Novel Reversible Data Hiding Framework Using HS (Histogram Shifting)

Pooja Wagh[1], Dr. Shivnath Ghosh[2]
[1]M.Tech Student, Department Of Computer Science & Engineering, MPCT Gwalior(India)
[2]Associate Professor & H.O.D, Department Of Computer Science & Engineering, MPCT Gwalior(India)

Abstract- *This paper proposes a novel reversible data hiding scheme based on the histogram shifting-imitated approach. Instead of utilizing the peak point of an image histogram, the proposed scheme manipulates the peak points of segments based on image intensity. The secret data can be embedded into the cover image by changing the peak point pixel value to other pixel value in the same segment. The proposed method uses a location map to guarantee the correct extraction of the secret data. Since the modification of the pixel value is limited within each segment, the quality of the stego image is only related to the size of the segmentation, which means after embedding data into the cover image, it can be reused to do the multi-layer data embedding while maintaining the high quality of the stego image. The experimental results of comparison with other existing schemes demonstrate the performance of the proposed scheme is superior to the others.*

Keywords- Reversible Data Hiding, Histogram, Secret Data, Cover Image, Proposed, Stego-Image.

I. INTRODUCTION

Steganography is the art and science of writing hidden messages with reliability in such a way that no one can be aware of the existence of the concealed messages. The advantage of steganography over cryptography alone is that the hidden messages do not attract any attention. Therefore, cryptography protects the content of a message, but steganography can be said to protect the content of messages as well as the communicating parties. In steganography, media camouflaging information is called cover media, and the information to be hidden and communicated covertly is called the payload. The carrier with hidden payload is called stego media or covert message.

In steganography schemes (Alattar, 2004; Carli et al., 2006; Celik et al., 2005; Chan and Cheng, 2004; Chang and Kieu, 2010; Chang and Lu, 2006; Chang et al., 2010; Diljith and Jeffrey, 2007; Fridrich et al., 2002; Kim et al., 2008; Lee et al., 2008, 2010a,b; Lee and Chen, 2010; Lin et al., 2009; Luo et al., 2011; Mielikainen, 2006; Ni et al., 2003; Tai et al., 2009; Thodi and Rodríguez, 2007; Tian, 2002, 2003; Tsai et al., 2009; Tseng and Hsieh, 2009), the cover media will undergo some permanent destruction no matter which watermarking scheme or steganographic scheme is used. Often, this distortion of the media that is caused by embedding a message is small, but it is irreversible. The original cover media cannot be recovered after the hidden messages have been extracted. In many applications, it is not the only situation providing the fidelity of cover media and stego-media perceptually equivalent; the loss of cover media is not prohibitive because even the slightest media distortion may result in an incorrect final decision. For this reason, reversible data hiding schemes have been developed and proposed in the past decade. Although reversible data hiding schemes, like other data hiding methods, introduce embedding distortions to the cover media, they are also able to remove the distortion and restore the media exactly to its original and lossless format after the embedded information has been extracted. Embedding capacity and stego-image quality are often used to evaluate the performance of reversible data hid- ing schemes. Nevertheless, embedding more information usually creates greater distortion in the existing methods. Our main goal here is to present a new and simple steganographic scheme with reversibility designed for digital images. The key issues that we have considered are embedding capacity, the perceived quality of the stego image, the complexity of secret extraction and image restoration, and security. The proposed scheme uses a reversible data hiding scheme based on histogram-shifting-imitated reversible data hiding to embed data by using the pixel shifting strategy. To carry a k-bit secret value each time, each segment-peak is replaced by another value that also belongs to the same segment as the segment-peak. Therefore, a small segment has a tiny change between the cover pixel and the stego pixel. This property offers image values that are highly perceptible to the human eye and also provides significant superiority in multiplelayer embedding without loss in image fidelity because the segment confines the degree of pixel modification. According to the experimental results, our method produces insignificant visual distortion and provides a higher embedding capacity compared with other reversible data hiding schemes, such as Kim et al. (2008), Mielikainen (2006), Ni et al. (2003), Thodi and Rodríguez (2007), Tian (2003), and Tsai et al. (2009). In addition, the embedding or extracting process of the proposed scheme is time-efficient because of the simple function, i.e., pixel shifting mapping with a private key, which also provides the desired security.

II. BACKGROUND

Reversible Data Hiding schemes can be classified into two typical categories: reversible data hiding by difference expansion (called DE-based technique for short) and reversible data hiding by his- program shifting.

In the DE-Based Reversible Watermarking method (Tian, 2002, 2003), the differences between pixel pairs are to be expandable by 1 bit of watermark data. Since the overflow or underflow problem may be invoked after data embedding, the compressed bit-stream of locations of expanded difference numbers (known as the location map) is generated to indicate whether the pixel pair is expanded or not. Tian's DE-based technique can provide an embedding capacity of almost 0.5 bit per pixel (bpp); however, there is significant degradation of image quality due to bit-replacements of grayscale pixels. Besides, the DE-based scheme is not suitable for multiple embedding, which accumulates dramatic image degradation between pixel pairs. In contrast with Tain's DE-based scheme, Ni et al. (2003) manipulated the peak and zero (or minimum) points of the histogram that corresponds to a cover image. Data are concealed by means of shifting pixels between the peak and zero (or minimum) points. The histogram-shifting based scheme offers invisible image distortions with little auxiliary information. However, the embedding capacity is limited by the frequency of the peak-pixel values in the histogram.

To date, many reversible data hiding schemes (Alattar, 2004; Celik et al., 2005; Chan and Cheng, 2004; Chang and Kieu, 2010; Chang and Lu, 2006; Chang et al., 2010; Diljith and Jeffrey, 2007; Fridrich et al., 2002; Kim et al., 2008; Lee et al., 2008, 2010a,b; Mielikainen, 2006; Ni et al., 2003; Tai et al., 2009; Thodi and Rodríguez, 2007; Tian, 2002, 2003; Tsai et al., 2009; Tseng and Hsieh, 2009) that extend the DE-based scheme or the histogram- based scheme have been developed to enhance hiding capacity or reduce the distortion of the stego-image. Alattar (2004) extended Tain's scheme using a vector of cover pixels instead of a pixel pair to increase the hiding ability. Thodi and Rodríguez (2007) proposed a prediction error expansion (PE) scheme which utilizes a predictive method to generate the predictive pixel of the cover pixel, and then a secret bit is embedded by expanding the difference error between the predictive pixel and the cover pixel. Tsai et al. (2009) combined a linear prediction technique and histogram shifting to improve the embedding capacity of Ni et al.'s scheme. The cover image is divided into many sequential, non-overlapping blocks. The secret data are embedded into the difference values between the center pixel and others pixels in a block. Ni et al. (2003) offered a multi-level, reversible, data hiding scheme to achieve large hiding .capacity. Tseng and Hsieh (2009) proposed a reversible data hiding scheme that extended the scheme proposed by Tian (2002, 2003). Their scheme was based on perdition-error expansion, which differs from most DEbased schemes in that the location map is not required.

III. PROPOSED SCHEME

In this paper, we are proposing a histogram shifting-imitated reversible data hiding scheme. The proposed scheme divides the range of the intensity into non-overlapping segments, and finds the peak point pixel value having the highest number of occurrences in the histogram of each segment. Only peak pixel values are embeddable, except for the first peak pixel value that is encountered within a segment. The detailed depiction of the embedding procedure is as follows:

Input: A cover image I and a secret message SM(K).
Output: A stego-image I'.

Step 1: Divide the pixel values set PV for a grayscale cover image I into N mutually exclusive classes of pixels,each of which is an equal-sized segment.
Step 2: Identify the maximum pixel value of the frequency distribution for each segment, and call it a segment peak.
Step 3: In a zig-zag scanning order manner to process the cover image I, extract the k-bit data sd from the secret message SM(K) and hide sd to an embeddable pixel using the pixel shifting strategy via PkDP mapping with the private key(i).
Step 4: Mark an indicator bit at the location map corresponding to position(x,y). If the current processing pixel is a segment peak, then the indicator bit is '1', otherwise, the indication bit is '0'.
Step 5: Continue steps 3 & 4 until all secret data in SM(K) are concealed; at this time, apply an efficient and lossless compression software, such as JBIGI to condense the location map. Afterward, the compressed coding is regarde as part of the embedded data and can be hidden using the above steps.
Step 6: Output the stego image, r.

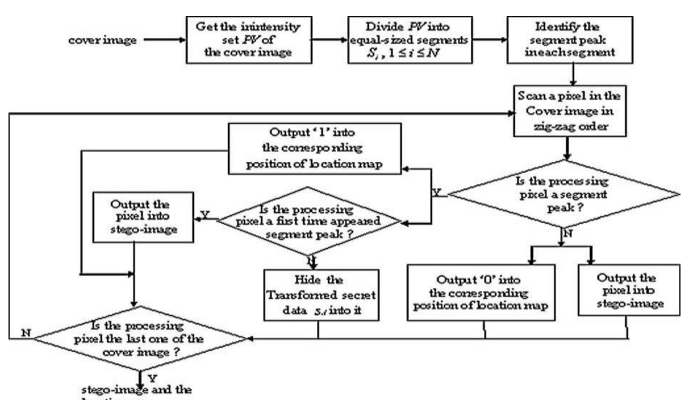

Fig.1 The flowchart of the embedding procedure

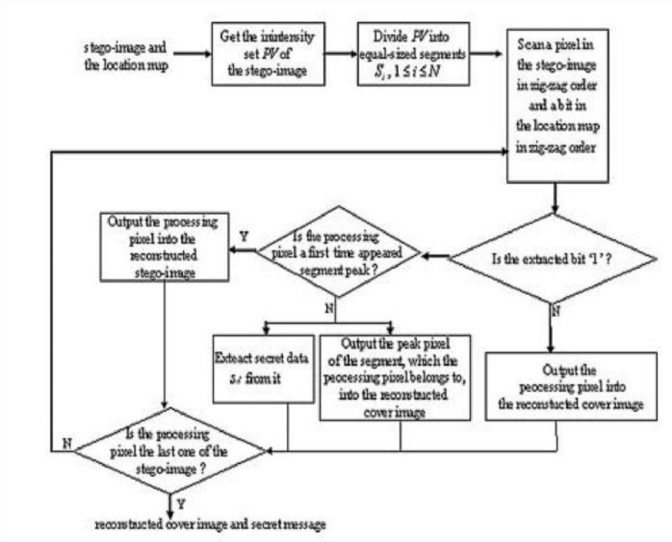

Fig.2 Flow chart of image reconstruction and getting

IV. SIMULATION AND RESULTS

In this section, some experimental results are presented to show the embedding capacities and stego-image quality in terms of the visualization and the fidelity measure of image representation. The binary secret bit stream S was randomly generated using the library function randint( ) in the MATLAB 16a library.To evaluate the performance in terms of the embedding rate and the image distortion.

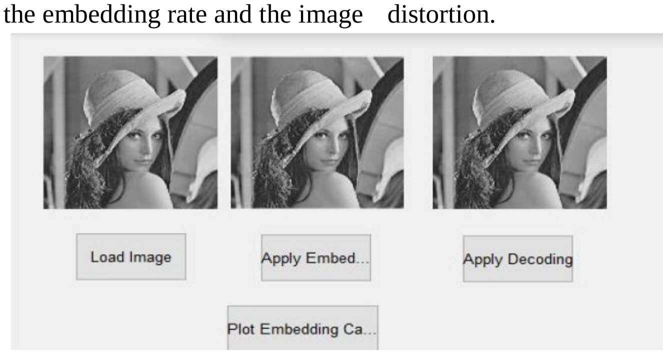

Fig.3 Graphical User Interface for Matlab Simulation

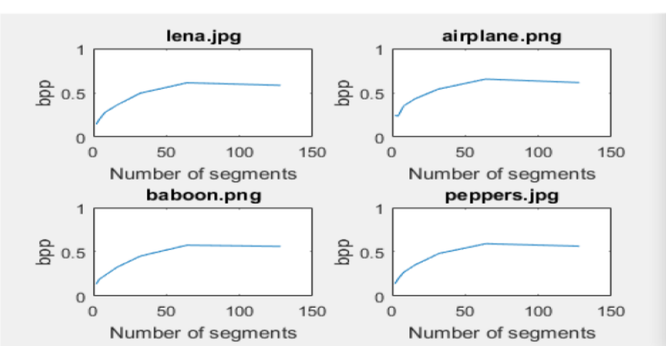

Fig.4 Graph showing embedding capacity varying over the number of segments for 4 images

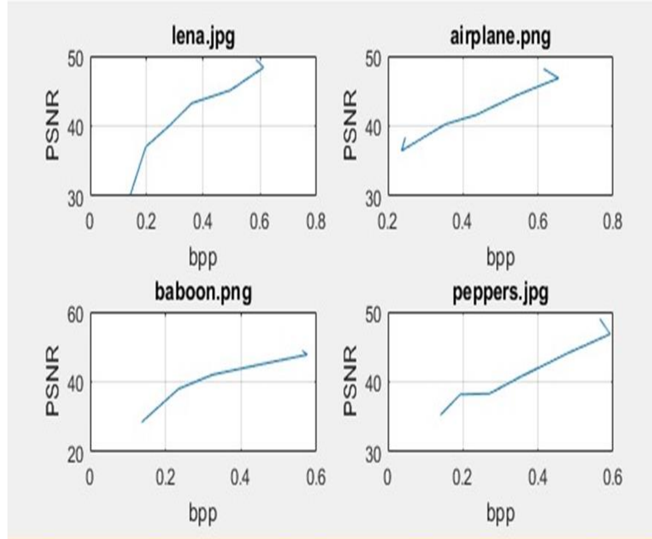

Fig.5 Graphs showing the tradeoff between PSNR Embedding Rate (bpp) for 4 images

V. CONCLUSION

This section summarizes the experimental results of the proposed scheme and compares that scheme with previous reversible data hiding schemes. First, this paper proposed a novel data hiding scheme with reversibility that offers several improvements over other schemes: (1)Tthe proposed scheme is a lossless process with respect to the image, which allows an authorized party to decode the embedded data and completely restore the original state; (2) The proposed scheme achieves at stego image that has high visual quality. A smaller segment size can yield a stego image with even better visual quality because of both the cover pixel and its corresponding stego-pixel fall within the same segment. With a small segment, the change in the range of values between the cover pixel and the stego-pixel is very small. Irrespective of which one of the cover images are used, the PSNR values approximately the same for the segment sizes. (3) The experimental results indicate that the proposed scheme is superior to other schemes for one single embedding layer; more than 0.5 bpp in the pure embedding rate with the range of 51.375– 56.24402 dB on average, which is the mostly perceptual image visible value for Human Visual System; (4) The proposed scheme is especially effective for multi-layer embedding without loss in image fidelity, because the segment confines the degree of pixel modification. No matter how many layers of message embedding are used, image distortion can only occur to a very limited extent; (5) The proposed scheme uses a simple function, i.e., pixel-shifting mapping with a private key, to perform the embedding and extracting processes, which takes a small amount of time and is secure. From the foregoing, it can be seen clearly that our proposed scheme provides high embedding capacity, provides a stego-image that has good visual quality, has low time complexity, and affords very high security.

REFERENCES

[1] Alattar, A.M., "Reversible watermark using the difference expansion of a generalized integer transform", IEEE Transactions on Image Processing 13 (8),1147–1156, 2004.
[2] Carli, M., Campisi, P., Neri, A., " Perceptual aspects in data hiding", Telecommunication Systems 33 (1–3), 117– 129, 2006.
[3] Celik, M.U., Sharma, G., Tekalp, A.M., Saber, E., "Lossless Generalized-LSB data embedding", IEEE Transactions on Image Processing 14 (2), 253–266, 2005
[4] Chan, C.K., Cheng, L.M., 2004. Hiding data in images by simple LSB substitution Pattern Recognition 37 (3), 469–474.
[5] Chang, C.C., Kieu, T.D, "A reversible data hiding scheme using complementary embedding strategy", 2010.
[6] Information Sciences 180 (16), 3045–3058. [6] Chang, C.C., Lu, T.C., "A difference expansion oriented data hiding scheme for restoring the original host images", Journal of Systems and Software 79 (12),1754–1766, 2006.
[7] Chang, C.C., Pai, P.Y., Yeh, C.M., Chan, Y.K., "A high payload frequency based reversible image hiding method" Information Sciences 180 (11),2286–2298, 2010.
[8] Diljith, M., Jeffrey, J , "Expansion embedding techniques for Reversible Watermarking Compression ratio", Wikipedia— the free encyclopedia. http://en.wikipedia.org/wiki/Data compression ratio/ (accessed August 2010), 2007.