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## **OPTIMIZED LOSSLESS AND REVERSIBLE DATA HIDING APPROACHES IN ENCRYPTED IMAGE SHARING WITH MULTIPLE HIDERS**

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#### ABSTRACT

Data hiding is an effective approach for protecting information by embedding it within a cover medium, making it imperceptible to anyone who may try to detect its presence. This technique typically involves three parties: the image provider, data hider, and receiver. Based on the security model and key management, data hiding schemes can be categorized into three types: share independent secret keys (SIK), shared one key (SOK), and share no secret keys (SNK). In the SIK model, both the image provider and data hider independently share secret keys with the receiver. In contrast, the SNK model does not require the sharing of any secret keys. This paper proposes Reversible and Lossless Data Hiding Schemes in Encrypted Image Secret Sharing involving multiple data hiders. The proposed method combines data hiding schemes for cipher-text images encrypted using public key cryptography that possess probabilistic and homomorphic properties. In the lossless scheme, additional data is embedded into the least significant bit (LSB) planes of cipher-text pixels by replacing the pixel values with new ones. For the reversible scheme, a histogram shrink preprocessing is applied before encryption, and half of the cipher-text pixel values are modified to accommodate the hidden data. These two schemes are compatible, allowing both data embedding operations to be carried out simultaneously in the encrypted image. Experimental results demonstrate the effectiveness and efficiency of the proposed method.

Keywords: Secret Sharing, Reversible Data Hiding, Lossless Data Hiding, Encrypted Image, Public Key Cryptography.

#### 1. INTRODUCTION

Data in the large amount gets transferred through public communication channels due to easily availability of the Internet. The transmitted data has to be protected from the illegitimate users. Data hiding is one of the approach used in the protection of the data [1].

It is scheme of transmitting data with the help of some cover media such that no onecan determine the presence of hidden data inside it. The cover media can be digital images, digital videos, audio or evenHTML codes. In the data hiding schemes, the pixels of the cover media are modified to carry the bits of secret data, and themodification is made up to a level that it is invisible to the human eyes.

If the hidden data and the cover media can be recovered without any loss, the data hiding is termed as Reversible Data Hiding(RDH) [2]. This technique ensures that the cover can be losslessly recovered after the extraction of the embedded data. Due to itsimportant reversibility, the RDH techniqueis also used for distortion-unacceptable covers, such as military, medical, and legalforensic images. The cover image after hiding secret data is termed as marked image. RDH schemes can be carried out in different ways like based on compressed domain, histogram shifting, difference expansion, prediction error expansion, etc. In compressed domain data hiding schemes, host image is compressed, andthen secret data bits are embedded insideit. Various modifications have beenproposed in these compressed standards like JPEG, JPEG2000, etc.

Due to the need for image privacy- preserving, contentowner is reluctant to display images to data-hider, especially those images that contain sensitive information. Encryption is an effective and common technique for protecting image privacy, as it converts a meaningful image into a meaningless image that is difficult for any unauthorized user to recognize [3]. Therefore, it is necessary to design reversible data hiding in encrypted images (RDH-EI). For instance, in cloud storage, the content-owner desires to store the image in the cloud with privacy-preservingby encrypting the image before uploadingit to the cloud. For management purposes, the cloud service provider will embed some additional data into the encrypted image without accessing the content. On the receiver side, the authorized receiver can perfectly restore the original image after decryption and data extraction as needed.

Lossless data hiding has drawn attention toresearchers in watermarking and digital rights management (DRM) systems [4]. For conventional data hiding or watermarking applications, at the encoder, the secret information can be embedded into the original images by use of algorithms designed by researchers, and then the image containing hidden data can be transmitted to the receiver. After reception of the marked media, only the secret information need to be extracted,

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and the ownership of such media can be authenticated. Different from conventionalwatermarking applications, for losslessdata hiding, while decoding, both theoriginal image, and the hidden data embedded into the image, need to be recovered and extracted perfectly. Therefore, evaluation of lossless data hiding algorithms would be somewhatdifferent from conventional viewpoints.

When having the encrypted image containing the additional data, a receiver knowing the data hiding key may extract the embedded data, while a receiver with the private key of the cryptosystem may perform decryption to retrieve the original plaintext image. In other words, the embedded data can be extracted in the encrypted domain, and cannot be extracted after decryption since the decrypted image would be same as the original plaintext. This paper presents Reversible Data Hiding and Lossless Data Hiding Schemes in Encrypted Image Secret Sharing withMultiple Data-Hiders. A combined data hiding schemes for cipher-text imagesencrypted by public key cryptography withprobabilistic and homomorphic properties.

#### 2. LITERATURE SURVEY

Nour Kittawi, Ali Al-Haj, et. al. [5]presents a novel algorithm is proposed to reversibly hide data into encrypted grayscale medical images in a separablemanner. The proposed algorithm hides twowatermarks in a given encrypted image. The first watermark is embedded by replacing selected encrypted image pixels based on data hiding key, and the second watermark is embedded in the watermarked encrypted image using the histogram shifting reversible data hiding method. The experimental results demonstrate that the proposed algorithm has high embedding capacity, high visual image quality, and high entropy.

Yingqiang Qiu, Zhenxing Qian, Lun Yu, et. al. [6] proposes a novel reversible data hiding (RDH) method with an adaptive embedding capability by extending the generalized integer transformation (GIT). We modify the GIT algorithm to a further generalized form, and accordingly wepropose an adaptive embedding algorithm. When hiding data into the original image, parameters of the extended GIT can be identified according to the content of each block. On the decoding side, the original image can be losslessly recovered after extracting the hidden message. Experimental results show that the proposed method outperforms state-of-the-art integer-transformation based RDH methods.

Y.-C. Chen, C.-W. Shiu, and G. Horng, et al. [7] proposed that one message bit is concealed into one pixel pair via modifying the encrypted parity-check bits. By comparing the decrypted parity-check bits, the embedded message bit can be extracted and the original image can be reconstructed.

Siren Cai, Xinlu Gui, et. al. [8] proposes efficient data hiding scheme based on reference pixel and block selection to further improve the embedding performance of histogram shifting. Specifically, we first divide the originalimage into non-overlapping blocks of an adjustable size. Then for each block, we assign the median of pixels as the reference pixel and the number of pixels equal to the reference value as the smooth level. In this way, difference histogramsfor each smooth level can be constructed. We embed the secret data using histogram shifting from the highest level histogram to lower level ones instead of sequential embedding. By this means, our proposed reversible data hiding scheme can adaptively embed data in the smoothblocks and thus improve the marked imagequality with a comparable embedding capacity. The experimental results also demonstrate its superiority over some state-of-the-art reversible data hiding works.

Zhang, et. al. [9] presents the pixel flipping based method in which the original image is encrypted by stream cipher, and one message bit is concealed into one stream-ciphered block by flipping the three least significant bits (LSBs) of pixels. The embedded data and the originalimage are jointly restored by estimating the texture complexity of each block. Since then, many improvements have beenmade, and these methods focused onenhancing data extraction accuracy, separating data extraction and image recovery, vacating room before encryption and the implementation of other covers. All of them were designed to increase the embedding capacity as high as possible while maintaining low distortion. W.

Puech, M. Chaumont, and O. Strauss, et.al. [10], introduced an RDHEI method thatencrypts the original image by the AES and embeds one message bit into an AES encrypted block by bit-plane replacement. The embedded data can be extracted by directly reading the bit of replaced location. The original image is restored by calculating the local standard deviation of decrypted blocks.

#### 3. REVERSIBLE DATA HIDING AND LOSSLESS DATA HIDING

#### SCHEMES IN ENCRYPTED IMAGESECRET SHARING

The block diagram of Reversible Data Hiding (RDH) and Lossless Data Hiding (LDH) Schemes in Encrypted Image Secret Sharing with Multiple Data-Hiders is represented in below Fig. 1.



recovery in plaintext domain

Modules at the Transmitter Side: 1. Input image initialization. 2. Image encryption. 3. Image segmentation. 4. Keymodulation. 5. Assembler. In Input Image Initialization module, we initialize the given image (i.e.) get the input image from user by using the

Additional data 1 Additional data 2

In Input Image Initialization module, we initialize the given image (i.e.) get the input image from user by using the keyword "uigetfile". This contains only thepathname and filename. To read the image filename, we used "imread" command. This read image was store in a variable as a matrix. Then we estimate the size of the given image using "size" command. This give information of size of given image to

Receiver Fig. 1: BLOCK DIAGRAM OF ENCRYPTEDIMAGE SECRET SHARING

Data extraction in encrypted domain

estimate whether the given text was within he size of input image. In encryption phase, the exclusive-or results of the original bits and pseudo- random bits are calculated. When stream cipher is employed.

The term image segmentation refers to the partition of an image into a set of regions that cover it. The goal in many tasks is for the regions to represent meaningful areasof the image, such as the crops, urban areas, and forests of a satellite image. In other analysis tasks, the regions might be sets of border pixels grouped into such structures as line segments and circular arcsegments in images of 3D industrial objects. Regions may also be denied asgroups of pixels having both a border anda particular shape such as a circle or ellipseor polygon. When the interesting regions do not cover the whole image, we can still talk about segmentation, into foregroundregions of interest and background regions to be ignored. The proposed technique embeds message through a public key modulation mechanism and performs data extractionby exploiting the statistical distinguish ability of encrypted and non encrypted image blocks. Since the decoding of the message bits and the original image is tied together, our proposed technique belongsto the category of non separable RDH solutions Compared with the state-of-the- art methods, the proposed approachprovides higher embedding capacity and isable to achieve perfect reconstruction of the original image as well as the embedded message bits. Assembler: The decoder in the data center has the decryption key K and attempts to recover both the embedded message and the original image simultaneously from [[f]]w, which is assumed to be perfectly received without any distortions. Note that this assumption is made in almost all the existing RIDH methods.

Modules at the Receiver Side: 1. Assembled image. 2. Segmentation. 3. Data extraction and Image Recovery.

Assembled Image: The decoder in the data center has the decryption key K andattempts to recover both the embedded message and the original image simultaneously from [[f]]w, which is assumed to be perfectly received without any distortions. Note that this assumptionis made in almost all the existing RDHmethods. Segmentation: 24 bit color image is best define by RGB color model in which each color appears in its primary spectral component of red, green and blue. This model is based on Cartesian coordinate system. Line joining the two corners has equal values for red, green and blue. This produces various shades of grey. The locusof all these points is called the grey line. InRGB model, each pixel is composed ofRGB values and each of these colors requires 8- bit for its representation. Henceeach pixel is represented by 24 bits.Sototal number of color possible with 24-bit RGB image.

Data Extraction and Image Recovery: The decoder in the data center has the decryption key K and attempts to recover both the embedded message and the original image simultaneously from [[f]]w, which is assumed to be perfectly received without any distortions. Note that this assumption is made in almost all the existing RIDH methods. Due to the interchangeable property of XORoperations, the any attacker without the data-hiding key cannot obtain the parameter values and the pixel-groups, therefore cannot extract the embeddeddata. Furthermore, although the receiver having the data-hiding key cansuccessfully extract the embedded data, he cannot get any information about the original image content.

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#### 4. RESULT ANALYSIS

Three test images including "Lena", "Peppers", "Boat" and "Sailboat" from the standard dataset are used for the experiments. All the test images are gray- scale images sized by  $512 \times 512$ .

The embedding rate of the RDH & LDH with Multiple Data-Hiders method is compared with several state-of-the-art methods. As shown in Table 1, the embedding rate of the proposed method is significantly higher than these state-of-the-art methods. Meanwhile, the embeddingrate of the proposed method is a constant value, which means that it is not affected by the image distribution. In these state-of-the-art methods, the embedding rates depend on image distribution. Images withsmooth textures can achieve higherembedding rates, while images with complex textures have lower embeddingrates, which can be avoided in the proposed method. This is because they vacate embedding room before encryption by the correlation of natural images, such as MSB prediction and adaptive coding.Instead, the RDH & LDH with Multiple Data-Hiders method vacates embedding room after encryption and embeds data into encrypted images with bit-plane replacement.

Images	RDH & LDH withMultiple Data- Hiders	MSB prediction	Adaptivecoding
Lena	3.5	1.7	2.4
Peppers	3.5	1.9	2.9
Sailboat	3.5	1.6	2.3

#### Table 1: EMBEDDING RATE COMPARATIVE ANALYSIS (bps)

#### **Encryption Process:**



Fig. 2: INPUT IMAGE, ENCRYPTED IMAGE



Fig. 3: ENCRYPTION KEY IMAGE





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**Decryption Process:** 



Fig. 5: ENTRY KEY FOR DECRYPTION



Fig. 6: DECRYPTED IMAGE



#### Fig. 7: RECEIVED DATA

The original image is reconstructed efficiently without any noise or disturbance with described Reversible Data Hiding (RDH) and Lossless Data Hiding (LDH) Schemes in Encrypted Image Secret Sharing with Multiple Data-Hiders. Finally, the experimental results illustrate the effectiveness of the proposed method.

#### 5. CONCLUSION

This paper presents Reversible Data Hiding (RDH) and Lossless Data Hiding (LDH) schemes for Encrypted Image Secret Sharing involving multiple data hiders. The proposed approach combines data hiding techniques for cipher-text images encrypted using public key cryptography with probabilistic and homomorphic properties. In the lossless scheme, new values replace the cipher-text pixel values to embed additional data into the least significant bit (LSB) planes of the cipher-text pixels. The two schemes, lossless and reversible, are designed to be compatible, allowing the data embedding operations of both schemes to be performed simultaneously within the encrypted image. This ensures that the original image can be reconstructed accurately without any distortion or noise. Experimental results further demonstrate the effectiveness of the proposed method.

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