. The converted subbands of $\sum_{i,j=0}^{m,n} BT_{1\,(i,j)}, \sum_{i,j=0}^{m,n} BT_{2\,(i,j)}, \sum_{i,j=0}^{m,n} BT_{3\,(i,j)}$ and $\sum_{i,j=0}^{m,n} BT_{4\,(i,j)}$are obtained from the equation 3 and it’s given in equation 4.

$$\sum_{i,j=0}^{m,n} BT_{(i,j)} = Bin\{\sum_{i,j=0}^{m,n} ST_{(i,j)}\} \quad (2)$$

$$Bin\{\sum_{i,j=0}^{m,n} ST_{(i,j)}\} = Bin\{\sum_{i,j=0}^{m,n} ST_{1\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{2\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{3\,(i,j)} + \sum_{i,j=0}^{m,n} ST_{4\,(i,j)}\} (3)$$

$$\sum_{i,j=0}^{m,n} BT_{(i,j)} = \sum_{i,j=0}^{m,n} BT_{1\,(i,j)} + \sum_{i,j=0}^{m,n} BT_{2\,(i,j)} + \sum_{i,j=0}^{m,n} BT_{3\,(i,j)} + \sum_{i,j=0}^{m,n} BT_{4\,(i,j)} \quad (4)$$

Fig. 3: Encoded and cover images

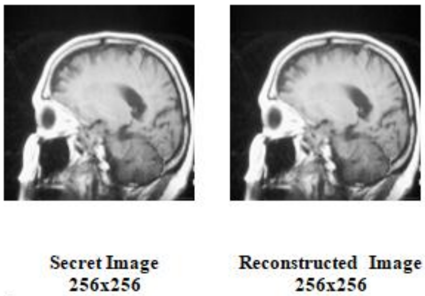

Fig. 4: Secret and reconstructed secret images

Inverse substitution process

In this process, the converted subbands $\sum_{i,j=0}^{m,n} BT_{1\,(i,j)}$, $\sum_{i,j=0}^{m,n} BT_{2\,(i,j)}$, $\sum_{i,j=0}^{m,n} BT_{3\,(i,j)}$ and $\sum_{i,j=0}^{m,n} BT_{4\,(i,j)}$ every least significant bit (LSB) are concentrated for obtaining the secret image bits based on the inverse process of Algorithm I. In result, the secret $\sum_{i,j=0}^{m,n} BS'_{(i,j)}$and cover $\sum_{i,j=0}^{m,n} BC'_{(i,j)}$ images can be obtained from the following deviations as given in equations 5 -10.

$$\sum_{i,j=0}^{m,n} BT_{1\,(i,j)} \Rightarrow \sum_{i,j=0}^{m,n} BC'_{1(i,j)} + \sum_{i,j=0}^{m,n} BS'_{1(i,j)} \quad (5)$$

$$\sum_{i,j=0}^{m,n} BT_{2\,(i,j)} \Rightarrow \sum_{i,j=0}^{m,n} BC'_{2(i,j)} + \sum_{i,j=0}^{m,n} BS'_{2(i,j)} \quad (6)$$

$$\sum_{i,j=0}^{m,n} BT_{3\,(i,j)} \Rightarrow \sum_{i,j=0}^{m,n} BC'_{3(i,j)} + \sum_{i,j=0}^{m,n} BS'_{3(i,j)} \quad (7)$$

Algorithm I

Step 1. *Start*

Step 2. *Substitute* $\sum_{i,j=0}^{m/2,n} BS1\,(i)_{(i,j)}$ *bits into* $\sum_{i,j=0}^{m/2,n} BC1\,(i)_{(i,j)}$ *(from the last pixel LSB to first pixel LSB of* $\sum_{i,j=0}^{m/2,n} BC1\,(i)_{(i,j)}$*).*

Step 3. *The second bit of LSB has to be replaced by secret bit.*

Step 4. *Once, all pixels, second bit of LSB has replaced, the same process has to be continued for the first bit of LSB in the same subband.*

Step 5. *The second part of the pair* $\sum_{i,j=0}^{m/2,n} BS2\,(i)_{(i,j)}$ *and* $\sum_{i,j=0}^{m/2,n} BC2\,(i)_{(i,j)}$ *bits are to be substituted as per the steps 2, 3 and 4.*

Step 6. *End*

Decimal conversion process

The $\sum_{i,j=0}^{m,n} BC'_{(i,j)}and\sum_{i,j=0}^{m,n} BS'_{(i,j)}$every 8-bits are converting into the corresponding decimal value in decimal conversion process.

$$\sum_{i,j=0}^{m,n} BT_{4\,(i,j)} \Rightarrow \sum_{i,j=0}^{m,n} BC'_{4(i,j)} + \sum_{i,j=0}^{m,n} BS'_{4(i,j)} \quad (8)$$

$$\sum_{i,j=0}^{m,n} BS'_{1(i,j)} \oplus \sum_{i,j=0}^{m,n} BS'_{2(i,j)} \oplus \sum_{i,j=0}^{m,n} BS'_{3(i,j)} \oplus \sum_{i,j=0}^{m,n} BS'_{4(i,j)} = \sum_{i,j=0}^{m,n} BS'_{(i,j)} \quad (9)$$

$$\sum_{i,j=0}^{m,n} BC'_{1(i,j)} \oplus \sum_{i,j=0}^{m,n} BC'_{2(i,j)} \oplus \sum_{i,j=0}^{m,n} BC'_{3(i,j)} \oplus \sum_{i,j=0}^{m,n} BC'_{4(i,j)} = \sum_{i,j=0}^{m,n} BC'_{(i,j)} \quad (10)$$

As an outcome, the grayscale secret $\sum_{i,j=0}^{m,n} S'_{(i,j)}$and cover $\sum_{i,j=0}^{m,n} C'_{(i,j)}$ images are reconstructed as shown in Figure 3 and 4 and equations 11 and 12. Finally, the reconstructed secret image is validating in order to ensure the integrity and quality of the secret image.

$$Dec\{\sum_{i,j=0}^{m,n} BC'_{(i,j)}\} = \sum_{i,j=0}^{m,n} C'_{(i,j)} \quad (11)$$

$$Dec\{\sum_{i,j=0}^{m,n} BS'_{(i,j)}\} = \sum_{i,j=0}^{m,n} S'_{(i,j)} \quad (12)$$

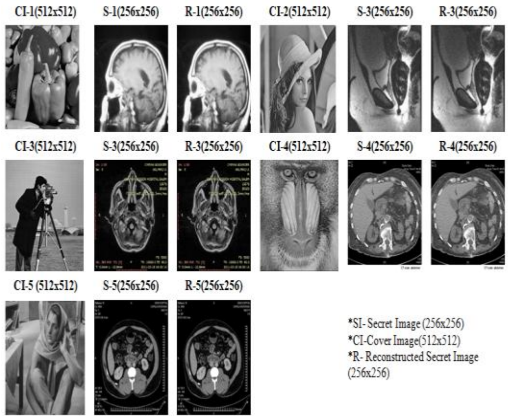

Fig. 5: The cover, secret, reconstructed secret images

3. Experimental result and discussion

This section deals with the experimental results of proposed and conventional steganography decode schemes. There are many gray scale cover and secret images are tested during the experimentation. However, five combinations of the image results have been illustrated in this paper. The 512x512 grayscale cover and 256x256 grayscale secret images have been considered as an input image. All the input images are in .BMP format. The figure-5 shows the input cover (CI), secret (S) and reconstructed (R) images.

Table I: Correlation Coefficient (R Vs.S)

CC (R Vs. S)				
Image Set	Method [9]	Method [11]	Method[12]	Proposed
R1,S1	0.859	0.788	0.845	1
R2,S2	0.815	0.749	0.844	1
R3,S3	0.895	0.762	0.879	1
R4,S4	0.811	0.768	0.869	1
R5,S5	0.865	0.799	0.897	1

Table II: Correlation Coefficient (C Vs.RC)

CC (C Vs. RC)				
Image Set	Method [9]	Method [11]	Method[12]	Proposed
C1,RC1	0.458	0.461	0.458	0.895
C2,RC2	0.469	0399	0.475	0.768
C3,RC3	0.478	0.478	0.421	0.723
C4,RC4	0.368	0.433	0.268	0.820
C5,RC5	0.470	0.489	0.352	0.841

The standard parameters have been chosen for analyzing the proposed decode scheme performances. Those parameters are CC, complexity; strength and execution time of decode process. The CC has been chosen for investigating and ensuring the integrity of the reconstructed secret image. In addition to that, the original cover (C) and reconstructed cover (RC) images are also tested by CC. In result, the proposed decode scheme is providing the best results than other conventional methods as shown in table I and II as well in figures 6 and 7 [9, 11 and 12].

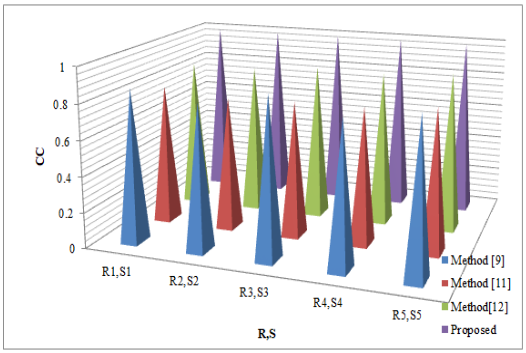

Fig. 6: The Correlation Coefficient (R Vs. S)

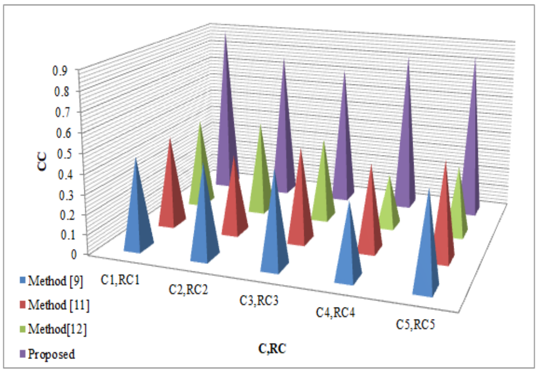

Fig. 7: The Correlation Coefficient (C Vs. RC)

The standard formula has been used for computing the CC. The range of CC is from 0.00 to 1.00. If the computation value is 1 or near to 1 then the reconstructed image is exactly same as like original one. The Table –I shows that the proposed decode scheme CC values of all images (Secret and reconstructed secret image) are 1.

Table III: The Execution of Decode Process

Time (Sec)				
Image Set	Method [9]	Method [11]	Method[12]	Proposed
R1	3.045	4.251	3.978	2.011
R2	3.454	4.694	3.254	2.015
R3	3.256	4.789	3.852	2.065
R4	3.055	4.802	3.001	2.078
R5	3.545	4.651	3.320	2.097

Table IV: The Complexity and Strength Performances

Image Set	Method [9]	Method [11]	Method[12]	Proposed
Complexity	3.05	3.02	3.56	4.86
PA	4.26	4.12	4.65	4.96
HVA	4.39	4.68	4.75	4.95

The cover and reconstructed cover ‘RC’ images CC values are near to 1. This occurred due to the perfect pixel substitutions in decode process. The proposed decode scheme has provided best result than the other conventional schemes as shown in Table II and in figure 7. The tables III and IV are describing the execution time of decode process, the algorithm complexity and strength. The proposed MSI decode technique is providing the minimum execution time than the other conventional methods [9, 11 and 12].

On the other hand, the complexity and strength have been measured by the standard software tools. The pixel and human visual attacks are considering for proving the algorithm strength.

In result, the proposed MSI decoding scheme has provided best result than other conventional schemes as shown in the figures 6 and 7 [9, 11 and 12].

4. Conclusion

Many authors had been proposed the secret image hiding techniques. However, it fails to obtain the exact replica of the original image during the reconstruction process. The MSI decode scheme has proposed to answer the mentioned issues. The proposed MSI decode process is mainly designed for the medical image transmission over the network. The aim of MSI decode scheme is to transmit the medical image without any loss. This scheme is providing the best result of minimum execution time, better reconstruction quality of the secret image, more complexity and strength than other schemes [9, 11 and 12]. As a result, 100% of the original can be reconstructed from the MSI decoding process without any losses with the minimum decode time. The time range is between 2.0 to 2.1 seconds.

In future, the same technique will be used for the defense application with few modifications.

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