IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
National Conference on Emerging Trends in Engineering and Technology (NCETET'16)
Lourdes Matha College of Science & Technology, Thiruvananthapuram
Vol. 3, Special Issue 3, August 2016

A New Secure Image Transmission Through Secret-Fragment-Visible Partial mosaic image Transformation

Muneera U A[1], Hema S[2]

M.Tech Student, ECE, LBSITW, Trivandrum, India [1]

Assistant professor, ECE, LBSITW, Trivandrum, India [2]

Abstract: A new secure image transmission is proposed which transform automatically a given secret image into a secret partial fragment partial mosaic image. The partial mosaic image which looks similar to a promptly selected mask image is created by dividing the secret image into blocks and transferring the colour characteristics to be those blocks of mask image. Efficient techniques are created to conduct the colour conversion process so that the secret image may be retrieved losslessly. A technique of handling the overflows/underflows in the altered pixel's colour space is also proposed .The information required for retrieving the secret image is inserted into the created partial mosaic image by a lossless data hiding scheme using a key. Good experimental result shows the practicality of the proposed method.

Keywords: Data hiding colour transformation, handling overflows/underflows, partial mosaic image.

I. INTRODUCTION

Presently, images are generally transmitted through the internet for various applications such as personal photographs, confidential business archives, medical imaging systems and military image database. These images usually contain confidential data or private data so that they should be protected from leakages during transmission. Two common methods are image encryption and data hiding.

Image encryption is a process that uses the basic property based on Shanon's confusion and diffusion properties [1]-[7].Due to the encrypted image is a noise image , no one can obtain the secret image from it unless he has a correct key. The encrypted image is a senseless file, which cannot provide additional data about the secret image. It may arouse a raider's attention during transmission due to randomness in form. An another method to avoid this problem is data hiding [8]-[18] that hide a covert message into a mask image so that no one can understand the existence of the covert message. Existing data hiding method utilize LSB substitution [8], histogram modification [9], difference expansion [10]-[11], prediction error expansion [12]-[13], recursive histogram modification [14] and discrete cosine/wavelet transformation [15]-[18].

In order to reduce the bias of the resulting image, the payload of the mask image is set on by an upper bound for the bias value. Rate of distortion can be found in [19].The main issue for hiding data in images is the difficulty to insert a large amount of message into a single mask image .In the case of image hiding ,the secret image must be highly compressed previously. For instance, for a data hiding method with an embedding rate of.5 bits per pixel, a secret image with 8 bits per pixel must be squeezed at a rate of at least 93.75% in order to hidden into a cover image .But keeping or transmitting medical and military images, legal documents etc that are valuable with no allowance of distortions, such data compression operation are impractical.

In this paper new technique for secure image transmission is proposed, which convert a secret image into a meaningful partial mosaic image and looking like a preselected mask image. The transmission process is controlled by a secret key and only with the key can a person retrieve the secret image .The proposed method is inspired by Lai and Tsai [21] in which a new type computer art image called secret fragment visible partial mosaic image was proposed. The partial mosaic image is the result of rearrangement of tiles of a secret image with another image called the mask image preselected from a database .But the weakness of Lai and Tsai [21] is the requirement of large image database. Using their method the user is not allowed to select freely his/her preferred image for use as the mask image. To remove this weakness Ya Lin lee and WenHsiangTsai proposed a new method [25].Using their method a secret image can be transformed to secret fragment visible partial mosaic image of the same size that has the visual appearance of any freely selected mask image without the need of databases. The weakness is blocky appearance of partial mosaic image is noticeable and that will arise the question about the originality of the image .This will arise the doubt about the image. So a new method is designed in which the blocky appearance is reduced and no one can realize the partial mosaic effect in the resulting image. Because a part of mask image is used for partial mosaic image generation.

As an illustration Fig 1 shows the result produced by the proposed method. Specifically, the given secret image first divided into rectangular fragments called tile images. The size of the mask image is increased 2 or 4 times the secret image.Then the tile image is fit into similar blocks in the mask image called mask blocks. Next the colour characteristics of each tile image are transformed to be that of the corresponding block of mask image. Relevant scheme are proposed to conduct nearly lossless retrieval of the original secret image from the resulting image. The proposed method is new in that a meaningful partial mosaic image is created counter to the image encryption method that only creates a meaningless noise image. Also the proposed method can transform a secret image into a partial mosaic image without compression, while a data hiding method must hide a highly compressed version secret image into a cover image if they have the same volume In the remainder of this paper, the idea of the proposed method is described in section 2 and 3.Detailed algorithm for partial mosaic image creation and secret image retrieval are given in section 4.In section 5, the experimental result are presented to show the feasibility of the proposed method and in section 6 the security problem of the proposed method is discussed followed by conclusion in section 7

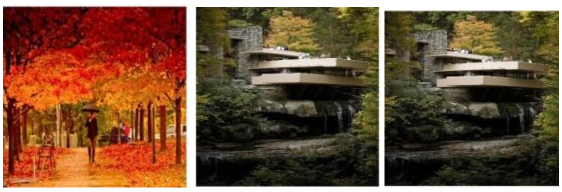

Fig 1: Result yielded by the proposed method. (a) Secret image. (b) Mask image. (c) Secret-fragment-visible partial mosaic image created from (a) and (b) by the proposed method.

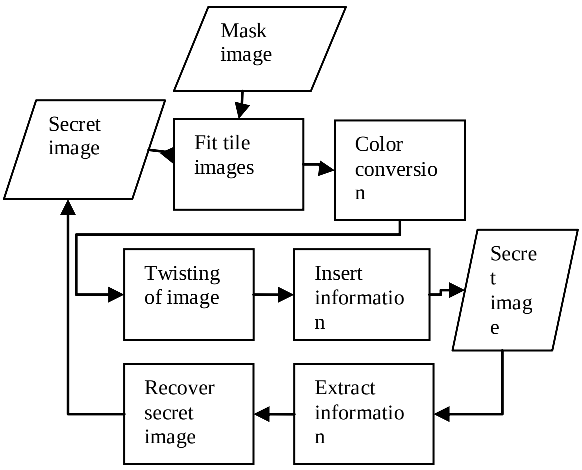

Fig. 2. Flow diagram of the proposed method

II. IDEAS OF PROPOSED METHOD

The proposed method include two main phases(1)partial mosaic image creation.(2)Secret image retrieval .The two main phases are shown in the flow diagram. In the first phase, a partial mosaic image is yielded. The phase include four stages 1) fitting the tile image of the secret image into the mask block of a mask image. 2)transforming the colour characteristics of each tile image to become that of the corresponding mask block 3)twisting each tile image into a particular direction with the minimum RMSE value with respect to its mask value 4)Embedding relevant information into the created partial mosaic image for future retrieval of the secret image. In the second phase 1) the embedded information is extracted to retrieve the secret image from the partial mosaic image 2) retrieving the secret image using extracted information.

III. IDEAS OF PARTIAL IMAGE GENERATION

Problem encountered in generating partial mosaic image are discussed in this section.

A. Colour conversion between the blocks
In the first step of the proposed method ,each tile image T in the given secret image is fit into mask block B in the mask image Reinhard et al [22]proposed a colour conversion scheme which convert colour characteristics of an image to be that of another in 1αβ colour space. This idea is an answer to the issue and is adopted in this paper except that the RGB colour space is used to reduce the volume of the required information for retrieval of the original secret image. More clearly, Let T and M be described as two pixel sets $\{p_1, p_2, p_3 ...p_n\}$ and $\{p_1', p_2', p_3' ...p_n'\}$ respectively. Let the colour of each p_i be denoted by(r_i, g_i, b_i) and that of each p_i' by (r_i', g_i', b_i').At first we compute the mean and standard deviation of T and M by the following formulas.

$$\mu_c = \frac{1}{n}\sum_{i=1}^{n} c_i, \quad \mu_c' = \frac{1}{n}\sum_{i=1}^{n} c_i' \qquad (1)$$

$$\sigma_c = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(c_i-\mu_c)^2}, \quad \sigma_c' = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(c_i'-\mu_c')^2} \qquad (2)$$

In which c_i and c_i' denote the colour component values of pixel p_i and p_i' respectively with c=r, g or b .Next we compute the new colour values r_i'', g_i'', $b_i''$for each p_i in T by

$$c_i'' = q_c(c_i - \mu_c) + \mu_c', \qquad (3)$$

In which $q_c = \sigma_c'/\sigma_c$ is the standard deviation quotient and c=r, g or b. It can be seen easily that the new colour mean and variance of the resulting tile image T' are equal

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
National Conference on Emerging Trends in Engineering and Technology (NCETET'16)
Lourdes Matha College of Science & Technology, Thiruvananthapuram
Vol. 3, Special Issue 3, August 2016

to those of M. To calculate the original colour values (r_i, g_i, b_i) of p_i from the new one r_i', g_i", b_i", we use the following formulas

$$c_i = (1/q_c)(c_i'' - \mu_c') + \mu_c. \quad (4)$$

We have to embed the relevant information into the created partial mosaic image about the tile image T' for use in the after stage of recovering the original secret image. However the involved mean and standard deviation values in the formula are all real numbers each with many digit in operated partial mosaic image. Therefore we limit the numbers of bits used to represent important parameter values in (3) and (4).Specifically for each colour component we allow each of mean of T and M to have 8 bits with it value ranges from 0 to 255 and the standard deviation quotient q_c in (3)..

B. Choosing Appropriate Mask Blocks And Twisting Blocks To Fit Better With Smaller RMSE Value

In transforming the colour characteristics of a tile image T to be that of corresponding mask block M as described above, how to choose an appropriate M for each T is an issue. For this we use the standard deviation of colours in the block as a measure to select most similar M for each T. Specially we sort all the tile images to form a sequence S_{tile} and the entire mask block to form another S_{mask} according to the average values of the standard deviation of the three colour components. Then we fit the first in S_{tile} into first in S_{mask} and second in S_{tile} into second in $_{Smask.}$

Moreover after a mask block B is chosen to fit a tile image T and after the colour characteristics of T is transformed, we carryon a further advance on the colour similarity between the resulting tile image T' and mask block M by twisting T' into one of four direction0º,90°,180°and 270º which yield a rotated version of T' with the minimum root mean square error(RMSE) value with respect to the M among the four direction for final use to fit T into M..

C. Handling overflows /underflows in colour transformation

After the colour conversion process is conducted as described previously, some pixel value in the new tile image T' might have overflows or underflows .To solve this problem we convert such values to be non overflow or non under flow ones and keep the value differences as residuals for use in later recovery. We convert all the non pixel value in T' not smaller than 255 to be 255 and all not larger than zero to be zero. Next, we compute the difference between the original colour value and converted one are the residual and record them as the part of information associated with T'. Accordingly, the pixel value which is just on the bound of 255 or 0 cannot be distinguished from those with overflow or underflow values during later recovery. We define the residual of those pixels as to be zero and record them as well.

D. Embedding information for secret image

In order to recover the secret image from the partial mosaic image, we adopt a technique proposed by Coltuc and Chassery (24) and apply it to the least significant bits of the pixel in the created partial mosaic image to conduct data embedding. Unlike the classical LSB replacement method [8],[25],[26] which substitute LSBs with message bits directly the reversible contrast mapping method [24] apply simple integer transformation to pairs of pixel values. The method conducts forward and backward integer transformation as follows; severally in which (x. y) is a pair of pixel values and (x', y') are transformed pairs by following formula

$$x' = 2x - y, \quad y' = 2y - x \quad (6)$$

$$x = \left\lceil \frac{2}{3}x' + \frac{1}{3}y' \right\rceil, \quad y = \left\lceil \frac{1}{3}x' + \frac{2}{3}y' \right\rceil. \quad (7)$$

The method yield high data embedding capacities close to highest bit rates and has the lowest complexity reported so far.The data required to recover a tile image T which is mapped to a mask block M includes 1) the index of M 2) the optimum twisting angle of T 3) the truncated mean of T and M and the standard deviation quotient of all colour components and 4) the overflow or under flow residuals. This data items for recovering a tile image T are integrated as a five bit stream of the form

$BS=t_1t_2...t_mr_1r_2m_1m_2....m_{48}q_1q_2....q_{81}d_1d_2...d_k$

In which the bit segment $t_1t_2...t_mr_1r_2m_1m_2...m_{48}q_1q_2...q_{81}d_1d_2...d_k$ represent the values of the index of M, the twisting angle of T the mean of T and M, the standard deviation quotient and the residual respectively.

In more detail, the number of required bits for the five data items in M are discussed below.1) the index of M needs m bits to represent, with m computed by

$$m = \lceil \log[(W_S \times H_S)/N_T] \rceil$$

in which W_s and H_s are respectively the width and height of the secret image S and N_T is the size of the mask image 2)It needs two bits to represent the twisting angle of T because there are four possible twisting angle of T 3)48 bits are required to represent the mean of T and M because we use the eight bits to represent the mean value in each colour component 4)it needs 21 bits to represent the quotient of the T over M in the three colour component with each component requiring 7 bits and 5)the total number k of needed bits for representing all the residuals depend on the number of overflows or underflows in T'.

Then the above explained bit streams of all the tile images are concatenated in order further into a bit stream BSt for entire secret image. In order to protect BSt from being attacked we encrypt it with secret key. To obtain the encrypted bit stream BSt' which is finally embedded into

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology
National Conference on Emerging Trends in Engineering and Technology (NCETET'16)
Lourdes Matha College of Science & Technology, Thiruvananthapuram
Vol. 3, Special Issue 3, August 2016

the pixel pairs in the partial mosaic image using the method of Coltac and Chassery [24] described above. It may require more than one iteration in the encoding process since the length of BSt' may be larger than the number of pixel pairs available in an iteration.

Moreover we have to insert as well some related information about the partial mosaic image generation process into the mosaic for use in the secret image recovery process. Such information described as a bit stream I like BS mentioned antecedently includes the following data items 1) the number of iteration conducted in the process for embedding the bit stream BSt' 2) the total number of used pixel pairs in the last iteration for embedding BSt' and 3) the Huffman table for encoding the residuals.

IV. ALGORITHEM OF PROPOSED METHOD

Based the above discussion, the detailed algorithm for partial mosaic image creation and secret image recovery may now be explaind as algorithm 1 and 2

Algorithem1: Partial mosaic image generation
Input: A secret image S, a mask image M and a secret key K
Output: A secret –fragment –partial mosaic image F
Steps:
Stage 1: Fitting the tile images into the mask blocks
Step 1: If the size of the mask image is different from secret image, change the size of the mask image to be four times that of secret image and divide the secret image into n tile images $\{T_1, T_2 ... T_n\}$ as well as first part of mask image T into n mask images $\{M_1, M_2, ... M_n\}$ with each T_i or M_i being of size of NT and 4*NT
Step 2:Compute the mean and the standard deviation of each tile image Ti and each mask image M_j for the three colour components according to (1) and (2) and compute the standard deviation for T_i and M_j respectively for i=1 through n and j=1 through n.
Step 3: Arrange the tile images in the set $S_{tile}= \{T_1, T_2 ,..T_n\}$ and the mask blocks in the set $S_{mask}= \{M_1, M_2,..M_n\}$ according to the average standard deviation values of the blocks. Map in order the blocks in the sorted S_{tile} to those in the S_{mask} in a 1 to 1 manner and reorder the mappings according to the indices of tile images resulting in a mapping sequence of the form T_1 to M_{j1},T_2 to M_{j2}...T_n to M_{jn}
Step 4: Create a partial mosaic image F by fitting the tile images into the corresponding mask blocks according to L
Stage 2: Performing colour conversions between the tile images and mask blocks
Step 5: Create a counting table TB with 256 entries, each with an index corresponding to a residual value and an initial value of zero is assigned to each entry (note that each residual value will be in the range of 0 to 255)
Step 6:For each mapping T_i to M_{ji} in sequence L represent the mean and of T_i and M_{ji} respectively by 8 bits and the standard deviation quotient qc appearing in (3) is represented by seven bits .
Step 7: For each pixel Pi in each tile image T_i of partial mosaic image F with colour value ci where c=r, g and b transform c_i into a new value c_i" by (3).whether c_i" is not smaller than 255 or if it is not larger than zero then change ci" to be zero or 255,compute the residual value R_i for each pixel pi and increment by 1 the count in the entry in the counting table TB whose index is identical to R_i
Stage 3:
Step 8: Compute the RMSE value of each colour transformed tile image T_i in F with respect to its corresponding mask block M_{ji} after rotating T_i into each of the direction 0 .90 ...180 ,270 and twist T_i into the best direction with the smallest RMSE value.
Stage 4: Embedding the secret image recovery information
Step 9: Construct a Huffman Table using the content of the counting table TB to encode all the residual value computed previously.
Step 10: For each tile image T_i in partial mosaic image F construct a bit stream Mi for recovering T_i
Step 11:Concatenate the bit streams BS_i of all T_i in F in a raster scan order to form a total bit stream BS_i .Use the secret key K to encrypt Mt into another bit stream BS_t' and embed BS_t' into F by reversible contrast mapping.
Step 12:Construct a bit stream including 1) the number of conducted iteration N_i for embedding BS_t'2) the number of pixel pairs used in the last iteration 3) the Huffman table constructed for the residuals and embed the bit stream I into the partial mosaic image F

Algorithem2: Secret image recovery
Input: A partial mosaic image F with n tile images $\{T_1, T_2,..T_n\}$ and the secret key
Output: the secret image S
Steps:
Stage 1: Extracting the secret image recovery information
Step1: Extract the bit stream from F by a reverse version of scheme proposed in [24] and decodes them to obtain the data items.
Step 2: Extract the bit stream BSt' using the values of N_i and N_{pair} by the same scheme used in the last step.
Step 3: Decrypt the bit stream BS_t' into BS_t by K
Step 4: Decompose BS_t' into n bits streamsBS_1 through BS_n
and M_1 through M_n
Step 5: Decode the BS_i for each tile image T_i to obtain the following data items 1) the index j_i of the block M_{ji} in F corresponding to the T_i 2) optimum twisting angle of T_i 3) the mean of T_i and M_{ji} and the related standard deviation quotient of all colour components and 4) the overflow /underflow residuals in T_i decoded by the Huffman Table HT
Stage 2:retrieving the secret image
Step 6:Retrieve one by one in a raster scan order the tile images $T_{i,}$ i=1 through n of the desired secret image S by the following steps 1)twist in the reverse direction the block indexed by ji namely M_{ji} in F through the optimal

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
National Conference on Emerging Trends in Engineering and Technology (NCETET'16)
Lourdes Matha College of Science & Technology, Thiruvananthapuram
Vol. 3, Special Issue 3, August 2016

angle θ and fit the resulting the resulting block content into T_i to form an initial tile image T_i 2) Use the extracted mean and the related standard deviation quotient to recover the original pixel values in T_i according to (4).3)use the extracted mean and standard deviation quotient and 5)to compute the two parameters c_s and c_l 4)scan T_i to find out pixel with values 255 or zero which indicate that overflows or underflows respectively have occurred there 5)add respective values c_s and c_l to the corresponding residual values of the found pixel and 6) take the result as final pixel values ,resulting in a final tile image T

Step 7: Compare the entire final tile image to form the desired secret image S as output.

V. EXPERIMENTAL RESULT

Fig. 3 Experimental result of partial mosaic image creation (a) Secret image (b) Mask image (c) Partial mosaic image created with tile image size 8×8

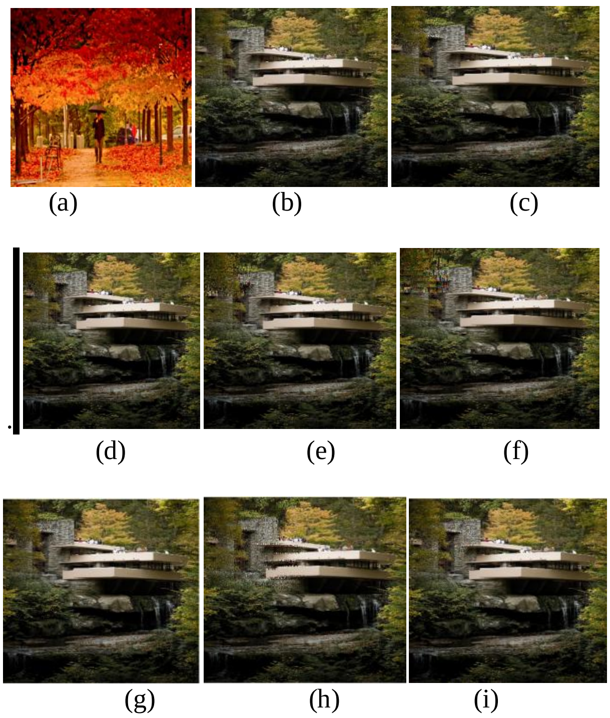

Fig. 4. Experimental result of mosaic image creation. (a) Secret image. (b) Mask image. (c)Partial Mosaic image created with tile image size 8×8.(d)-(f) Mosaic images created with different tile image sizes: 16×16, 32×32, and 64×64.(g)-(i)partial mosaic image with different mask image size :4,3,2

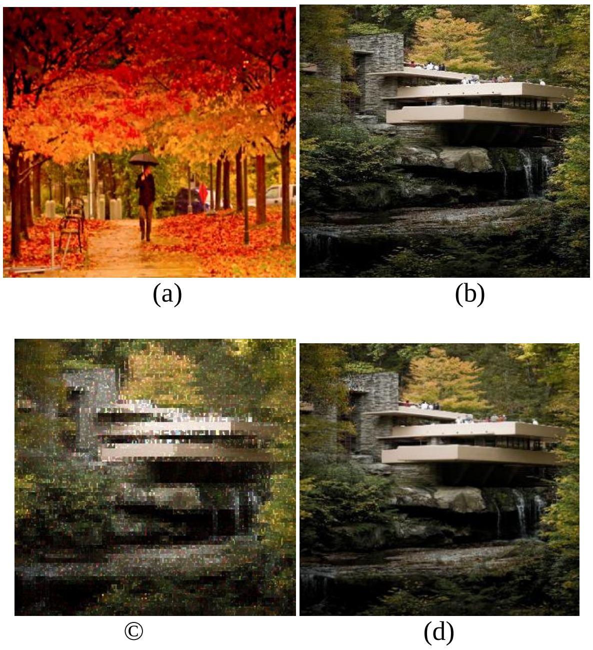

Fig. 5. Comparison of results of Ya-Lin Lee and Wen-Hsiang Tsaiand proposed method.(a) Secret image. (b) Target image. (c) Mosaic idmage created from (a) and(b) by [32] . (d) Mosaic image created from (a) and (b) by proposed method

A series of experiment will be conducted to test the proposed method using many secret image and mask image with size 1024*768 or 768*1024.To show that the created partial mosaic image looks like the preselected mask image, the quality metric of RMSE is utilized which is defined as the square root of the mean square difference between the pixel values of the two images.

An example of the experimental result is shown in figure 3.Fig 3(c) shows the created partial mosaic image using Fig 3(a) as the mask image and fig 3(b) as the secret image .The tile image size is 8*8.The recovered secret image using a correct key is shown in figure 3(d) which looks nearly identical to the original secret image shown in figure 3(a) with RMSE=.948 with respect to the secret image

VI. SECURITY CONSIDERATION

To increase the security of the proposed method the embedded information for later retrieval is encrypted with a secret key as explained in algorithm 1.Only the receiver who has the key can decode the secret image. However a hacker who does not have the key may still try all possible permutation of tile image to get secret image back. Fortunately the number of all possible permutation here is n!. So the probability for him to correctly guess permutation is very small in value. Furthermore ,even if one happen to guess the permutation correctly ,he still does not know correct parameter retrieving the original colour appearance of the secret image .Because such parameter information for colour retrieval is encrypted as a bit stream using a secret key.

REFERENCES

[1] J. Fridrich, "Symmetric ciphers based on two-dimensional chaotic maps," Int. J. Bifurcat. Chaos, vol. 8, no. 6, pp. 1259–1284, 1998.
[2] G. Chen,Y. Mao, and C. K. Chui, "A symmetric image encryptionscheme based on 3D chaotic cat maps," Chaos Solit. Fract., vol. 21,no. 3, pp. 749–761, 2004.
[3] L. H. Zhang, X. F. Liao, and X. B. Wang, "An image encryption approach based on chaotic maps," Chaos Solit. Fract., vol. 24, no. 3, pp. 759–765, 2005.
[4] H. S. Kwok and W. K. S. Tang, "A fast image encryption system based on chaotic maps with finite precision representation," Chaos Solit. Fract.,vol. 32, no. 4, pp. 1518–1529, 2007.
[5] Behnia, A. Akhshani, H. Mahmodi, and A. Akhavan, "A novelalgorithm for image encryption based on mixture of chaotic maps,"Chaos Solit. Fract., vol. 35, no. 2, pp. 408–419, 2008.
[6] D. Xiao, X. Liao, and P. Wei, "Analysis and improvement of a chaosbased image encryption algorithm," Chaos Solit. Fract., vol. 40, no. 5, pp. 2191–2199, 2009
[7] V. Patidar, N. K. Pareek, G. Purohit, and K. K. Sud, "A robust and secure chaotic standard map based pseudorandom permutationsubstitution scheme for image encryption," Opt. Commun., vol. 284,no. 19, pp. 4331–4339, 2011.
[8] C. K. Chan and L. M. Cheng, "Hiding data in images by simple LSB substitution," Pattern Recognit.., vol. 37, pp. 469–474, Mar. 2004
[9] Z. Ni, Y. Q. Shi, N. Ansari, and W. Su, "Reversible data hiding," IEEETrans. Circuits Syst. Video Technol., vol. 16, no. 3, pp. 354–362, Mar.2006.
[10] H. S. Kwok and W. K. S. Tang, "A fast image encryption system based on chaotic maps with finite precision representation," Chaos Solit. Fract.,vol. 32, no. 4, pp. 1518–1529, 2007.
[11] J. Tian, "Reversible data embedding using a difference expansion,"IEEE Trans. Circuits Syst. Video Technol., vol. 13, no. 8, pp. 890–896, Aug. 2003.
[12] Y. Hu, H.-K. Lee, K. Chen, and J. Li, "Difference expansion based reversible data hiding using two embedding directions," IEEE Trans.Multimedia, vol. 10, no. 8, pp. 1500–1512, Dec. 2008.
[13] V. Sachnev, H. J. Kim, J. Nam, S. Suresh, and Y.-Q. Shi, "Reversible watermarking algorithm using sorting and prediction," IEEE Trans.Circuits Syst. Video Technol., vol. 19, no. 7, pp. 989–999, Jul. 2009.
[14] X. Li, B. Yang, and T. Zeng, "Efficient reversible watermarking based on adaptive prediction-error expansion and pixel selection," IEEE Trans.Image Process., vol. 20, no. 12, pp. 3524–3533, Dec. 2011.
[15] W. Zhang, X. Hu, X. Li, and N. Yu, "Recursive histogram modification:Establishing equivalency between reversible data hiding and lossless data compression," IEEE Trans. Image Process., vol. 22, no. 7, pp. 2775–2785, Jul. 2013.
[16] J. Fridrich, M. Goljan, and R. Du, "Invertible authentication," Proc. SPIE, vol. 3971, 2001, pp. 197–208.
[17] C. C. Chang, C. C. Lin, C. S. Tseng, and W. L. Tai, "Reversible hiding in DCT-based compressed images," Inf. Sci., vol. 177, no. 13,pp. 2768–2786, 2007.
[18] S. Lee, C. D. Yoo, and T. Kalker, "Reversible image watermarking based on integer-to-integer wavelet transform," IEEE Trans. Inf. Forens. Secur., vol. 2, no. 3, pp. 321–330, Sep. 2007.
[19] W.-H. Lin, S.-J. Horng, T.-W. Kao, P. Fan, C.-L. Lee, and Y. Pan,"An efficient watermarking method based on significant difference of wavelet coefficient quantization," IEEE Trans. Multimedia, vol. 10, no. 5,pp. 746–757, Aug. 2008.
[20] Hu, W. Zhang, X. Hu, N. Yu, X. Zhao, and F. Li, "Fast estimation of optimal marked-signal distribution for reversible data hiding," IEEE Trans. Inf. Forens. Secur., vol. 8, no. 5, pp. 187–193, May 2013.
[21] W. B. Pennebaker and J. L. Mitchell, JPEG: Still Image Data CompressionStandard. New York, NY, USA: Van Nostrand Reinhold, 1993,pp. 34–38.
[22] I. J. Lai and W. H. Tsai, "Secret-fragment-visible mosaic image—A new computer art and its application to information hiding," IEEE Trans. Inf.Forens. Secur., vol. 6, no. 3, pp. 936–945, Sep. 2011.
[23] E. Reinhard, M. Ashikhmin, B. Gooch, and P. Shirley, "Color transfer between images," IEEE Comput. Graph. Appl., vol. 21, no. 5, pp. 34–41,Sep.–Oct. 2001
[24] D. L. Ruderman, T. W. Cronin, and C. C. Chiao, "Statistics of cone responses to natural images: Implications for visual coding," J. Opt.Soc. Amer., vol. 15, no. 8, pp. 2036–2045, 1998.
[25] D. Coltuc and J.-M. Chassery, "Very fast watermarking by reversible contrast mapping," IEEE Signal Process. Lett., vol. 14, no. 4, pp. 255–258, Apr. 2007.
[26] A New Secure Image Transmission Technique via Secret-Fragment-Visible Partial mosaic images by NearlyReversible Color TransformationsYa-Lin Lee, Student Member, IEEE, and Wen-Hsiang Tsai, Senior Member, IEEE