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Effect Of Encryption Method and Quantity of Data on Correlation Coefficient in Encrypted Data

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ABSTRACT

Text, Images, videos have a significant role in communication, entertainment and business etc. data may convey confidential information, and so various methods for encryption algorithms ensure security of secret information. The correlation coefficient in encrypted data is an important security criterion to measure the level of security of encrypted information. Various factors can affect the correlation coefficient in the encoded information. So, this work reveals the effect of data encryption method and the size of a various data on correlation coefficient in the corresponding encrypted data

KEYWORDS Cipher. Correlation coefficient, encryption, encrypted image, image, size of image

The Internet and information technology are increasing rapidly so users prefer to communicate through multimedia. Images are highly utilized in communication. Some images convey secret information, so there is always a need to protect these images from banned. There are various techniques to making an image secure, for example stenography, cryptography and watermarking etc. Encryption method is a part of cryptography and greatly used to make an image secure [1, 2, and 3]. There are various image encryption algorithms to provide protection to images. So, different criteria are used to measure the capability of an image encryption algorithm and security level of encrypted image. One significant criterion is the correlation coefficient that is used for statistical analysis of encrypted image [4].

Correlation coefficient assesses the correlation between two adjoining pixels in an image [4, 5]. Generally, correlation measures the degree of similarity between two pixels. An encrypted image should have low correlation between two adjoining pixels [4, 5, 6], so that it becomes difficult to guess the value of neighbors of a pixel. For example, xi and yi are two pixel pair then the correlation coefficient can be obtained by the equation (4) [4, 5, 6].

$$E(x) = \frac{1}{N}\sum_{i-1}^{N} Xi$$

$$D(x) = \frac{1}{N}\sum_{i=0}^{N}\left(Xi - E(X)\right)$$

$$cov(x,y) = \frac{1}{N}\sum_{i=0}^{n}\left(Xi - E(X)\right)(Yi - E(Y))$$

$$r_{xy} = \frac{cov(x,y)}{\sqrt{D(x)}\,\sqrt{D(y)}}$$

$$where\ \sqrt{D(x)} \neq 0\ and\ \sqrt{D(y)} \neq 0$$

Where xi and yi are gray level value of two adjacent pixels, N is the number of pairs (xi, yi) and E(x) is the mean of xi and E(y) is the mean of yi.

This paper demonstrates the effect of image encryption algorithm and size of an image on correlation coefficient in the corresponding encrypted image. For the demonstration, four different algorithms are used to encrypt a same image of different sizes.

The rest of the paper is divided as: existing algorithms that will be used for experiment, experimental results, conclusion and suggested future work.

2. EXISTING ALGORITHMS

Amitava Nag, Jyoti Prakash Singh, Srabani Khan, Sushanta Biswas, D. Sarkar and Partha Pratim Sarkar [3] have suggested a technique that uses 64 bits key in the encryption process. This approach uses the affine transformation to shuffle the pixels by applying four sub keys of 8 bits. Thereafter, this algorithm decomposes an image into 2*2 pixel block size, afterward, applies an XOR operation on each block to change the pixels value.

Qiudong Sun, Ping Guan, Yongping and Yunfeng Xue [7] have imparted a one-dimensional random scrambling based method. At the beginning, this technique transforms a two-dimensional image into the one-dimensional vector and then applies the one-dimensional random scrambling [7]. Thereafter, this algorithm performs an anti transformation on the dispersed vector to generate an encoded image.

Mohammed Abbas and Fadhil Al-Husainy [8] have propounded an approach that relies on the bit level permutation. This technique utilizes two Boolean operations: XOR and Rotation on the bits of the pixels to satisfy the confusion and diffusion properties.

Long Bao and Yicong Zhou have [9] recommended a new chaotic system that constitutes the three distinct one- dimensional chaotic maps. The imparted method utilizes the substitution-permutation network (SPN) structure to obtain the confusion and diffusion property [9, 10].

3. EXPERIMENTAL RESULTS

Four different techniques have been used to observe the impact of size of an image on correlation coefficient in encoded image. For this test, same gray level images of 8 different sizes

have been used. The gray level image is shown









Table 1 shows the result of the four different techniques that have been applied on these images. Furthermore, correlation coefficient is calculated in the corresponding encrypted images that are produced after 11 rounds of encryption technique.

Cover Image	ORIGINAL SIZE (KB)	ENCRYPTED SIZE (KB)	Time in second
Image 1.jpg	35	46.4	1
Image 2.jpg	33.4	44.2	1
Image 3.jpg	33.5	44.4	1
Image 4.jpg	34.4	45.9	1
Correlation Coefficient between Original size and Encrypted Size			0.99

4. CONCLUSION

This empirical results disclose that dimension of an image affects the correlation coefficient in the corresponding encrypted image. Moreover, if an image encoding technique utilizes the both scrambling and substitution, then the correlation coefficient is reduced as the size of the image increases. Moreover, correlation coefficient is decreased greatly after each round. However, if an image encryption algorithm applies only shuffling process, then correlation coefficient remains high or gets abatement slowly with respect to the area of the image increases. Reduction in the correlation coefficient in an encrypted image also depends on the cipher approach and number of rounds. However, it is decreased only to some extent. Consequently, an effective design of encoding system is capable to curtail the correlation coefficient to some limit in encoded image gradually after every round

Thus, this work divulges that an image encryption algorithm should use appropriate procedures to reduce the correlation coefficient in an encoded image. Moreover, the substitution process is extremely essential along with a scrambling method for this purpose

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