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CODEBOOK OPTIMIZATION USING HYBRID IMAGE COMPRESSION MODELS

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***Abstract*—Compression primarily aims to reduce the number of bits needed to represent an image file while generally maintaining the original input quality to a significant extent. Image compression is among the essential compression topics. The primary objective of compression is to decrease the coverage of data requisite to represent an image. In initial contribution a fresh image compression model through the utilization of an adaptive Vector Quantization (VQ) method, which further incorporates the Linde Buzo Gray model for VQ. In this work codebook gets optimized to produce a better image compression outcome. To minimize the disparity in errors among the input and output images while simultaneously enhancing the compression ratio used VQ method along with modified Linde Buzo Gray (LBG) and DCT technique. In this research hybridized form of Slime Mold Algorithm and Genetic Mating Influenced Slime Mould (GMISM) is adopted. Based on the results, the proposed image compression method outperforms alternative approaches. Input image is partitioned into blocks, known as vectors and its codeword is elected. The encoder compresses the vectors and transmits to decoder. Then decoder translates the index to retrieve the vector. The proposed hybrid model is achieving superior PSNR, 84.76 for Text image, 87.92 for natural image, 86.82 for medical image, 92.34 for satellite and 72.43 for miscellaneous image. Result is compare with BFUROA and FPARA.**

***Index Terms*— Genetic Mating, Slime Mold, Vector Quantization, Linde Buzo Gray**

I. INTRODUCTION

Image compression is indeed a technology employed to save or transport images more effectively. It employs digital information compression strategies; this refers to the act of lowering the data size to convey a specific quantity of information. For example, a data set could comprise disused information that has minor significance or information that's also repeated in the gathering, which may be detected or eliminated (Abdula meer et al. 2022).

Image compression methods are classified as lossless and lossy. In some types of images, like those used in law or medicine, it is not allowable to lose data during compression. For images like video conferencing visuals, it's possible to tolerate minimal errors while preserving image quality, thus facilitating the enhancement of image compression. Similarly, compression strategies are not usually utilized individually; rather, lossy compression strategies utilize lossless compression methods to create superior compression(Mentzer et al. 2020). The fastest advancement in the digital field has given the scope for varied image processing applications. To make use of digital images capably, explicit techniques are necessary to reduce the count of bits neededfor their presentation. This aided in instant improvement in the field of Image Processing. This encouraged researcher to build codebook optimization techniques.

Compression focuses on dropping image size without losing the uniqueness and data in the real-time scenario. With this objective compressing the image, decreases redundancy in the image and increases the capacity of storage for well- organized communication. For a particular colour image, there is no requirement for massive storage space to accumulate the original data.

Since the count of images to be saved raises or imageries to be transferred raises, the whole storage needs turnout to be irresistible. Along with storage size, transmission bandwidth and transmission time for uncompressed images become more. Outcome is essential to set up image compression methods for compressing large files, so that the time taken for transmission will be minimized and more storage space can be saved.

Main contribution of paper is utilizing adaptive vector quantization as well as a modified rider optimization strategy,to develop a novel image compression model. To design an optimize codebook for image compression using GMISM.

II. RELATED WORK

Xiaoxiao Liu et al. (2022) provided a better lossless imagecompression technique by integrating the linear predictive model, integer wavelet transform (IWT) with performance coefficient processing, and Huffman coding. The key contribution of this approach was a novel hybrid transform that used a new prediction pattern and an IWT coefficient processing step factorization. A novel approach called integer DTT (iDTT) was provided effective lossless image compression. Several tests were run, and the results demonstrated that the suggested iDTT algorithm was not only more efficient than theiDCT approach but also consistent with the widely adopted JPEG standard.

Hernández et al. (2019) introduced the Mosaic Optimization (MO) technique for creating irreversible and reversible colour transformations that were concurrentlyoptimised for any WSI and the resulting optimization technique. Once the optimalcodebook gets fully constructed, each vectoris given an index utilizing the index valuefrom the index table. These index counts are delivered to the receiver via a channel. The decoder part also contains the index table, the optimal codebook that was built, as well as the rebuilt image and index table prepared. The codebook that is optimally formed at both the receiver as well as transmitter is the same. To make the size of compression algorithm. MO aims to achieve a the rebuilt image equal to that of the manageable level of computing complexityand enable continuous scanner operation.

Hochang Rahe et al. (2021) and Rhee et al.(2021) presented a novel approach based on Multilayer Perceptrons (MLPs) discovering ofimage pixels and contexts for lossless image compression. Similar to traditional lossless compression techniques, adaptive arithmetic encoders receive the misclassification rate and contexts provided by MLPs. For lossless compression, MLP- based prediction wasincluded with Convolution Neural Networks (CNNs).

III. OBJECTIVES

In this paper an image compression for transferring images is prepared, which analyze the qualities and limitation of image compression and efficiency. The research work proposes development of novel image compression algorithms hybridized form of Genetic Mating Influenced Slime Mould (GMISM). To investigate and validate the developed hybrid image compression model across various state of art models. For effective Vector quantization, the optimization-dependent KLBG is created. This study’s major goal is to decrease the error disparity connecting the input as well as output images by reducing the compression ratio. The goal function is described inequations (1) and (2), accordingly. The best input image corresponding code-words were assigned to the received index ratings.

IV METHODOLOGY

In this this paper, a Codebook is optimized by the utilization of the hybrid optimization approach termed Genetic Mating- Influenced Slime Mould (GMISM) to provide effective image compression.

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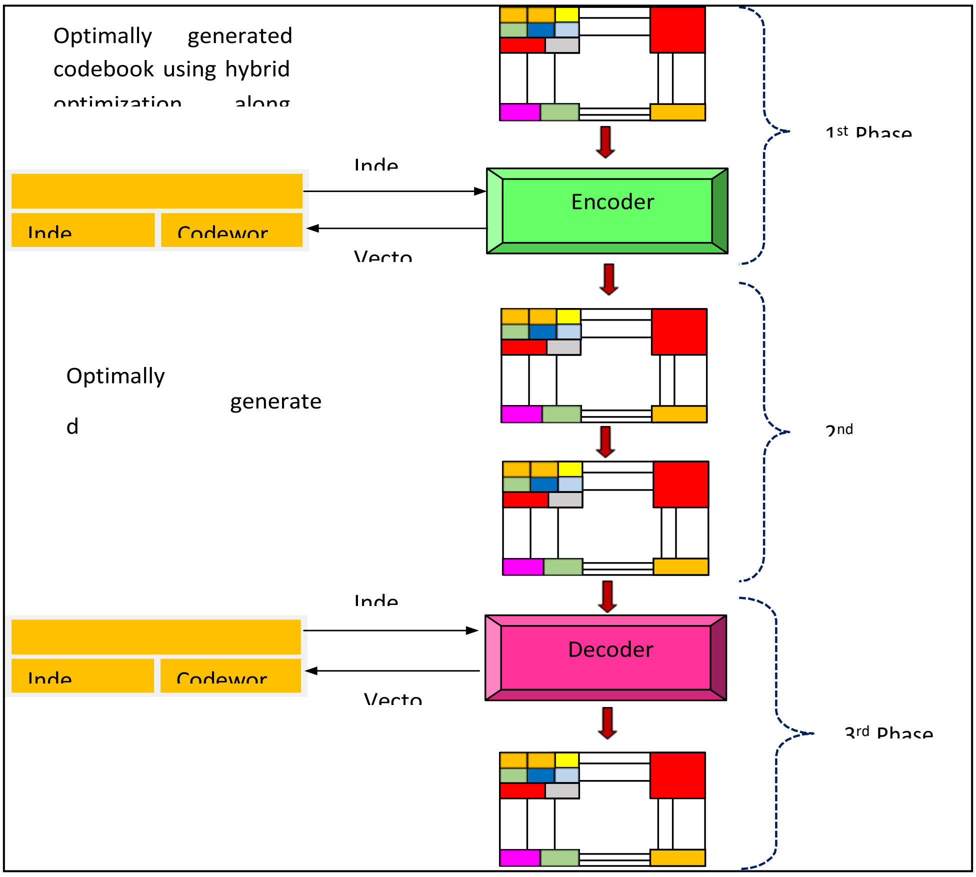

Fig. 1. Overall architecture of Hybrid imagecompression model

The Recent research on VQ has,however, uncovered several significant issues,such as edge integrity as well as codebook design efficiency. For effective Vectorquantization, the optimization-dependent KLBG is created. This study's major goal is to decrease the error disparity between theoriginal as well as decompressed images by reducing the as original image sizes, correspondingly. Vector quantization withcodebook generation is accomplished using optimization model.

The KLBG process for VQ:

Encoder, channel, as well as decoder are indeed the 3 main phases of the proposed KLBG process for VQ.

Phase1- Encoder

The image vector creation stage, the codebook creation stage, as well as the indexing stage make up the encoding portion of phase 1.

- Image vector generation: The input image is typically split into many simultaneous as well as non-overlapping blocks or vectors, and these are merged to form the image vector.
- Code Book generation: The key challenge in vector quantization is indeed the creation of an effective codebook. A collection of code words that have the equivalent size as a non-overlapping block has been contained in the codebook.

The prime objective of VQ would be to reproduce the vector utilizing a collection of reference vectors (Rk which implies dimensional space). Here, C j c1 , c2 ,...., ck stands for j th codeword ....while CB stands for the codebook containing reproduction codewords. The total count codeword CB is N . Additionally, the count of dimensions' k is for each codeword. A strategy is considered to be superior if the codebook it produces is competent.

Indexing stage:

Codebook is generated successfully, index number are taken from the index table and sent to the receiver.

- K-LBG-based optimal Codebook creation

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In this work, a novel hybrid optimization technique is employed to create the best codebook for VQ. For this, the GA as wellas SMA are conceptually merged. The GA is predicated on Charles Darwin's "survival of the fittest" hypothesis.

Furthermore, the oscillation behaviour of slime mould served as motivation for the formation of SMA. The resulting codebooks serve as the GMISM model's input. The positions in this work are these books that were created. The output from GMISM is the optimally generated codebook.

V DISCUSSION

GMISM model was executed in MATLAB. Texture Images has been taken and exposed as
Type 1: http://www-cvr.ai.uiuc.edu/ponce_grp/data/ Nature images, represented
Type 2: http://www.ultrasoundcases.info/case- list.aspx?cat=26, Medical Images, representedas
Type 3 : http://www-cvr.ai.uiuc.edu/ponce_grp/data/Satellite images,represented
Type 4: ,http://vismod.media.mit.edu/pub/VisTexand Miscellaneous image, represented
Type 5,https://sites.google.com/site/dctresearch/Home/content based image retrieval.
The assessment was done in terms of compression ratio and error measurements. Moreover, the original anddecompressed images for the 5 types are shownin Figure 2 to Figure 6. The PSNR analysis ofthe GMISM methodology of the five datasets,Texture, Nature, Medical, satellite and Miscellaneous is shown in Figure 2 to 6. Basedon the measure, the natural image type PSNR is84.76, for Text image, 87.92 for natural image, 86.82for medical image, 92.34 for satellite and 72.43 formiscellaneous image. Result is compare withtraditional methods. Hence, result proves theenhanced performance of the GMISM with abetter PSNR.

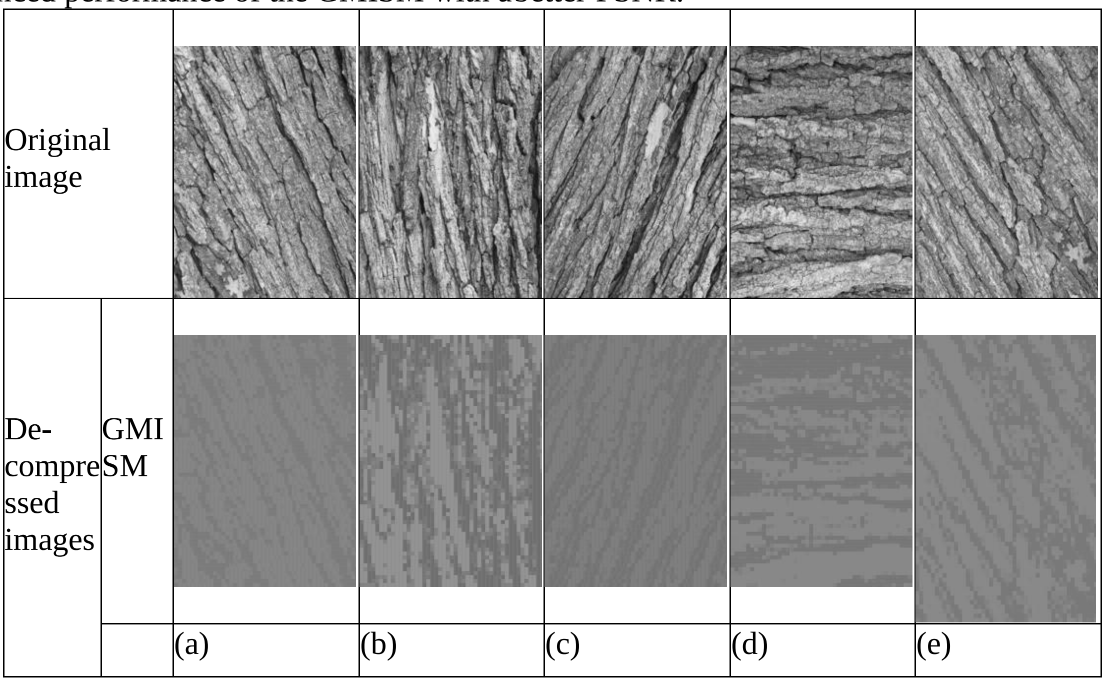

Figure 2 Sample images for original and decompressed texture images

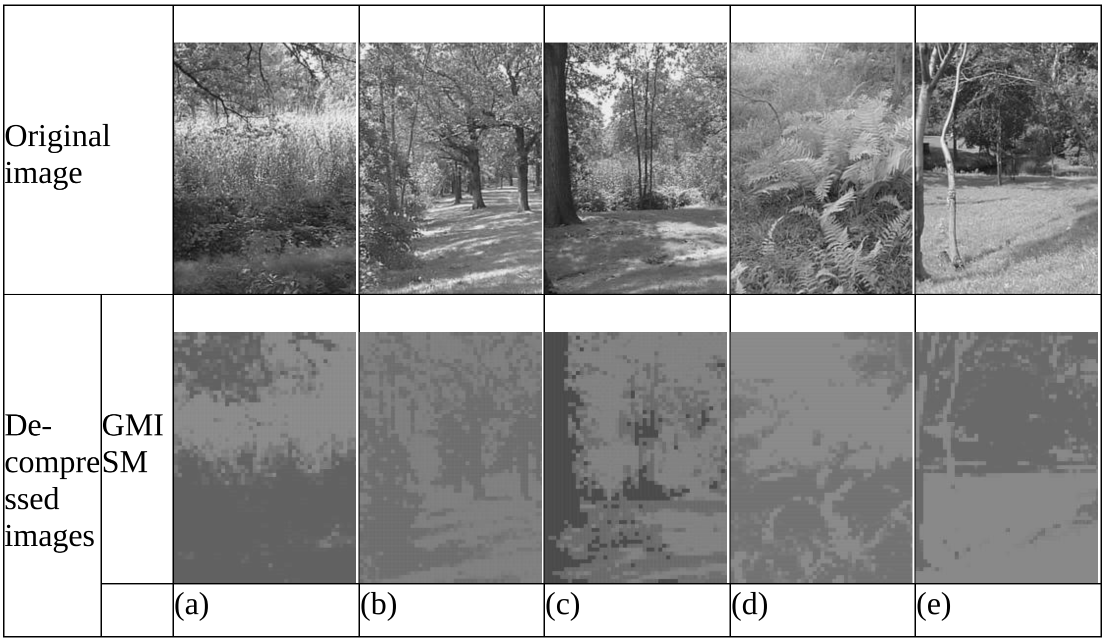

Figure 3 Sample images for original and decompressed nature images

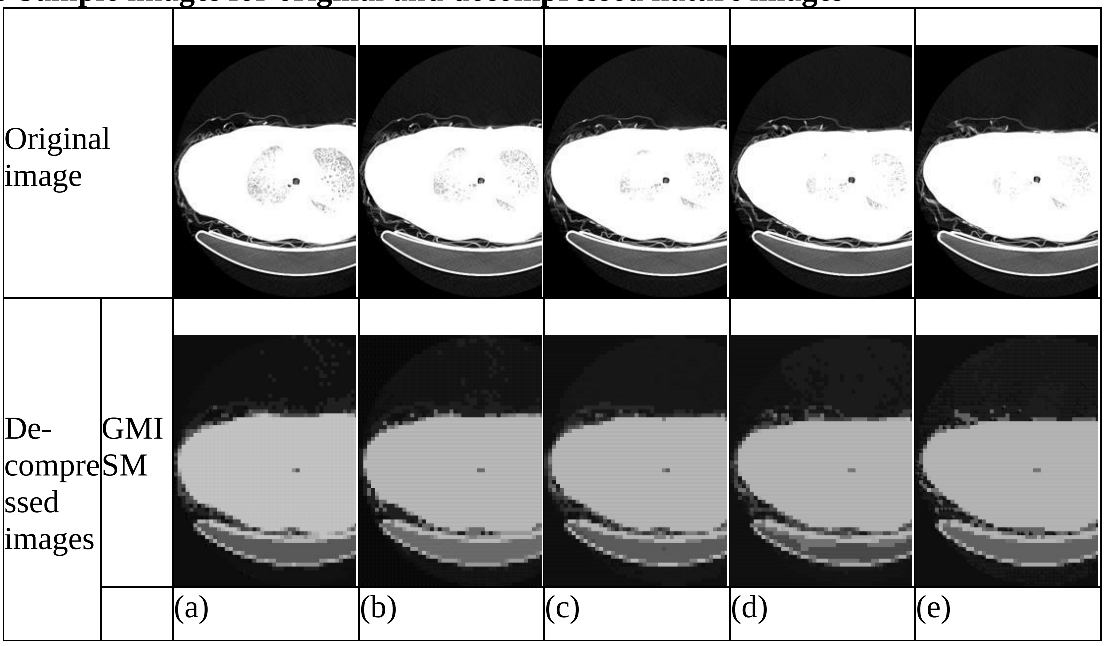

Figure 4 Sample images for original and decompressed Medical images

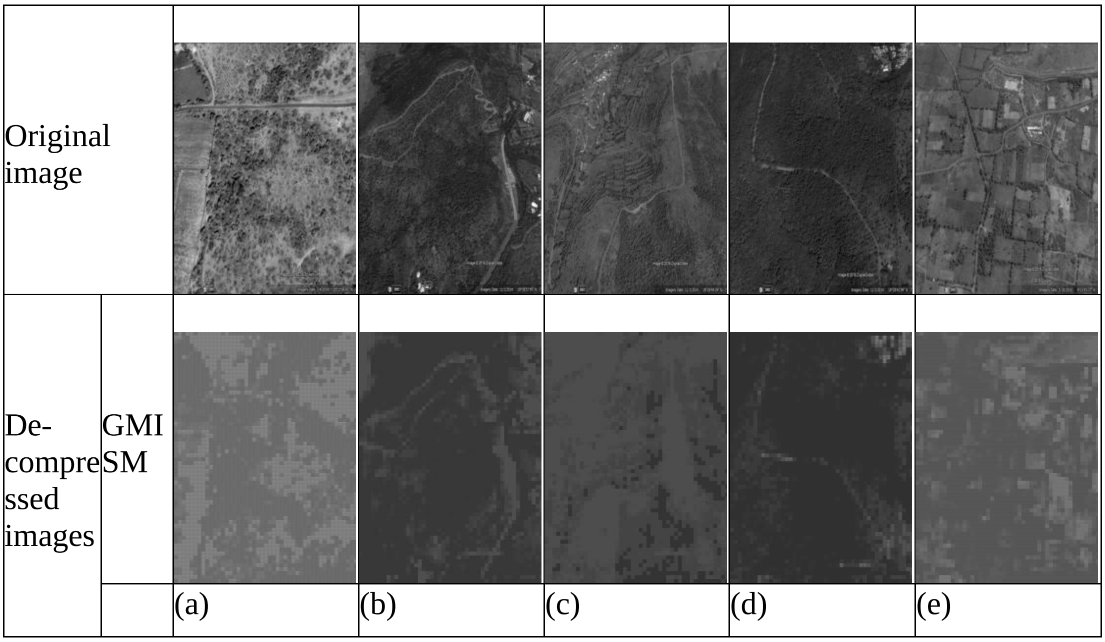

Figure 5 Sample images for original and Satellite images

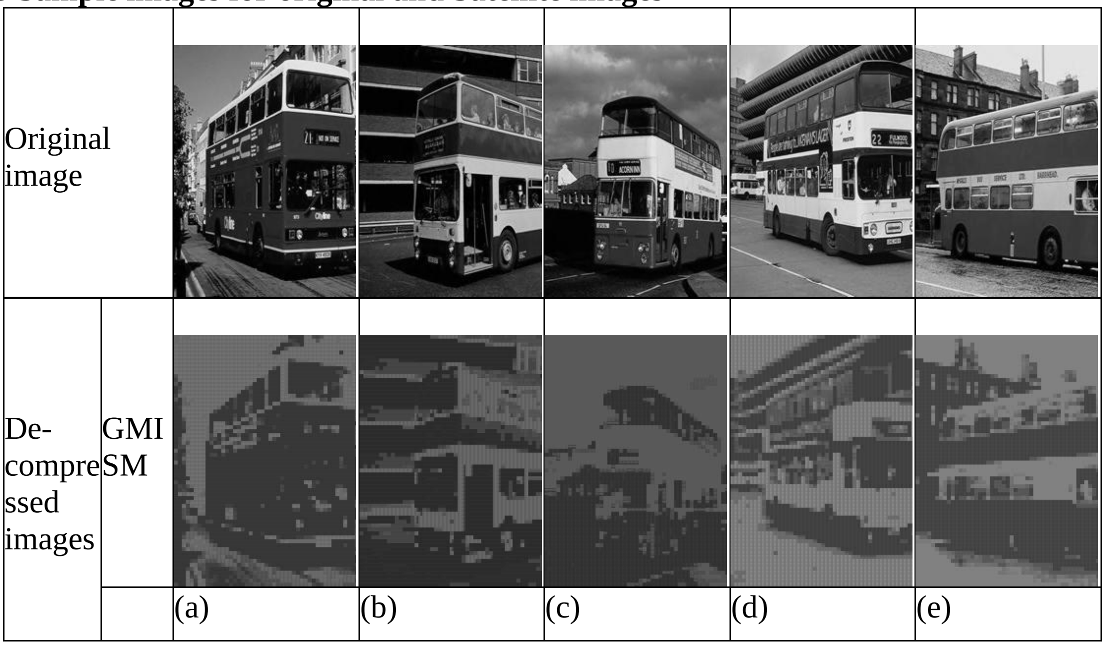

Figure 6 Sample images for original and miscellaneous images

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Table 1: PSNR Analysis of the GMISM versus Traditional approaches for various types of images : Texture Images

Texture imagesPSNR						
Methods	codebook size					
	256		512		1024	
	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8
GMISM	**69.329**	**84.761**	**70.223**	**71.577**	**83.034**	**75.726**
GA	18.678	17.542	18.132	19.328	19.302	17.69
SMO	18.412	19.555	17.265	17.997	17.837	20.336
LA	18.866	19.141	17.393	20.009	18.947	19.753
ROA	18.766	17.879	17.037	19.561	17.483	17.977
PSO	17.641	17.733	17.241	17.932	19.807	19.397
BFU-ROA	23.875	24.492	23.848	24.417	23.834	24.408
FPARA	58.405	71.736	59.665	58.217	68.853	64.874

Table 2: PSNR Analysis of the GMISM versus Traditional approaches for various types of images : Natural images

Natural imagesPSNR						
Methods	codebook size					
	256		512		1024	
	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8
GMISM	**77.992**	**84.118**	**79.834**	**87.921**	**71.455**	**80.056**
GA	22.683	25.052	22.971	23.519	22.259	24.322
SMO	21.722	22.317	21.398	24.976	23.346	24.285
LA	21.585	22.393	21.579	24.653	23.481	24.945
ROA	22.236	24.736	21.36	22.517	23.804	23.126
PSO	23.596	24.27	23.103	23.175	21.336	22.624
BFU-ROA	28	29.109	27.972	29.055	27.945	29.025
FPARA	64.384	70.645	69.564	73.956	60.421	69.484

Table 3: PSNR Analysis of the GMISM versus Traditional approaches for various types of images : Medical images

Medical imagesPSNR						
Methods	**codebook size**					
	256		**512**		**1024**	
	Block Size = 4	**Block Size = 8**	**Block Size = 4**	**Block Size = 8**	**Block Size = 4**	**Block Size = 8**
GMISM	**70.133**	**66.985**	**79.625**	**74.004**	**83.444**	**86.802**
GA	16.386	15.825	15.567	17.501	17.322	17.111
SMO	15.449	16.718	16.337	16.631	14.863	16.942
LA	16.397	16.592	15.265	18.064	15.317	15.799
ROA	15.718	16.366	15.674	15.887	16.807	17.232
PSO	15.793	17.807	16.83	18.084	17.549	16.456
BFU-ROA	21.738	22.302	21.725	22.281	21.716	22.284
FPARA	56.616	52.331	68.249	59.941	70.258	72.28

Table 4: PSNR Analysis of the GMISM versus Traditional approaches for various types of images : Satellite images

Satellite imagesPSNR						
Methods	**Codebook size**					
	256		**512**		**1024**	
	Block Size = 4	**Block Size = 8**	**Block Size = 4**	**Block Size = 8**	**Block Size = 4**	**Block Size = 8**
GMISM	**84.305**	**91.551**	**92.345**	**84.656**	**91.199**	**80.13**
GA	26.895	25.919	26.145	24.786	25.284	26.16
SMO	24.76	26.049	25.357	25.111	25.641	26.7
LA	24.558	25.801	26.083	25.489	26.631	25.424
ROA	24.041	25.763	25.597	24.79	25.786	26.744
PSO	24.004	25.261	25.744	25.057	26.081	24.874
BFU-ROA	30.921	31.63	30.88	31.688	30.84	31.653
FPARA	72.93	76.997	79.979	74.506	79.311	65.418

Table 5: PSNR Analysis of the GMISM versus Traditional approaches for various types of images : Miscellaneous images

Miscellaneous imagesPSNR						
Methods	codebook size					
	256		512		1024	
	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8	Block Size = 4	Block Size = 8
GMISM	**66.495**	**63.491**	**67.521**	**69.126**	**72.431**	**64.681**
GA	16.068	17.372	16.981	17.408	16.833	17.215
SMO	14.728	16.873	14.795	15.617	15.577	17.405
LA	15.846	15.648	14.565	15.886	17.042	16.452
ROA	16.516	15.331	15.633	16.931	15.955	17.563
PSO	15.184	17.492	16.605	15.368	16.636	15.789
BFU-ROA	21.477	21.608	21.476	21.597	21.462	21.58
FPARA	53.499	52.652	52.684	55.649	61.425	54.582

VI CONCLUSION

To provide an effective image compression, Vector Quantization with K-means Linde-Buzo-Gary (K-LBG) approach was developed. To provide an optimal codebook, a hybridized optimization technique termed Genetic Mating Influenced Slime Mould (GMISM) had been developed. By utilizing this optimal codebook design, edge integrity and efficiency had been increased. Performance analysis indicated that GMISM model outperforms the other proposed techniques.

VQ with K LBG model is used for optimization of image compression using GMISM algorithm. To achieve this generated codebook optimized using hybrid model. Error analysis and Compression rate has been prepared for theestimation. Consequently, the development of the GMISM based VQ with K LBG for image compression was verified effectively.

REFERENCES

[1] Abdulameer .F.S (2022), "Image Compression using Various Methods: A Review", Eurasian Journal of Engineering and Technology, Vol. 8, pp. 99-106.

[2] Alfio .V.S, Costantino .D and Pepe .M (2020), "Influence ofImage TIFF Format and JPEG Compression Level in the Accuracy of the 3D Model and Quality of the Orthophoto in UAV Photogrammetry", Journal of Imaging, Vol. 6, No. 5, p.30.

[3] Alhayani .B.S (2021), "Visual sensor intelligent module based image transmission in industrial manufacturing for monitoring and manipulation problems", Journal of Intelligent Manufacturing, Vol. 32, No. 2, pp. 597-610.

[4] Binu .D and Kariyappa. B.S (2014), "Ride NN: A New Rider Optimization Algorithm-Based Neural Network for Fault Diagnosis in Analog Circuits", IEEE Transactions on Instrumentation and Measurement.

[5] Brahimi .T, Laouir .F, Boubchir .L and Ali-Chérif .A (2017), "An improved wavelet-based image coder for embedded greyscale and colour image compression", AEU-International Journal of Electronics and Communications, Vol.73, pp. 183-192.

[6] Cai .C, Chen .L, Zhang .Xand Gao .Z (2019), "Efficient Variable Rate Image Compression With Multi-Scale Decomposition Network", IEEE Transactions on Circuits and Systems for Video

Technology, Vol. 29, No. 12, pp. 3687-3700. doi: 10.1109/ TCSVT.2018. 2880492.
[7] Chaurasia .V and Chaurasia .V (2016), "Statistical feature extraction based technique for fast fractal image compression", Journal of Visual Communication and Image Representation, Vol.41, pp. 87-95.
[8] Chavan , P.U, Chavan .P.P and Dandawate .Y.H (2009), "Codebook optimization in vector quantization using genetic algorithm", In 2009 Second International Conference on Computerand Electrical Engineering, Vol. 1, pp. 280-283.
[9] Chavan .P.U, Joshi .M. A, Dandawate .Y.H and Chavan .P.P (2008), "Vector Quantizer design Using Genetic Algorithm for Image Compression", 3rd International Conference On Advanced Computing and Communication Technologies, Panipat, Haryana, India, Vol. 1, pp. 571-574 .
[10] Chen .L. -H, Bampis.C. G, Li .Z, Norkin .A and Bovik.A. C(2021), "ProxIQA: A Proxy Approach to Perceptual Optimization of Learned Image Compression", IEEE Transactions on Image Processing, Vol. 30, pp. 360-373 doi: 10.1109/TIP.2020.3036752.
[11] Chiranjeevi. K and Jena .U.R (2018), "Image compression based on vector quantization using cuckoo search optimization technique", Ain Shams Eng. J., Vol. 9, pp. 1417-1431.
[12] Chuan Fu, YaohuaYiand FulinLuo(2018), "Hyperspectral image compression based on simultaneous sparse representation and general-pixels", Pattern Recognition Letters, Vol.116, pp. 65-71.
[13] Ernawan .F, Kabir .N and Zamli .K.Z (2017), "An efficient image compression technique using Tchebichef bit allocation", Optik, Vol.148, pp. 106-119.
[14] Fatema Rashid, Ali Miri and Isaac Woungang(2016), "Secure image deduplication through image compression", Journal of Information Security and Applications, Vol.27-28, pp. 54-64.
[15] García-Sobrino .J, Pinho .A. Jand Serra-Sagristà.J (2020), "Competitive Segmentation Performance on Near-Lossless and Lossy Compressed Remote Sensing Images ." IEEE Geoscience and Remote Sensing Letters, Vol. 17, No. 5, pp. 834-838 doi: 10.1109/ LGRS. 2019.2934997.
[16] Gupta .M.P (2014), "A review on clustering with geneticalgorithms", International Journal of Computer Science and Communication Networks, Vol.4, No. 3, pp. 94-98.
[17] Hardi .S.M, Zarlis .M, Lubis .D.R.P, Sihombing .P and Elveny .M(2021), "Text File Compression Using Hybrid Run Length Encoding (Rle) Algorithm with Even Rodeh Code (ERC) And Variable Length Binary Encoding (VLBE) to Save Storage Space", In Journal of Physics: Conference Series, IOP Publishing, Vol. 1830, No. 1 , p. 012022.
[18] Hernández-Cabronero.M, Sanchez .V, Blanes .I, Aulí-Llinàs.F, Marcellin .M. Wand Serra-Sagristà.J (2019), "Mosaic-Based Color-Transform Optimization for Lossy and Lossy-to-Lossless Compression of Pathology Whole-Slide Images", IEEE Transactions on Medical Imaging, Vol. 38, No. 1, pp. 21-32, doi: 10.1109/ TMI.2018. 2852685.
[19] Zhang .Y, Cai .Z and Xiong .G (2020), "A new image compression algorithm based on non-uniform partition and U- system", IEEE Transactions on Multimedia, Vol. 23, pp. 1069- 1082.
[20] Xie .Y, Cheng .K.L and Chen .Q (2021), "Enhanced invertible encoding for learned image compression", In Proceedings of the 29th ACM International Conference on Multimedia, pp. 162-170.