Journal of Education and Science
Vol. 28, No.4, 2019, pp.258-269
ISSN 1812-125X
http://edusj.mosuljournals.com

تضمين البيانات في صورة شخصية باستخدام الفسيفساء الصورية

كنار محمد سامي
قسم علوم الحاسوب / كلية التربية للعلوم الصرفة
جامعة الموصل/ العراق
Email:lamarsafwan111@uomosul.edu.iq

DOI: 10.33899/edusj.1970.163323

القبول	الاستلام
2018 /09 / 17	2018 / 05 / 20

الملخص

تتداول في السنوات الاخيرة افكار كثيرة لاخفاء البيانات والصور بانواعها واحجامها المختلفة. ومع اختلاف طرق الاخفاء تتوحد الاهداف المرجوة من هذه العملية واهم تلك الاهداف هي اخفاء اكبر كمية من المعلومات باقل حجم ممكن او على اقل تقدير الاحتفاظ بالحجم الاصلي للصور المخفية او صورة الهدف. من الطرق التي تحقق الهدفين المطلوبين هي طريقة الاخفاء باستخدام الفسيفساء الصورية (Mosaic Image).

تعد الفسيفساء الصورية في معالجة الصور صورا تتكون من دمج بلاطات صغيرة. وتكون البلاطات هي الصورة المصدر التي تهدف الى اعادة هيكلة المعلومات البصرية الاصلية والتي تترجم الى اسلوب جديد يشبه الفسيفساء. ان عملية تكوين الصور الفسيفسائية من سلسلة من المشاهد الجزئية تعتبر وسيلة فعالة للحصول على مشهد اكبر مما هو موجود في مشهد منفرد وقد تم استخدامه على نطاق واسع من التطبيقات وخاصة في مجال الاخفاء. حيث نستطيع بهذه الطريقة اخفاء معلومات بحجم الصورة الاصلية من دون زيادة في الحجم او اجراء عمليات كبس بيانات لتصغير حجمها. في هذا البحث تم اخفاء ضعف حجم البيانات المستخدمة وذلك عن طريق اخفاء بيانات صورة (السرية) داخل صورة شخصية (الهدف) مع تشويش الصورة الشخصية نفسها بحيث تختفي معالم صاحب الصورة وتكون النتيجة بالنهاية صورة مخفية وصورة مشوشة. وقد تم اختيار صور مختلفة وامتدادات مختلفة في هذا البحث منها شخصية او طبيعية او بيانات فضائية، استخدمت الصورة الشخصية كصورة هدف لاخفاء البيانات الاخرى داخلها اما باقي الصورفهي عبارة عن صور سرية يتم تضمينها داخل الصورة الشخصية. كما تم اعتماد لغة Matlab لتنفيذ خوارزمية الفسيفساء الصورية.

الكلمات المفتاحية: الفسيفساء الصورية، علم الاخفاء، اخفاء البيانات

Embedding Data In Personal Image By Using Mosaic Image

Kanar M. Sami

Computer Science Dept., College of Education for pure Science,
University of Mosul, Iraq.
Email:lamarsafwan111@uomosul.edu.iq

DOI: 10.33899/edusj.1970.163323
Received 20/05/2018 **Accepted** 17/09/2018

ABSTRACT

Many ideas have been dealt with in recent years about hiding data and different types and sizes of images. Different ways of hiding leads to unifying the desirable goals of this process. The main goal of a great bits of information with the smallest size or at least maintaining the original one of the hidden images or the target ones. One way to achieve the two goals is the hiding method by using mosaic image. Mosaic Images that are used image processing are those made by combining small tiles. The tiles are the source images which aim at restructuring the original visual information which is rendered into a new mosaic-like style. The Creation of mosaic images, made by a sequence of partial views, is a powerful means for obtaining a larger view than available within a single view, and it has been used in a wide range of applications especially in the field of steganography. Using this way, it is possible to hide information with the same size of the original image without increasing the size or the compression of data to reduce the size. In this research, twice the data size used has been hidden by hiding the data of the 'secret' image embedded in a 'target' personal image, noising the image itself. Thus the features of personal image disappear, making a hidden image and a noisy one. Different types and extensions have been chosen in this research including personal, natural, or satellite images. The personal image is used as a target image to hide other data inside it while other images are secret ones embedded in the personal image. Matlab is used to execute mosaic image algorithm.

Keywords: image mosaic, steganography, hide information.

1. Introduction

Steganography is the science of hiding secret messages into cover media so that no one can realize the existence of the secret data [1][2]; it is derived from the Greek, since it was used for covered writing; it is essentially means "to hide in plain sight". According to Cachin [3], finding the message in steganography, which is the art and science of communication, is unattainable. Simple steganographic techniques have been in use for hundreds of years, but with the increasing use of files in an electronic format, new techniques for information hiding have become possible [4].

Existing steganography techniques can be classified into three categories: image, video, and text steganographies; image steganography aims at embedding a secret message into a cover image with the yielded stego-image looking like the original cover image[5].

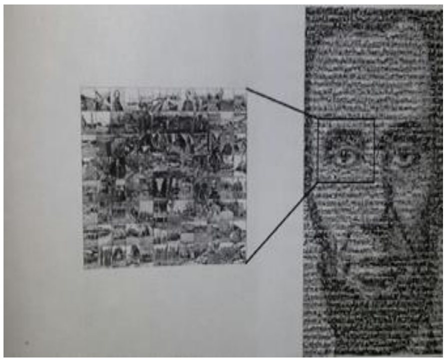
Many image steganography techniques have been proposed [6] [7] [8] [9], and some of them try to hide secret images behind other images [8],[9]. The main issue in these techniques is the difficulty to hide a huge amount of image data into the cover image without causing intolerable distortions in the stego-image.[10]
One of these techniques is called Mosaic Image, which means the collection of small images arranged in such a way that when they are seen together from a distance they suggest a larger image. Arranging the small images to form a large picture as much as possible to helps in giving the larger form in a visual way, and then adjusting their colors to suggest the overall form in a better way[4].
Mosaic images can be classified into four types: crystallization mosaic, ancient mosaic, photo mosaic, and puzzle mosaic image [11] [12]. The first two types of mosaics decompose a source image into tiles (with different color, size and rotation), reconstructing the image by properly painting the tiles. So they can be grouped together under the denomination of tile mosaics. The last two kinds are obtained by fitting images from a database to cover an assigned source image. Hence they may be grouped together under the denomination of multi-picture mosaics [12]. This taxonomy should not be intended as a rigid one. Many mosaic techniques may fit in more than a single class and it is likely that other new types of mosaics will appear in the future[13]. In this research, steganography and the use of the theory of mosaic as a method of hiding have been tackled. In section 2 there is a reference to some previous researches in the same field. In sections 3,4, and 5 the used images in this research have been formed and chosen to be primarily processed in order to be used in section 6. The results and conclusions of the next sections are to be discussed.

2. Related works

In 1996 Silvers R. created photomosaic based on the same property [14]; he wrote a program that starting from a data base of small photos called tiles images. and Finkelstein et al described methods for arranging a set of small images that we call tile images and adjusting their colors so that together they suggest a larger form [4]. Carlo B. and Clemente considered a particular class of pseudorandom images and the image mosaics description. [15]. Li Y. and Tsai W. [10] described the algorithm for mosaic image creation and secret image recovery. But Lai I. and Tsai W. defined mosaic image as a result of random rearrangement of the fragments of image[16][17]. In 2013 Kede Ma finds algorithm for data hiding into an image by reserving room before image encryption; this research shows that first enough space is reserved in the image after which it is converted into encrypted form[18].

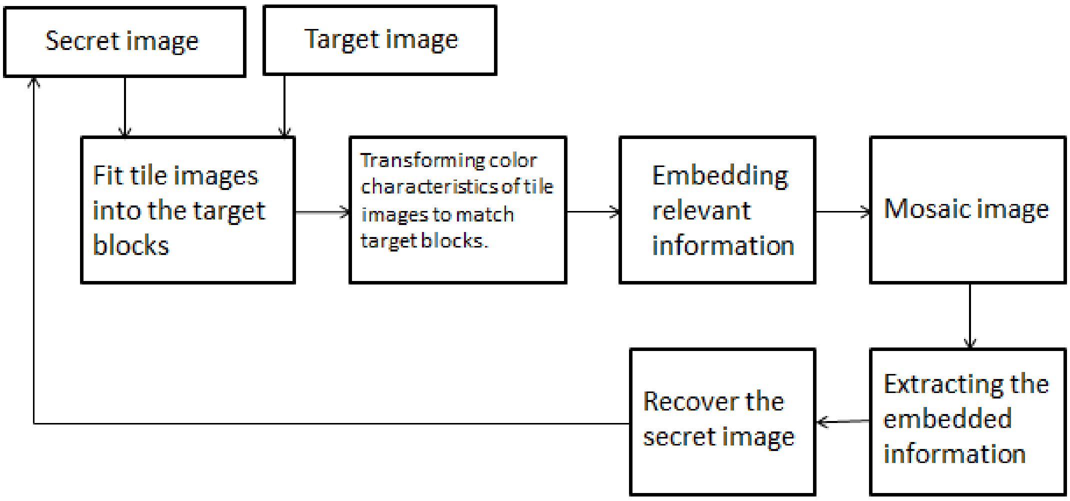
Accordingly, we propose in this paper a method that creates secret-fragment visible mosaic images; any image may be selected as the target image for a given secret image. Selecting a target image randomly, the provided secret image is divided firstly into fragment that are rectangular, which then become similar blocks in the target image according to a similarity criterion based on color variations. Then, the color characteristic of each tile image is transformed to be that of the corresponding block in a target image, resulting in a mosaic image which looks like the target image. Such a type of camouflage image can be used for securely keeping of a secret image in disguise of any pre-selected target image. Relevant schemes are also proposed to conduct *nearly-lossless* recovery of the original secret image. There are various examples of these study as shown in figure 1 [4] and figure 2 [15].

Figure(1): A Photomosaic of President Johan kenedy.



Figure(2): A Photomosaic of President Lincoln.

In 2016 Mukund R. Joshi and Renuka A. Karkada [19] shows a method that is based on secret fragment visible mosaic image which includes two phases: mosaic image creation and secret image recovery, this method is shown in the following block diagram:

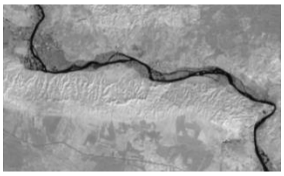


Figure(3): A block diagram of mosaic image creation and secret image recovery

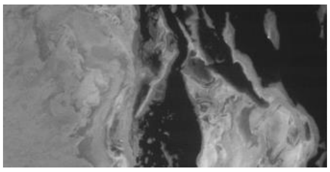
3. Choosing program, images and methods

1. Matlab: has been used to execute the algorithm of mosaic image under windows. These programs have been presented on any type of images.
2. Images: The target image contains personal image of a boy figure (4) and images that Stand for secret images which consist of two satellite images and pepper image. The first satellite image represents one of the region in Nenawa Governorate (Elan mountain) north west Mosul taken by ETM which was borne by landsat7-figure(5) and the second is the region of red sea taken by TM which was borne by landsat5-figure(6). the last image represents pepper in figure (7).

figure(4)
a boy



figure(5)
Elan mountain



figure(6)
Red Sea

figure(7)
pepper

3. Mean squared error (MSE) of an estimator (of a method for estimating a seen quantity) computes the average of the error squares or deviations that shows the difference between the estimator and what is estimated. The MSE is considered a non-negative, and the better value is the one close to zero [20]. If Y is a vector of n predictions, and Y is the vector of the observed values of the variable being predictor is computed as

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 \qquad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

i.e., the MSE is the mean $\left(\frac{1}{n}\sum_{i=1}^{n}\right)$ of the squares of the errors $((Y_i - \hat{Y}_i)^2)$.
This is an easily computable quantity for a particular sample.

4. Signal-to-noise ratio (with the abbreviations SNR or S/N) is used to measure the comparison of the ratio of a desired signal to the ratio of background noise. It is mainly used in science and engineering. S/N ratio is defined as the ratio of signal power to the noise power, often expressed in decibels. If the ratio is higher than 1:1 then it indicates more signal than noise. Signal-to-noise ratio is sometimes used metaphorically to refer to the ratio of useful information to false or irrelevant data in a conversation or exchange. For instance, in forums of online discussions and other online websits, off-topic posts and spam are considered as "noise" that interferes with the "signal" of appropriate discussion.

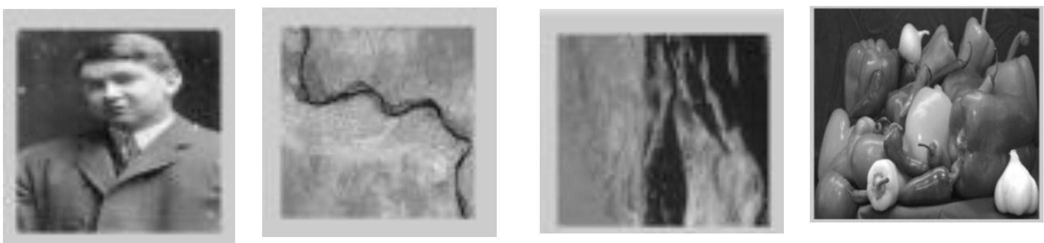
Signal-to-noise ratio is defined as the ratio of the power of a signal (meaningful information) and the power of background noise (unwanted signal):

$$\mathrm{SNR} = \frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}}, \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

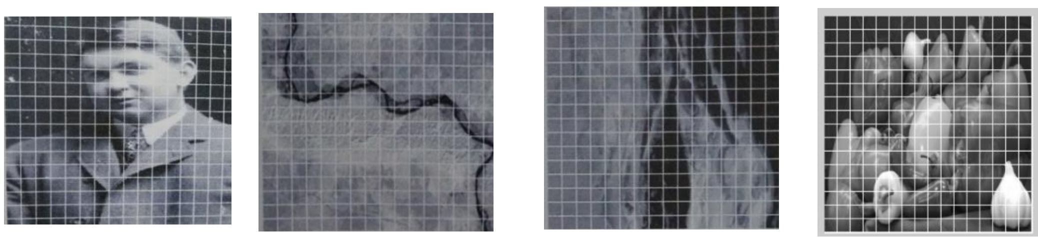
where P is average power. Both signal and noise power must be measured at the same or equivalent points in a system, and within the same system bandwidth [21].

4. Primary processing:

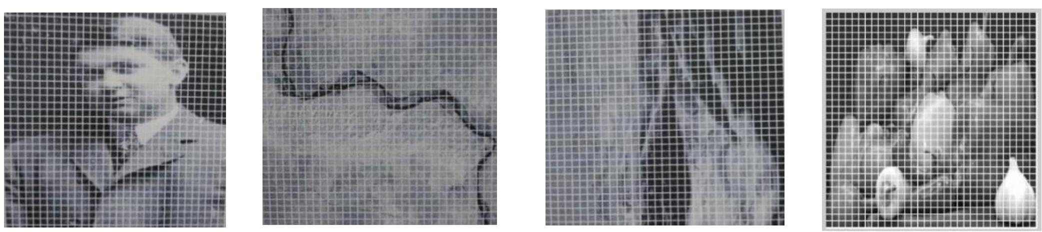
These images in section (3) are resized (256*256) pixels because 256 is one of the multipliers of no. 8 and 16. These numbers represent the sized used for segmenting the tiles. (figure (8-a)) followed by image segmentation which is executed in the sizes (16*16) and (8*8) of the tile size (figure (8-b) and(8-c) respectively).



(a)



(b)



(c)

Figure (8-a) resize image (256*256), figure(8-b) image segmentation in size (16*16),figure(8-c) image segmentation in size (8*8)

5. Algorithm of creating mosaic image

To create image mosaic, two images must be identified: first tile image, second: target image applying the following steps:

1. Choosing target image.
2. Choosing tile image.
3. Finding a method to organized tile image depending on its structure or texture.
4. Correcting tile image to be match with the target image.

Based on the above steps, detailed algorithms for mosaic image creation and secret image recovery [10].

Input: a secret image *S* with *n* tile images of size *NT*; a pre-selected target image *T* of the same size of *S*; and a secret key *K*.

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

Steps:

1. Divide secret image *S* into a sequence of *n* tile images of size *NT*, denoted as *Stile* = {*T*1, *T*2, …, *Tn*}; and divide target image *T* into another sequence of *n* target blocks also with size *NT*, denoted as *Starget* = {*B*1, *B*2, …, *Bn*}.

2. Compute the means (μ) and the standard deviations (σ) of each *Ti*.

3. if we have three colored 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).

$$\mu_c = \frac{1}{n}\sum_{i=1}^{n} c_i, \quad \mu_c' = \frac{1}{n}\sum_{i=1}^{n} c_i'; \tag{1}$$

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

4. Do similarly to the last step to compute the means (μ_r', μ_g', μ_b'), the standard deviations (σ_r', σ_g', σ_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.

5. 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 $T1 \rightarrow Bj1$, $T2 \rightarrow Bj2$, etc.

6. 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*. figure (9) shows the flowchart of algorithm for mosaic image creation which hides the data in the target image.

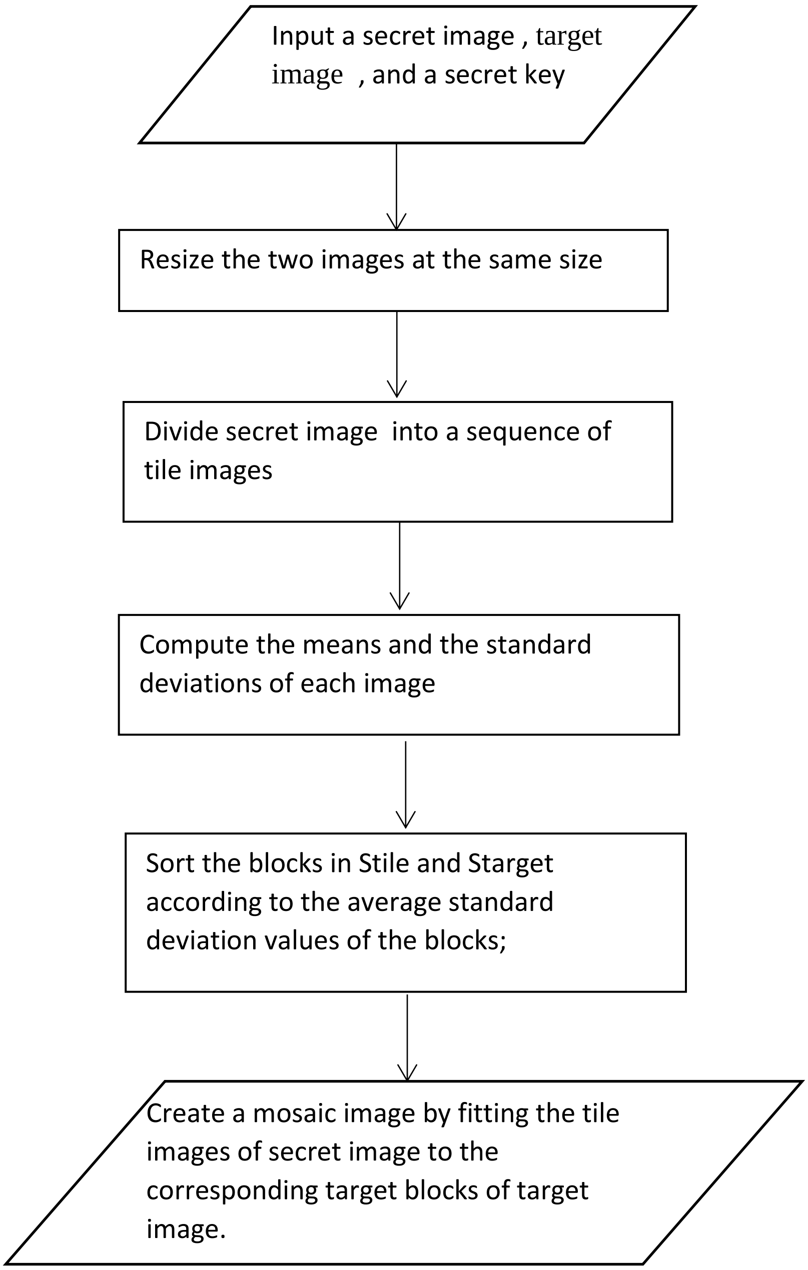


Figure (9) flowchart of algorithm for mosaic image creation

Algorithm 2. 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:
1. Decode the bits 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 means of Ti and Bji, and the standard deviation quotients of gray-level channels;
(3) the overflow/underflow residual values in Ti;
(4) the number m of bits to encode the index of a block;

(5) the number k of residual values.
2. Recover one by one in a tile images Ti, i = 1 through n, of the desired secret image S by :
(1) resulting content into Ti to form an initial tile image Ti;
(2) scan Ti to find out pixels with values 255 or 0 which indicate that overflows/underflows have occurred there,
3. Compose all the final tile images to form the desired secret image S as output. figure (10) shows the flowchart of algorithm for secret image recovery.

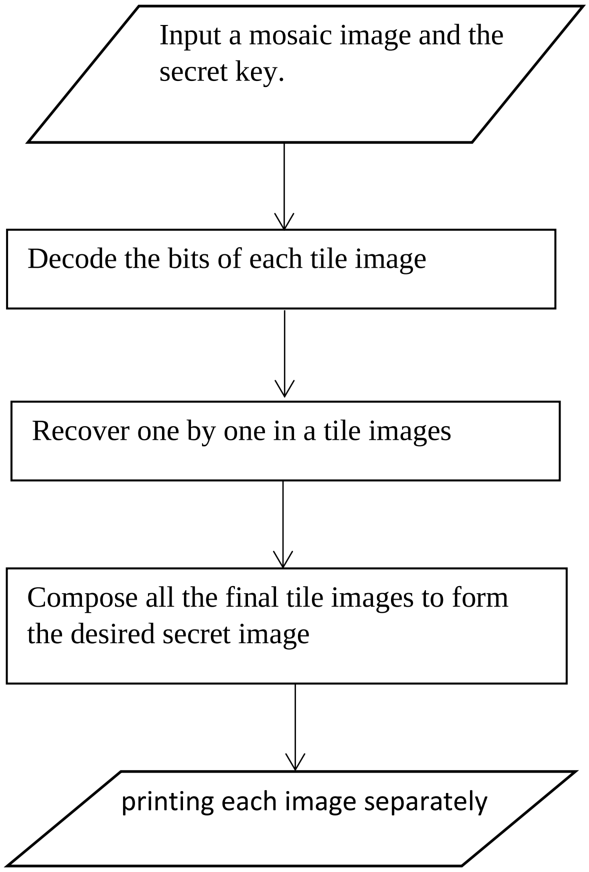


Figure (10) flowchart of algorithm for image recovery

6. Results

After the previous algorithm has been executed, the results represented by a personal image is obtained. The image includes satellite data as shown in figure (11):

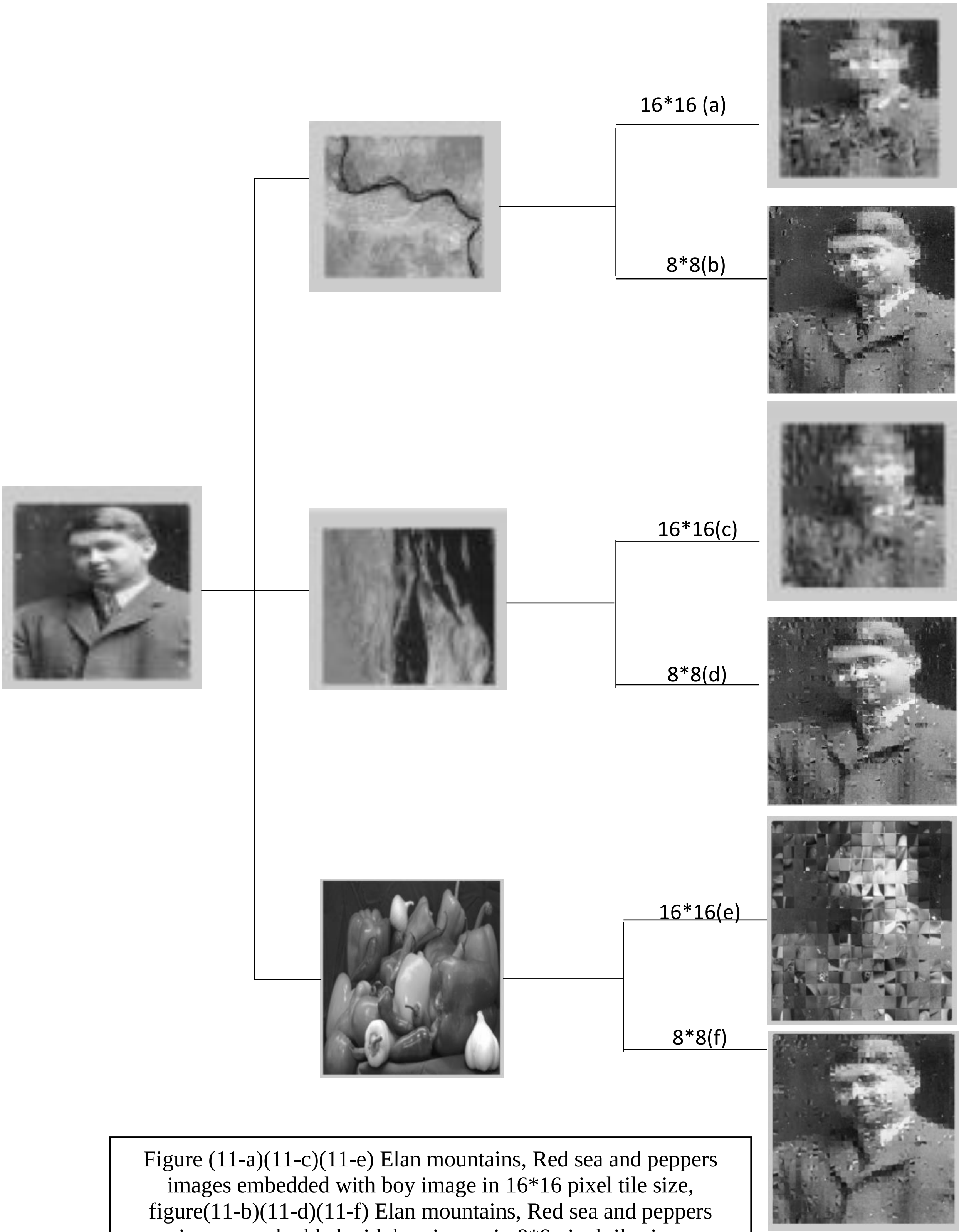


Figure (11-a)(11-c)(11-e) Elan mountains, Red sea and peppers images embedded with boy image in 16*16 pixel tile size, figure(11-b)(11-d)(11-f) Elan mountains, Red sea and peppers images embedded with boy image in 8*8 pixel tile size.

Observing the results, it is obvious that the image whose tiles are segmented by 8*8 gives a higher resolution than the one which is segmented 16*16. Mere observation is not enough to measure clarity and fussiness of each image and finding the optimal image in the embedding. Two measures have been used in this research, the first to measure the ratio of error in the image(MSE). The second measure is used to measure the noise (SNR) as follows:

Cover image	Tiles image	Size of tiles	MSE	SNR
The boy	Red Sea	16*16	1.1273e+03	6.4565
	Elan mountains		1.0518e+03	6.1552
	Peppers		1.2062e+03	6.7503
The boy	Red Sea	8*8	473.2134	2.6867
	Elan mountains		475.8842	2.7111
	Peppers		456.9751	2.5350

Table (1) illustrates MSE and SNR of the resulting
images from the algorithm

The results obtained in the two measures reveal a ratio of error and fussiness in both images with a slight difference. This fussiness is considered natural because the image is a number of tiles representing the original image. However, there is a slight difference among the resulting ratios as the tiles are taken from images that differ in their textures and grey levels. Concerning the images of different grey levels (peppers), they have higher degree of error and fussiness than the image which has a little grey levels since the tiles do not include all grey levels of the original image (image of Elan mountain). Besides, an image of small tiles (8*8) provides less error ratio than that of the bigger tiles (16*16).

7. Conclusions

In this paper we have presented a novel approach to image embedding in images. We have identified a class of images that are suitable for this task, these images are mosaics, which can be used, not only for secure keeping of secret images but also can be used as a new option to transport the secret images safely behind cover images as a personal photo. A novel algorithm has also been proposed for searching the tile images in a secret image for the most similar ones to fit the target blocks of a selected target image.

References:

1. Battiato S., Blasi G. Di, Farinella G. M., and Gallo G., Eurograph. -Comput. Graph. Forum , vol.26, no. 4, pp. 794–812, Dec. (2007).
2. goston M. K. A “Computer Graphics and Geometric Modeling: Implementation and algorithm.” New York Springer-Verlag, p.61, (2004).
3. Close C. , Yau J. , “Recent Paintings”, Pace Wildenstein, (1995).
4. Finkelstein A. and Range M., Technical Report: TR-574-98, Computer Science Department, Princeton University, Princeton, NJ 08540, USA (1998).
5. Lisha . L, Kavitha . M, IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN:2278-8719, Vol. 3, ||V2|| PP 01-07, Issue 3 ,Mar.(2013).

6. Bender, W., Gruhl, D., Morimoto, N., Lu, A. IBM System Journal, Vol. 35, 313－336 (1996).
7. Petitcolas, F.A.P., Anderson, R.J., Kuhn, M. G. a Survey. Proceedings of IEEE, Vol. 87, No. 7, 1062－1078 (1999)
8. Thien, C. C., Lin, J. C. Pattern Recognition, Vol. 36, 2875－2881 (2003).
9. Wang, R. Z., Chen, Y. S. IEEE Signal Processing Letters, Vol. 13, No. 3, 161－164 (2006).
10. Li Y. L. , Tsai W. H. (2012).
11. Battiato S. , Blasi G. Di, Farinella G. M. and Gallo G. , Eurographics Italian Chapter Conference ,pp. 129-135,(2006).
12. Battiato S., Blasi G. Di, Farinella G. M., and Gallo G., Eurograph.—Comput. Graph. Forum , vol.26, no. 4, pp. 794–812, Dec. (2007).
13. Abraham R. and Simon P., International Journal of Software Engineering Research & Practices Vol.3, University of Kerala, Kariavattom, Thiruvananthapuram, Kerala, India, Issue 1, April, (2013).
14. Silvers, R.(1996) photomosaics. http://www.photomosaic.com.
15. Blundo C. , Galdi C. , British Computer Society, (2003).
16. Lai, I.J., Tsai, W.H . Accepted and to appear in IEEE Transactions on Information Forensics and Security (2011)
17. Li Y. L, Tsai W. H., IEEE Transactions On Circuits And Systems For Video Technology, Vol. 24, No. 4, April (2014).
18. Ma K., Zhao W. Z. and Li F., IEEE Transactions on Information Forensics and Security, vol. 8, no. 3, march (2013).
19. Joshi M. R., Karkade R. A. A Monthly Journal of Computer Science and Information Technology ISSN 2320–088X IJCSMC, Vol. 5, Issue. 2, pg.89 – 95 February (2016)
20. Lehman n, E.L., George C., “Theory of point Estimation” (2nd ed).New York: springer. ISBN 0-387-98502-6. MR 1639875(1998).
21. Johnson D. H. , Scholarpedia, 1(12):2088, Electrical & Computer Engineering, Rice University (2006).