A review paper on Image compression using optimization with LBG algorithm

POOJA DEVI, R.N. College of Enginering & Techonology, Madulada, Panipat, Haryana and Mrs. Chetan Rani, Assistant Professor, R.N. College of Enginering & Techonology, Madulada, Panipat, Haryana.

Abstract- In the present days; the transfer of data from one place to other through communication channel has basic applications. The data can be large, which is not easy to transfer. So compression is the basic requirement of higher size data for the transmission process. The reason behind is that small size data take lesser time during the transferring stage. The digital data present in the form of image or text. We consider the problem of image compression for our study. Several challenges arrived during image compression. The quality of the image and its size is affected badly during the compression stage. We studied lots of research paper of image compression in which different methods were proposed. LBG method is proposed in various techniques for the vector quantization process. Different optimization algorithm also proposed to improve the quality of the compressed image.

Keywords- LBG, image compression, optimization etc.

I. INTRODUCTION

In the present scenario, digital image processing has wide applications. The digital image processing refers to the processing of a 2 D image with the digital computer. The visual image transformed into the digital image before processing by the computers. A digital image represented by a finite number of bits which is the array of a real and complex number. The digital image provided into the computer with one pixel at a time. The computer programmed inserts these images in the form of equations and store the results at each pixel. In previous years the image processing has applications in all technical field like a video conferencing, satellite image, defense, agriculture, news, etc. A large amount of data stored into the image like text, information, audio, video and compressing image which is very difficult to transfer. The time consumption is more while transferring the image from one network to another. The size of the image can be compressed to achieve the best storage space and transmission time because both are costly. The image compression concept added to the image processing field to improve the transmission time and storage space quality. In image compression the size of image is reduced in bytes without affecting the quality of image

1.1 Data Compression

The data can be defined as the set of information and redundancy. The information is the segment of data which always preserve in the original form and reflects the meaning of data. The redundancy is that segment of data which can be removed while not required and reinserted at the requirement. The redundancy is reinserted to reconstruct the data in its actual form. So the reduction in the redundancy of data and minimize storage space necessity is called data compression. The reduced storage capacity minimize the cost of the communication section. The static and dynamic are the two data compression scheme present in the market. In static data compression, the mapping of a set of data to be corresponding to compressed data code to be fixed. In the dynamic data compression scheme, the mapping of the group of messages to the group of compressed codes varies with respect to time. Following advantages of data compression are [6];

- It reduces the requirement of data storage.
- It provides a better quality signal in the form of audio/video signal data.
- Due to the small data representation, the input and output operations increased.
- Minimize the backup cost and efficient data recovery in the computer system.

II. LITERATURE REVIEW

Muruganandham et al. (2010)-proposed the PSO (Particle Swarm Optimization) method for fast fractal image compression (FIC) system. In FIC at low bitrate with the acceptable quality of the encoded image was achieved with the longer encoding time. The longer encoding time was reduced by using PSO algorithm. The PSO was proposed for the MSE depend on the stopping situation among the domain and range block. PSO increased the speed of the fractal encoder and better image quality of medical image preserved [1].

Kumar et al. (2019)- presented a BAT optimization algorithm combined with LBG (Linde Buzo Grey) in the codebook design for the vector quantization (VQ). The dynamic BAT-LBG algorithm provided efficient results in the codebook selection while compared to VQ method, JPEG loss-less method, and static BAT-LBG method. The performance analysis depended on the PSNR, compression ration, and MSE. The proposed algorithm applied was not only for the codebook design even for the size selection of the codebook. The quality of the reconstructed images was good, which compress by the BAT-LBG algorithm [2].

Omari et al. (2015)-proposed a new technique of image compression based on the minimization of rational numbers in nominator and denominator form. Mapped image converted into the RGB form, and then fractal quotient was analyzed. The Genetic Algorithm is used to enhance the search for close fraction, which further minimizes to an efficient quotient. The implemented method provided the high compression ratio, so image quality was enhanced [3].

Chen et al. (2005)-presented a new method called the improved PSO algorithm to construct a high-quality codebook for image compression. Previously used algorithm

LBG results were provided to initialize the global best particle for improved the convergence of PSO. The image encoding and decoding were implemented in this work. The proposed method was reliable and reconstructed images obtained by this method gets a high-quality image while compared to the other method of image compressions like VQ and LBG [4].

Chiranjeevi et al. (2016)- used a metaheuristic optimization algorithm called Cuckoo Search (CS) for optimizing the codebook of LBG using levy flight function. The Gaussian distribution function replaced by Mantegna's method. The CS algorithm obeys the levy flight distribution function, which takes 25% and 75% of convergence time for the local and global codebook. The CS optimized codebook has a greater value of PSNR and provided improved fitness value than previously used algorithms like LBG, PSO-LGB, HBMO-LBG. The computation time of the proposed algorithm was also less than the other algorithm [5].

Nag et al. (2019)-proposed an improved differential evolution (IDE) optimization algorithm for the LBG generating codebook. In this work, the IDE algorithm was combined with the LBG. The output of the IDE provided as the input to the LBG which produced efficient codebook. Previously used a differential algorithm doesn't have efficient control scaling factor and boundary limits. The IDE modifies the scaling factor and boundary control methods. The IDE-LBG method provided optimal VQ codebook. The computational time of the proposed method is less and high PSNR value achieved — the excellent quality of the reconstructed image obtained by IDE-LBG algorithm. The implemented method was provided better results while compared with the other method like IPSO-LBG, FA-LBG, and BA-LBG [6].

Chiranjeevi et al. (2016)-proposed the BAT optimization algorithm with LBG for VQ image compression. In this work, the BAT algorithm coupled with the LBG for the better quality codebook of VQ image compression. The BAT optimization is proposed to optimize the initial parameters of the LBG then the efficient quality image was reconstructed with the help of codebook. The proposed method provided good PSNR value and regularly zooming attributes via loudness of bats and adjusting the pulse emission rate. The observed results of BAT-LBG were greater than the PSO-LBG, FA-LBG, and convergence speed is 1.841 times. There was no significant difference observed in the BAT-LBG while compared to the PSO [7].

Uma et al. (2011)-proposed the comparison among various image compression techniques. The fractal image compression (FIC) provided great robustness beside the salt and pepper noise. The computational cost of the FIC algorithm was high, so the optimization method can be used to reduce encoding with the good quality of the reconstructed image. Different optimization methods were studied with the FIC, ACO provided the best results while compared with the PSO and GA. The robustness of the reconstructed image depends on the PSNR value and encoding time. The optimization method improved the PSNR value and reduced the encoding time [8].

Abouali (2014)-proposed a vector quantization (VQ) algorithm for the compression of the image. The VQ algorithm contains three phases initial, iterative, and final. The starting phase was covered with the max-min algorithm. An adaptive LBG algorithm was used for the iterative phase, and finalization frees the codebook from noise. The iterative algorithm locates the codebook points to line up across the boundary of the object in the image. The results reflect that the image features remain stable in the high compression ratio. The proposed algorithm also implemented the codebook bins for better improvement in the quality of the area [9].

Roy et al. (2015)-proposed a hybrid image compression approach by combining Vector Quantization (VQ) and Discrete Cosine Transform (DCT). The initialization phase, a codebook is generated with the help of 10 different images using VQ. The DCT technique performs the final codebook generation. The generated codebook can compress any image. Selected codewords are used to compress the selected image, and based on these codewords compressed image was obtained. The decompression of image also performed by this method in which the original image was reconstructed from the compressed image. The proposed method was tested on the standard images and compared with the VQ method. The higher value of PSNR was provided by the hybrid algorithm while compared with the standard VQ algorithm [10].

Kekre et al. (2016)-presented a hybrid scheme using VQ and hybrid wavelet transform image compression method. Kronecker product of different transform was used to generate the hybrid wavelet transform. The image converted into the transform domain by hybrid wavelet transform and low-frequency components were retained to obtained better compression of the image. The VQ method applied to the low-frequency components for increasing the image compression ratio significantly. The implementation of VQ on the transformed images and 16 or 32 small size codebooks were generated. The better performance was achieved by using KFCG and KMCG algorithms. The image compression ratio was 192, and lowest distortion provided by the KFCG hybrid wavelet transform method [11].

Guo et al. (2014)-proposed the VQ method for the image segmentation. The image divided into the sub-block and each sub-block contains vectors which were cluster by the VQ method. In this scheme, the self-organizing map (SOM) neural network was adopted for the VQ realization. The adaptive search algorithm was proposed for estimating the optimal codebook size by using a minimization ratio of the matrix. The computational complexity of the proposed method was quite high in SOM as well as in adaptive algorithm case. The computation time also increased with the proposed method because the SOM and adaptive algorithm structure are in parallel [12].

Snayal et al. (2013)-developed an efficient VQ scheme in which a stochastic optimization algorithm called BFO (Bacterial Foraging optimization) proposed for the image compression method. In this study, the codebook design process was obtained by the fuzzy logic membership based algorithm, and determine the free parameters for the fuzzy sets. These parameters are further used for the optimization

process. An improved BFO algorithm was applied to the codebook by which compression ratio and PSNR value increase. The improved results provided the robustness to the image compression system [13].

Chiranjeevi et al. (2016)-proposed modified firefly algorithm (MFA) of VQ for image compression. In MFA the movement of brighter fireflies was in the direction of brightness in its place of random move. The codebook was generated with the help LBG method. The MFA optimization algorithm used to provide the initial command for LBG. The results show that MFA-LBG algorithm provided a better-reconstructed image than the FA-LBG and LBG algorithms. The convergence time of MFA is also less than the FA [14].

Li et al. (2014)-presented a multivariate vector quantization (MVQ) for the compression of hyperspectral imagery (HSI). In HIS the pixel spectra are taken as the linear combination of two codewords from the codebook and indexed maps, their corresponding components are coded and compressed. The fuzzy C-mean (FCM) scheme was proposed for designing the codebook, in which the number of cluster data and codeword selected for the codebooks. The proposed algorithm tested on the real dataset, which provided better performance than the conventional VQ and other algorithms used for the compression of HIS [15].

S. Mirjalili (2015) proposed a nature-inspired algorithm called Ant Lion Optimization (ALO) algorithm for the benchmark function optimal solution. The ALO follows the hunting steps of ant lion. There are five main steps of hunting of ant lion like the random walk of ants, building traps, entrapment of ants in traps, catching preys, and re-building traps. These steps were followed in the optimization algorithm and provided an optimal solution as per the position of ant lion. The benchmark functions, truss structure and ship propellers were examined by the ALO and provided the efficient design[16].

Natu et al. (2017)-proposed a hybrid approach for color image compression by combining wavelet transform and vector quantization (VQ) method. The hybrid wavelet transform was used for the image compression by which the high compression ratio achieved. The out of the wavelet transform is a compress error image. For the improvement of compression ratio, the VQ technology applied to the compress error image. A small codebook size of 32 bits was generated with VQ which provide high compression ratio. The error image also contains the distortion which can be removed by the vector quantization (VQ) approach. The obtained error image added to the transform error image, which provided the better-reconstructed image. The proposed work provided 10% less distortion than the previous work [17].

Valsesia et al. (2016)-proposed universal spectral vector quantization method for the multispectral image compression. In this approach theory of universal spectral quantization used for the vector quantization. The universal spectral theory used in the distributed context of coding. It reduces the encoding rate of the quantizer by the side information. The image was reconstructed using the total weight minimization because the side information saved in the form of weight [18].

Agustsson et al. (2017)-proposed the end to end method for the image compression and neural network. The continuous relaxation in this studies the challenges against the image compression and neural network training were discussed. The soft to hard annealing method provided the transfer of soft relaxation of sample entropy on the actual image compression. The proposed method optimized the rate of distortion between the net loss and entropy [19].

Wang et al. (2017)-presented a new technique of VQ compression by using the K-means algorithm for clustering the features. The K-mean algorithm is used to design the codebook section of VQ. The feature classification and efficient grouping method were proposed in this study. The two-level classifier, edge classifier and contrast classifier were used to divide the vector section into the 16 categories. Each category vector is sorted depend on their normal value and divides into the groups. The size of the group is the same and the centroid of the vector are estimated on the initial value of codebooks. We obtained the design of VQ codebook fast in nature and convergence speed increases by the proposed method [20].

Pantsaena et al. (2015)-presented the codebook selection scheme by using the splitting codebook method. The quality of compressed image improved with the splitting codebook selection method. The image quality of the proposed method compared with the random codebook image quality, which provided better image quality while low bit rate achieved. The splitting codebook method provided good image quality at a lower bit rate. The LBG method used for the vector quantization process and codebook design was selected by the split method. The PSNR term was considered for the performance evaluation of the compressed image [21].

Mittal et al. (2013)-presented a survey on the various algorithms used for the vector quantization (VQ) process. The algorithm from all provided the less noise produced good image quality. In VQ process, the codebook selection is a major phase, which can be formularized by various algorithms. In this study, the LBG (Linde-Buzo-Grey) algorithm, ENN (Equitzs-Nearest-Neighbor) algorithm, BPNN (Back Propagation Neural Network) and FBPNN (Fast Back Propagation Neural Network) were discussed. The quantitative comparison also observed for different algorithms in vector quantization. Among all above-said algorithms, the BPNN and FBPNN provided better image quality than the LBG and ENN. The size of the codebook was also small in case of BPNN and FBPNN [22].

Sathappan (2013)-proposed the vector quantization scheme for the low bit rate image compression system. In this method, a residual codebook is produced by the Weighted Mahalanobis Distance and Modified Fuzzy Possibilistic C-Means with Repulsion. This residual codebook removed the noise from the reconstructed images and improved the quality of the images. The proposed method provided the highest PSNR value than the other image compression technique [23].

Rishav Chatterjee (2017)- proposed the vector quantization algorithm and k-means algorithm for the image compression. The image was divided into the blocks by using VQ method. The LBG method and wavelet transform

method used for the vector quantization process. The quality measure parameters distortion and reconstruction ratio were considered for the image compression analysis — the better quality compressed image estimated by the proposed method [24].

Jiang et al. (2012)-provided an improved vector quantization, and wavelet transforms for the medical images compression. The Huffman coding was proposed for high and low-frequency components. The improved VQ applied to the wavelet transform, which provided a better visual quality compress image and high compression ratio. The parameters like PSNR, MSE, and NCC considered as the evaluation type for the compressed image [25].

III. ANALYSIS

In this research we studied various image compression methods which previously used by the researcher. The LBG algorithm developed in 1980 which commonly used in all the image compression method [1-20]. The image compression provided the reduced size with higher PSNR value or pixel value. Vector quantization is the first step of image compression in which the original image divide into the vector segments. A codebook is design in VQ method with the help of LBG algorithm. The VQ method applied to the low-frequency components for increasing the image compression ratio significantly. The implementation of VQ on the transformed images and 16 or 32 small size codebooks were generated [11]. Different types of VQ techniques used for the vector segments extraction.

The optimization algorithm used for the optimal selection of VQ parameters like PSNR and MSE. The PSO algorithm proposed in [1, 3] with LBG for the better PSNR value, BAT[2], CS[5], IDE[6], GA[8], BFO[13] etc.. also used for the image compression. ANN technique used for the image compression in [22].

IV. CONCLUSION

This is the survey paper of image compression methods. Different optimization algorithm proposed for the improvement of PSNR and MSE. Vector quantization with LBG method used for the partition of the image segments. We get an idea form paper [15] to used ALO optimization with the LBG for image compression. We will implement ALO for the better results observation.

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Table 1 Summary of Literature Review

Author	Year	Technique	Advantages	Limitations
Muruganandham et al.	2010	PSO with the FIC	Increased the speed of the fractal encoder	Only for medical image
Kumar et al.	2019	BAT-LBG for the VQ image compression	Small size codebook achieved, high compression ratio and MSE	NA
Omari et al.	2015	Genetic algorithm (GA) for image compression	The high value of PSNR obtained so image quality enhance	Iterative process
Chen et al.	2005	PSO-LBG for codebook design	Reliable reconstructed image	NA
Chiranjeevi et al.	2016	Cuckoo search (CS-LBG)	Improved convergence time, high PSNR and MSE	NA
Nag et al.	2019	Improved Differential Evolution (IDE) with LBG	Better quality image reconstructed via optimal codebook selection	NA
Chiranjeevi et al.	2016	BAT-LBG algorithm for VQ image compression	Better PSNR value achieved with VQ codebook selection	No significant difference between PSO and BAT
Uma et al.	2011	Comparison study of various FIC methods like BAT-LBG, PSO-LBG and CS-LBG	Better PSNR provided better image reconstruction	NA
Abouali	2014	Optimization for codebook noise removal	The high value of PSNR and reliable reconstructed image obtained	NA
Roy et al.	2015	A hybrid method of VQ-DCT for image compression	Image encoding and decoding both work followed	NA
Kekre et al.	2016	VQ-wavelet transformed method like KFCG and KMCG	192 image compression ratio achieved and low distortion	Only passes Low-frequency components
Guo et al.	2014	VQ with SON neural network	Computational time	NA

			increased	
Sanyal et al.	2013	VQ with BFO and Fuzzy logic	Robustness to the image	NA
Chiranjeevi et al.	2016	MFA-VQ with LBG	High PSNR value	NA
Li et al.	2014	MVQ with HSI	Better performance than VQ	NA
Seyedali Mirjalili	2015	ALO (Ant Lion Optimization)	Tested on benchmark function and provide fast convergence results	NA
Natu et al.	2017	Wavelet transform with VQ	High image compression ratio with less distortion	NA
Valsesia et al.	2016	Universal spectral vector quantization	Using side information for weight minimization	NA
Agustsson et al.	2017	End to end method for image compression and neural network training	High compression ratio	NA
Wang et al.	2017	VQ by K-mean algorithm	Codebook convergence time is fast	NA
Pantsaena et al.	2015	Spilt codebook selection technique for vector quantization	Improved compression ratio and quality of the compress image	NA
Mittal et al.	2013	Comparison among LBG, ENN, BPNN and FBPPNN	BPNN provided the better quality compress image and improved compression ratio	NA
Sathappan	2013	Residual codebook generated by the Modified Fuzzy Possibilistic C-Means with Repulsion and Weighted Mahalanobis Distance.	The quality of the compress image improved by the residual codebook slection	Only reduces the bit rate
Rishav Chatterjee	2017	vector quantization and K-means algorithm	Reduced noise and improved reconstruction ratio	NA
Jiang et al.	2012	Wavelet transform and improved vector quantization	High PSNR value compressed image computed	NA