International Journal of Information Processing, 8(3), 31-41, 2014
ISSN : 0973-8215
IK International Publishing House Pvt. Ltd., New Delhi, India

Fisher-Yates Chaotic Shuffling Based Image Encryption

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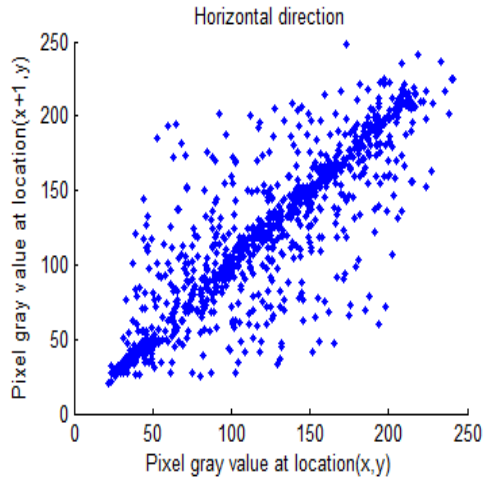
In Present era, information security is of utmost concern and encryption is one of the alternatives to ensure security. Chaos based cryptography has brought a secure and efficient way to meet the challenges of secure multimedia transmission over the networks. In this paper, we have proposed a secure Grayscale image encryption methodology in wavelet domain. The proposed algorithm performs shuffling followed by encryption using states of chaotic map in a secure manner. Firstly, the image is transformed from spatial domain to wavelet domain by the Haar wavelet. Subsequently, Fisher Yates chaotic shuffling technique is employed to shuffle the image in wavelet domain to confuse the relationship between plain image and cipher image. A key dependent piece-wise linear chaotic map is used to generate chaos for the chaotic shuffling. Further, the resultant shuffled approximate coefficients are chaotically modulated. To enhance the statistical characteristics from cryptographic point of view, the shuffled image is self keyed diffused and mixing operation is carried out using keystream extracted from one-dimensional chaotic map and the plain-image. The proposed algorithm is tested over some standard image dataset. The results of several experimental, statistical and sensitivity analyses proved that the algorithm provides an efficient and secure method to achieve trusted gray scale image encryption.

Keywords : Fisher-Yates Shuffle, Haar Wavelet Transform, Piece-wise linear Chaotic Map, Self Keyed Diffusion.

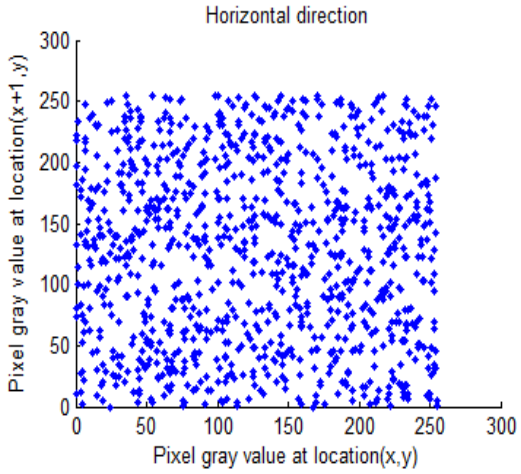
1. INTRODUCTION

Nowadays, public networks are not suitable for the direct transmission of confidential messages because of the rapidly rising problem of security threats. As a result, security is still an open challenge in spite of the tremendous advancement in internet technologies. This is an important challenge in the areas where reliable, secure, fast and robust transmission of information is the major requirement especially in the field of military and medical systems. To deal with the problem of secure transmission of information over the networks, numerous encryption algorithms have been proposed based on different methodologies and ideas [1][2][3].

Traditional ciphers RSA, DES, AES, can be used to encrypt image, but these are not ideal for two reasons [4]. First, since image size is generally much greater than text. This results in conventional ciphers taking much more time to encrypt images. Second, image data has high correlation among adjacent pixels. Consequently, it is rather difficult for these ciphers to shuffle and diffuse image data effectively. Chaos-based cryptosystems usually have higher speeds and lower costs. In this regard, chaos based encryption techniques have demonstrated exceptionally good behavior because these technique have faster speed, reasonable computation overheads without compromising the security. Moreover, chaotic systems have many important properties such as the sensitivity to initial conditions and system parameters, pseudorandom property, non-periodicity and topological transitivity [1]. These optimistic features make the chaotic al-



(a) Original Image



(b) Cipher Image

Figure 6. Distribution of Adjacent Pixels in Horizontal Direction

make shuffling key dependent. Moreover, the chaotic modulation of shuffled approximate coefficients results a good quality of shuffled image. Then, in second phase the shuffled image is self keyed diffused and mixing operation is carried out with the generated keystream sequence and shuffled image. The simulation and experimental analyses proved that the proposed encryption algorithm is secure, efficient, and highly robust towards cryptanalysis.

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