A Survey of Image Compression Techniques in an Agriculture Field

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Abstract

Image processing plays a significant role in the field of an agriculture. Because for the detection of unwanted growth of crops and its health monitoring. Image Encryption and Compression techniques are utilized to achieve the better reconstructed image. Generally, remote sensing equipment is utilized in the broadcast of images that are captured in the agriculture field. During transmission, image size and bandwidth are the main issue which requires huge storage space and large bandwidth for the transmission. Hence, it is obligatory to compress the image before transmission. Various compression and Encryption methodologies are used so far. But there are some limitations of the existing techniques like high encryption time and the quality of reconstructed image will be affected. Therefore, to overwhelm this limitations a novel Homomorphic Encryption algorithm (NHE) for encryption process and an Enhanced Discrete Wavelet Transform (EDWT) for compression procedure (NHE-EDWT) is proposed. The Image is encrypted, compressed, decompressed, and finally decrypted to get the resultant image.

Index Terms— *Novel Homomorphic Encryption, Enhanced DWT, Compression, Remote sensing, Mean Squared Error (MSE), PSNR*

I. INTRODUCTION

Many peoples in India are depending on the agriculture sector. Therefore, some developments in this field will be an encouraging one. The multimedia is having some profits than the classical tools of media like word and audio as it consists of more information on comparing the classical media which can be anticipated clearly and visually.

Image processing methods are utilized [1] to enhance the practice of agriculture on improving the consistency and accuracy of the procedure by decreasing the manual monitoring of the farmer's crop land. There exists an advanced techniques that are offered for the reason of enhancing the farm output which leads to profitable and an environmentally sensible manner.

In agriculture field, the technique of Remote Sensing is utilized for analyzing the crop land. The remote [2] sensing image is considered as the important carrier of remote sensing information. The images that are captured will be stored and transmitted which requires a huge storage space and bandwidth if the captured image is not compressed. Hence, the compression system is important for reducing the storage space and bandwidth size during transmission.

There are some image encoding approaches like Huffman coding, wavelet image coding, and Discrete Cosine transform. However, the encryption method should be included for enhancing the quality of coded image. The fractal coding of image is an [3] effective method of compressing an image due to its high ratio of compression. Generally, the information regarding crop is captured by the sensors in which there is a requirement of small size of the object as much enough for transmission. But, basically the main concern of image is its huge size that is difficult to transmit and store. For this purpose, the method of image compression and encoding must be introduced for decreasing the size of object without affecting its quality.

The following difficulties are identified in the existing methodologies:

- The reconstruction of the compressed image.
- The complexity of the encoding process.

In this proposed work, to overwhelm the issue of fractal compression, a NHE procedure is introduced for encoding the image. An enhanced DWT approach is applied for compression. The image is then de-compressed and decrypted to attain the resultant image. The foremost intentions of this approach are as follows:

- To perform noise removal for preprocessing step.
- To compress the preprocessed image.
- To analyze the enactment of the proposed system.
- To diminish the execution time of the encoding process thereby reducing the complexity

- To retain the compressed image by encrypting and decrypting without affecting its original quality

The remaining portion of this paper is schematized as follows: Section II demonstrates the related works associated to the several image compression and encoding methods in image processing. Section III illuminates about the proposed NHE - EDWT methodology for image retrieval and classification. Section IV exhibits the performance study of the projected mechanism and in conclusion, Section V concludes the proposed work.

II. RELATED WORKS

This section describes the literature analysis of image processing in the field of agriculture. The fractal encoding method depending on the statistical loss that was utilized in the agricultural field by image compression was presented. In recent [4] days, several images of the cropland were snapped and transmitted by the wireless sensors at the agricultural automation. But, in this case, only the high-quality images are needed for the needs of recognition having small sizes. The fractal encoding process with the compression has ensued in this work and to identify the distributional loss value, the box-plot was created. After that, it has been separated and mapped the benefit of this method was its high compression ratio. This work needs some modification regarding microcosmic rule and also the encoding time must be enhanced. A new improved fast fractal image compression procedure was offered by [5] decreasing the encoding process time over manipulating the domain pool decline approach similarly with the support of predefined inventive values. The procedure was being verified and the consequences were related with the state-of-art mechanism. The significance [6] of the image compression at the plant phenotyping presentations was described. The main use of this methodology was the high output values. The detection and classification [7] of plant infection at the image processing was stated in which the heterogeneous plant disease that was feasible with their distinct methodologies were stated. This work involves the image de-noising, image cropping, and image compression with k-means clustering mechanism so as to articulate the images of disease. Various such disease can be found using the approach of fuzzy logic, MSVM and LBP (local binary pattern). This work offers an explanation regarding all the diseases of plant and their identification methods. However, this work needs improvement by combining two or more methods that might be utilized in the detection of disease in plants.

The application [8] of image processing for the resolution of grading some agriculture products was presented and discussed. The grading of numerous things was performed by the classification and the neural network mechanisms. Moreover, the ranking and sorting systems permit the maintenance of consistency, depletion time, and uniformity. On comparing the features from one category, the usage of different combination of categories will be helpful in case of classification outcome. Furthermore, the accuracy and optimization of the grading methods must be enhanced with the use of some methods that were meant for grading.

A new comparative [9] case study was performed on the comparison algorithm for the remote sensing images. The comparative study was stated over various algorithms for remote sensing and satellite images. The broadcast of remote sensing images that were recorded to the ground along with the efficient algorithm for compression was mystified. An analysis was made for the image compression procedure with [10] the usage of DCT, DWT, and DFT transforms. Image compression was the reduction of graphics file size without affecting its quality. Simultaneously, the need of storage space was also reduced, cost of transmission and the time needed for the transfer must be reduced. The reduction of irrelevancy and redundancy presented in the image must be reduced which was the foremost intention of this image compression technique. For, high compression ratio the Lossy compression is utilized and to attain the identical image of the reconstructed and original image the lossless compression was utilized.

A method of image de-noising depending [11] on the wavelet transform was structured in the detection of seabed data collection process. The better outcomes were attained by energy got from the de-noised image processing approach. In this, the compression might be conceded out at several ways of transform. However, the effects of edges might cause the image to be cropped slightly. The fractal encoding scheme [12] was used because of its small decompressing time and a high ratio of compression. But, there exists some high computational complexity and subsequent extensive compression time. The image de-noising technique depending on the 2-D wavelet transform was utilized in the agricultural collection of data system. So as to swap the original [13] signal with the low-frequency smooth signals the details of the signal were obtained from the study of multi-scale de-noising of the images that were collected. The image with a lot of noise could be eliminated by this de-noising method. Also, the threshold of the noise was reduced by this method of wavelet transform.

An innovative survey was made regarding the image processing which was [14] the most challenging area in the arena of communication. The multi media images without applying compression may require large storage space and bandwidth for transmission. Hence, the compression of image was the essential factor for saving the time of transmission and storage space. The different compression procedures were surveyed for compressing the image without affecting its quality. On this analysis it has been revealed that the existing methods were having some limitations like decompression was slow, complexity of space and time memory requirement was high and so on.

The fractal compression of image utilizes [15] the possessions of rehearsed functions for the persistence of encoding it. This approach was of important owing to its high ratio of compression. However, there were some limitations of the fractal compression of image like retrieved images were of poor quality, and the computational cost for compression was high. Hence, to overwhelm this a mechanism of pollination based optimization was introduced for categorizing the satellite, rural image set and phantom. The encoding was reduced by the usage of this pollination centered optimization method by extracting the image with high quality. However, further enhancement of this approach could be made by using any algorithms in optimization and this should be capable of applying in the medical image such as MRI, CT scan and so on.

A novel [16] study was made on the algorithm of flower pollination with its application which was regarded as the recently enhanced nature stimulated algorithm that was depending on the self-pollination process of the plant. The constrained and unconstrained optimization problem was resolved with the support of this algorithm. It was easy to alter the robustness and requirements, also it was benefit in terms of the enhanced speed of processing. The benefit of this method was its simplicity, better to resolve the optimization technique, and flexibility. This should be improved by the solicitation of this approach in medical image processing field.
Image segmentation [17] is the most significant part in the field of agriculture for segmenting the image. The fuzzy means algorithm was utilized for recognizing the location of affected area of the plant. The images were segmented and the marker controlled image watershed mechanism was applied which yields a better outcome and a good convergence rate. But, the limitation of this approach was the optimization techniques were not analyzed depending on the performance measures and the estimation must be prolonged to an extensive variety of application.
The review [18] was made for the identification of plant disease by the technique of image processing. The information regarding the health of crop and detection of disease could be assessed earlier by some strategies of management. Several classification techniques for the categorizing of plant disease was overviewed by some transformation methods. Moreover, there were some limitation of this approach like optimization method for a specific plant data, effect on background resultant image, automatic monitoring of the plant disease must be enhanced.

III. PROPOSED WORK

This section deliberates the proposed technique of image encryption and compression in which the input crop land images are encrypted by utilizing a NHE algorithm. This Homomorphic Encryption is the type of Encryption which permits the computation on cipher texts by generating the encrypted results. After that, an EDWT is applied for the method of compression.

At the receiver side, the reversal process is performed to enhance the quality of the image. The decryption and decompression technique should be performed for which the performance measures will be dignified in terms of PSNR, Compression Ratio, and Execution Time.

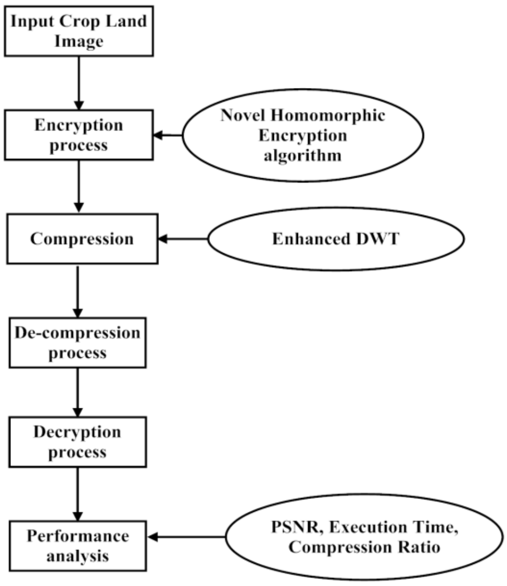


Figure 1 Flow of the proposed system

A. Novel homomorphic encryption :

In this proposed work a NHE algorithm is used in which each pixels of an image are encrypted which allows the computation of cipher texts on generating the encrypted results, finally after compression and de-compression the decryption method is performed and the subsequent image is attained.
The image undergoes encryption process by the following procedure.

Algorithm:

Image Encryption Algorithm:
Input: Input Agricultural Image (IAi)

Output: Encrypted Image (IAE)

Procedure:

Step 1: Let IAi be the Input image which has to be encrypted.
Step 2: Then the Size of the image be [x, y, z]
Where x and y denote the width and the height
Z will be the number of bands in the image.
Step 3: Now for encryption, the key has to be generated,
The key generated as follows:
n← x*y*8
Where n represents the initial seed for key generation
Step 4: For idxI=2 to n
Step 5: Compute xn=1-2*rx(n-1)*rx(n-1)
Where,
rx is the random initialized minimum values.
Step 6: Update rx using the below equation
rx(idxI-1) = {1 if (xn>0) xn Other Wise
End for idxI
Step 7: Now, Generating key with the computed rxidx
For idxi=1 to n/8
For idxj=1 to 8
Keyidxi=Keyidxi+(rx(idxi*idxj)*2)idxj-1
End for idxj
End for idxi
Step 8: Now Encrypt the Image based on the below procedure:
For Y =1 to y
KgE= Key(1+Y-1*x,(Y-1*x)+x)
End for Y
Step 9: When m is the length of the IAi
And n is the breadth of the IAi
Then the Encrypted image IAE= IAi(m, n) ⊗ KgE(m, n)

B. Discrete Wavelet Transform:

In this proposed method the image can discrete the samples of image and offers temporal resolution. DWT plans high-detail image constituents on smaller basis roles with advanced firmness, though minor detail constituents are anticipated onto superior basis purposes, which resembles to contracted sub-bands. However, at the side of receiver the reverse process is taken place for enhancing the quality of image.

Algorithm:

Compression of the Encrypted Image:
Input: Encrypted Image (IAE)
Output: Compressed Image (IACM)

Procedure:

Step 1: Convert the Encrypted Image IAE to a Illuminance and Chrominance (IAYcbr) Image
Step 2: Let N be the number of bands present in the input Image
Step 3: For I = 1 to N
Step 4: The Discrete Wavelet transform function is applied to the image by using the below equation,
Step 5: Fx,y=-∞f(m). x,ym dx
Where,
f(m) is the pixels in the IAYcbr image.
Step 6: Check the condition below for the computed DWT,
And x,y should satisfy the following condition like,
-∞x,y dt=0 and -∞|x,y|2 dt=0
Step 7: The computed output of the discrete wavelet transformations are an approximation coefficient matrix (LLCM) and three details coefficient matrices like LHCm,HLCm and HHCm))
Step 8*:* Lcoff(x)= 1M xfx*φx
Step 9*:* Hcoff(x)= 1M xfx* ψx
Step 10*:* LLcoff(x)= 1M xLcoffx* φ x
Step 11*:* LHcoff(x)= 1M xLcoff x* ψx
Step 12*:* HLcoff(x)= 1M xHcoff x*φx
Step 13*:* HHcoff(x)= 1M xHcoffx* ψx
Step 14*:* φ x= {1 0≤x<1 0 else
Step 15*:* x= {1 0≤x<1/2 -1 1/2≤x<1 0 else
Where,
x-pixel location , LLcoff-Appraoximate Coefficient ,LHcoff-Detail Coefficient1 ,HLcoff-Detail Coefficient2 ,HHcoff-Detail Coefficient3 ,M – length of the image ,fx-Image Pixels , φ x-Scalling Coefficient , x-Wavelet Coefficient
Step 16: Generate and compute sub- bands of the approximation matrix (LLCM)
Step 17: End for I
Step 18: Recursively compute the discrete wavelet transform (DWT) function for the approximation matrix by repeating the steps from 3 to 17 for 3 levels as, LL2CM and LL3CM
Step 19: compute the Maximum of the 3rd level of approximation matrix by
ML←Max (LL3CM)* fc where fc is the 1% of the Maximum Value of the ML
Step 20: Now compute the Compute the DCT II (Discrete cosine Transform) of LL3CM with the computed quotient value
Step 21: The DCT -II is implemented based on the below equation;
DIIk=n=0 N-1LL3CMcos Nk+12*n , where K is the size of LL3CM
Step 22: compute the DCT-IV of the LL3CM by applying the below equation
DIVk=n=0 N-1LL3CMcos N n+12 k+12 , where K is the size of LL3CM

Step 23: Then eliminate zeros from the extracted HL, LH, and HH matrix for the second and third level of the coefficient matrices.

Step 24: Except the Low Frequency, for all the other high frequency bands compute the Arithmetic Encoding for all the 2^{nd} and the 3^{rd} level sub- bands using the below steps:

Step 25: compute the Probability (Pbk) and the Cumulative Probability (CPbk) between the sub bands intervals

Step 26: Compute the Limits on the Low and high frequency range to apply the arithmetic coding based on the formulas

Lmk=CPb1+x=2NCPbi* y=1x-1Pbj+r

Where r is the range between 0 < r < y=1NPbj

Step 27: Scale and update the new limit values.

IV. PERFORMANCE ANALYSIS

This section provides the performance analysis and comparative analysis of the proposed and existing system.

A. *Performance Metrics:*

1) MSE:

MSE and PSNR are the two computation metrics of error that are utilized for the calculation of squared error among the original and compressed image. The mean squared error can be illustrated as follows:

MSE=M,Nl1m,n-l2(m,n)2M*N (1)

2) PSNR:

The PSNR is the computation of peak signal to noise ratio between two images. For the image having PSNR vale high, then the compressed or reconstructed image quality is better. This ratio is used as a quality measure among the compressed and original image. It is the representation of peak error measure. The PSNR ratio can be depicted as follows:

PSNR=10log10R2MSE (2)

3) SNR:

It is defined as the ratio of power signal to the power of noise of the image. It is provided as the ratio of mean value of the signal and the standard deviation of the noise in that image.

4) Encrypting Time:

The time taken to encode the image during broadcast is known as the encryption time. The Encoding time of the image must be reduced to increase the efficacy of transmission.

(a) Input Image

(b) Encrypted Image

The input image is encrypted after that the encoded image will be decrypted. The compression and decompression are taken and then the decryption process is carried out. Finally we get a decrypted output image as provided below.

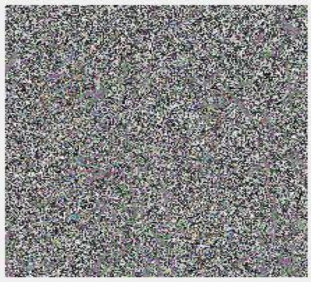
(c) Decrypted Image

5) Compression Ratio:

The Compression Ratio is the ratio among the compressed image and the actual image. The compressed ratio can be defined as follows:

$$\text{Compression Ratio} = \frac{\text{original size of image}}{\text{compressed size of the image}}$$

(3)



(a) Decompressed image

B. *Performance Analysis:*

The PSNR value, compression ratio and the encoding time for the input images of the proposed system is provided in the table 1. The PSNR value ranges from 30.8938 for the image 1, 30.4594 for the image 2, for image 3 it is 31.0126, and 31.5156 for image 4. Similarly, the Compression ratio ranges from 63.2436, 63.2584. 64.9479, 62.9904 for four images.

Table 1 performance study of the proposed system

Images	PSNR	Compress Ratio
Im1	30.8938	63.2436
Im2	30.4594	63.2584
Im3	31.0126	64.9479
Im4	31.5156	62.9904

Figure 2 Performance analysis of the proposed system (NHE-EDWT)

The figure depicts the performance analysis of the proposed system. The value of PSNR and Compression ratio is performed for the input images. The x-axis is the representation of images and y-axis is the representation of ratio in percentage.

Table 2 Encoding Time of the Input Images

Input Images	Encoding Time
Im1	6.69
Im2	6.54
Im3	6.3387
Im4	6.214

The table provides the result of encoding time of the input images. The figure provided here depicts the input image encoding time. The x-axis is the representation of Input Images provided and y-axis is the representation of encoding time. In the proposed system the encoding time is reduced on comparing the other existing methodologies.

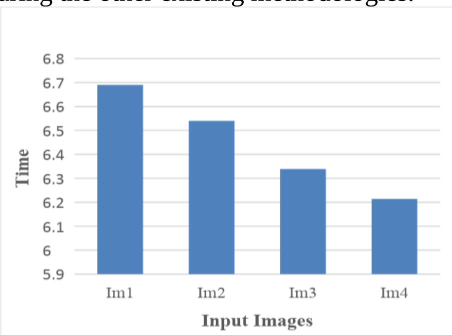


Figure 3 Encoding Time of the Input Images.

Table 3 provides the SNR and MSE values of the proposed system for the provided input images. Four input images are provided and the signal to noise ratio and mean squared error is computed. The results shows a better improvement over efficiency of the proposed system by reducing the error rate of the reconstructed image thereby reducing the noise.

Table 3 SNR and MSE value of the proposed system

Images	SNR	MSE
Im1	13.59	53.3452
Im2	12.72	58.957
Im3	13.83	51.9057
Im4	14.83	46.2291
Lena	12.7	59.11

This figure depicts the graphical representation of SNR and MSE values for the proposed system. The x-axis is the representation of Input Images and y-axis is the representation of ratio.

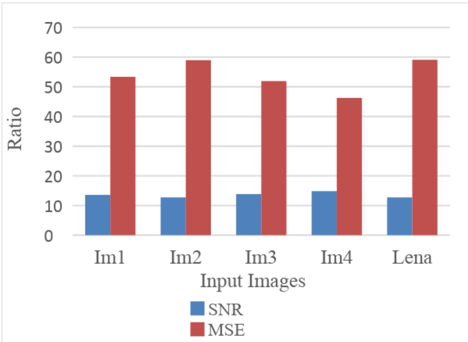


Figure 4 SNR and MSE values of the proposed system

The performance analysis of the proposed system is compared with that of the existing methods, classical methods and the comparative results are provided by computing the values of compression ratio, encoding time, and PSNR rate.

Table 4 Comparative Analysis of the proposed and existing systems

	Proposed Work (NHE-EDWT)			Shuai Liu et Al			Classic Method		
Input Images	PSNR	Encoding Time	Compress Ratio	PSNR	Encoding Time	Compress Ration	PSNR	Encoding Time	Compress Ration
Im1	30.8938	6.69	63.2436	27.31	10	13.7	26.24	65	10.1
Im2	30.4594	6.54	63.2584	24.93	10	13.7	24.14	65	10.1
Im3	31.0126	6.3387	64.9479	28.26	10	13.7	26.89	65	10.1
Im4	31.5156	6.214	62.9904	25.89	10	13.7	25.07	65	10.1

The comparative analysis of the proposed and existing methods are carried out for the values of PSNR, Encryption time, and Compression ratio. From, the results it is evident that the proposed method performs better than the existing methodologies.

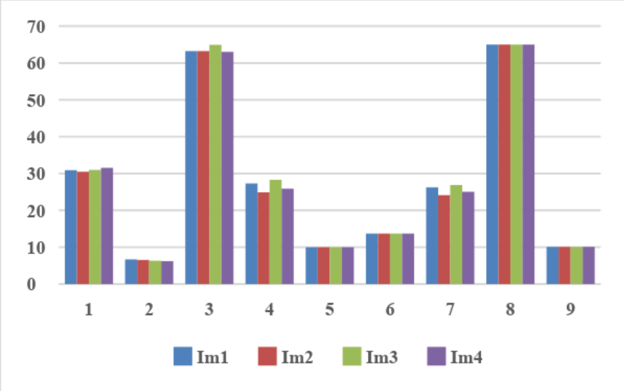


Figure 5 comparative analysis of proposed (NHE-EDWT), classical and existing methods

Table 5 Comparative Analysis of Lena

Performance Metrics	Classic Method	Shuai Liu et Al	Proposed
PSNR	24.92	27.45	30.4482
Encoding Time	61	9	3.973
Compression Ratio	10.1	12.8	63.39
SNR	9.2	10.5	12.6976
MSE	79.24	69.2	59.11

Table 5 provides the comparative analysis of the proposed, existing and classical methods by Lena. The performance measures are computed for PSNR, encoding time, Compression ratio. On analyzing this results, the proposed method provides a better and effective outcome.

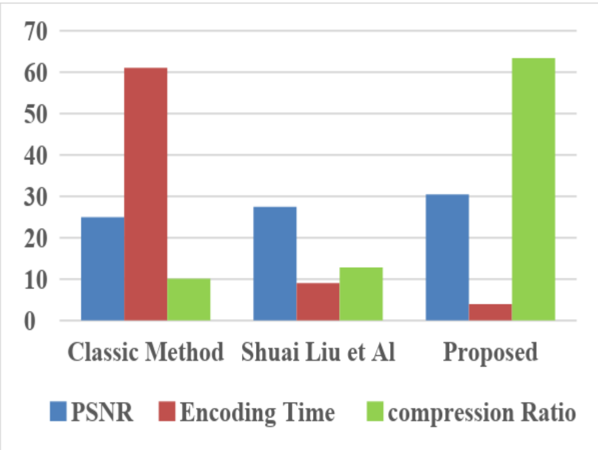


Figure 6 Comparative analysis of Lena for proposed, classical, and existing methods

V. CONCLUSION

In agricultural field, the crop field images were captured by the remote sensor for the identification of crop disease or unwanted growth of crops. During the transmission of this image, its size and bandwidth were the common issue which requires high bandwidth size and huge space for storage. To, overcome this Image encryption and Compression is applied to encrypt the image and reduce its size. A NHE-EDWT novel Homomorphic Encryption was proposed for the process of encryption which reduces the time of encryption, and an enhanced DWT was projected to improve the quality of reconstructed image. At the receiver side, the reverse process had been done to attain the resultant image. From, this it was shown that the proposed method performs well than existing methods by providing efficient values of PSNR, Compression ratio, and Encryption time.

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