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SQUIRREL INSPIRED IMPROVED SEARCH METHOD FOR FRACTAL IMAGE COMPRESSION ON STANDARD AND MAGNETIC RESONANCE IMAGES

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ABSTRACT:*The complexity in search of suitable range domain and considerable loss in compression parameters like PSNR and MSE are the major constrictions of the baseline fractal image compression. Hence the existing research is focused on finding optimal solutions to pace up the search rate with marginal loss of image parameters oncompression. Major existing fast search fractal algorithms attain the fractal search speed lowering the image quality.Addressingthis,aSquirrelinspiredfastsearch(SIFS)method is proposed for fractal image compression (FIC). Existing methods mainly depend onwaveletclassification,theproposedSIFSusesmethodicalvectorofrangeblocksbased on thesimilarity and optimizing the search based on dynamic behavior of flying squirrels and their efficient way of gliding by the coordinate distance. The proposed SIFS method uses foraging behavior of flying squirrels to find the best range block search showing scalable improvements in search complexity to Particle Swarm Optimization and Genetic Algorithm based methods. The noteworthy reduction in MSE (Mean Square Error) calculations is observed as only six of the eight dihedral transformations are enoughtocompare the range blocksimilarityintheproposedSIFS. Proposed method is experimented on different kinds of images including medical MRI image and results found are encouraging.*

Keywords*: Squirrel Search, Fractal Image, Genetic Algorithm, Particle swarm, MRI &, Medical Imaging*

1.INTRODUCTION

FractalImagecompression (FIC) exhibits superior compression ratio and good quality of decompressing which grabbed the attention of researchers since 1987. The compression time (T) because of too complex search was supposed to be a major challenge along with identifying similar blocks in image restricting its encoding capabilities. The concept of iterated function systems by Barnsley et al is the major support for FIC implementation. Many researchers have contributed on decreasing compression time by divergent like [1-4]

To increase the computing features of processor methods with evolutionarytechniques like fuzzy logic, particle swarm (PS) [5] and Genetic algorithms (GA) [6] are found to improve Computational time and compression metrics. This article proposes a flying squirrel improved search method for FIC. The goal of this research is tobound the fast search iteration finding optimal Domains for a suitable Range block (Rb) and focus on reducingthe mean square computation.

Most of the conventional methods group Dbs into three classes created on wavelength similarities of three different levels, proposed SIFS method depends on two Rb Vectors. Firstly, ordering the Rbs on similarity basis and then ordering with their coordinate distance. Proposed algorithm starts with random initial Domain block (Db) as per flying squirrel representing a vector search space ordering of similar Rbs. Proposed SIFS generates random domains, evaluate its similarity or fitness for each Rb in ascending order based on most similar block. The SIFS strategy limits the number of iterations on domain search to 6 reducing MSE and search time exceptionally. The contents of this paper are organized into following sections. Section 2 depicts existing literature; section 3 explains fractalimagecodingbysquirrelinspired improved search. Section 4 shows experimentalanalysisand performancemeasuresection 5 shows conclusions and future scope.

2.EXISTING LITERATURE

Wang hai [1] proposed model of GA for hybrid selection, the two band selection of Db selection reduced computation time which lead to reduced compression time. Wang xing [2] et al proposed modified search on gray transformation using fitting plane for Db Search improving PSNR. It used high and low bits for each pixel to get stability in PSNR. Chao zhang [3] et al proposed a strategy where dissimilar Dbs were searched instead of similar for a given Rb. Iano, Yuzo [4] et al proposed modified partitioned with non-iterative classification on fractal encoding. Jacobs proposed FIC based on averaged intensity pixels with Wang using entropy for Db group classes. Wang [2] adapted image content segmentation with threshold quad tree speeding up coding process[7].Kung [8] et al. used classification of Dbs into four class edges using DCT. Similarity was measured by structural similarity index measurement (SSIM)metric.Chen[9] et al. proposed irrelevant Db eliminating towards Rbs replacement using normalization[10]. Palazzari [11] proposes a sequential hardware processor based model relating Dbs and Rbs sequentially on each block for individual processor[12].It had limitation of resource allocation. Furao [13]et al devised

no searchbased FIC[14] similar to model proposed by Wang. Zang [15]et al proposed diamond search method using wavelets for Db classification. Hague[16-18] et al proposed parallel search process with GPU for improving FIC. Chauhan [19] proposed another parallel search model using GPU clusters dividing Dbs into slave machines triggering Rbs for compatibility. The Rb matching process is iterated and proposed by Wang et al using absolute Pearson coefficient restricting a certain class of Dbsspecific to a Rbclass[20-21].
The existing literature found discusses on improving domain classification and parallel processing, none of them contribute in redefining the search criteria. Lin et al [5] had proposed PSO based minimization of search iterations with Dbs classified as three classes using HAAR transforms. This method used PSO technique on selected similar classes of Dbs.A 4 range strategy was used to limit similarity Db check which reduced MSE calculations to half of actual required. Kulkarni et al [6] devised search optimization using rank selection based on GA which achieved 155 reduced search iterations and 66% improvement in reduced MSE calculations. These above methods of PSO and rank selection proved performance improvement through search reduction by Db selection. These methods of GA and PSO initiated random Db directed to least optimal search path without ordering or optimizing the Rbs
Our Proposed Method Squirrel inspired search concentrates on specific number of iterations with range of 1-6 where 1 corresponds to best search and 6 to worst. All the methods so far studied in the contemporary literature classify Dbs, however our method first orders the Rbs by their similarity index and distance coordinates. our Proposed SIFS method explores minimum MSE computation with 97 % decline and 224 times reduced search iterations compared to complete search giving improved results in encoding time and marginal improvement in image quality.

3.FRACTALIMAGE CODINGBYSQUIRRELINSPIRED IMPROVED SEARCH

3.1. Inspiration

Flying squirrel is a diverse nocturnal rodent species that adapts gliding motion very well. Currently these flying squirrels are identified and found mostly in South east Asian deciduous forests [22]. These are characterized to have most aerodynamic features helping them to glide from one tree to other with sophisticated lift and drag modified based on their necessity [23][24].
The interesting datum about this species of squirrels is they glide instead of flying, gliding locomotion helps them to be more quick and cover more distance efficiently [25]. Avoiding predators and foraging cost is the primary reason for their evolution to glide [26][27], saving their energy to reach the tree for their food resource exhibiting dynamic forage behaviour [28].
For example, to chance their food requirements in fall season, they choose to consume food as acorns (a special nut) as they are available in plenty and stock other nut food called hickories under shells or nests. During midwinters when nutrition demand is greater due to slung temperatures, hickory nut food is consumed and taken as reserve food storage. This selective

eating of nuts and storing other based on season wise nutrition requirement gives optimum utilization of available resources [29][30]. This intellectual dynamic evolutionary behaviors of flying squirrels serves as the core motivation in designing Squirrel fast search algorithm by M. Jain et al [31]. Proposed SIFS method uses SSA to select and order range blocks based on coordinate distances

3.2 Fractal ImageCompression

Basic Traditional FIC is a encoding method illustrated in fig 1where in image is partitioned into non overlying same size blocks called Rb and then the same image is partitioned into overlying un similar size blocks called Domain Blocks(Db) with at least twice the size of Rb. Using affirmation indexes shown in table 2 [32]

Table 1 Dihedral Transforms

$T_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	$T_1 = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	$T_2 = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$	$T_3 = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$
$T_4 = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$	$T_5 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$	$T_6 = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	$T_7 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

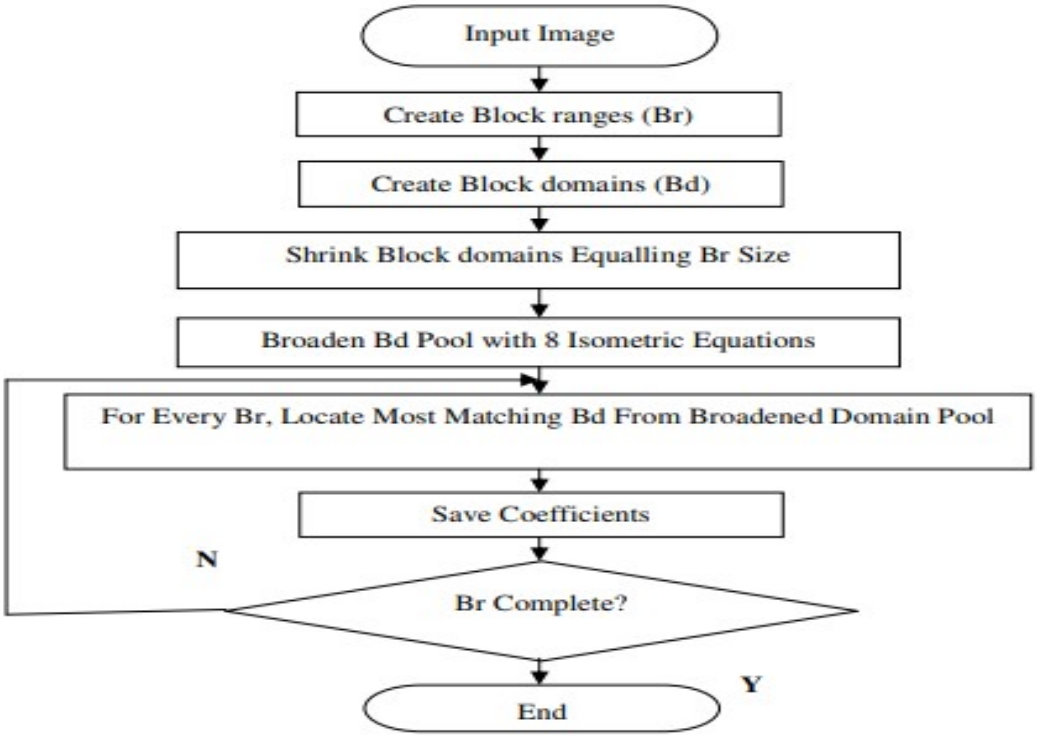


Figure 1 Schematic of Fractal Image Encoding Method

In basic model of FIC, encoding is performed such that an image is partitioned into non-overlapping same size square Block range (Br).A transform constraint is recognized for each Rb, the greatest similar Db is found by relative changes in offset and Sensitivity The eight dihedral transforms shown in Table 1 represents matrixes class as identity, 90º rotation, 180 º rotation, -90º rotation, mid-vertical side reflection, mid-horizontal side reflection, first diagonal section and second diagonal section[24] [31]For each and every Rb the highest match in Db is searched by above 8 transform changes. Figure 1 shows schematic of baseline FIC method

3.3 Squirrel Search Method

Figure 2 shows the basic method involved in SSA[30] The search procedure begins once flying squirrel starts foraging. During hot or humid weather, a squirrel explores for food resource through gliding from one fruit tree to another. Whereas by performing this they often alter the locations and discover diverse areas in forest. While the climatically condition is warm enough, they encounter their daily food requirements more speedily with acorns available in plenty and eat them immediately as and when they find. After completing their routine energy needs, they flinch to search for winter food for storage (hickory nut) for maintaining their food requirements in extreme climatic conditions and reduce foraging search increasing their survival probability being them inactive during winter Later again wait for warm season to repeat their activeness in

foraging continuing this process for their lifetime which forms the base for Squirrel search algorithm[32]

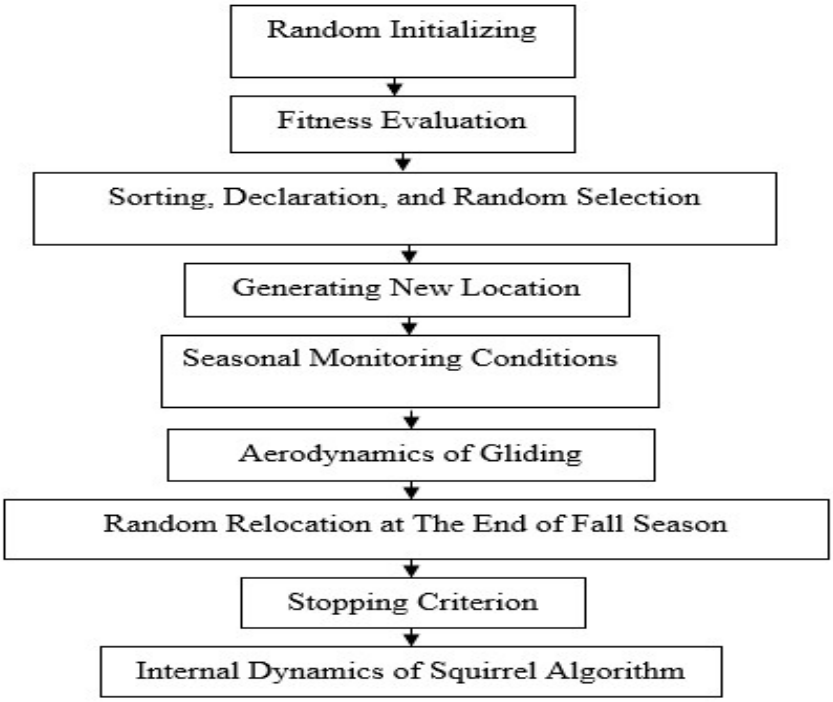


Figure 2 Schematic of Squirrel Inspired Fast Search Algorithm

3.4 Squirrel Inspired Fast Search (SIFS) Implementation Steps

- Partition Sample test image into Block ranges (Brs) of non-overlapping blocks and Block domains (Bds) of overlappingblocks.
- Select Brs of size8X8.
- Make Comparison of BrswithBds based on the assumptions of SSA[31]inthedomainpool,having at least doublesizeofBrs.
- Use Gliding probability of SSA to match the random location of Bd block Image component sorting and declaration of lattice ofN/4.
- Apply only 6 most optimum transformationsfor averagingthedomain groupsreducingtheirsize. and search most similar candidate from Bd to code for a specific selectedBr

Order the Rbs by their coordinate distances appeared in given image, enabling eachRb to search for similar or most compatible Db

4.EXPERIMENTALANALYSISANDPERFORMANCE MEASURE

Input Factors of Sample Test Images M (image size) 512 N (Rb size) 8 R (No of Rbs 1024 D (No of Dbs) 58081.Implementation of proposed algorithm is experimented on intel 7-

5200U;8 GBRAM1 TBdisk memory,4 GBGraphic cardwithWindows 10. Experimentation is made on standard test images of Lena, Barbara and Pepper using MATLAB 2018b tool. The MSE check between each Rb and eightdihedral transformed Dbs as per Table 2 performing the best Db match. The proposed algorithm is compared with baseline FIC, PSO [6] andGA[5]. In this experiment, size of Rbs is chosen as 8×8, and Dbs as 16×16. Quality of image is evaluated by PSNR which is logarithmic of MSE among the original and decompressed image relating $(2n-1)^2$, where in $2n-1$ representing higher limit of gray level. n represents number of bits per pixel(bpp). More the PSNR value, the lower will be the distortion. we also compare indicators like compression time (T), speed ratio (SR), and compression rate (CR) by Equations.1-3. Figure 3,4,5 and 6 shows the implementation results on 3 test sample standard images of Lena. Barbara, Pepper and MRI Images. Table 2 shows comparative results for performance indicators with Genetic Algorithm and Particle Swarm methods. Figure 7 shows comparative chart for all variety of images implemented on existing and proposed SIFS method.

4.1 Comparison Indicators

Peak Signal to Noise Ratio (PSNR)

$$\begin{cases} PSNR = 10 \times \log_{10}\left[\dfrac{(2^8-1)^2}{MSE}\right] \\ MSE = \dfrac{1}{n}\sum_{i=1}^{n}(X_i - Y_i)^2 \end{cases} \quad (1)$$

n represents image pixel, Xi and Yi of i-th gradation respectively.

Compression Ratio (C.R) $C.R = \dfrac{Size\ of\ input\ image}{Size\ of\ decoded\ image}$ (2)

Speedup Ratio (SR) SR = Ts / Tc (3)

where Ts is the time taken for baseline FIC. Tc is the time taken for the proposed SIFS method

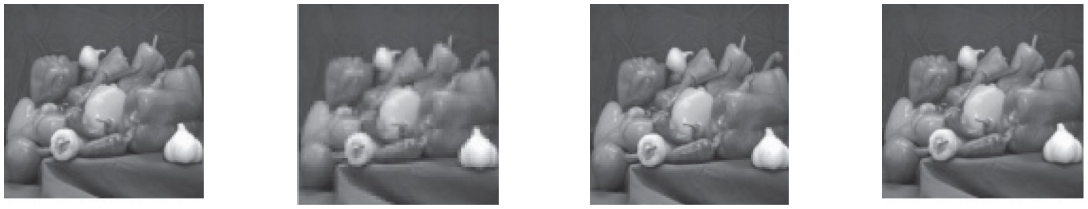
(a) Lena Standard (b)PSO (c) GA (d) DecodedbySIFS

image

Figure3 TheStandardanddecodedLenaimage applied with various algorithm

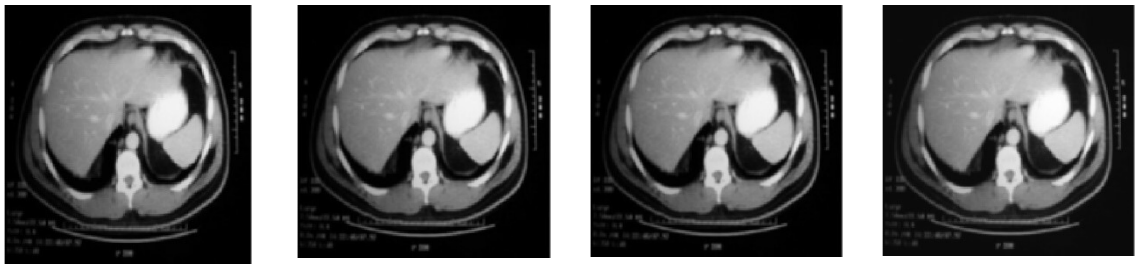
(a) Barbara Standard (b)PSO (c) GA (d)DecodedbySIFS Image

Figure4 TheStandard Barbara image applied with various algorithm



(a) Pepper Standard (b)PSO (c) GA (d) DecodedbySIFS Image

Figure5 TheStandardPepperimage applied with various algorithm



(a) MRI sample Grey Image (b)PSO (c) GA (d) DecodedbySIFS

Figure6MRI grey scale sample image applied with various algorithm

TABLE I

SAMPLE IMAGE	METHOD	T(SEC)	PSNR (DB)	C.R	S.R
LENA	Baseline FIC	107.8	24.9	12.42	1
	PSO	106.6	26.9	14.12	1.01
	GA	104.5	28.67	13.21	1.03
	Proposed SIFS	98.6	29.76	8.3	1.09
BARBARA	Baseline FIC	134.5	19.23	15.6	1
	PSO	121.4	17.56	17.8	1.10
	GA	118.8	17.23	19.0	1.13
	Proposed SIFS	109.2	23.37	19.67	1.23
PEPPER	Baseline FIC	112.20	25.12	8.88	1
	PSO	109.11	28.27	10.47	1.02
	GA	106.32	29.65	13.37	1.05
	Proposed SIFS	97.17	31.65	18.65	1.15
MRI	Baseline FIC	156.20	24.50	09.25	1
	PSO	136.23	29.10	12.93	1.12
	GA	152.11	23.21	16.14	1.51
	Proposed SIFS	132.12	33.10	17.93	1.92

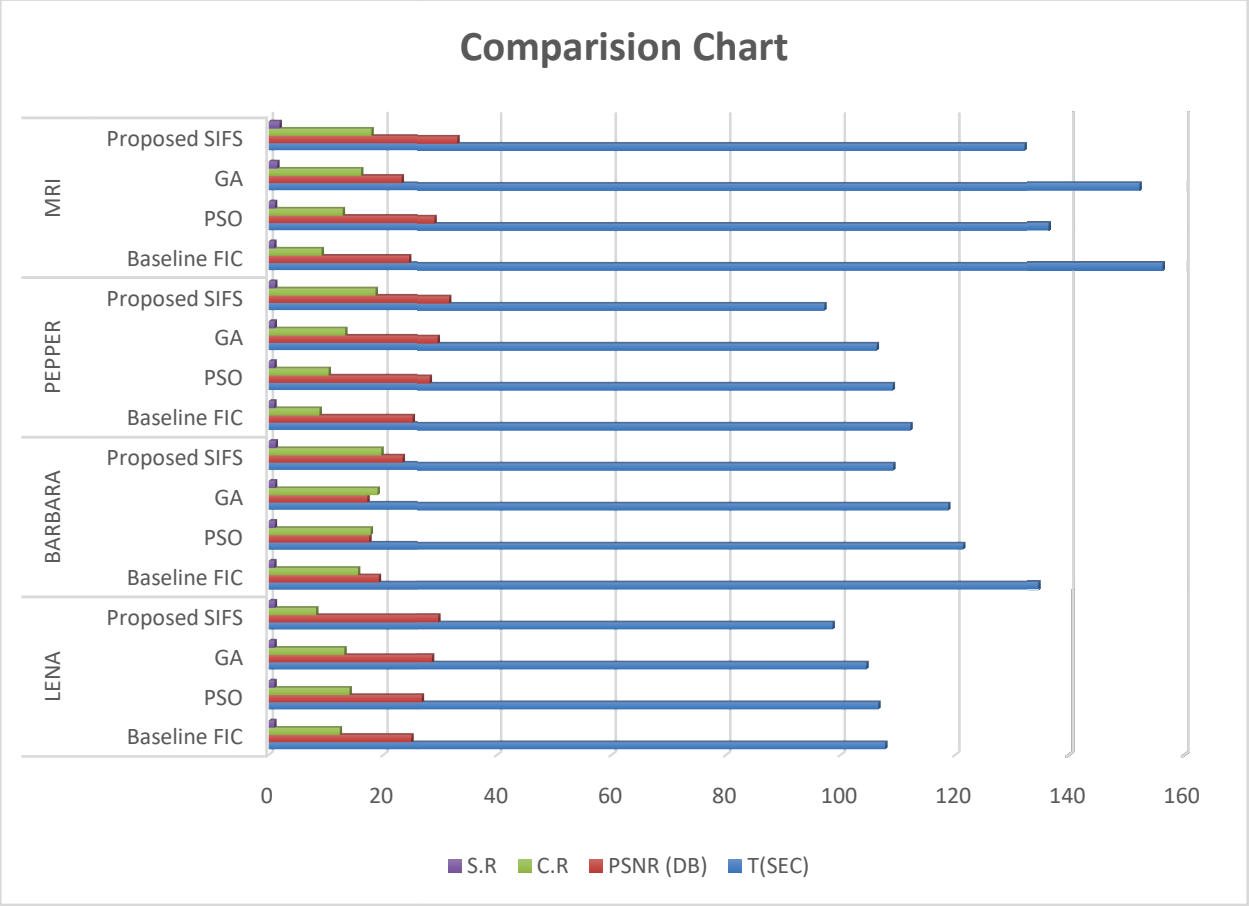


Figure 7 Comparative Chart for Various methods and Images implemented with Proposed SIFS Method

5.CONCLUSION

The article here develops a Squirrel Inspired Fast Search (SIFS) methodtoacceleratetheimage compressionprocess in fractal technique.TheSIFSisuses vectorsof Rbs thatareorderly arranged based on their similarity and coordinating distance inspired by flying squirrels. Theproposed search adapts limited transforms as compared to baseline FIC using 8 dihedral forms. initialRbselectionforsearchfollows SSA strategy. The features used for this modified search depends on Gliding probability of SSA to match the random location of Bd block component sorting and declaration with one fourth slide lattice slide.

Thepredecessor Rb vector is ordered based on similarity representing Dbs compatibility with nearest adjacent block reducingMSEcalculations resulting in decreasing encoding time(T) and improve PSNR. Results show T is reduced to maximum of 15 % and PSNR by maximum of 26%comparedtobaseline FIC search. It is convincingly proved that proposed SIFS compression time is better and robust. The comparative analysis of proposed SIFS method also overcomes optimal speed and quality with other methods like PSO [6]

andGAwithRSM[5].The experimentation results of the proposed SIFS method proves that the methodology used is suitable for all variety of images from standard Lena to Medical MRI. This method can be further improved by hybridizing optimal search with wavelet methods which will be a future research scope for region-based compression of images specially in medical applications.

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