A Survey on Reversible Image Data Hiding

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Abstract

This Reversible image data hiding is one of the popular image processing approach for data security. Image processing is simply the processing of images by using any sort of signal processing, where the input is a picture, a series of pictures, or a video and the output is also either a picture or a collection of properties associated with picture. Data security means protecting data from the persons who are not authorized to access the data. Much work have been done in the field of hiding data in images such as medical images ,texture images, aerial images and may more. For this, various techniques have been used such as histogram modification, image encryption, histogram shifting, difference expansion, side match vector quantization, multilevel histogram modification and many more. Normally these techniques worked for grayscale images. In this study, we describe the main techniques used to solve the problem of reversible image data hiding.

Keywords: Histogram Modification, Data Security, Data Hiding, Reversible Image Data Hiding

Introduction

Data Hiding [1] is basically a process of hiding or embedding data into various types of media such as picture, text, audio, moving pictures, video and many more so that the observer has no idea that some data is hidden inside media. Out of all the available media the pictures are considered to be the best one. The main aim of hiding the data is to embed the data in such a manner that it can be recovered. There are two important disciplines under data hiding, first is the steganography and the second is the digital watermarking There are various methods that can be used for hiding the data such as Digital Image Watermarking, Multimedia watermarking techniques and there are many more proposed in [1]

Reversible Image Data Hiding [11] means to embed a piece of data or information into a image in order to generate a marked image from which the original image can be exactly obtained after extracting the embedded data. The hiding process shown in Fig.1 simply links the data to be embedded with the cover image in which the data will be embedded. For instance, in covert communications [12] the embedded data may not be related to cover image whereas in authentication, the data to be embedded need to be closely related to cover image. Thus in any type of application, hiding of data is an important need. In many cases of hiding the data, the cover image may distort due to embedding of data and hence it cannot be exactly recovered from marked image because of occurrence of some sort of permanent distortion. However in many applications it is desired that original image must be exactlyrecovered, so in order to satisfy such requirement, reversible image data hiding techniques are used. Reversible image data hiding facilitates linking between embedded data and cover image in such a way that original cover image can be easily recovered after extracting the embedded data. Data can be hidden in color images or gray images. A color image improves hiding capacity and hence gives better PSNR

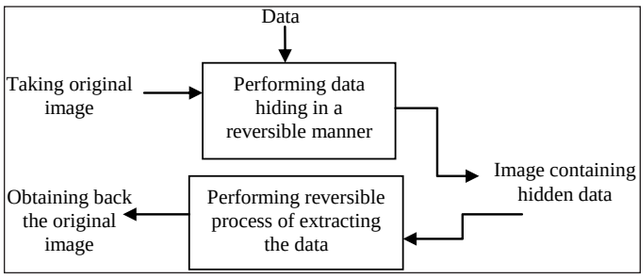

Fig. 1. Process of Reversible Image Data Hiding

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RELATED WORK

Many scholars have published a tons of research work on data hiding and reversible image data hiding. There have been extensive studies on the improvements of approaches for hiding of data for many years. A variety of techniques have been proposed [1-20]

In previous work, Yu-Chee Tseng [1] et al. in 2002 have presented a novel steganography method that is capable to hide the important data in a picture. The method uses two keys in order to provide high security to embedded data, these keys are the binary matrix and weight matrix. The experiment have shown that this method maintains better image quality, provides good data embedding capacity and more security to data

Cheng-Hsing [2] Yang et al. in 2008 have proposed a new steganographic method known as Adaptive LSB using PVD (pixel-value differencing). This method basically find out the difference values of the two pixels that are consecutive to each other, The main reason for doing this is to know how much data can be embedded into the two consecutive pixels. These difference values are distributed into three levels-lower, middle and upper levels and data embedding is done by k-bit LSB substitution method, where k is adaptive and is based on level. It was shown experimentally that this method provides good embedding capacity as well as maintain good quality of image.

Zhicheng Ni [3] et al. in 2008 have presented a a novel robust lossless data hiding technique, it simply involves determining the robust quantity and then using it to hide the data. The experimental analysis have shown that this technique achieves two important characteristics, first is losslessness and second is robustness. This method was basically usen for semi-fragile image authentication

Chi-Kwong Chan [4] et al. in 2004 have proposed simple LSB substitution for hiding of data in image.It involves using OPAP i.e optimal pixel adjustment process. The main benefit which was observed is that it enhance the quality of image and lowers its complexity. The experiment shows that the performance of this method is far better than the other methods as described in [5].

Ran-Zan Wang [5] et al. in 2001 have proposed optimal LSB substitution and have used genetic algorithm in order to embed data in rightmost k LSBs of host picture and they have also used a special modeling technique known as perceptual modeling and with this they have improvise data hiding techniques so that good quality of embedding can be achieved.

Ran-Zan Wang [6] et al. in 2000 have proposed a new data hiding method in which they hide the vital data within the moderately-significant-bit of a picture and applies a substitution process in a global level and neighborhood constituent adjustment process to scale back any picture distortion. Experimental results shows satisfactory quality of the ensuing picture.

Chih-Hsuan Tzeng [7] et al. in 2004 have presented a new method for hiding data in pallete images.the idea involves using a new form of relationship, known as color-ordering relationship, from this relationship a new function is defined which is known as color-mapping function which provides binary output. In order to hide the data, the pixel which is highly suitable foe embedding is determined and selected and then adjustments are made in its color so that the result of function becomes equal to the data to be hidden. On inspection of output of function, it becomes easy to get back the embedded data. The experimental results have shown that a good balance is maintained between quality of image and capacity of data embedding.

Min Wu and Bede Liu [8] in 2004 have presented a new approach to hide texts, diagrams and signatures in binary pictures. They simply change the pixels that are flippable in order to hide the data. In order to get back the embedded data, it is not necessary to use original image but a few marks, popularly known as registration marks are needed. This method is being used to check the authorization of digital signatures.

Tsung-Yuan Liu [9] et al. in 2007 have presented a new change tracking method for hiding data in MS-Word document. With this method, the data is embedded at the time of transformation of document in a particular stage of degeneration. In order to get back the hidden data, the changes made in degeneration are tracked.

Hao-Tian Wu [11] et al. in 2015 have used RDH (Reversible Data Hiding) algorithm for digital images. The algorithm not only keeps higher PSNR value but also improves the quality of image by enhancing its contrast. They have used histogram modification [11] in which the highest two bins are selected first and then these bins are divided into two bins that are adjacent to each other such

that histogram equalization [13]can be performed, this process is repeated several times to increase the capacity of embedding the data. For exact recovery of original image the location map and bits of messages and some additional information is embedded in image. By using this algorithm, they found that not only the visual quality of image is preserved but it is better than that of three contrast enhancement MATLAB functions.

Arun K Mohan [14] and team in 2014 presents a novel reversible data hiding algorithm with better security such that it is possible to get back the original image from the marked image with no kind of distortion, after the embedded data is taken out. In this algorithm, at the side of sender, the image is encrypted by a key known as encryption key and then the data is embedded into the encrypted image by a key which is called as data hiding key. At the side of receiver, if receiver has both the encryption and data hiding key then only he can first get the data by data hiding key and then it can decrypt the encrypted image by using the encryption key. It is proved analytically and shown experimentally that the peak signal-to-noise ratio (PSNR) of this method is higher than the other methods that exists i.e 48.13dB.

Dae-Soo Kim [15] and team in 2013 have proposed reversible image hiding scheme using histogram shifting for high quality. They have used modulo operation in order to improve the image quality and gradient-adjusted prediction (GAP) method is also used to increase the data hiding capacity. The experimental results have shown that the data hiding capacity is increased to almost quadraple and the quality of image is also increased by almost 7db, which is more than general histogram shifting technique

Xiaolong Li [16] et al. in 2013 have presented a novel reversible data hiding (RDH) Scheme which is based on two-dimensional difference histogram Modification and for this they have used a difference-pair-mapping (DPM).They have extended the expansion embedding and shifting techniques which were used in RDH histogram based methods. On comparing with two histogram-based RDH methods i.e one-dimensional difference-histogram and one-dimensional prediction-error-histogram, it was found that the redundancy and the embedding capacity of the image is improved.

Zhenfei Zhao [17] et al. in 2011 have proposed a RDH method based on histogram modification and seqential recovey of natural images.In this method, the diference between the tow pixels that are adjacent to each other is found out and then the data to be kept secret is hidded in the difference due to which not only the quality of marked image is enhanced but also the capacity of embeding the data is improved as compared to that of one or two level level histogram modification based methods.

Yongjian Hu [18] et al. in 2009 have presented difference-expansion (DE)-based reversible data Hiding method in which the bit stream that is to be embedded comprises of two main parts- first is the data that has to hidden and second is the 2-D binary overflow location map and the header file. They basically provides a scheme by which the location map can be compressed to a good extent, as this compression is very much beneficial for increasing the data embedding capacity. The experiments have shown that this method works well for varied images for which other algorithms do not provide a good amount of data embedding and better image quality.

Chin-Chen Chang [19] et al. in 2006 have proposed a RDH scheme based on side match vector quantization (SMVQ) for digitally compressed images. In this scheme the sender embeds the secret data in a compressed image and the receiver simply extracts the hidden data and reconstructs the SMVQ compression codes. The analysis shows that the performance of this method is better than the other VQ or SMVQ-based reversible hiding methods in terms of image quality, capacity of hiding data and rate of compression.

Jun Tian [20] et al. in 2003 presented reversible data embedding method based on difference expansion for digital images. It embeds restoration information, a message authentication code, and additional data in difference values neighboring pixel for the difference expansion (DE). The experimaental results show that this method explores the redundancy of digital images in order to provide higher embedding capacity and lower distortion of images.

There are various other methods and algorithms to embed watermark(for eg.[26]) that is visible and some data which are not visible(for eg.[21]-[25]) in pictures

LITERATURE SURVEY

S.no.	*Author*	*Year*	*Title*	*Methodology*	*Result*
1.	Hao-Tian Wu, Jean-Luc Dugelay and Yun-Qing Shi [11]	2015	Reversible Image Data Hiding with Contrast Enhancement	Histogram Modification is used for embedding and histogram equalization is done in order to enhance the contrast.	Experimental results have shown that not only the visual quality of image is preserved but it is better than that of three contrast enhancement MATLAB functions.
2.	Arun K Mohan, Saranya M R and K. Anusudha [14]	2014	An Algorithm for Enhanced Image Security with Reversible Data Hiding	Encryption method is used for data embedding .	It is proved analytically and shown experimentally that the peak signal-to-noise ratio (PSNR) of this method is higher than the other methods that exists i.e 48.13dB.
3.	Xiaolong Li, Weiming Zhang, Xinlu Gui, and Bin Yang [16]	2013	A Novel Reversible Data Hiding Scheme Based On Two-Dimensional Difference-Histogram Modification	Difference-Pair-Mapping (DPM) is used to perform Two-Dimensional Difference-Histogram Modification.	On comparing with two histogram-based RDH methods i.e one-dimensional difference-histogram and one-dimensional prediction-error-histogram, it was found that the redundancy and the embedding capacity of the image is improved
4.	Dae-Soo Kim, Gil-Je Lee and Kee-Young Yoo [15]	2013	Reversible Image Hiding Scheme for High Quality based on Histogram Shifting	Histogram Shifting technique is used. To improve the performance modulo operation and GAP method is employed.	The experimental results have shown that the data hiding capacity is increased to almost quadraple and the quality of image is also increased by almost 7db, which is more than general histogram shifting technique
5.	Yongjian Hu, Heung-Kyu Lee, and Jianwei Li [18]	2009	DE-Based Reversible Data Hiding With Improved Overflow Location Map	Difference-Expansion (DE)-based reversible data Hiding method is used for embedding and recovery.	method works well for varied images for which other algorithms donot provide a good amount of data embedding and better image quality

METHODOLOGY

In past different methodologies have been followed in order to perform reversible image data hiding. Here is the generalized methodology-

Phase-1: Data Embedding

Different data embedding methods have been used in the past and some common are discussed here, Hao-Tian Wu [11] et al. have used histogram modification, in which the highest two bins are first chosen in the histogram. All the bins within these chosen bins are kept as it is and the bins those are outwards to the highest bins are shifted outwards so that the highest bins can be divided into two bins that are adjacent to each other. This process of dividing the highest bins is repeated many times until desired data is embedded and the contrast of image is enhanced. But before embedding, the pixels are preprocessed to generate a location map and then histogram of image is constructed.

Yongjian Hu [18] et al. have used Difference expansion (DE) method. In embedding process, the histogram is divided into two parts:- for embedding there is a inner part and for shifting there is a outer part. This process involves 2 major changes-

i) Before embedding, the outer part has to be shifted.

ii) The inner part needs to be embedded.

In this method, 1st calculate the distinction between the present pixel and the pixel that is adjacent to it and then expand the distinction by doubling it. Thus, the expanded distinction became an excellent range. in step with the embedding rule, the expanded distinction was changed as odd,once the message to b hidden is one; otherwise, the expanded distinction remains unchanged once the message to be hidden is zero.

Chin-Chen Chang [19] et al. have used side match vector quantization. In the method, the data that needs to be hidden is preprocessed for various privacy reasons. The hidden data can be encrypted in order to make them

secured. Then SMVQ is used to encode the original image and then compressed image is created. Then the data that has to be kept secret is hided in the compressed image. Now finally the image is ready to be sent to the receiver.

Phase-2: Data Extraction and Recovery

There are various ways to get back the data that was embedded.

In [11] there are few steps that needs to be performed to get back the data-

i) To get the values of last peak values, the LSB's of 16 excluded pixels is obtained.

ii) From the last peak values , the data and all the other values which were embedded are extracted.

iii) Then the compressed location map is decompressed and with this the original image is recovered.

In [18] the confidential message will be obtained by extracting the LSB of the expanded distinction. For this, The algorithm is enforced through 2 stages.

Firstly we will construct the overflow location map by selecting embeddable locations and then use the embedding information to form header file.

Secondly, embedded image is constructed by using encoded auxiliary information with the payload into chosen embeddable location.

In [19] following steps are performed-

i) Once the stego-image is received, it is divided into blocks.The indexes of first row and first column are gathered.

ii) For all the other blocks, the blocks generated in step i) are used to build subcode books, then codeword is selected from subcode book in such a manner that the Euclidean distance(ED) between them must be shortest. If the ED is equal to 0 then hidden bit is also 0 else the hidden bit is 1.

RESULT AND CONCLUSION

This paper's objective is to present the major methods of data hiding and reversible image data hiding. This paper surveys some of the important techniques. The techniques considered in this paper are histogram modification, difference expansion method, support vector quantization, histogram shifting and many more. By analysis of all these techniques it was found that histogram modification is most suitable technique that increases the contrast of image and also provide a good data embedding capacity. So one can easily increase the robustness of this method and use it for medical and satellite images in order to have a good and clear vision.

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