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Image Scrambling Technique Using Block Segmentation Method

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Abstract

The paper introduces a method for Image scrambling using block segmentation method. This proposed method explains the concept of image scrambling where an input image is segmented into blocks using block segmentation algorithm and each block is scrambled using different transforms in a successive manner. Every scrambled block is combined into a single image to obtain the scrambled/encrypted image. Descrambling of the image also performed. This proposed method provides better security compared with other existing methods.

Keywords: Image segmentation, scrambling, DCT, DST

1. Introduction

Scrambling is the technique in which various components are added to the original image reducing the probability of obtaining/tracking the secret image. There are numerous scrambling algorithms like Arnold's transform or cat map transform, magic square

technique, Hilbert curve and Gray code conversion method are some of them. Image scrambling is a one of the technique for image encryption. This technique produces an unintelligible image from the input image from which the original information cannot be retrieved. This technique changes the image though it is not hidden providing better security.

In digital world, there are numerous image scrambling algorithms available to achieve this scrambling technique. Most of the scrambling techniques are based on Arnold transform and the combination of Arnold transform, applicable only to equilateral images. Prashan Premaratne proposes key-based scrambling for secure image communication, where the pixel values are 'shuffled' using the row wise and column wise shuffling algorithm [1]. Dongxu proposes an image scrambling method using two kinds of non-linear transformation namely the higher-dimensional Arnold transformation and the higher-dimensional Fibonacci Q-transformation [2]. Shang presented a block location scrambling method for digital image using Arnold transform [3]. Yicong Zhou uses a parameter based M-sequences technique [4] where the authorized person gives the parameters: shift parameter r and the distance parameter p which are used to generate the 2-D M-sequence to descramble the scrambled image.

In this paper, the secret image is first separated to blocks using the block separation method. The blocks are scrambled in row order using transformations and combined to produce the scrambling image.

2. Image scrambling technique

In this paper, the scrambling method is achieved in three steps. First step is the block separation of the image, the second is applying the transformations in the blocks and the third is combining the blocks into a single scrambled image. Figure 1 explains the various steps using a flowchart.

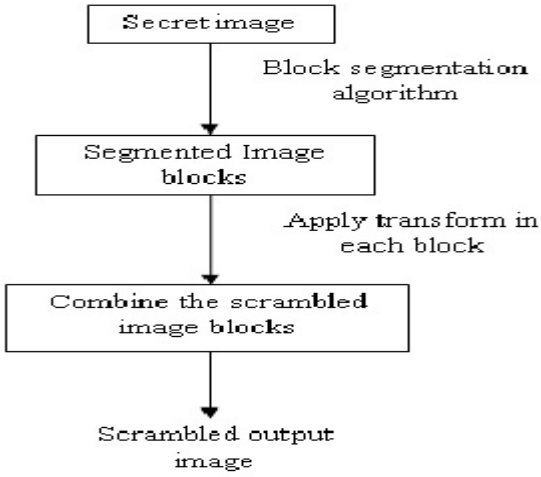


Fig. 1 block diagram for steps involved in scrambling process

2.1. Block separation and scrambling for secret image

The image is separated into blocks using the block segmented algorithm. The algorithm separates the image into a 3×3 block. Figure 2b shows the block separated image. All the blocks are separated in the same size and are scrambled using the DCT and DST transforms in a consecutive manner. DWT transforms are also another option. FFT transforms, cannot be performed as it produces a complex output making it difficult to combine the blocks after scrambling.

In the first block DST is performed and the second block uses a DCT for scrambling and the same process repeats till the last block to obtain the scrambled image. The equation for the DST is given by,

$$\boldsymbol{F(u,v)} = \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} \boldsymbol{\alpha(x).\alpha(y).sin}\left[\frac{\pi u}{2N}(2x+1)\right] \boldsymbol{sin}\left[\frac{\pi v}{2M}(2y+1)\right] \; \boldsymbol{f(x,y)} \quad \textbf{(1)}$$

DCT is given by

$$\boldsymbol{F(u,v)} = \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} \boldsymbol{\alpha(x).\alpha(y).cos}\left[\frac{\pi u}{2N}(2x+1)\right] \boldsymbol{cos}\left[\frac{\pi v}{2M}(2y+1)\right] \; \boldsymbol{f(x,y)} \quad \textbf{(2)}$$

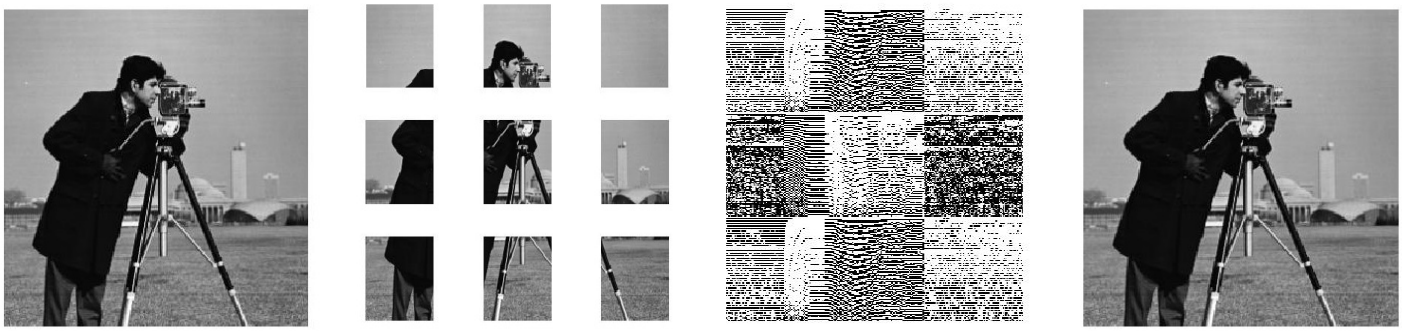
Both the transforms scramble the image blocks and produces the scrambled version of original image.

2.2. Scrambling and descrambling of the image

After applying transforms in all the blocks, they are changed to unintelligible image blocks after which all the scrambled blocks are combined into a single image producing a scrambled image. This scrambled image is shown in figure 2c. Descrambling is the reverse process of the algorithm. Inverse transforms descrambles the scrambled blocks to obtain the original image.

3. Results and simulation

The proposed method is simulated using MATLAB tools. The results are shown in figure 2. Secret/input image is shown in a), the block separated image in b), the scrambled image is shown in c) and the descrambled image in d).



a) b) c) d)

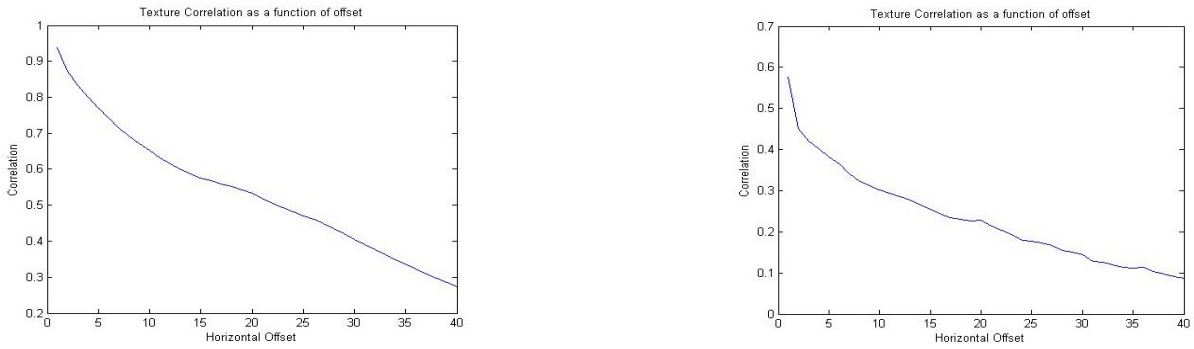
Fig. 2 simulation results: a) input image, b) block segmented image, c) scrambled image, d) descrambled image

4. Security analysis

Security analysis plays a major role in image encryption/scrambling, certain parameters like texture analysis, and correlation analysis decides the analysis. This section describes the metrics which comes under the category of statistical analysis of image scrambling technique.

4.1 Texture analysis

The section explains the texture correlation analysis for horizontal offsets. Correlation is used to measure the joint probability of the specified pixel pairs in an image. Spatial relationship or offset is defined as the relationship between the two horizontally adjacent pixels of an encrypted image. The figure 3 shows the correlation analysis of the secret and scrambled image. In this analysis the correlation plot starts with the value of 1 in an input image and for the scrambled image it starts with the value of 0.6.



(a) (b)

Fig. 3 Texture correlation analysis for a) secret image and b) scrambled image

4.2 Correlation analysis

Correlation analysis used to reduce the statistical attack in image scrambling. Table 1 shows the horizontal and vertical correlation coefficient values.

Table 1 Correlation coefficients for original and scrambled images

Correlation coefficients	Original image	Scrambled image
Horizontal	0.9968	0.0041
Vertical	0.9416	0.0054
Diagonal	0.9374	0.0045

Figure 4 shows the correlation analysis of adjacent pixel value for original and scrambled image. a), c), e) are the correlation analysis for horizontal, vertical and diagonal adjacent pixel value for original image respectively. Similarly b), d), e) are the correlation analysis plot of horizontal, vertical and diagonal adjacent pixel value for scrambled image. From this figure we can observe that the correlation of adjacent pixels value for original image is much greater than the scrambled image.

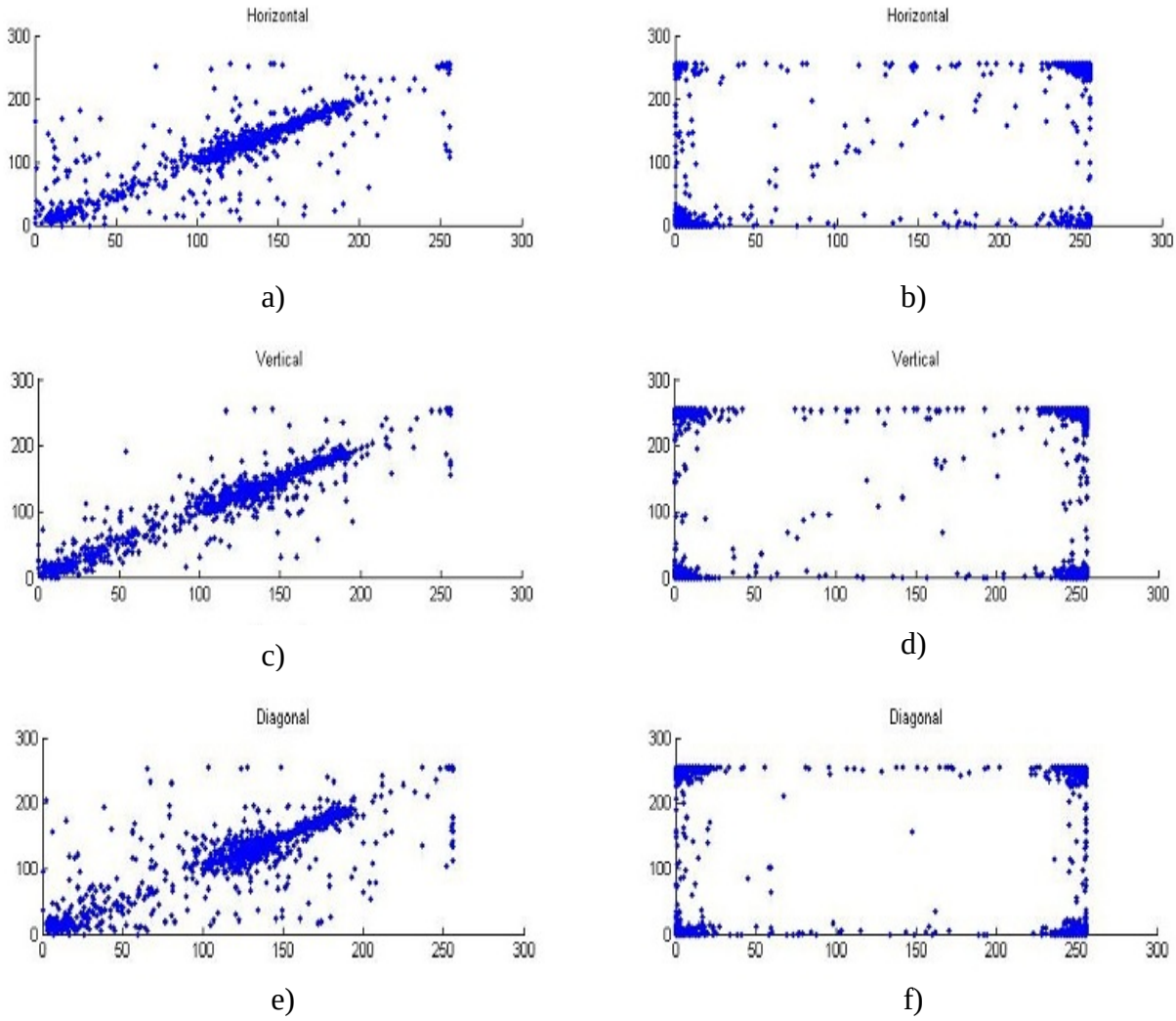


Fig. 4 Correlation distribution plot for secret image and scrambled image

5. Conclusion

Scrambling is widely used in secure image transmission .In this proposed method the image is scrambled using the block segmentation algorithm and every block are scrambled individually using DST and DCT in a consecutive order. The scrambled image is obtained by combing all the blocks into a single image and the descrambling is also achieved by the reverse process. The security analysis parameters are calculated using correlation coefficient values and the texture analysis also plotted by using horizontal offset. This method is simple and reliable for the secure communication.

6. Reference

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