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IMAGE COMPRESSION WITH EFFICIENT CODEBOOK INITILIZATION USING LBG- OPTIMIZATION ALGORITHM

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ABSTRACT

In this paper we present a very simple and yet effective algorithm to generate good codebook. In general VQ codebook generation algorithm focus on solving two problem(i)To reduce the computational complexity of code words search the building the codebook. (ii) Extra Computational overhead to calculate the measurement of codeword in codebooks..in this paper, a novel VQ codebook generation method based on the Linde-Buzo –Gray (LBG) is presented. VQ based image compression technique has four major steps namely(i) Codebook design (ii)VQ encoding process (iii\)VQ decoding process and (iv) Optimization process. The performance of VQ based image compression technique depends upon the constructed codebook. Novel VQ algorithm is proposed in this paper which needs less execution time and less number of iterations to converge than conventional VQ Linde-Buzo-Gray (LBG) algorithm.

KEYWORDS: Image Compression, Codebook Generation, LBG Algorithm, Optimization

INTRODUCTION

Image compression using vector Quantization (VQ) is a lossy compression technique. It is used as mapping Q of K-dimensional Euclidean Space R^k into a finite subset Y of R^k. Thus $Q:R^k \rightarrow Y$, where $y=(X_i;i=1,2,3,\ldots\ldots N)$ is the set of reproduction vectors and N is the number of vector in y.

A VQ is composed of two parts, encoder and decoder. An Encoder will compare each input vector with every code vector in the codebook and generate index which represent the minimum distortion code vector from the input vector. A decoder takes the indexes to locate the code vector in codebook and generate the output vectors.

A codebook is the set of finite code vector for representing the input vectors. The popular technique in code book design is the Linde-Buzo-Gray (LBG) Algorithm. The whole image is partitioned into sub blocks and all sub blocks are used training this codebook. In VQ the most important task is designing an efficient codebook. The performance of the LBG algorithm is extremely dependent on the selection of the initial codebook. In conventional LBG algorithm, the initial codebook is choosen at random from the training data set. It is observed that some time it produces poor quality codebook. Due to the bad code book initialization; it always converges to the nearest local minimum. In this paper, we have proposed a novel codebook initialization technique. In the initialization process, we have first chosen a highest level approximate image from original image, using image pyramid and subsequently the selected highest level approximated image is decomposed into blocks to select as the initial codebook for codebook generation. The purposed algorithm has been implemented and tested on a set of standard test images and the performances are compared with respect to the standard LBG algorithm.

VECTOR QUANTIZATION

Quantization is a process of mapping an infinite set of scalar or vector quantities by a finite set of scalar or vector quantities. Quantization has applications in the areas of signal processing, speech processing and Image processing.

In speech coding, quantization is required to reduce the number of bits used to represent a sample of speech signal. When less number of bits is used to represent a sample the bit-rate, complexity and memory requirement gets reduced. Quantization results in the loss in the quality of a speech signal, which is undesirable. So a compromise must be made between the reduction in bit-rate and the quality of speech signal. Two types of quantization techniques exist. They are scalar quantization and vector quantization. “Scalar quantization deals with the quantization of samples on a sample by sample basis”, while “vector quantization deals with quantizing the samples in groups called vectors”. Vector quantization increases the optimality of a quantizer at the cost of increased computational complexity and memory requirements.

Shannon theory states that “quantizing a vector is more effective than quantizing individual scalar values in terms of spectral distortion”. According to Shannon the dimension of a vector chosen greatly affects the performance of quantization. Vectors of larger dimension produce better quality compared to vectors of smaller dimension and in vectors of smaller dimension the transparency in the quantization is not good at a particular bit-rate chosen [8]. This is because in vectors of smaller dimension the correlation that exists between the samples is lost and the scalar quantization itself destroys the correlation that exists between successive samples.

So the quality of the quantized speech signal gets lost. Therefore, quantizing correlated data requires techniques that preserve the correlation between the samples, which is achieved by the vector quantization technique (VQ). Vector quantization is the simplification of scalar quantization. Vectors of larger dimension produce transparency in quantization at a particular bit-rate chosen. In Vector quantization the data is quantized in the form of contiguous blocks called vectors rather than individual samples. But later with the development of better coding techniques, it is made possible that transparency in quantization can also be achieved even for vectors of smaller dimension. In this thesis quantization is performed on vectors of full length and on vectors of smaller dimensions for a given bit-rate. A block diagram of vector quantizer show in figure 1.

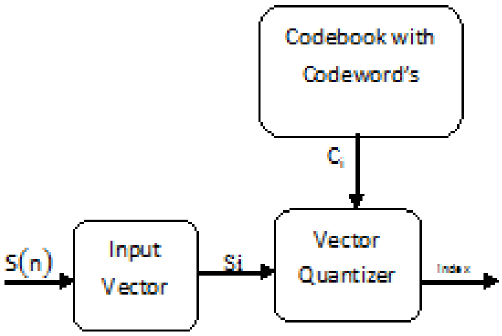

Figure 1: Block Diagram of Vector Quantizer

THE PURPOSED TECHNIQUE

In this section, the proposed LBG–Optimization algorithm using image pyramid is presented. The bottom of the pyramid represents the original image. After that, this is low pass filtered and subsamples by a factor of two to obtain the next pyramid level. Further repetition of the filters and subsamples steps.

Figure 3 shows the high level flow chart of the purposed LBG-O algorithm.LBG-O algorithm is proposed to overcome two existing problems in Conventional LBG algorithm: Empty cells and bad

Position of the code words. The basic idea of LBG-O algorithm is shifting the codeword (SoC). First of all there is an utility evaluation and then LBG-O algorithm identify the cells with a low utility. The total distortion of the i-th cell is Di and the average

Figure 2: Image Pyramid of Image

Distortion of all cells D_{mean} is

$$D_{mean} = \frac{1}{N} \sum_{i=1}^{N_C} D_i \qquad (1)$$

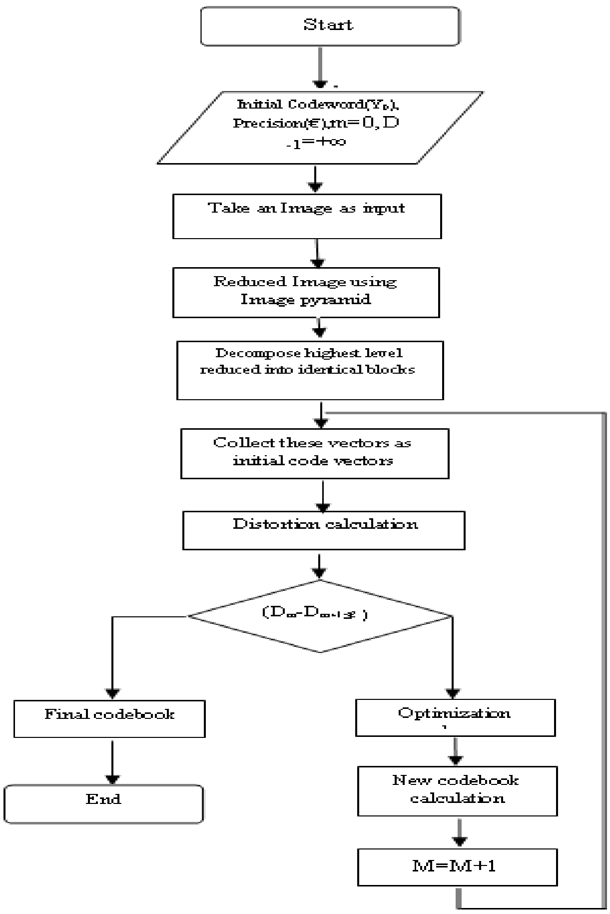

Figure 3: Flow Chart of Proposed Method

The utility Ui of the cell i is defined as

$$Ui=\frac{Di}{Dmean} \quad i=1,2\ldots..N_c \tag{2}$$

The idea of LBG-O algorithm is to obtain the desired equalization. For each SoC, We try to shift all the low utility codeword near the cells with high utility. Each Shifting will lead to a lower MQE. The aim of this operation is to obtain the Equalization of the total distortion related to the cells.

EXPERIMENTAL RESULTS

In this section, the simulation results are presented to evaluate the performance of the proposed method. We have carried out our proposed algorithm on a set of standard gray level images. All original images are shown in Figure. The experimental result are presented into three parts: the first part is to evaluate the convergence speed of the final codebook by the proposed initialization method, and the second part is to compute the PSNR & MSE value of the encoded image with the intention of know if the resultant codebook is good representive or not. The details of result of three parts are described in following subsection:

- **Computation of the Convergence Rate of Final Codebook**

The LBG algorithm and the proposed algorithm have been used to generate codebook sized 128,256,512 and 1024 to test the speed of convergence. The experimental results are presented in table 1, where we have considered stopping threshold value €=0.001.So, the proposed scheme has improved the convergence rate as compared to the LBG algorithm.

- **Quality Measurement of the Encoded Images**

In general, the measure of PSNR can be evaluating the quality of the encoded images. The PSNR values of the encoded images are listed in table 2.

- **Optimization**

LBG-O algorithm is to remove the Empty cell and bad position codeword than conventional LBG algorithm. Table 3 compares the Number of iteration for the codebook optimization process. The proposed LBG-O algorithm Reduced Number of iteration dramatically.

CONCLUSIONS

A simple and efficient codebook initialization technique for the generation of a VQ codebook has been proposed in this paper. The Simulation results shows that the proposed LBG-O algorithm gives better MQE performance and takes less number of iterations to converge than the conventional algorithm.

(a) Baby

(b) Gandhi

(c) Tulip

Figure 4: Original Images

Table 1: Performance Comparison in the Number of Iteration

Codebook Size	Block Size	Reduce Image Size	Method	Test Image (512×512)		
				Baby	Gandhi	Tulip
128	4×8	64×64	Con.LBG	9	16	7
			LBG-O	7	11	4
256	4×8	64×64	Con. LBG	10	15	11
			LBG-O	7	10	8
512	4×8	128×128	Con.LBG	11	14	14
			LBG-O	9	8	9
1024	4×8	128×128	Con.LBG	14	14	20
			LBG-O	9	10	14

Table 2: Performance Comparison in Image Quality (PSNR)

Codebook Size	Block Size	Reduce Image Size	Method	Test image (512×512)		
				Baby	Gandhi	Tulip
128	4×8	64×64	Con. LBG	28.5966	27.4666	27.1047
			LBG-O	28.4320	27.20	26.8047
256	4×8	64×64	Con.LBG	31.4367	28.5419	26.7625
			LBG-O	27.8901	28.2741	26.5432
512	4×8	128×128	Con.LBG	29.9681	29.4710	31.1701
			LBG-O	29.9261	29.5001	30.9802
1024	4×8	128×128	Con.LBG	33.1205	30.5173	32.0576
			LBG-O	33.2509	30.4812	31.9247

Table 3: Comparison of Iteration Number

Codebook Size	Number of Iteration		
	LBG	LBG-O	Gain
16	23	16	7
64	36	19	17
256	65	19	47

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