

Image Constraint Technique Used by Bio-Inspired TSA Optimized Algorithm for Large Memory Management

Sachin More^a and Dayanand Ingle^b

Bharati Vidyapeeth College of Engineering, Mumbai University, CBD Belapur, Navi Mumbai, India

Keywords: Image quality, Image Compression, Resolution Scalable Image Compression, Quality Scalable Image Compression, Highly Scalable Image Compression and TSA Optimized Discrete Wavelet Transform.

Abstract: The well-known classical image compression algorithms are renowned for their outstanding performance, low computational complexity, and production of an embedded bitstream that can be decoded at different bit rates with progressively better picture quality more bits are received. It takes a lot of computer memory since it stores the created sets and the pixel locations in linked lists. The transform's multiresolution capability does not lead to the generation of a resolution-scalable bitstream that would enable different resolutions to decode the image. The TSA Optimized Discrete Wavelet Transform approach, which only needs one list of fixed size measuring 1/4 the size of the image and an average of 2.25 bits/pixel, solves the massive memory problem of traditional techniques. The study's main contribution is to scale up image quality and resolution in order to free up more memory. The TSA Optimized Discrete Wavelet Transform approach is recommended in this study to decrease complexity and increase speed. Due to the algorithm's special characteristics, it is ideal for addressing the different skills and resolution related preferences of today's Internet users.


1 INTRODUCTION


The fundamental purpose of lossy image compression is to decrease the distinction between the unique and recovered photographs even as also reducing the common quantity of bits in step with the pixel of the compressed photo as a good deal as viable. The MSE among those pictures, or suggest squared errors, is usually used to quantify the disparity. The computational complexity and reminiscence use of an image compression method are extra important components. For this reason, most of these elements need to be considered for any algorithm to be truly judged (Jayasankar, 2012).

A picture may be recovered the use of a traditional photo compression scheme at a single bitrate (pleasant) and resolution (size). This compression paradigm might not work for all customers because the existing purchaser base has a wide range of bandwidth, show resolution, computing power, and memory capacities. Moreover, clients want to rapid look through all the searched photographs while viewing snapshots at the net in advance than choosing

the specified image(s). Adopting this approach of picture compression will bring about time, bandwidth, memory, and processing electricity losses. But a scalable image compression gadget permits the setup person to decode the photo at an appropriate excellent or/and determination through controlling the recovered image's outstanding or/and resolution (length). Most effective the first-rate. By the usage of the usage of some sorts a QSIC may be completed. However, the selection of the recovered image may be modified (Taubman, 2002). Due to the HSIC's potential to decode snap shots of various best and resolutions, it's miles specifically appealing to the desires of cutting-edge clients.

A picture may be recovered the use of a traditional image compression scheme at an single bitrate (nice) and backbone (length). This compression paradigm may not art work for all customers due to the reality the prevailing character base has a great type of bandwidth, show selection, computing strength, and reminiscence capacities. Furthermore, consumers want to fast look through all the searched snap shots

^a  <https://orcid.org/0000-0003-4077-2251>

^b  <https://orcid.org/0000-0002-2654-3279>

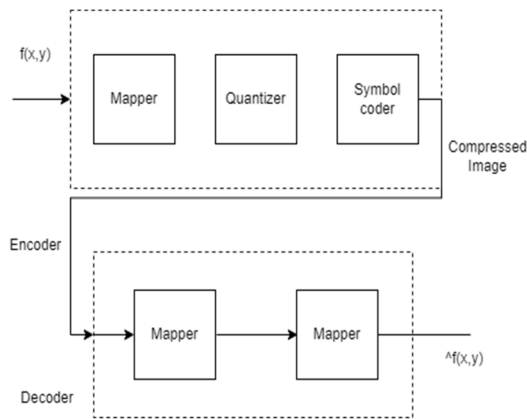


Figure 1: Conventional Image Compression Diagram

while viewing pics on the net earlier than selecting the required image(s). Certainly, adopting this technique of photo compression will bring about time, bandwidth, memory, and processing strength losses. Instead, a scalable image compression tool allows the end person to decode the photo at the suitable extraordinary or/and determination by way of manner of controlling the recovered photo satisfactory or/and determination (duration) (Said and Pearlman, 1996; Lee and Hung, 2019). Because of the HSIC's capability to decode photographs of diverse, first-rate resolutions, it is mainly attractive for the needs of contemporary customers.

The aim of this commentary was modified to signify a picture compression technique that would permit large reminiscence space to be maintained while lowering reminiscence length. The endorsed compression approach consists of an single image compression approach and a bit-fee approach for keeping the compression ratio and uniformity of photograph excellence at some point of the photo. The suggested machine, at the facet of the bit fee management technique, continues widely talking using the facts collected inside the contemporary frame. So that you can similarly improve picture excellence, the approach, also determines series. This may be completed by using something as fundamental as the photograph. It can drastically reduce the problem of image-satisfying imbalance photograph, a flaw in low-reminiscence compression strategies that is unavoidable.

The remaining sections of the paper are as follows: Background material and common compression techniques are given in Section 2 of this essay. Section 3 provides a description of the suggested compression scheme with memory management. The approach is assessed and the

findings are discussed in Section 4. This essay concludes in Section 5.

2 LITERATURE SURVEY

Based on zero tree capabilities of wavelet coefficients, the 1D SPIHT approach (Lee and Hung, 2019) is used. This technique creates 3 dynamic lists via frequently crossing better bit to the decrease bit plane to send important bit facts first, enhancing compression efficiency. This method is simple to use and proof in opposition to transmission faults. Because of its prolonged memory accesses at some point of the repetitious manner coding, the 1D SPIHT compression technique, nevertheless, incurs good sized energy consumption

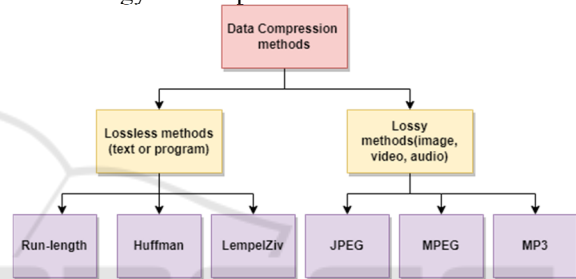


Figure 2: Different Techniques of Image Compression.

The visually lossless compression approach of line compression emerges as located out in (Umbaugh, 2023). Whilst errors are harder to identify, this approach might also carry out median component detection (MED) prediction of 2 4 blocks. It could also perform MED prediction of one-four blocks in complexity and diploma places in which errors are apparent. After the information has been in addition compressed through way of a preset non-uniform quantization step. A frequency adaptive line compression (FALC) method with less complexity in evaluation to modern compression techniques has been suggested in (Chew, 2009). The FALC approach uses entire after four stages of wavelet adjustments. The fourth step involves selective zero-area quantization within the four immoderate-frequency bands. Redundancy inside the low-frequency variability has eliminated using predictive coding. Then, using a Huffman coding-based totally variable duration coding (VLC) technique, data from every frequency band are compressed. With a visually lossless nation, FALC's compression ratio exceeds 3:1. To actively keep more power in contexts in which IoT programs are used, but, extra advancement is needed.

Because of the reality every line, even inside a single frame, has precise homes in phrases of compression effectiveness, the picture high-quality of the road-based totally compression algorithms regularly modifications at some stage in a single body. Both Jiang's and Edirisinghe's line-based totally bit charge manipulates (BRC) were proposed for use in the JPEG-LS context (Deepthi and Prasad, 2018). But, in terms of uniformity inside a single frame, those BRCs lack ok photograph well. Primarily based at the cutting-edge-day FALC method, a one-of-a-type bit rate management mechanism (Al-Janabi and Harbi, 2022) has been cautioned to decorate the consistency of photograph fantastic inside one frame. The quantization degree shift is saved sluggish. Whilst thirds of the frame have been processed, it additionally evaluates the picture exquisite and the closing bits to decide the proper quantization degree to be able to use up the very last bits.

However, modern-day BRC strategies nonetheless warfare with inconsistent image satisfactory, especially whilst scenes or pics are separated. Consequently, TSA desires to be more suitable greater earlier than it may be used for consumer goods

3 PROPOSED METHODOLOGY

The TSA Optimized Discrete Wavelet remodel techniques are to begin with brought on this section. In comparison to the alternative techniques, the TSA Optimized Discrete Wavelet redecorate, set of guidelines is drastically much less complicated and plays slightly higher. The number one contribution of the research is then provided, that is the advised TSA Optimized Discrete Wavelet rework method for memory control. A particularly scalable bitstream, this is each high-quality and backbone scalable in addition to less in duration and taking on greater RAM is created by using the usage of the TSA Optimized Discrete Wavelet remodel set of regulations.

One of the population-based algorithms is TSA (Tree Seed Algorithm), and the population will be referred to as stand moving forward. Eq. 1 (Meraj and Khan, 2021) is used to derive the stand.

$$a = T_{i,j} = L_j + r_{i,j} \times (U_j - L_j), \quad i = 1, 2, \dots, N \quad \text{and} \quad j = 1, 2, \dots, D \quad (1)$$

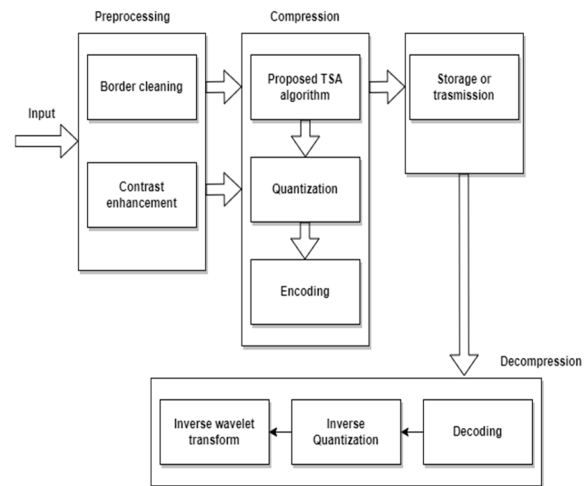


Figure 3: Proposed Block Diagram of this Work.

Following the production of the bushes within the stand, the fitness values of the trees are decided the usage of a goal characteristic tailor-made to the optimization mission.

Via utilizing Eq. 2 or three, a positive range of seeds is generated for every tree at the same time as a preset termination circumstance is glad (Al-Janabi, 2013)

$$S_{k,j} = T_{i,j} + \alpha_{i,j} \times (B_j - T_{r,j}) \quad (2)$$

$$S_{k,j} = T_{i,j} + \alpha_{i,j} \times (T_{i,j} - T_{r,j}) \quad (3)$$

The choice of Eqs. 2 or 3 relies upon on a TSA manage parameter. The ST (search tendency) manipulate parameter has a variety of [0,1]. If it is miles vital to intensify the stand across the ideal tree placement, a high fee for the ST parameter should be selected. If the stand's exploration ability is extended, the ST parameter should be set to a low fee. A random wide variety within the range [0,1] is created for the selection of equations 2 or 3. The Eq. 2 is selected if this fee is much less than ST; in any other case, the Eq. Three is chosen. In a nutshell, the ST parameter is utilized to modify the stand's potential for exploration and exploitation. The usage of the number of seeds can in addition beautify the local seek abilities around the tree websites. The minimum and the greatest number of seeds in the TSA algorithm are 10% of the timber and 25% of the trees, respectively. Therefore, based totally at the stand, the number of seeds is determined (Alam and Khan, 2012).

The quest method and equations defined above are iterated sequentially after the set of rules is initialized, if a predefined termination situation is happy.

- Step 1 select the general populace length (filter out window length), ST Values, and termination situation.
- Step 2: Initialize the populace in accordance with the supplied Eqs. (2) and (3).
- Step 3: the usage of the Eqs. (3) based on the values of ri_j and ST, create seed values for the modern tree values. If the seed values supplied progressed health in comparison to the unique tree values, replace the tree values.
- Step 4: the usage of Eq. (3), pick out the premier cost and confirm the termination circumstance.
- Step 5: Assign the optimized values and record the outcome if the termination situation is happy; in any other case, repeat steps 2, three, and four

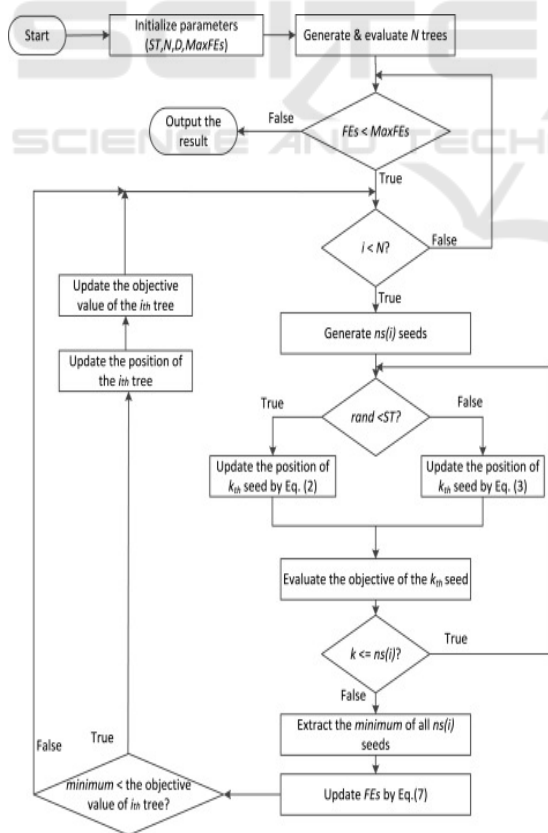


Figure 4: Tree Seed Algorithm Flowchart.

1. Select the best axolotls, according to the function
2. For each axolotl with optimization value $1 \leq j \leq |M|$
 Compute inverse probability of transition
 If each component I of the current axolotl as n
 Update the optimization value
 Update f_{best}

Even as a tree generates new seed web sites, there can be several seeds present; the variety of seeds depends on the dimensions of the population. The bottom wide type of seeds that may be generated through a set of rules inside the right manner. Eq. (3) is utilized for if a randomly generated integer in the range $[0, 1]$ is smaller than ST.

The suggested method for selecting the best compression, placing is depicted in determining Preceding to sending records to the receiver, the endorsed approach can shop for separately compressed image statistics using the further effective compression method is selected because the output value thru the comparator in the middle, which forecasts and compares the bits produced through each compression mode. For images with extra stated characteristic changes among picture traces, together with the recommended technique can make sure a more compression overall performance.

The counselled solution tries to apply get a higher compression ratio; it then chooses this sort of predictive coding options that is minimal in length. Due to the fact differential values exhibited much less correlations inside the vertical course after making use of the horizontal predictive coding, we did not use each prediction modes simultaneously.

Based at the average strength of the H1 bands from the preceding body, the cautioned approach also forecasts an regular compression outline for the present frame. Two centre subsections of the previous frame's many subsections are examined to look if a split mode exists. Break up mode may be dealt with by means of way of the recommended TSA optimized algorithm technique in a single body. In among successive frames, it could additionally deal with scene modifications. If resource of an additional than a threshold cost (TH) in advance than the closing quarter of the frame, the scene has altered. If a scene change happens interior a body, the default TCR charge (4.00) is used to compress the closing areas. Moreover, through manner of the usage of break up mode, this method helps forestall unneeded image

best deterioration delivered on by scene changes among frames.

4 RESULTS AND DISCUSSION

Because of the several problematic interactions between applications, this section can estimate the electricity intake of an set of rules running on a goal embedded system whilst warding off considerable estimation deviation (Calderbank, 1998). The mean squared blunders (MSE) among the preliminary N pixels is used to gauge overall performance. Image (Io) and the reconstructed image (Ir), each of size M, are described as MSE as (Hu and Yang, 2020):

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N [I_0(i, j) - I_r(i, j)]^2 \quad (4)$$

$$PSNR = 10 \log_{10} \frac{P^2_{max}}{MSE} \quad \text{decibel (db)} \quad (5)$$

$$MEM_{TSA} = 2b(2N^2) + 2c\left(\frac{N^2}{4}\right) = 4bN^2 + c\left(\frac{N^2}{2}\right) = \left(4b + \frac{c}{2}\right) N^2 \text{ bit} \quad (6)$$

Table 1: PSNR values evaluated for existing and proposed algorithm.

Bit rate (Bpp)	Encoding time (seconds)			Decoding time (seconds)		
	Lena			Goldhill		
	SPIHT (Harbi, 2022)	SLS (Sara, 2019)	TSA (Proposed)	SPIHT (Harbi, 2022)	SLS (Sara, 2019)	TSA (Proposed)
0.06	0.74	0.72	0.52	0.34	0.068	0.020
0.11	1.17	1.14	1.40	0.561	0.082	0.051
0.15	1.06	1.05	1.00	1.000	0.077	0.130
0.5	2.21	2.20	2.15	1.717	0.112	0.175
1	4.60	4.55	3.45	3.400	0.445	0.237

Table 2: Memory necessities of TSA, LHS-TSA, and the proposed HS-MSLS for different image sizes (Wu and Wang, 2013)

Image size	Memory (kb)					
	TSA		LHS-TSA		HS-MSLS (Song, 2017)	
	MEM (kb)	%	MEM (kb)	%	MEM (kb)	%
256×256	273	2.12	31	0.24	45	0.35
512×512	1270	2.40	127	0.24	200	0.38
1024×1024	5685	2.67	511	0.24	653	0.41

Table 3: Current and planned algorithms, complexity is expressed by the encoding time and decoding time against the bit rate

Bit rate (Bpp)	PSNR (db)								
	Lena			Goldhill			Barbara		
	SPIHT (Harbi, 2022)	SLS (Sara, 2019)	TSA (Proposed)	SPIHT (Harbi, 2022)	SLS (Sara, 2019)	TSA (Proposed)	SPIHT (Harbi, 2022)	SLS (Sara, 2019)	TSA (Proposed)
0.0615	25.61	26.46	27.69	25.16	25.18	25.25	22.17	22.20	22.50
0.115	28.38	30.14	31.19	26.66	26.69	26.75	23.26	23.31	23.46
0.15	31.61	32.00	34.17	28.65	28.67	28.78	25.86	25.89	25.93
0.5	35.12	35.20	37.41	31.16	31.18	31.30	30.87	30.90	30.96
1	38.40	38.51	39.72	34.41	34.45	34.56	35.15	35.21	35.35

5 CONCLUSIONS

In this research, a compression approach with bit rate control was presented for size reduction in memory management contexts. Given the power constraints of the memory management environment, the suggested TSA algorithm employs a low-complexity approach with the fewest number of processes and memory accesses. Based on the results of our tests, the suggested solution outperformed existing methods in terms of compression ratio while keeping a lower level of complexity. In terms of size reduction effect at the system level, it performed better than existing SPIHT or 4L HEVC methods. In cases where there is a high/low quality imbalance, picture split mode, and scene transitions, which frequently occur in conventional line compression methods, it may retain superior restorative and constant image quality performance.

REFERENCES

- Jayasankar, U., Thirumal, V., & Ponnuram, D. (2021). A survey on data compression techniques: From the perspective of data quality, coding schemes, data type and applications. *Journal of King Saud University-Computer and Information Sciences*, 33(2), 119-140.
- Thanki, R. M., & Kothari, A. (2019). *Hybrid and advanced compression techniques for medical images*. Springer International Publishing
- Taubman, D., Ordentlich, E., Weinberger, M., & Seroussi, G. (2002). Embedded block coding in JPEG 2000. *Signal Processing: Image Communication*, 17(1), 49-72.
- Rüfenacht, D., Naman, A. T., Mathew, R., & Taubman, D. (2019). Base-anchored model for highly scalable and accessible compression of Multiview imagery. *IEEE Transactions on Image Processing*, 28(7), 3205-3218.
- Van Fleet, P. J. (2019). Daubechies Wavelet Transformations.
- Vetterli, M. (1995). Wavelets and sub band coding.
- Said, A., & Pearlman, W. A. (1996). A new, fast, and efficient image codec based on set partitioning in hierarchical trees. *IEEE Transactions on circuits and systems for video technology*, 6(3), 243-250.
- Lee, R. C., & Hung, K. C. (2019). New modified SPIHT algorithm for data compression system. *Journal of Medical and Biological Engineering*, 39, 18-26.
- Khan, E., & Ghanbari, M. (2004). An efficient and scalable low bit-rate video coding with virtual SPIHT. *Signal Processing: Image Communication*, 19(3), 267-283.
- Senapati, R. K., Pati, U. C., & Mahapatra, K. K. (2012). Listless block-tree set partitioning algorithm for very low bit rate embedded image compression. *AEU-International Journal of Electronics and Communications*, 66(12), 985-995.
- Umbaugh, S. E. (2023). *Digital image processing and analysis: computer vision and image analysis*. CRC Press.
- Chew, L. W., Ang, L. M., & Seng, K. P. (2009, August). Reduced memory spiht coding using wavelet transform with post-processing. In *2009 International Conference on Intelligent Human-Machine Systems and Cybernetics* (Vol. 1, pp. 371-374). IEEE.
- Deepthi, S. A., Rao, E. S., & Prasad, M. G. (2018, January). Image transmission and compression techniques using SPIHT and EZW in WSN. In *2018 2nd International Conference on Inventive Systems and Control (ICISC)* (pp. 1146-1149). IEEE.
- Alam, M., Khan, E., & Gopal, B. (2012). Modified listless set partitioning in hierarchical trees (MLS) for memory constrained image coding applications. *Current Trends in Signal Processing*, 2(2), 56-66.
- Al-Janabi, A. K., Al-Musawi, H. K., & Harbi, Y. J. (2022). An efficient and highly scalable listless SPIHT image compression framework. *Journal of applied research and technology*, 20(2), 173-187.
- Meraj, Y., & Khan, E. (2021, March). Modified ZM-SPECK: A low complexity and low memory wavelet image coder for VS/IoT Nodes. In *2021 International Conference on Emerging Smart Computing and Informatics (ESCI)* (pp. 494-500). IEEE.
- Al-Janabi, A. K. (2013). Low memory set-partitioning in hierarchical trees image compression algorithm. *International Journal of Video & Image Processing and Network Security IJVIPNS-IJENS*, 13(2), 12-18.
- Alam, M., & Khan, E. (2012). Listless Highly scalable set partitioning in hierarchical trees coding for transmission of image over heterogenous networks. *International Journal of Computer Networking, Wireless Mobile Commun.*
- Danyali, H., & Mertins, A. (2004). Flexible, highly scalable, object-based wavelet image compression algorithm for network applications. *IEE Proceedings-Vision, Image and Signal Processing*, 151(6), 498-510.
- Calderbank, A. R., Daubechies, I., Sweldens, W., & Yeo, B. L. (1998). Wavelet transforms that map integers to integers. *Applied and computational harmonic analysis*, 5(3), 332-369.
- Hu, Y., Yang, S., Yang, W., Duan, L. Y., & Liu, J. (2020, July). Towards coding for human and machine vision: A scalable image coding approach. In *2020 IEEE International Conference on Multimedia and Expo (ICME)* (pp. 1-6). IEEE.
- Al-Janabi, A. K., Al-Musawi, H. K., & Harbi, Y. J. (2022). An efficient and highly scalable listless SPIHT image compression framework. *Journal of applied research and technology*, 20(2), 173-187.
- Sara, U., Akter, M., & Uddin, M. S. (2019). Image quality assessment through FSIM, SSIM, MSE and PSNR—a comparative study. *Journal of Computer and Communications*, 7(3), 8-18.
- Wu, D., Zhang, H., Li, X., & Wang, J. (2013, June). Multiview Video Coding Based on Wavelet Pyramids.

In *2013 International Conference on Computational and Information Sciences* (pp. 225-228). IEEE.

Song, X., Huang, Q., Chang, S., He, J., & Wang, H. (2017). Three-dimensional separate descendant-based SPIHT algorithm for fast compression of high-resolution medical image sequences. *IET Image Processing*, 11(1), 80-87.

