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Image Cryptography Based on Image Processing Technique and Classification Algorithm

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ABSTRACT
Data security is a set of means, actions and measures that we can take to protect our information, whether internal or external, in order not to allow it to be hacked or to not allow unauthorized people to access this information. Image encryption is one of the well-known mechanisms for maintaining the security and confidentiality of information. This medium is vulnerable to attacks, and thus effective encryption algorithms are essential to protect and transmit data securely. Encryption is one of the widely used types of protection to secure information, and the use of keys is a common process used to secure information. The strength and effectiveness of encryption depends on two main factors: (the algorithm, the length of the key in bits), the higher the bit, the more secure and difficult to decrypt. Image encryption is one of the most widely used methods to protect and secure data, to make the encrypted image impenetrable for cryptanalysis. In this paper, a new system and method is proposed to achieve data security using modern block cipher, symmetric key (International Data Encryption Algorithm (IDEA)), image processing techniques and classification algorithm.The implementation procedure is divided into two steps (key generation based on image processing techniques and classification algorithm, encryption and decoding), with metrics the objectivity is implemented on the images and the scale difference is observed in each of the images specified in each of the images mentioned algorithms.
Keywords: Gabor Filter Bank, K-Mean Algorithm, Idea Algorithm

1. Introduction:

Information security requirements have undergone many changes during the past decades, information security has been provided, and there has been the so-called physical security. It provided security for important and sensitive information for organizations and companies by achieving physical security such as the use of locks and safes, and the use of certain administrative procedures to achieve information security (such as placing special lockers for important information and placing more than one copy), through computer entry, use and publication. There was a need to provide new tools and methods to protect the security of information and files, in order to protect information on storage means, or to protect information transmitted through communication means [15]. Image encoder works on the innovative idea of taking consecutive or random pixels from an image, working together and modifying with logic, resulting in a whole bunch of new pixels, which are typical of the original bits. In this paper, a new and simple system was proposed and worked to achieve data security on the basis of modern block cipher and symmetric key by linking studies and research on hashing technology in image processing and classification algorithm to the process of key generation using (Gabor filter, k-mean clustering algorithm), as well as Studies and research on International Data Encryption Algorithm (IDEA), process (encoding and decoding). In the process of key generation this research used a combination of K-mean and Gabor filter block strategies, followed by mixed region and texture detection procedures. The pooling procedure is used to examine each pixel in the image and then assign it to one of the image groups to produce an image of different regions of intensities according to the minimum size. [2] The output of this process will be two images (the foreground image, the background image) where the foreground image is used as the key for the International Data Encryption Algorithm (IDEA) encryption and decryption process.This research paper will address (previous work and research and the method used in this research). Also, discuss the results and conclusions.

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Related Work

The reviews of previous works and studies included an in-depth study of all available research sources from books and letters, research and sites specialized in information security and fabric fragmentation and linking them, so that the researcher could link his results with the results of the research and his recommendations. Previous studies. The researcher developed perceptions of similarities and differences in his study from previous studies. A summary of the studies can be given as they appear below.

In 2006, researcher "Vibha S. Vyas and Priti Rege" used woven images from the Bordet texture database to implement a supervised texture segmentation algorithm, the problem is the effect of noise. If the noise content increases to the degree of image disturbance, then the Gabor filter method will not achieve optimal performance. Any image is processed If the pixel tag is set to the tag maximally in its vicinity is 11 x 11, the further sorted image will be processed. This ensures that classification noise is reduced, thus improving the segmented image. [3].

In 2011 , The researchers Rosdiyana Samad and Hideyuki Sawada ,It demonstrates that the data on the characteristics are well differentiated and grouped into each type of facial expression.[8].

In 2013, researchers Osama Al-Masry, Hajar Matt Jani, proposed a new design and early implementation of a more secure encryption algorithm based on the International Data Encryption Algorithm (IDEA), a limitation of the International Data Encryption Algorithm (IDEA). . The largest number of weak keys. During the sixth round of International Data Encryption Algorithm (IDEA) operations, a new attack was discovered. The DS-IDEA method has been suggested. The complexity of the algorithm will increase when the key size is increased from 128 to 512 bits. By increasing the amount of propagation (additional mass multiplication) in one cycle, the complexity of the algorithm increases. Attacks will be less likely. Also helps to spread with two double blocks. As a result, the algorithm has become more secure and resistant to cryptanalysis. [17].

In 2015, The researchers J.Gowri1, Dr.S. Janakiraman2 used a very basic, compact, but very effective texture segmentation based on the K-means and Gabor filter, which incorporates digital image processing concepts.The precision of the texture segmentation using the K-means and Gabor filter. I see the problem in this reference is, the shortcomings of these methods are largely dependent on k-means outcomes, where if the clustering function is not properly implemented, the other strategies we used would produce incorrect results.The problem of unwanted segmentation outcomes generated by the Gabor filters was, however, solved.[1].

In 2017 ,The researchers 1Agyztia Premana, 2Akhmad Pandhu Wijaya, 3 Moch Arief Soeleman aims to examine the outcome of image segmentation using the process of Gabor Filter and K-means Clustering. The researchers used the K-means Clustering method for segmentation, while the Gabor filter is used for the feature extraction method. In this approach, I define the issue with one weakness, which is unnecessary segmentation (over segmentation). Therefore, a preprocessing is required before making a transformation and one of the methods used is noise reduction.[2].

In 2017, researchers Omar Farouk Muhammad, Muhammad Shafri Muhammad Rahim, Subhi Rafiq Muhammad Zebari, and Falah Yahya. Ahmed with an existing work that uses classical and modern techniques to encode images, such as classical techniques using alphabet-based text as key elements while modern techniques overcome this limitation through mathematical algorithms used to encode information for its existence. digital system. A comparison has been made of several cipher techniques (classical and modern) for images based on different parameters. Analysis of the simulation result shows that the stochastic coding technique, especially the hyper-chaos, is the most efficient among all.[18].

In 2019, researchers Robbi Rahim1*, Helmy Fauzi Siregar2, and Delima Sitanggang introduced a structured approach to protocol ciphers at the security level and combining protocols with other algorithms. The experiment used the random pixel value of the image to improve the encryption and decryption of the IDEA algorithm, and it was found from the examination

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that the decoding process with different images could not be performed due to the difference in the pixel image, and that reading the random pixel images takes a long time to experiment when generating the keys. [19].

In 2021, researchers Mujib Ur Rehman, Aslan Shafiq, Sohail Khaled and Iqdar Hussain in 2021 Dynamic substitution and chaotic systems were used to suggest a picture encryption technique. The proposed approach is built on a jumbled logistics map, jumbled pocket maps, and dynamic replacement boxes (S-boxes). The suggested scheme's safety and efficiency are supported by simulation and balance results using the most up-to-date methods. [31].

In 2021 researchers Naim Muhammed and Ali Pasha The Linear Regression Record Generator (LFSR), the SHA 512 hash function, supersimilar systems, and the Josephus problem were used to develop a new technique for encoding satellite images. The experimental and analytical results revealed that the suggested method performs well in terms of high security, a big enough key space, tolerance to single event disruptions (SEU), and low time difficulty. [32].

Based on previous studies, we did not find a research or scientific paper that works on achieving data security by linking the special research (Texter Segmentet) and the research on achieving data security using encryption algorithms, so we contributed to this research in achieving data security. through linkage. Searching Texure partitioning process using Gabor filter and K-mean clustering classification algorithm and searching cryptographic algorithms (International Data Encryption Algorithm (IDEA)).

It was concluded that the applied benefit of this research is to achieve data security by relying on the classification algorithm.

2. Research Method

To implement the proposed approach, several steps can be performed: (key generation using the cut-off technique in digital image processing using texture segmentation using the Gabor filter and the well-known classification algorithm K-mean clustering Algorithms, encryption, decryption, using the international cryptographic algorithm (International Data Encryption Algorithm (IDEA)) and evaluation algorithm work). Figure 1 shows all the steps of the proposed method.

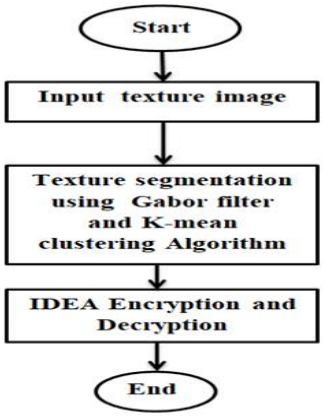

Figure1. shows all the steps of the proposed method [14].

2.1 Key Generation

The process of key generation using tissue segmentation using multichannel filtering includes the following steps [4], [10], (development of filter banks, decomposition of the input image using filter bank, function extraction, and pixel-space clustering of features).as show in Figure 2:

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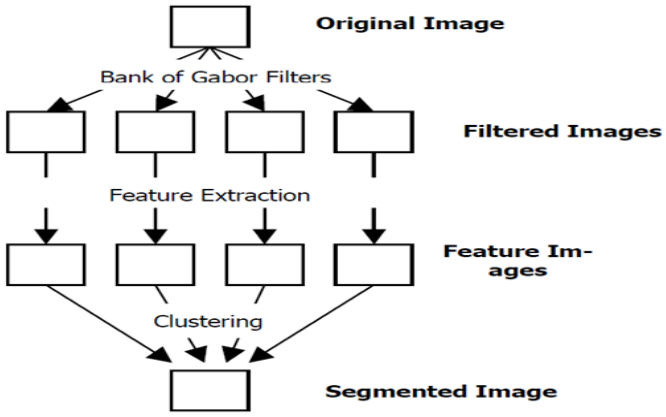

Figure 2. Texture Segmentation Process [4]

Gabor filters are band-pass filters [4]. The Fourier transform of a Gabor filter is a Gaussian transform of frequency [2]. Gabor filters have the ability to perform polymorphic analysis due to spatio- and spatio-frequency domain localization [1].Smaller filters for bandwidth. It is more desirable in the spatial frequency domain because it helps in differentiation of the different lists as well as the effective display of filters and bandwidth in the spatial domain. For this form of segmentation problem, this is why the I Gabor filter is well suited. [10].

Extraction of Characteristics, Filter outputs aren't good for recognizing Kay texture features by default.There are several alternatives, including using the magnitude response, applying spatial smoothing, just using the real variable, employing a non-linear sigmoidal function, adjacent pixel information.[4],[8]

Spatial Smoothing, is a technique known to improve segmentation efficiency by producing substantial changes in the feature map in areas that belong to the same texture. Smoothing, on the other hand, can affect texture region localization edges negatively. [1],[4].

The last step in texture segmentation is to group pixels into clusters that correspond to the original texture regions. [1], for simplicity in this technique, we used the simple K-mean clustering algorithm to label the segmented image for each cluster. [4].

2.1.1 Gabor filter bank :

It comes out properly so that this is Gaussian, and similarly, a Gabor kernel will look at how to do this in one minute, but this is a Gabor kernel, and now when you represent this core on the picture as in Figure. 3.

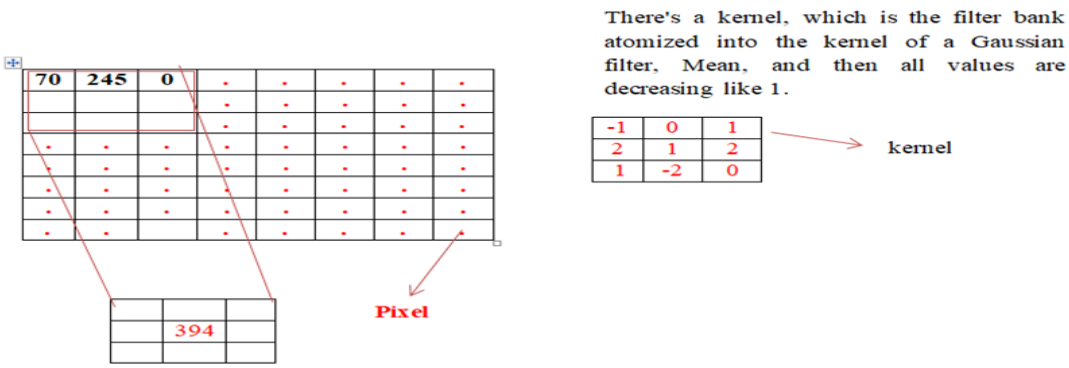

Figure 3: our image and it has different pixel values

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You're taking out the matrix one by one, not the matrix as a whole. -1 170, 0 x 245, -1 170, -1 170, -1 170, -1 170, -1 1 minus 0 The value of 394 indicates that in this middle, where we fought to substitute the value, the wrapping process is easy and 3 3 can get 5 5 and can also be done step by step.

The Gabor filter[1] is a convolution filter that represents Gaussian and Sinusoidal terms. The weight is provided by a combination of the Gaussian Component and the sine component, and the directionality is provided by the sine component.[8].Gabor can be used to build texture and edge-representing features[2]. That's why this incredible filter is made up of a set of kernel (Bank of filter) filters that can be used to discover texture and then remove it again[4]. The filter equation, as shown in equation (1):

$$g(x,y,\lambda,\theta,\psi,\sigma\gamma) = \exp(-\dot{x}^2 + \gamma^2\dot{y}^2/2\sigma^2)\exp(i(2\pi\ \frac{\acute{\gamma}}{\lambda}\ \psi)) \qquad (1)$$

What does the meaning of these ingredients imply? , According to the theta, we can evaluate the filter in any direction, so in one filter one can get a million filters despite the existence of a million filters[1].

2.1.2 K-mean Clustering Algorithm :

K-means clustering is a system for clustering data that is not hierarchical. There are more clusters / groups than methods for classifying data into one or more clusters. The info that are almost the same[2].

$$d_{ij} = \sqrt{\sum_{k=1}^{p}\{x_{ik} - x_{jk}\}} \qquad (2)$$

Formula :

d_{ij} : Distance Object of Between i and j.
P : Dimension of Data.
X_{ik} : Coordinate of Object i on Dimension k.
X_{jk} : Coordinate of Object j on Dimension k.

There are several approaches in the construction ofclustering technologies that connect multiple options In image grouping, K-Means Clustering groups each cooled pixel that is included in the Cluster parameter, for researchers who need methods based on dataset clustering.

- Determine the value of K (k = number of groups) first.
- Identifying the group's middle random value.
- Using Euclidean distance, calculate the matrix's distance.
- Shift the group's center.
- Repeat steps 3–5 before no shift occurs.

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In end Through this process, we get two images, a front image and a background image. The data of the front image is used as a key for the encryption and decryption process. As shown in the Figure 4.

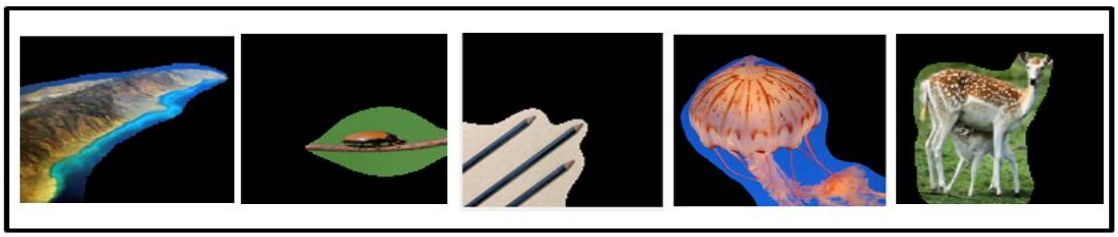

Figure 4: The private key for encryption and decryption

2.2 **International Data Encryption Algorithm (IDEA)**

Xuejia Lai and James Massey created the International Data Encryption Algorithm (IDEA) in 1990 [1]. It is a block cipher. The size of the key is commonly used as a measure of an encryption algorithm's strength. IDEA is faster than the Data Encryption Standard, despite its 128-bit encryption level (DES). XOR, addition modulo 216, and multiplication modulo 216 + 1 operations are the three basic operations. The IDEA method employs a 128-bit key, as previously stated. To encrypt or decrypt a 64-bit data block.[15].

Sub key creation, round operation, and output transformation are the three phases that make up IDEA's operations. The 128-bit key is separated into a set of eight sub keys in the sub key generation step, as indicated in the key generation process: k1, k2, k3, 1(4, k5, k6, k7, and k3. The 128-bit key is then shifted 25 bits to the left and subdivided into eight 16-bit sub keys. This operation is done eight times to obtain a total of 52 sub keys for encryption. [17].

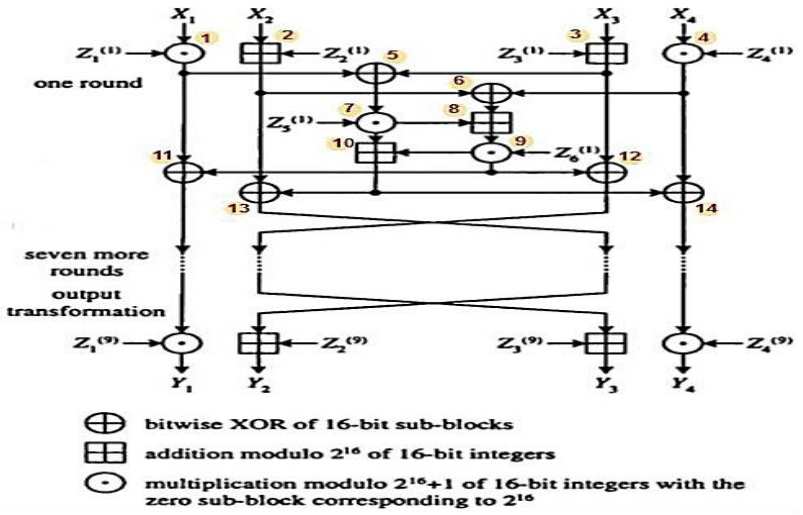

Figure 5 : IDEA General Structure[17].

Figure 5 depicts the steps of the IDEA encryption algorithm. Round divides the 64-bit input data block into four 16-bit vectors, P1, P2, P3, and P4. These vectors will be processed via eight rounds in order to yield four 16-bit output vectors. Each round produces four vectors: Si 1, 512, 513, and 514. Each cycle of the IDEA algorithm's operations can be summarized as follows:[16].

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For j = 1 to 8
S1 = P_1 * K_1
S2 = P_2 + K_2
S3 = P_3 + K_3
S4 = P_4 * K_4
S5 = S1 ⊕ S3
S6 = S2 ⊕ S4
S7 = S5 * K_5
S8 = S6 + S7
S9 = S8 * K_6
S10 = S7 + S9
S11 = S1 ⊕ S9
S12 = S3 ⊕ S9
S13 = S2 ⊕ S10
S14 = S4 ⊕ S10

Vectors S 12 and Si 3 are switched after the operations of one round are completed and before Si 1, 512, 513, and 514 are introduced into the operations of the following round. As a result, the next round's input blocks are p1 =s1 1, p2 =512, p3 = 513, and p4 = 514. For the next seven rounds, the operations are repeated. After the eighth round, output transformation is applied to Si 1, 512, 513, and 514, resulting in four outputs: ci, c2, c3, and c4.

c1=sil *k1 , c2=si2+k2 ,c3=513+k3 , c4=514*k4

To generate 64-bit ciphertext, the four sub-blocks cl, c2, c3, and c4 are finally connected. The IDEA algorithm was created with the goal of making decryption as simple as encryption. Subkeys, on the other hand, are implemented in the opposite order and in a slightly different way.

2.2.1 Encryption Process

In the first step of the image encryption process, the digital image is divided into block. The size of block is 64 bit,with the key generated in the previous process and then the encryption algorithm is applied in loop, the result is an incomprehensible encrypted image. As shown in the Figure 6:

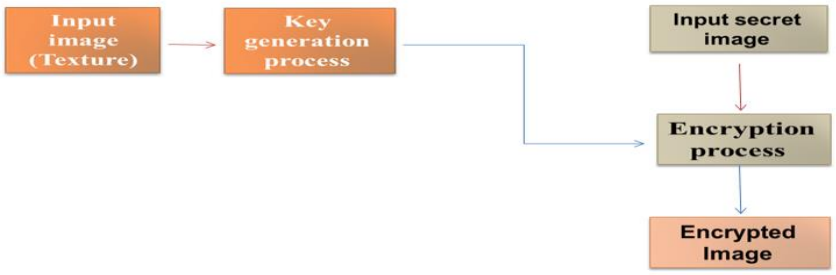

Figure 6 : encryption process steps .

2.2.2 Decryption Process

In the second step the encrypted image isdivided into block. The size of block is 64 bit entered with the key generated in the previous process and then the decryption algorithm is applied, the output being a retrieved image (the secret image). As shown in the Figure 7:

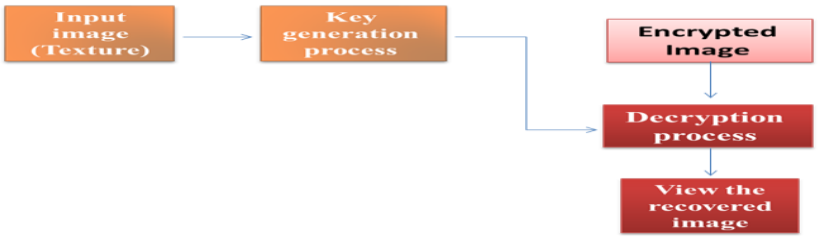

Figure 7: decryption process step

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3. **Result and discussion**
   Standards and algorithms for key generation, encryption and decryption were implemented using Matlab R2020B software. We used 5 images of the generation key ,we get two images, a front image and a background image. The foreground image data is used as the key to the encryption and decryption process. As shown in Figure 8.

and 5 images of the encryption and decryption process, as shown in Figure 9.

For example, we apply the images as they appear in the stroke of the figure. In the encryption process, the process of entering the texture image (key 1,key 2) of size (256-256) and then generating the key by applying the key generation algorithm, and entering the secret image (Lena, Peppers) of size (128128) to be encrypted and applying the encryption algorithm after applying the encryption algorithm The encoded image was obtained and the PSNR good result was (8.8055,8.1966) as shown in Figure 11,as shown in Table 1.

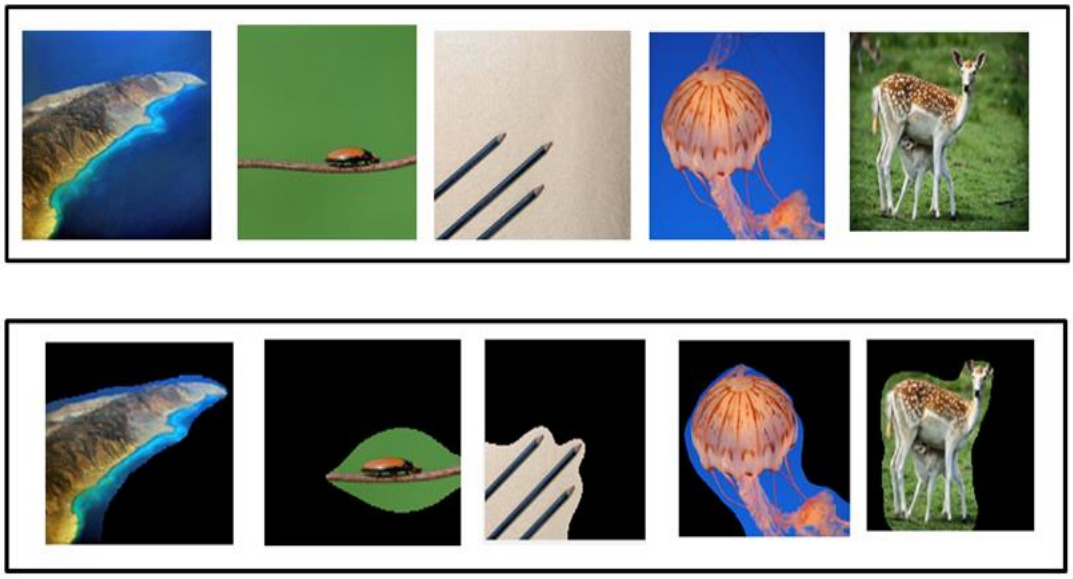

Figure 8 : The private key for encryption and decryption

Figure 9 . secret image

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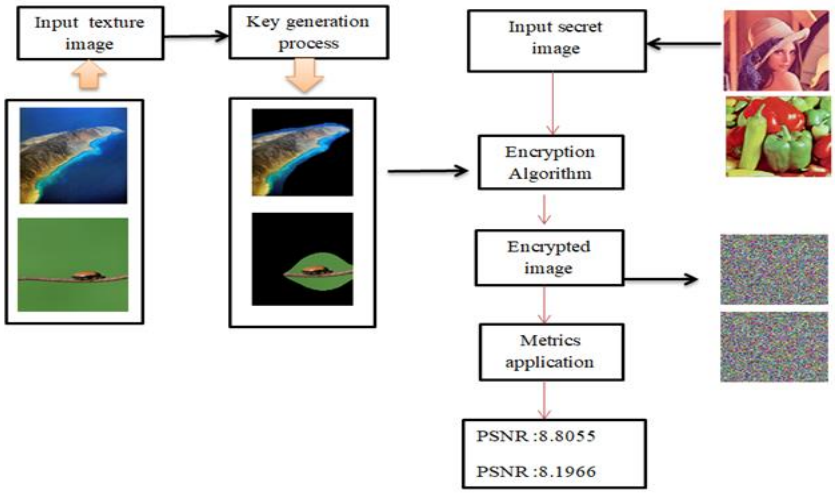

Figure 10 : Implement Encryption Algorithm

In the decryption process, the process of entering the texture image (a)of size (256 256) and then generating the key is done by applying the algorithm for generating the key, entering the encrypted image of size (128 128) to be decrypted and applying the decryption algorithm after applying the decryption algorithm , the recovered original images was obtained and the best and result of the CORR2 (0.9994,1) , was as shown in Figure 12,as shown in Table 1.

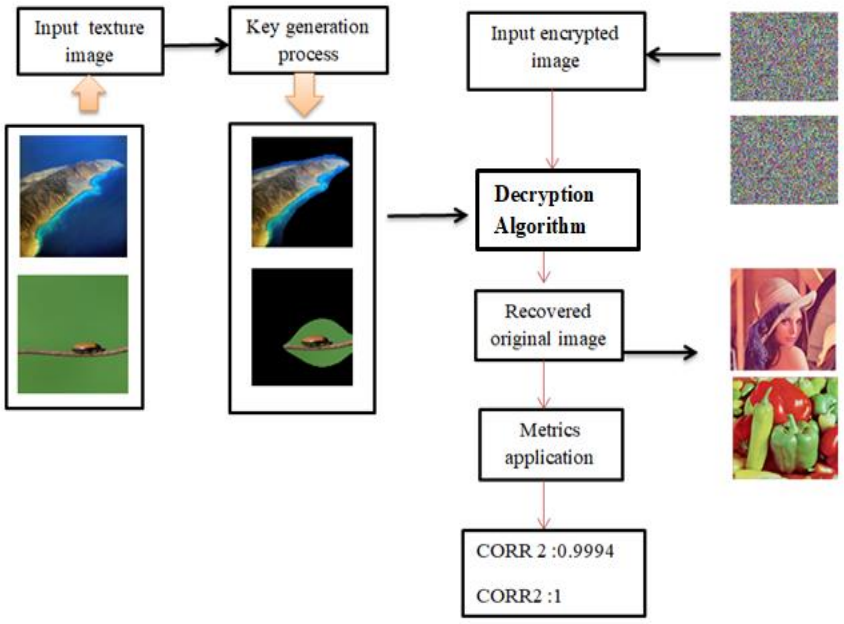

Figure 11. Implement Decryption Algorithm

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Table 1. Summarizing the result of objective evaluation (PSNR)for encryption process and ((correlation(CORR)for decryption process segmentation.

Used Key	Encrypted Image	Objective evaluation for encryption process			Objective evaluation for decryption process			
		PSNR	SSIM	MSE	PSNR	SSIM	MSE	CORR
Key 1	'pepper.png'	8.2284	0.0132	9.7777e+03	Inf	1	0	1
	'lena.jpg'	8.8055	0.0266	8.5611e+03	42.5577	0.9991	3.6084	0.9994
	'pencil.jpg'	6.9902	0.0052	1.3004e+04	Inf	1	0	1
	'Motor.jpg'	6.2470	0.0096	1.5430e+04	Inf	1	0	1
	'hand.jpg'	7.6772	0.0012	1.1101e+04	Inf	1	0	1
Used Key	Encrypted Image	Objective evaluation for encryption process			Objective evaluation for decryption process			
		PSNR	SSIM	MSE	PSNR	SSIM	MSE	CORR
Key 2	'pepper.png'	8.1966	0.0097	9.8495e+03	Inf	1	0	1
	'lena.jpg'	8.7205	0.0065	8.7303e+03	Inf	1	0	1
	'pencil.jpg'	7.0182	0.0142	1.2920e+04	Inf	1	0	1
	'Motor.jpg'	6.2966	0.0072	1.5255e+04	36.3364	0.9884	15.1160	0.9991
	'hand.jpg'	7.6410	0.0031	1.1194e+04	Inf	1	0	1
Used Key	Encrypted Image	Objective evaluation for encryption process			Objective evaluation for decryption process			
		PSNR	SSIM	MSE	PSNR	SSIM	MSE	CORR
Key 3	'pepper.png'	8.2338	0.0074	9.7656e+03	38.1046	0.9986	10.0606	0.9988
	'lena.jpg'	8.7120	0.0049	8.7474e+03	Inf	1	0	1
	'pencil.jpg'	7.0218	0.0089	1.2909e+04	Inf	1	0	1
	'Motor.jpg'	6.3094	0.0101	1.5210e+04	Inf	1	0	1
	'hand.jpg'	7.6150	0.0076	1.1261e+04	37.5492	0.9967	11.4329	0.9978
Used Key	Encrypted Image	Objective evaluation for encryption process			Objective evaluation for decryption process			
		PSNR	SSIM	MSE	PSNR	SSIM	MSE	CORR
Key 4	'pepper.png'	8.2065	0.0089	9.8273e+03	Inf	1	0	1
	'lena.jpg'	8.6388	-0.0053	8.8962e+03	Inf	1	0	1
	'pencil.jpg'	6.9978	0.0095	1.2981e+04	35.1523	0.9992	19.8542	0.9977
	'Motor.jpg'	6.1727	-0.0066	1.5697e+04	Inf	1	0	1
	'hand.jpg'	7.6537	0.0098	1.1161e+04	Inf	1	0	1
Used Key	Encrypted Image	Objective evaluation for encryption process			Objective evaluation for decryption process			
		PSNR	SSIM	MSE	PSNR	SSIM	MSE	CORR
Key 5	'pepper.png'	8.2640	0.0136	9.6979e+03	Inf	1	0	1
	'lena.jpg'	8.7297	0.0114	8.7118e+03	Inf	1	0	1
	'pencil.jpg'	7.0234	-0.0012	1.2905e+04	Inf	1	0	1
	'Motor.jpg'	6.3296	-0.0022	1.5140e+04	38.3730	0.9956	9.4576	0.9994

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	'hand.jpg'	7.6899	0.0115	1.1069e+04	Inf	1	0	1

4. Conclusion

Several techniques have been used to perform texture segmentation using a combination of K-means clustering and the Gabor filter method .In the proposed works, an algorithm was developed that relied on the K-mean and Gabor filter rules to detect texture from the image. The K-mean algorithm consists of two key steps that are set by one and refreshed by the other. The clustering is first done using this and we switch to next technique called a Gabor filter, in which we follow four steps to achieve the result.. 1-Bank filter design, 2-Extraction of Features,3- Smoothing Spatial,4-Clustering the feature space. We propose and describe a new design and initial implementation of a more secure encryption algorithm using symmetric key block cipher (International Data Encryption Algorithm). In this paper, we present the applications of IDEA algorithms for image coding based on classification algorithm, where software simulation results showed that cipher images are not understood. And the algorithm achieved its results. We also introduced texture feature segmentation using the Gabor filter and the K-mean clustering algorithm system, which is used to generate a key and use it in the encryption and decryption process, improving the throughput of the color image coding system. Software simulation results show that the encoded image is not well understood. And the algorithm achieved its result.

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