

INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATION & MANAGEMENT

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SECURE IMAGE TRANSMISSION USING LOSSLESS ARITHMETIC CODING**AASHA M. VANVE****STUDENT****SHAH & ANCHOR KUTCHHI ENGINEERING COLLEGE****CHEMBUR****ABIRAMI SIVAPRASAD****ASST. PROFESSOR****SHAH & ANCHOR KUTCHHI ENGINEERING COLLEGE****CHEMBUR****SWATI DESHPANDE****ASST. PROFESSOR****SHAH & ANCHOR KUTCHHI ENGINEERING COLLEGE****CHEMBUR****ABSTRACT**

Image compression addresses the problem of reducing space required to represent a digital image yielding a compact representation of an image, and thereby reducing the image storage and transmission time requirements. The key idea here is to remove redundancy of data presented within an image to reduce its size without affecting the essential information of it. In this, an efficient lossless image compression arithmetic coding is used to compress the resultant mosaic image to transfer it securely to the receiver. Here, a secure image transmission technique is used which transforms automatically a given large-volume secret image into a so-called secret-fragment-visible mosaic image. The mosaic image is the outcome of arranging of the tile fragments of a secret image in different way so as to disguise the other image called the target image which is already selected from a database. The mosaic image, which looks similar to a randomly selected target image, which is used for hiding of the secret image by color transforming their characteristics similar to the tile fragments of the target image. Such technique is necessary so for the lossless recovery of the transmitted secret image. The information required for recovering the secret image is embedded into the created mosaic image by a lossless data hiding scheme using a key. At the end, the decompression method is performed on the mosaic image to obtain the original secret image.

KEYWORDS

Data hiding, Image encryption, Mosaic image, secure image transmission.

1. INTRODUCTION

Today, 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 images usually contain confidential information so that they should be protected from leakages during transmissions. Nowadays, many methods have been proposed for securing image transmission, for which two common approaches are image encryption and data hiding.

In this, a new method is proposed for the transmission of the image securely. This method transforms the secret image into a meaningful mosaic tile image which looks like another image which was preselected as the target image. The process of transformation is done with the help of some relevant information that is embedded and only with the help of this embedded information a person can losslessly recover the transmitted secret image from the mosaic tile image of the same size. The mosaic tile image is the outcome of arranging the tile fragments of a transmitted secret image and it is concealed in another image called the target image which was earlier selected from the database.

Here, the lossless image compression technique that is Arithmetic Encoding is proposed if a person have a very large secret image and small target images for selections then the secret image has to be compressed to become equal with the size of target image. And then a person will be able to transfer his/her secret image securely over the network. Arithmetic Encoding is a flexible. Though this method is slow in processing, it provides better compression ratio.

2. REVIEW OF LITERATURE

1. Ya-Lin Lee, Student Member, IEEE, and Wen-Hsiang Tsai, Senior Member, IEEE in April 2014 presented A New Secure Image Transmission Technique via Secret-fragment-Visible Mosaic Images by Nearly Reversible Color Transformations. In this paper, Ya-Lin Lee shows a technique for the transmission of the secret image securely and losslessly. This method transforms the secret image into a mosaic tile image having the same size like that of the target image which is preselected from a database. This color transformation is controlled and the secret image is recovered losslessly from the mosaic tile image with the help of the extracted relevant information generated for the recovery of the image.
2. Pratibha S. Ghode, Prof. Pragati Patil, Prof. Vinod Nayyar, Prof. Shashank Moghe in May 2014 presented A Keyless Approach to Image Encryption, by Indian Institute of Technology Roorkee. This paper shows a keyless approach to encryption methods which are used to encrypt images. They make the use of this paper to apply the keyless approach in the proposed method. This is done by generating relevant information with the help of some RMSE value which help to rotate the tile images to a certain angle.
3. Ashwind S, Ganesh K, Gokul R, Ranjeeth Kumar C in 2014 presented Secure Data Transmission Using Reversible Data Hiding. In this Paper, they proposed a method that can achieve real reversibility i.e., data extraction and image recovery are free of any error. Their experiments show that this novel method can embed more data for the same image quality as the previous methods, such as for PSNR = 40 db.
4. Rucha R. Raut, Prof. Komal B. Bijwe in October 2014 is presented A Survey Report on Visual Cryptography and Secret Fragment Visible Mosaic Images. In this paper, They had done the literature survey on existing work which used different techniques for image hiding from 2001 to 2014 and also given general introduction about visual cryptography and secret fragment visible mosaic images.
5. Pragati Pal, Sukanya Kulkarni in 2014 is presented Data Hiding based on Color Image Compression Technique. In this paper, they present a color block truncation coding along with data hiding. Block Truncation Coding is one of the lossy compression technique which is basically used to reduce the size of digital image. In this method the computational involved is very simple. The compressed file obtained by BTC is further used to hide the secret data by bit reversal method.
6. Kede Ma, Weiming Zhang, Xianfeng Zhao, Member IEEE, Nenghai Yu, and Fenghua Li in March 2013 presented Reversible Data Hiding in Encrypted Images by Reserving Room before Encryption. In this paper, they proposed a novel method by reserving room before encryption with a traditional RDH algorithm,

and thus it is easy for the data hider to reversibly embed data in the encrypted image. The proposed method can achieve real reversibility, that is, data extraction and image recovery are free of any error. Experiments shows that this novel method can embed more than 10 times as large payloads for the same image quality as the previous methods, such as for PSNR=40 db.

7. JPEG: Still Image Data Compression Standard. Here, author tries to explain that the main obstacle in many applications is the quantity of data required to represent a digital image. For this we would need an image compression standard to maintain the quality of the images after compression. To meet all the needs the JPEG standard for image compression includes two basic methods having different operation modes: A DCT method for "lossy" compression and a predictive method for "lossless" compression.

3. PROBLEM DEFINITION

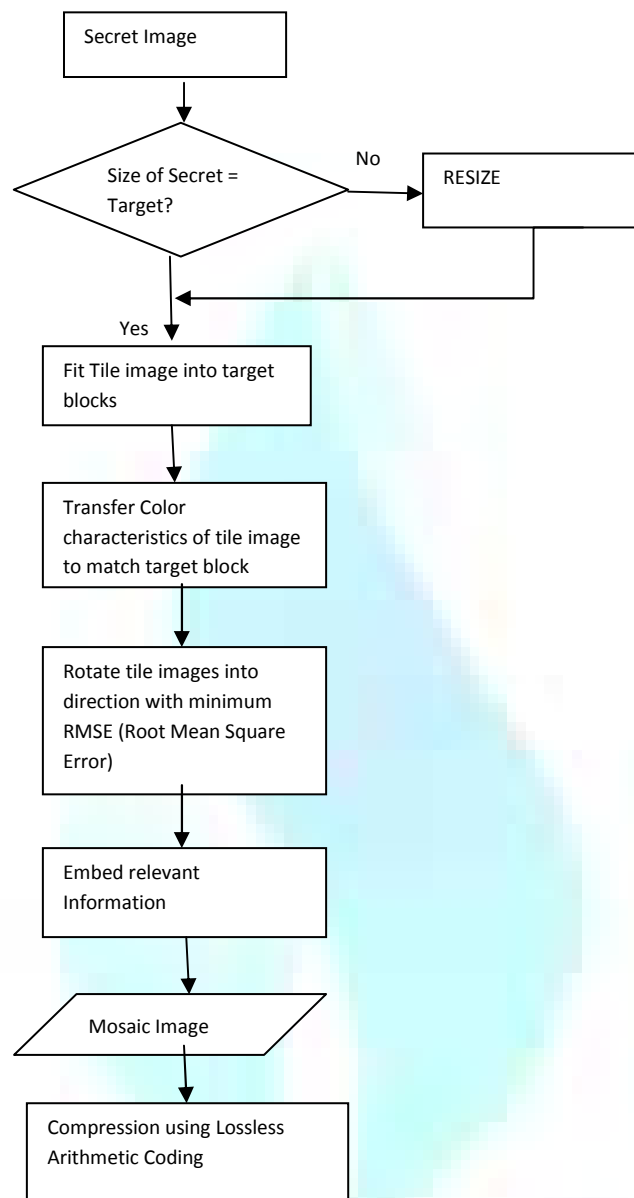
An arithmetic coding, a lossless image compression technique is proposed to secure the image transmission technique via secret-fragment-visible mosaic images by nearly reversible color transformations. The arithmetic coding technique is required to compress the secret images if the size of the secret images are large than that of the target images stored in the database for the selections. The complete system includes the secure image transmission for the different types of image file formats like JPEG (Joint Photographic Experts Group), GIF (Graphics Interchange Format), PNG (Portable Network Graphics) etc. used over the internet. When the sender sends the secret image to the proposed system the system checks for the equal size of the target image present in the database for mosaic image creation. If the size of secret and target image unmatched, the lossless image compression algorithm is used to compress the secret image to make it equal with the target image and then mosaic image creation takes place. Again the information is embedded for the recovery of the original secret image. In order to increase the security of the proposed method, the embedded information is encrypted with a secret key. Only the receiver who has the secret key can decode the secret image.



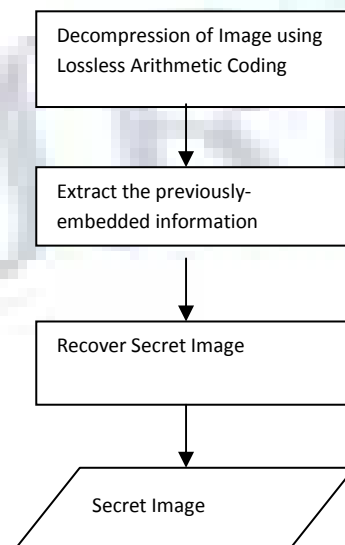
4. METHODOLOGY

FIGURE 1: FLOW DIAGRAM OF THE PROPOSED METHOD

SENDER SIDE



RECEIVER SIDE



The proposed system mainly includes 3 modules namely:

1. MOSAIC TILE IMAGE CREATION

This module includes following four sub-modules.

- Fitting the tile images of the secret image into the target blocks of a preselected target image.
- Transforming the color characteristic 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 (Root Mean Square Error) value with respect to its corresponding target block.
- Embedding relevant information into the created mosaic image for future recovery of the secret image. In the second phase, the embedded information is extracted to recover nearly losslessly the secret image from the generated mosaic image.

2. COMPRESSION AND DECOMPRESSION USING ARITHMETIC CODING (AC)

Arithmetic coding is the most powerful technique for statically lossless encoding that has attracted much attention in the recent work on lossless techniques. It provides more flexibility and better efficiency than Huffman coding. The aim of AC is to define a method that provides code words with an ideal length. The average code length is very close to the possible minimum given by information theory. In other words, AC assigns an interval to each symbol whose size reflects the probability for the appearance of this symbol. The code word of a symbol is an arbitrary rational number belonging to the corresponding interval.

Properties of Arithmetic Coding are:

- It uses binary fractional number.
- Suitable for small alphabet with highly skewed probabilities.
- Incremental transmission of bits are possible, avoiding working with higher and higher precision numbers.
- This encoding takes a stream of input symbol and it replaces it with floating point number (0, 1).
- It produces result in stream of bits.

3. SECRET IMAGE AND SECRET TEXT RECOVERY

This module includes following two sub-modules.

- Extracting the embedded information for secret image recovery from the mosaic image.
- Recovering the secret image using the extracted information.

5. ALGORITHM OF THE PROPOSED METHOD

The proposed system includes

ALGORITHM 1. SECRET-FRAGMENT-VISIBLE MOSAIC IMAGE CREATION

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

Output: a secret-fragment-visible mosaic image F.

Steps:

STAGE 1.1 - FITTING TILE IMAGES INTO TARGET BLOCKS

1. Divide secret image S into a sequence of n tile images of size NT(size of target image), denoted as Stile = {T1, T2, ..., Tn}; and divide target image T into another sequence of n target blocks also with size NT, denoted as Starget = {B1, B2, ..., Bn}.
2. Compute the means (μ_r, μ_g, μ_b) and the standard deviations ($\sigma_r, \sigma_g, \sigma_b$) of each Ti in Stile for the three color channels according to Eqs. (1) And (2); and compute the average standard deviation $\sigma_{Ti} = (\sigma_r + \sigma_g + \sigma_b)/3$ for Ti where i = 1 through n.

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

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

Do similarly to the last step to compute the means (μ_r', μ_g', μ_b'), the standard deviations ($\sigma_r', \sigma_g', \sigma_b'$), and the average standard deviation $\sigma_{Bj} = (\sigma_r' + \sigma_g' + \sigma_b')/3$ for each Bj in Starget where j = 1 through n.

3. Sort the blocks in Stile and Starget according to the 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 into a mapping sequence L of the form of T1 → Bj1, T2 → Bj2, etc.
4. Create a mosaic image F by fitting the tile images of secret image S to the corresponding target blocks of target image T according to mapping sequence L.

STAGE 1.2 - PERFORMING COLOR CONVERSION BETWEEN THE TILE IMAGES AND TARGET BLOCKS

5. For each pair Ti → Bj in mapping sequence L, let the means μ_c and μ_c' of Ti and Bj respectively be represented by 8 bits with values 0~255 and the standard deviation quotients $q_c = \sigma_c'/\sigma_c$ by 7 bits with values 0.1~12.8 where c = r, g, b.
6. For each pixel pi in each tile image Ti of mosaic image F with color value ci where c = r, g, b, transform ci into a new value ci'' by Eq. (3); and if ci'' is not smaller than 255 (i.e., if an overflow occurs) or if it is not larger than 0 (i.e., if an underflow occurs), assign ci'' to be 255 or 0, respectively, and compute a residual value for pixel pi.

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

STAGE 1.3 - ROTATING THE TILE IMAGES

7. Compute the RMSE values of each color-transformed tile image Ti in F with respect to its corresponding target block Bj after rotating Ti into the directions 0o, 90o, 180o and 270o; and rotate Ti into the optimal direction θ_o with the smallest RMSE value.

STAGE 1.4 - EMBEDDING THE SECRET IMAGE RECOVERY INFORMATION

8. For each tile image Ti in F, construct a bit stream Mi for recovering Ti including the bit-segments which encode the data items of:
 1. The index of the corresponding target blocks Bj.
 2. The optimal rotation angle θ_o of Ti.
 3. The means of Ti and Bj and the related standard deviation quotients of all color channels.
 4. The overflow/underflow residual values in Ti.
 5. The number m of bits to encode the index of a block.
 6. The number k of residual values.
9. 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 Mt'; and embed Mt' into F by reversible contrast mapping.

ALGORITHM 2. COMPRESSION AND DECOMPRESSION USING ARITHMETIC CODING TO COMPUTE OUTPUT NUMBER

1. Low = 0.
2. High = 1.
3. Loop. For all the symbols:
4. Range = high – low
5. High = low + range (high_range of the symbol being coded)
6. Low = low + range (low_range of the symbol being coded)
7. Range keeps track of where the next range should be.

8. High and low, specify the output number.

ALGORITHM 3: SECRET IMAGE RECOVERY

Input: a mosaic image F with n tile images and the secret key K used in Algorithm 1.

Output: the secret image S embedded in F using Algorithm 1.

STEPS

STAGE 3.1 — EXTRACTING THE SECRET IMAGE RECOVERY INFORMATION

1. Extract from mosaic image F the bit stream Mt' for secret image recovery by a reverse version of the reversible contrast mapping scheme and decrypt Mt' using the secret key K into a non-encrypted version Mt .
2. Decompose Mt into n bit streams Mi for the n to-be-constructed tile images Ti in S, respectively, where $i = 1$ through n.
3. Decode the bit stream Mi of each tile image Ti to obtain the following data:
 1. The index ji of the block Bji in F corresponding to Ti .
 2. The optimal rotation angle θ_0 of Ti .
 3. The means of Ti and Bji and the related standard deviation quotients of all color channels.
 4. The overflow/underflow residual values in Ti .
 5. The number m of bits to encode the index of a block.
 6. The number k of residual values.

STAGE 3.2 — RECOVERING THE SECRET IMAGE

4. 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 the block indexed by ji , namely Bji , in F through the optimal angle θ_0 and fit the resulting content into Ti to form an initial tile image Ti
 2. (2) Use the extracted means and related standard deviation quotients to recover the original pixel values in Ti according to Eq. (4)
 3. Use the extracted means, standard deviation quotients, and Eqs. (5) to compute the two parameters cS and cL
 4. Scan Ti to find out pixels with values 255 or 0 which indicate that overflows/underflows have occurred there, and add respectively the values cS or cL to the corresponding residual values of the found pixels, resulting in a final tile image Ti .

$$\mu_c = \frac{1}{n} \sum_{i=1}^n c_i, \quad \mu_c' = \frac{1}{n} \sum_{i=1}^n c_i' \quad (4)$$

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

$$\sigma_c' = \sqrt{\frac{1}{n} \sum_{i=1}^n (c_i' - \mu_c')^2} \quad (5)$$

5. Compose all the final tile images to form the desired secret image S as output. The time complexity of Algorithm 1 is $O(n \log n)$ because the running time is dominated by sorting the blocks in Stile and Starget. And the time complexity of Algorithm 3 is $O(nNT)$ because it just extracts the embedded information and recovers the secret image back with the extracted data.

6. SUMMARY

A lossless image compression technique is proposed to remove the weakness of new secure image transmission method. The proposed method creates meaningful mosaic image from the variable sizes of secret image. An arithmetic coding technique is used to compress the resultant mosaic image as it is very large in size. By using this one can securely transfer the secret image to the receiver. The proposed method gives a new option to solve the difficulty of hiding images with huge data volumes behind cover images. By the use of proper pixel color transformation as well as skillful scheme for handling overflows/underflows in the converted values of the pixels' colors, secret-fragment-visible mosaic images with very high visual similarities to arbitrarily-selected target images can be created with no need of a target image database. Also, the original secret images can be recovered nearly losslessly from the created mosaic images. This proposed system can be applied to RGB as well as HSV color models. For the analysis purpose, RMSE (Root Mean Square Error) value and metric of MSSIM (Mean Structural Similarity) of mosaic image and secret image of different file formats with different file sizes can be analyzed.

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