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Hiding of Data in Mosaic Images by Reversible Color Transformations

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Abstract: Images are transmitted through the internet for various purposes, such as confidential enterprise archives, document storage systems, medical imaging systems, and military applications. These images may contain secret or confidential information since it should be protected from leakage during transmissions. An approach for secure image transmission is needed, which is to transform a secret image into a meaningful Secret Fragment Mosaic Image with size almost same and looking similar to the preselected target image. The mosaic image is the outcome of arranging of the block fragments of a secret image in a way so as to disguise the other image called the target image. The mosaic image looks similar to a randomly selected target image. It is used for hiding of the secret image by color transforming their characteristics similar to the blocks of the target image. The appropriate information is embedded into the mosaic image for the recovery of the transmitted secret image.

Keywords: Color transformation, data hiding, mosaic image, covert communication.

I. INTRODUCTION

In recent years data hiding has been proposed for the purpose of information assurance, authentication, fingerprint, security, data mining, and copyright protection, etc. In data hiding, pieces of information which are represented by some data are hidden in a cover media like image. In many cases, the cover media experienced some eternal distortion due to data hiding and cannot be inverted back to the original data. In the last some year image mosaic has become a popular topic in field of digital image processing and image based technique. Mosaic is a different type of art created by generating small pieces of any materials, such as stone, glass, tile, etc. It is invented in ancient time, but still used in many applications today. Creation of mosaic images by computer is a new research direction in recent years. Currently, images from various sources are frequently utilized and transmitted through the internet for various applications, such as online personal photograph albums, confidential enterprise archives, document storage systems, medical imaging systems, and military image databases. These mosaic images usually contain private or confidential information so that they should be protected from leakages during transmissions.

Image transmission is a technique where not only meaningful mosaic images are created but also can transform secret image. With the use of proper overflows and underflows as well as pixel color transformations in the converted values of pixels' colors, secret fragment visible mosaic images with almost similar to selected target image. The original secret image is recovered nearly lossless from the created mosaic image [1]. LSB substitution with pixel adjustment process for hiding of data is proposed. The image quality of stego image can be improved with less complexity [2]. Lossless data embedding embeds invisible data into a digital image in reversible way. In this method one can improve the embedded data to restore the original image [3].

A traditional approach for quality assessment based on degradation of structural information. In this paper objective method for accessing perceptual image quality attempted to quantify the visibility of errors between a distorted image and a reference image [4]. This paper has proposed reversible data hiding algorithm, which can recover the original image without any distortion from the marked image once the secret data have been extracted. It is showed that peak signal-to-noise ratio of the marked image generated using this method is above 48 dB [5]. A spatial domain reversible watermarking providing high data embedding bit-rate at a very low mathematical complexity has been discussed in the paper [6],[9]. A blind watermarking method based on the DWT has proposed in the paper. The values of PSNRs of the watermarked images are always greater than 40 dB as shown in results [7]. DE algorithm may cause distortions in the output image; moreover the algorithm cannot perform smoothly near the layer embedding capacity limit. In this paper a new embedding algorithm has proposed to overcome these problems. The mechanism effectively avoids embedding distortions resulting from the use of large differences in the previous difference image [8].

In the proposed scheme the difference between centre index and its neighbouring indexes in each sub-block of indexed table by using a palette colour replacement is used[10],[11]. A new type of digital art called secret-fragment-visible mosaic image has been proposed in this paper. A new color scale and new gray scale have been proposed to define a new feature which then are used to define appropriate similarity measures for images and blocks for generating secret-fragment-visible mosaic images more effectively [12].A image steganography

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method has been proposed in this paper [13], which creates secret mosaic image from an arbitrarily selected target image.

II. PROPOSED SYSTEM

In this paper, a new technique for safe imagetransmission is proposed, which transforms a secret image into a meaningful mosaic image with the same size and looking like a preselected target image. The transformation is controlled by a secret key and only with the key a person can recover the secret image nearly lossless from the mosaic image. The Proposed method is inspired by [12], in which a new type of computer art image, called secret-fragment-visible mosaic image, was proposed. The mosaic image is result of rearrangement of the fragments of a secret image in disguise of another image called the target image preselected from a database.

The weakness of [12] is that requirement of large image database so that the generated mosaic image can be sufficiently similar to the selected target image. Using this method the user can not select his/her favourite image as a target image. Therefore to overcome this drawback; a new method has been designed that can transform a secret image into secret fragment visible mosaic image of the same size.

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

As shown in fig. 1 fig (a) indicates secret image, fig (b) indicates target image and fig (c) indicates secret-fragment-visible mosaic image. Once the target image has selected by the user, the given secret image is first divided into rectangular fragments called tile images, which then are fir into similar blocks in the target image, called target blocks, according to similarity criterion based on color variations. The color characteristics of each tile image is transformed onto a corresponding target block in the target image, which results in a mosaic image looking like a target image. The proposed method can transform a secret image into mosaic image without any compression, at the same time data hiding method must hide highly compressed version of the secret image into cover image when the secret image and the cover image have the same data volume.

III. IDEAS OF THE PROPOSED METHOD

The embedding of secret image into the target image in tile form and maintaining the visibility of the original target image. The proposed method includes two main phases as shown in fig. 2: 1) mosaic image creation 2) Multiple secret images recovery.

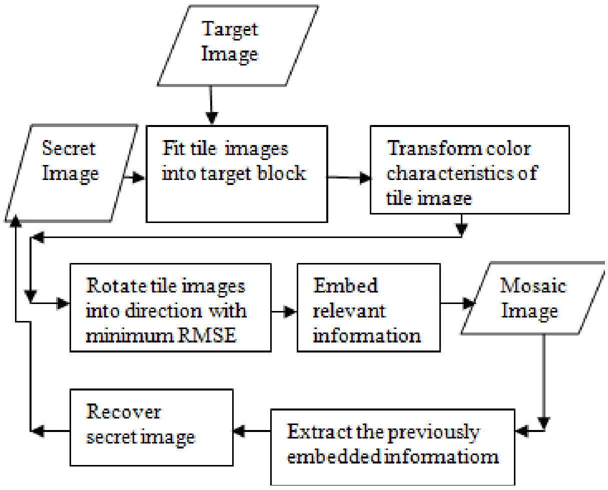

Fig. 2 Block diagram of proposed methodology.

1) Mosaic image creation :

- Fitting the tile images of the secret image into the target blocks of a preselected target image.
- Transforming the color characteristics of each tile image in the secret image to become that of the corresponding target block in the target image.
- Rotating each tile image into a direction with the minimum RMSE value with respect to corresponding target block.
- Embedding relevant information into the created mosaic image for future recovery of the secret image.

2) Multiple secret image recovery :

- Extracting the embedded information for multiple secret images recovery from the mosaic image.
- Reverse transforming the color characteristic of each tile image in the secret image to become that of the corresponding target block in the target image.
- Reverse rotating each tile image into a direction with respect to its corresponding target block.
- Recovering the secret images using the extracted information.

Performance parameters:

1) RMSE: The Root Mean Square Error (RMSE) (also called the Root Mean Square Deviation, RMSD) is frequently used measure of the difference between values predicted by a model and the values actually observed from the environment that is being modelled. These individual differences are also called residuals, and the RMSE serves to aggregate them into a single measure of predictive power.

2) PSNR: The Peak Signal to Noise Ratio (PSNR) has been used as a benchmark to evaluate new objective perceptual video quality metrics. The calculation of PSNR is highly dependent upon proper estimation of spatial alignment, temporal alignment, gain and level offset between the processed video sequence and the original video sequence, the method of measurement for PSNR should ideally include a method for performing these calibration procedures.

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IV. ALGORITM OF THE PROPOSED METHOD

Based on the proposed method, the algorithms for mosaic image creation and secret image recovery may describe respectively as Algorithm 1 and 2.

ALGORITM 1: Mosaic image creation

Input: A secret image S, a target image T, and secret key K.

Output: A secret fragment-visible mosaic image F.

Steps:

Stage 1.Fitting the tile images into the target blocks.

Step 1. If the size of the target image T is different from that of the secret image S, change the size of T to be identical to that of S; and divide the secret image S into n tile images {T1 , T2 , ... , T n } as well as the target image T into n target blocks {B1 , B2 , ... , Bn } with each T i or Bi being of size N T .

Step 2. Compute the means and the standard deviations of each tile image T i and each target block Bj for the three color channels; and compute accordingly the average standard deviations for Ti and Bj , respectively, for i = 1 through n and j = 1 through n.

Step 3. Sort the tile images in the set Stile = {T1 , T2 , ... , T n } and the target blocks in the set Starget = {B1 , B2 , ... , Bn } according to the computed average standard deviation values of the blocks; map in order the blocks in the sorted Stile to those in the sorted Starget in a 1-to-1 manner; and reorder the mappings according to the indices of the tile images, resulting in a mapping sequence L of the form: T1 → Bj1 , T2→ Bj2 , ... , Tn → Bjn.

Step 4. Create a mosaic image F by fitting the tile images into the corresponding target blocks according to L.

Stage2. Performing color conversions between the tile images and the target blocks.

Step 5. Create a counting table TB with 256 entries, each with an index corresponding to a residual value, and assign an initial value of zero to each entry (note that each residual value will be in the range of 0 to 255).

Step 6. For each mapping Ti → Bji in sequence L, represent the means μc and ′ of Ti and Bji, respectively, by eight bits; and represent the standard deviation quotient qc by seven bits, according to the scheme described in Section III(A) where c = r, g, or b.

Step 7. For each pixel pi in each tile image Ti of mosaic image F with color value ci where c = r, g, or b, transform ci into a new value ″; if ″ is not smaller than 255 or if it is not larger than 0, then change ″to be 255 or 0, respectively; compute a residual value Ri for pixel pi by the way described in Section III(C); and increment by 1 the count in the entry in the counting table TB whose index is identical to Ri.

Stage3.Rotating the tile images.

Step 8. Compute the RMSE values of each color transformed tile image Ti in F with respect to its corresponding target block Bji after rotating Ti into each of the directions θ =0o, 90o, 180o and 270o; and rotate Ti into the optimal direction θo with the smallest RMSE value.

Stage 4. Embedding the secret images recovery information.

Step 9. Construct a Huffman table HT using the content of the counting table TB to encode all the residual values computed previously.

Step 10. For each tile image Ti in mosaic image F, construct a bit stream Mi for recovering Ti in the way as described in Section III(D), including the bit-segments which encode the data items of: 1) the index of the corresponding target block Bji; 2) the optimal rotation angle θ° of Ti; 3) the means of Ti and Bji and the related standard deviation quotients of all three color channels; and 4) the bit sequence for overflows/underflows with residuals in Ti encoded by the Huffman table HT constructed in Step 9.

Step 11. Concatenate the bit streams Mi of all Ti in F in a raster-scan order to form a total bit stream Mt ; use the secret key K to encrypt Mt into another bit stream ′ ; and embed M t into F by the reversible contrast mapping scheme proposed in [6].

Step 12. Construct a bit stream I including: 1) the number of conducted iterations Ni for embedding ′ ; 2) the number of pixel pairs N pair used in the last iteration; and 3) the Huffman table HT constructed for the residuals; and embed the bit stream I into mosaic image F by the same scheme used in Step 11.

ALGORITM 2: Secret image recovery.

Input: A mosaic image F with n tile images {T1, T2,….,Tn} and the secret key K.

Output: The secret image S.

Steps:

Stage1: Extracting the secret images recovery information.

Step 1. Extract from F the bit stream I by a reverse version of the scheme proposed in [6] and decode them to obtain the following data items: 1) the number of iterations Ni for embedding M ; 2) the total number of used pixel pairs Npair in the last iteration; and 3) the Huffman table HT for encoding the values of the residuals of the overflows or underflows.

Step 2. Extract the bit stream ′ using the values of Ni and Npair by the same scheme used in the last step.

Step 3. Decrypt the bit stream M ′ into Mt by K.

Step 4. Decompose Mt into n bit streams M1 through Mn for the n to-be-constructed tile images T1 through Tn in S, respectively.

Step 5. Decode Mi for each tile image Ti to obtain the following data items: 1) the index ji of the block Bji in F corresponding to Ti; 2) the optimal rotation angle θ° of Ti; 3) the means of Ti and Bji and the related standard deviation quotients of all color channels; and 4) the overflow/underflow residual values in Ti decoded by the Huffman table HT.

Stage2: Recovering the secret image.

Step 6. Recover one by one in a raster-scan order the tile images Ti, i = 1 through n, of the desired secret image S by the following steps: 1) rotate in the reverse direction the block indexed by ji, namely Bji, in F through the optimal angle θ° and fit the resulting block content into Ti to form an initial tile image Ti; 2) use the extracted means and related standard deviation quotients to recover the original pixel values in Ti according to (4); 3) use the extracted means, standard deviation quotients, and (5) to compute the two parameters c_S and c_L; 4)scan Ti to find out pixels with values 255 or 0 which indicate that overflows or underflows, respectively, have occurred there; 5) add respectively the values to the corresponding residual values c_S or c_L of the found pixels; and 6) take the results as the final pixel values, resulting in a final tile image Ti.

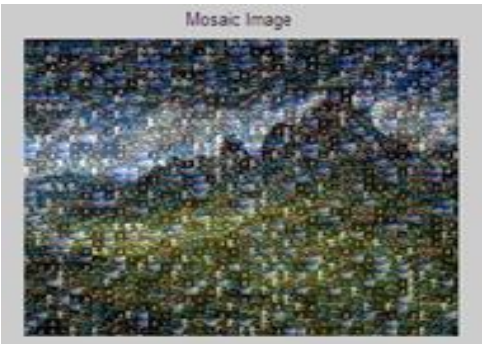
Step 7. Compose all the final tile images to form the desired secret image S as output.

V. EXPERIMENTAL RESULTS

A series of experiments are conducted to check the projected methodology. Associate examples of the experimental results of mosaic image shown in fig. 3(b).

Here we are using multiple secret images, so that user can save his/her time .

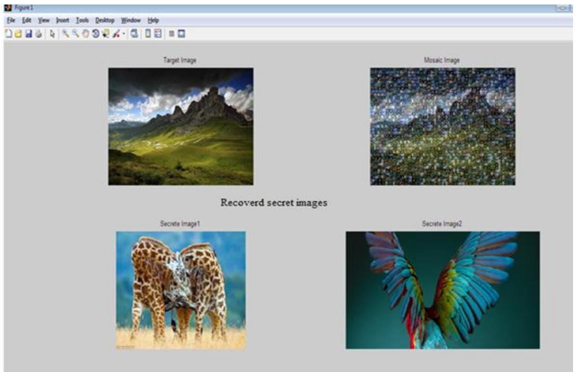
3(a) Target image



3 (b) Mosaic images created from target image and tile images.

3(c) Secret image no 1.

3 (d) Secret image no 2.



3 (e) Recovered secret images

Fig. 3 An example of the experimental results 3(a) target image, 3(b) mosaic images created from target image and tile images, 3(c) secret image 1, 3(d) secret image 2, 3(e) recovered secret images.

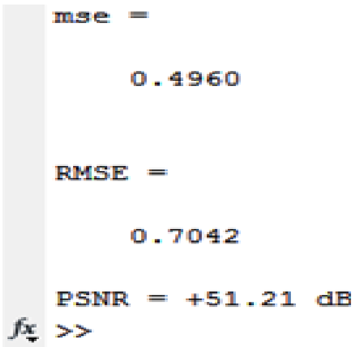


Fig.4 MSE, RMSE, PSNR calculation of recovered secret images.

It can be seen from fig. 4 that the mosaic image formed by the proposed method has smaller RMSE value with respect to the target image, which is that image is more similar to the target image in appearance. The other results of the experiments show the same conclusion and users can select their favorite images for uses as target images.

VI. CONCLUSION

A novel method for secret transmission of images is presented. The secret color image is camouflaged into a target image of the same size to produce a mosaic image. The mosaic image resembles the target image and is visually indistinguishable from it. The mosaic image creation involves block by block processing of the images. Gaussian noise is added to the secret image to ensure positive variance of intensities within image blocks. Image blocks are matched according to the standard deviation of the intensities. Then a color transformation equation is utilized to transform the secret image blocks into the mosaic image blocks. The performance of the method was experimentally analyzed using RMSE and PSNR. It was found that the method yields high quality mosaic images and the extraction of the secret image accurate.

VII. FUTURE SCOPE

Future studies may be directed to applying the proposed method to images of color models other RGB and GRAY model.

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