Lecture Notes in Networks and Systems 166

Dinesh Goyal · Amit Kumar Gupta ·
Vincenzo Piuri · Maria Ganzha ·
Marcin Paprzycki *Editors*

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A Efficient Approach for Securing Images Using RSA and Arnold Technique Metamorphose

Kanak Giri, Pankaj Dadheech, and Amit Kumar Gupta

Abstract People across the globe exchange information but security remains primary concern while sharing information (data or images). This paper highlights the encryption technique using Arnold's cat mapping and RSA algorithm in which first images are jostled using Arnold technique and then encrypted these jostled images using RSA algorithm. This concludes that the suggested new method will improve the security and encrypted and decrypted quality of images.

Keywords Cryptography · Image encryption · Image decryption · Asymmetric RSA · Arnold's cat mapping

1 Introduction

In any case, the world is digitised. Each division of government agencies and private companies search for digital images using each department as a method to transfer all important data. These online images are not secure. Therefore, it is necessary to protect the image. With the rapid growth of digital communication and multimedia application, security of storing image and its transmission is a big issue for the current system. Cryptography is a way to give high data security. Images are used in many areas, such as medicine and military science. The latest encryption technology provides technology to protect information and multimedia data. In recent years,

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cryptography technology has evolved rapidly and many image encryption methods are used to protect sensitive image data from unauthorised users or system.

Many fields, like medical industrial, research, and military, are sharing information mostly in form of images. So, many images are transfer through the Internet which is highly insecure so that it is very important to provide a proper security approach that can secure data unauthorised users. The advantage of this paper is to protect and secure different types of multimedia information. Main aim of proposed approach is to provide image security system which supports image integrity, confidentiality and originality because of this we can send and save images online.

Encryption is the most effective way, but if we use large amount of grey-level data, security issues is again appear [4].

2 Arnold's Cat Mapping

Arnold's mapping is based on two-dimensional matrix conversion. In this mapping function, one point changes to another point in a plane without any changing in information. Let (x, y) is the unit function of a plane Z. This mapping function changes the point (X, Y) to point(x', y') using the below written Eq. [1].

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \bmod 1 \tag{1}$$

Here, $N = 1$. Inverse transformation [1] is moving the pixels of the square digital image $I = [I\ i, j]_{N \times N}$ to (i, j).

$$\begin{bmatrix} i' \\ j' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} i \\ j \end{bmatrix} \bmod N \tag{2}$$

Arnold's forward and inverse mapping function work in a periodic manner. The number of iterations needed to restore the image can be $<N^2$. Arnold's period's linear approximation is shown in Eq. 3, as in [1].

$$\begin{aligned} T' &= 40.8689 + 1.4938N \\ 2000 &\geq N \geq 2 \end{aligned} \tag{3}$$

According to Arnold's concept, the encode of the Arnold's cat mapping algorithm is the safeguard of the image without reducing the value or information of an image. It is good enough to provide security to the pixels of the images. Encoded image compared with initial image ("chao") which means that random mapping function is more efficient. Arnold's conversion is used to increase image protection.

Figure 1 depicts the basic flow chart of the image using Arnold's mapping.

Using the Arnold's Cat Mapping

Arnold's mapping first to encrypt images and then secured the images using image encryption techniques. Figures 2 and 3 show final result of image transformation.

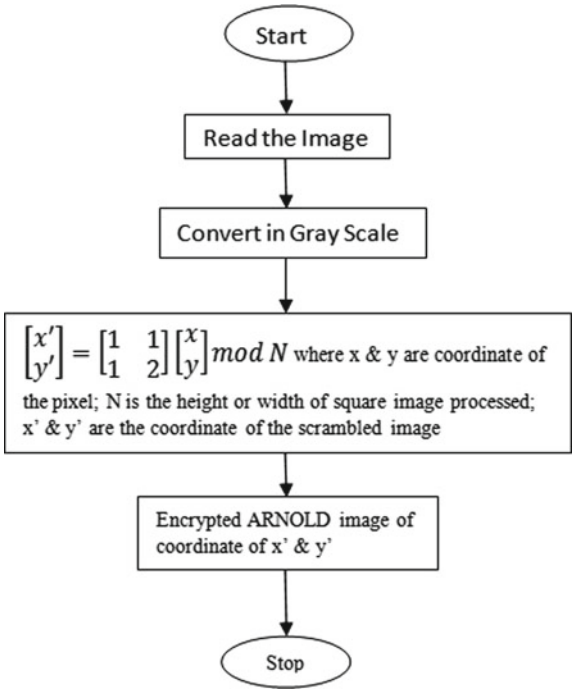

Fig. 1 Flow chart of randomisation of image

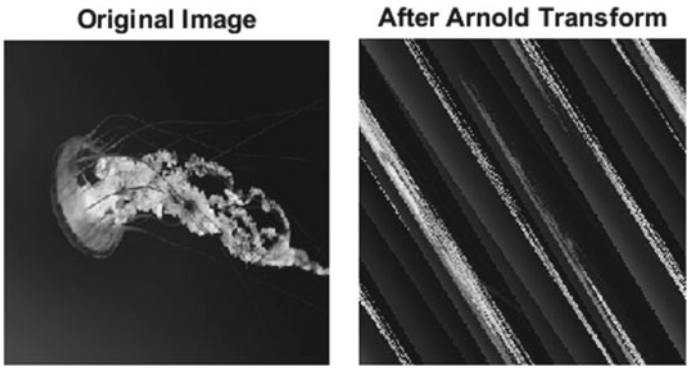

Fig. 2 Initial image and randomised image after applying Arnold's cat mapping

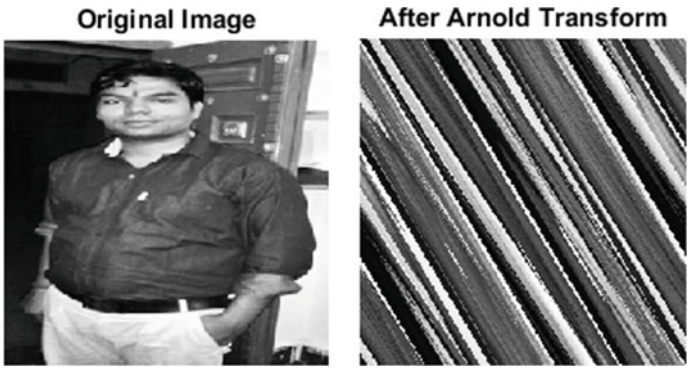

Fig. 3 Initial image of person and randomised image of person after applying Arnold's cat mapping

3 Asymmetric RSA Algorithm

RSA is known as asymmetric cryptographic algorithm where it uses two keys as it is asymmetric (public and private key). In this process, public key is available for every receiver but the private key is only available for the user who is at decoding end. Factorization of a large number is a key terminology of RSA. Public key consists of multiplication of two large prime numbers. Private key is also only derived from the same two prime numbers hence this process can create more difficulties for unauthorised users.

RSA algorithm is one of the most commonly used in digital image security or encryption. Encryption is one of the best ways to protect data or images while using internet. Once initial image is encrypted, no one can see the initial image, only after decrypting the encrypted image, for again finding initial image decrypting is needed of encrypted image.

Basic flow chart of image encryption using RSA (Figs. 4, 5 and 6).

4 Proposed Image Encryption Technique

RSA algorithm is the asymmetric cryptography algorithm where asymmetric means that it works on two different keys, i.e. private and public here decryption key kept secret so that receiver can easily trusted onto sender. One more advantage of RSA is difficult to decrypt images because this algorithm includes a second private key which is difficult to reproduce by unauthorised user. Using permutations or hacking attempts by one or the other, can get a decryption key, which is almost the same as the original key. It can exit and decode 65–85%. Then, it is possible that image can be decrypted (obtained original image).

So that to increase this percentage, we are using Arnold's cat mapping algorithm, is the safeguard of the image without reducing the value or information of an image that

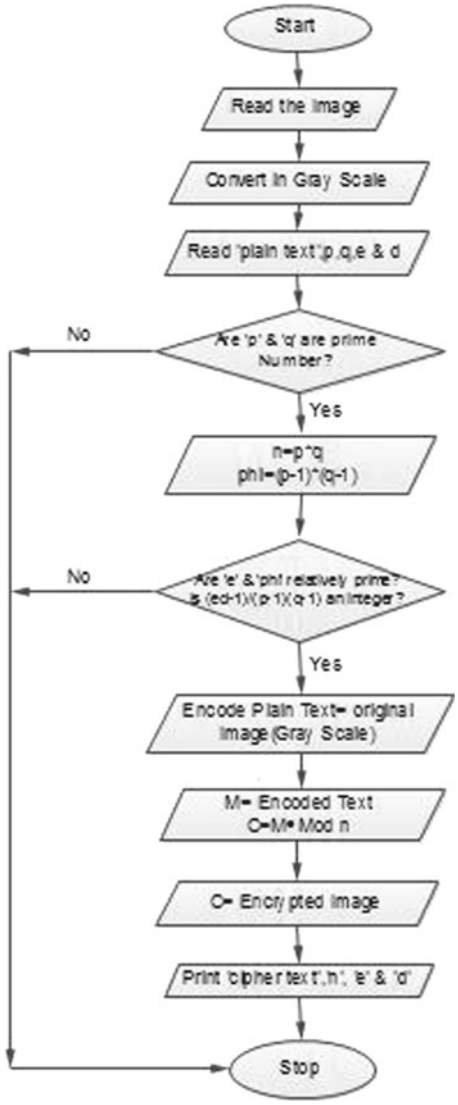

Fig. 4 Flow chart of RSA algorithm

means image data is secured and this is one of the best advantages of this algorithm hence it is easy to provide more security to the image pixels.

The random function is one important part of Arnold's algorithm which may lead unauthorised user to understand original images 75–85% before applying inverse function, so for safety, we should always try to increase the complexity of the image so that it will become more confusing for the unauthorised user.

The flow chart of the proposed new method is shown in Fig. 7.

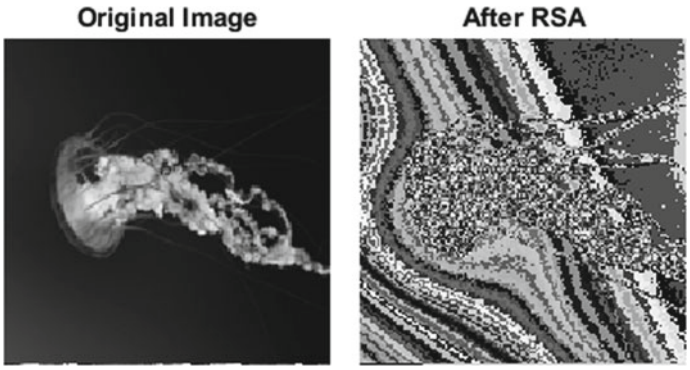

Fig. 5 The original image and encrypted image using the RSA algorithm

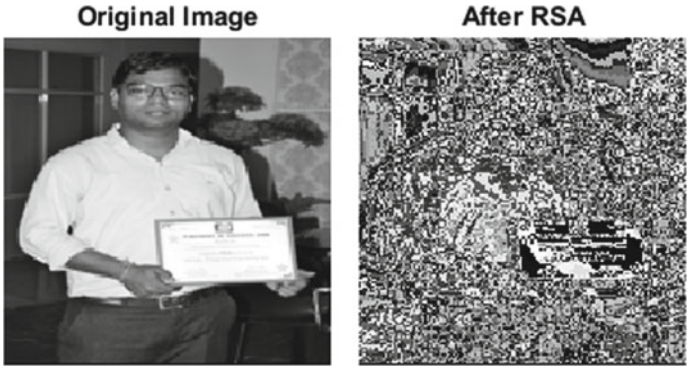

Fig. 6 The original image and encrypted image of a person using the RSA algorithm

Therefore, the proposed method uses Arnold mapping and asymmetric RSA algorithm. The final results of using proposed image encryption method are shown in Fig. 8.

5 Conclusion

This paper includes our proposed technique presents the various analyses of image encryption and decryption using Arnold's cat mapping algorithm and asymmetric RSA algorithm.

RSA algorithm is the asymmetric cryptography algorithm where asymmetric means that it works on two different keys, i.e. private and public here decryption key kept secret so that receiver can easily trusted onto sender. One more advantage of RSA; i.e. difficult to decrypt images because this algorithm includes a second

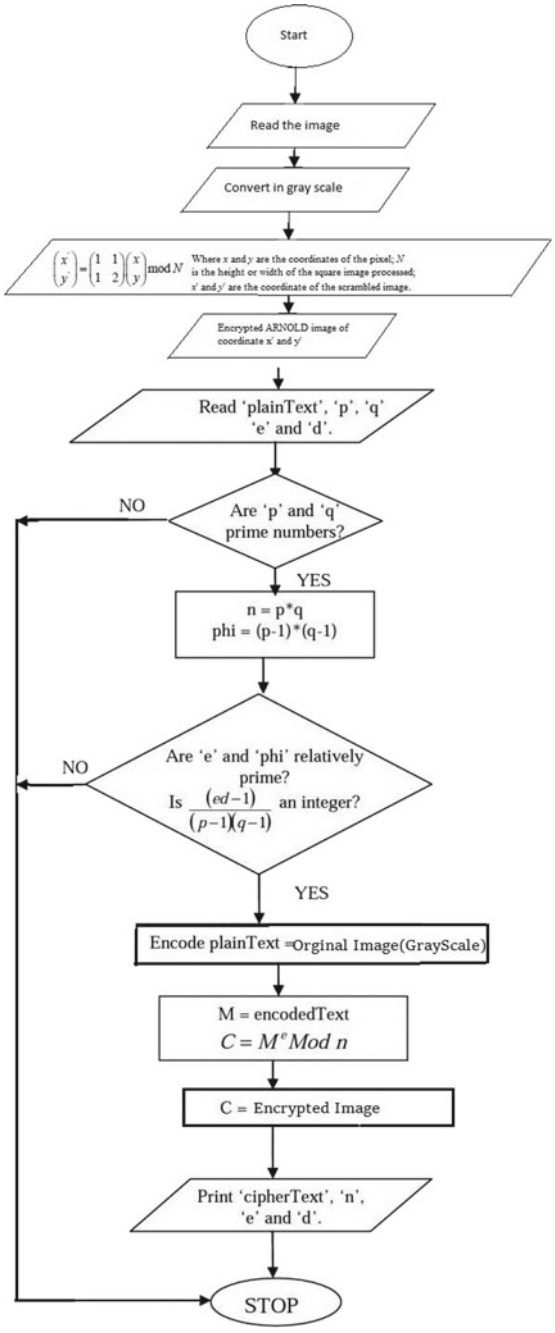

Fig. 7 Proposed algorithm's flow chart

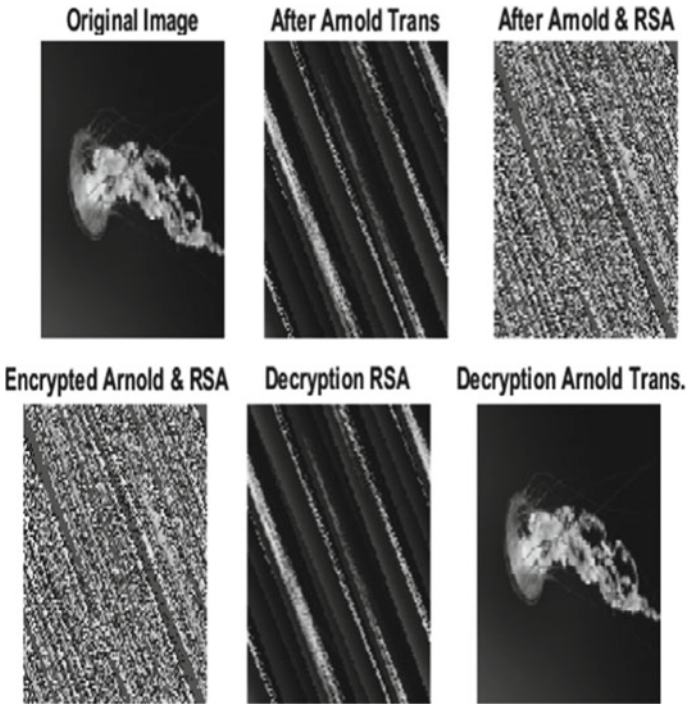

Fig. 8 Arnold's mapping and RSA algorithm for image encryption and decryption

private key which is difficult to reproduce by unauthorised user. Using permutations or hacking attempts by one or the other, can get a decryption key, which is almost the same as the original key. It can exit and decode 65–85%. Then, it is possible that image can be decrypted (obtained original image).

So that to increase this percentage, we can use Arnold's cat mapping algorithm, is the safeguard of the image without reducing the value or information of an image. It means image data is secured and this is one of the most advantages of this algorithm. so that it is good enough to provide security to the pixels of the images. The shuffling function is the one important part of Arnold's algorithm which may lead unauthorised user to understand original images 75–85% before applying inverse function, so for safety of we should always try to increase the complexity of the image so that it will become more confusing for the unauthorised user.

This concludes that the suggested new method (Arnold's cat mapping and RSA algorithm) is the more secured or provide a reliable image with minimum quality losses in the original the image.

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