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Image Compression Using Hybrid Technique Combining VQ and Bacteria Foraging Optimization

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ABSTRACT: It is used specially for the compression of images where tolerable degradation is required with the wide use of computers and consequently need for large scale storage and transmission of data, efficient way of storing of data have becomes quite necessary. Compressing an image is significantly different than compressing raw binary data. General purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space Image compression may be lossy or lossless. Vector quantization techniques are well known methodologies that have attracted the attention of research communities. Code book design is an important step in the design of Vector Quantization. For achieving a high peak-signal to noise-ratio (PSNR) to provide high fidelity and SSIM is to provide good texture (better quality measure) near optimal code book is designed by employing a natural inspired the bacterial foraging behaviour of a common type of bacteria, Escherichia coli, popularly known as E. Coli. Genetic Algorithm is a search method based on natural selection of biological systems and representing them in the mathematical operators: crossover, mutation, fitness and selection of the fitness. Genetic algorithms have become very successful in solving a wide range of optimization problems. An improved methodology is proposed here over the BFO Algorithm in a more efficient manner. The presented image compression using high bride technique combining Vector Quantization and Bacterial Foraging optimization ensures that the global codebook will be generated to effectively compress the image. The proposed is experimented on various images and the results are assessed in terms of Peak Signal to Noise Ratio, Mean Square Error, Structural Similarity Index.

KEYWORDS: Image compression, BFO, PSNR, MSE, SSIM.

I. INTRODUCTION

Images compression is very important for efficient transmission and storage of images. Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through internet is growing explosive with the use of digital cameras requirements for storage manipulation and transfer of digital images has grown explosively these image file can be very large and can occupy a lot of memory. The basic objective of image compression is to find an image representation in which pixels are less correlated.

The fundamental principles used in image compression are redundancy and irrelevancy. The term data compression refers to the process of amount of data required to represent a given quantity of information. Data and information are not the same thing data are the means by which information is conveyed. Because various amounts of data can be used to represent the same amount of information, representations that contain irrelevant or repeated information are said to contain redundant data. . It also reduces the time required for images to be sent over the Internet or downloaded from Web pages. Compression is achieved by the removal of one or more of the three basic data redundancies

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1. Coding Redundancy
2. Inter pixel Redundancy
3. Psycho visual Redundancy

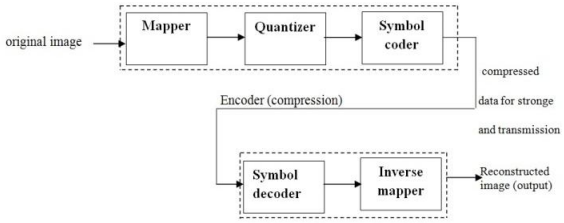
Coding redundancy is present when less than optimal code words are used. Inter pixel redundancy results from correlations between the pixels of an image. Psycho visual redundancy is due to data that is ignored by the human visual system (i.e. visually non-essential information). Image compression techniques reduce the number of bits required to represent an image by taking advantage of these redundancies. An inverse process called decompression (decoding) is applied to the compressed data to get the reconstructed image. The objective of compression is to reduce the number of bits as much as possible, while keeping the resolution and the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks: an encoder and a decoder

Image compression models:-

Shows an image compression the encoder performs compression and the decoder performs the complementary operation of decompression. Both operations can be performed in software as is the case in web browsers and many commercial image editing programs or in a combination of hardware and firmware as in commercial DVD players.

The encoding or compression process:-

The encoder is designed to remove the redundancies described above diagram through a series of three independent operations. In the first stage of the encoding process, a mapper transform f (x….) into a (usually non visual) format designed to reduce spatial and temporal redundancy.
The quainter reduces the accuracy of the mapper' s output in accordance with a pre established fidelity criterion the goal is to keep irrelevant information out of the compressed representation. It must be omitted when error free compression is desired.



Decoder (Decompression)

Symbol coder generates a fixed or variable length code to represent the quantize output and maps the output in accordance with the code.
Quantization is the process of mapping a continuous or discrete scalar or vector, produced by a source into a set of digital symbols that can be transmitted or stored using a finite number of bits.

The decoding or decompression process:-

The decoder contains only two components a symbol decoder and an inverse mapper. They perform, in reverse order the inverse operations of the encoder and mapper. Because quantization results in irreversible information loss an inverse quantize block is not included in the general. Decoder model

Vector Quantization has become a very popular tool for data compression now a days. It is basically an encoding and decoding methodology of data. When applied to image, a codebook is first generated using training dataset. Then by sectionalizing an image into a set of image blocks which are non-overlapping in nature, image vectors are produced. Each codebook vector is compared to each image vector, and proper image vector-codebook vector combination for which distortion is quite minimum. During transmission, the codebook or the codeword is transmitted along with a se-

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ries of index numbers, where each index number represents the index of the codebook vector that should represent an image vector in the reconstructed image at the receiving end. Thus the data contained by the original image is very much reduced in codebook. The popular LBG algorithm used to design vector quantizer (VQ) has got a disadvantage of higher computation volume. Recently fuzzy inferencing system is also used for designing VQ algorithms in many image processing applications. If each training vector belongs to multiple clusters a Fuzzy based soft decision making scheme can be used to design a vector quantizer. The main objective of such design is to get a codebook that gives globally optimal solution and to reduce the computational complexity involved .There are several special strategies where finally fuzziness parameter is reduced to small values and each training vector is assigned to a definite codebook vector. Gaussian type fuzzy membership function has been found its application as a soft estimator for determining the similarity between the code book vectors and the image patterns to obtain the maximum fidelity. The optimal codebook can be generated by using a stochastic optimization based schemes, as a global solution, based on minimum average distortion measure. Such methods employ a population of candidate solutions that undergo modification in an iterative manner and the final solution is expected to reach the global optimum avoiding the possibility of getting stuck in local optima as the optimum codebook.

Lossless compression involves with compressing data which, when decompressed, will be an exact replica of the original data. This is the case when binary data such as executables, documents etc. are compressed. They need to be exactly reproduced when decompressed. On the other hand, images need not be reproduced 'exactly'. An approximation of the original image is enough for most purposes, as long as the error between the original and the compressed image is tolerable.

II. BACTERIAL FORAGING OPTIMIZATION (BFO)

Bacterial Foraging Optimization (BFO) is optimization technique proposed by K. M. Passinoin 2002. To tackle complex search problems of the real world, scientists have been drawing inspiration from nature and natural creatures for years. Bacterial Foraging Optimization is a burgeoning nature inspired technique to find the optimal solution of the problem. Natural selection has a tendency to eliminate animals having poor foraging strategies and favor the ones with successful foraging strategies to propagate their genes as these are more likely to reach a successful reproduction. Poor foraging strategies are eliminated after many generations are produced. This evolutionary process of foraging inspired the researchers to utilize it as an optimization tool. The E. coli bacteria present in our intestines also practice a foraging strategy. The control system of these bacteria governing their foraging process can be subdivided into four actions, which are chemo-taxis, swarming, reproduction and elimination-dispersal.

- **Chemo-taxis**

This process is achieved by swimming and tumbling via flagella. Depending upon the rotation of flagella in each bacterium, it decides whether it should move in a predefined direction (swimming) or altogether in different directions (tumbling) in the entire lifetime tumbling in these step bacteria moves randomly in a particular direction where high nutrients are available in the search space. Initially all the bacteria are having natural nutrients. Swimming up: and Swimming Down: After successful and sufficient nutrient from tumbling, the bacteria move in the same direction if nutrients are further increasing or else it take swimming step. This swimming movement is called swimming up.

- **Swimming down**

If the direction of movement decreases the bacteria nutrients then movement is called swimming down. When bacteria experience swimming down then immediately it changes its direction.

- **Swarming**

During the process of reaching toward the best food location, it is always desired that the bacterium which has searched the optimum path should try to produce an attraction signal to other bacteria, so that they swarm together to reach the desired location. In this process, the bacteria congregate into groups and hence move as concentric patterns of groups with high bacterial density.

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- **Reproduction**

After all chemo tactic steps have been completed, a reproduction step takes place. Then, the health values of the bacteria are sorted in descending order. The least healthy bacteria die and the other healthiest bacteria each split into two bacteria, which are placed in the same location. This makes the population of bacteria constant.

- **Elimination and dispersal**

In the local environment of the bacteria, the lives of a bacteria population may change either gradually (e.g., via consumption of nutrients) or suddenly due to some other influence. All the bacteria in a local region may be killed or a group may be dispersed into a new location in the environment. They have the effect of possibly destroying the chemotaxis progress, but they also have the effect of assisting in chemo-taxis, since dispersal may place bacteria near good food sources.

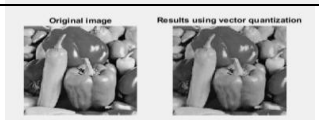
III. PROPOSED WORK

A good image compression skill is not only achieving the highest compression rate but also assuring the good quality of the compressed image. Codebook design is an important step in the design of VQ. Smallest possible codebook size is possible. Our proposed work is about proper codebook design. The popular LBG algorithm used to design vector quantizer (VQ) has got a disadvantage of higher computation volume. The primary fours of QQ is to determine limited length of the proper codebook which is assigned to represent the entire origin image data set as similar as possible when an optimum codebook is learnt from the training image, it can preserve the possible highest fidelity. As we will see in previous proposed methods, no single approach to quality measurement has gained universal acceptance. However some unbiased numerical measurement, especially mean-squared-error (MSE) measure and its variants have received more intensive consideration than others, due to their advantages such as simplicity in computation, effectiveness in quality measure and supportability in mathematics.

The present work proposes the development of a new fuzzy vector quantization scheme for image compression employing bacterial foraging based stochastic optimization with varying population technique henceforth will be known as FBFVPAVQ. The VQ based bacterial foraging optimization algorithm with fixed population (FBFOAVQ) has already been reported to be applied in image compression. This FBFVPAVQ has been employed in image compression for a number of benchmark images.

IV. RESULT ANALYSIS

The results obtained by performing proposed work are

S. NO	Image	MSE	PSNR	SSIM
1		75.2955	29.3631	0.8752
2		83.2636	28.9262	0.8790

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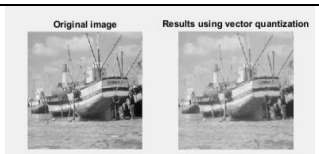
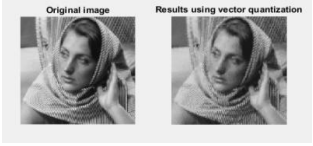
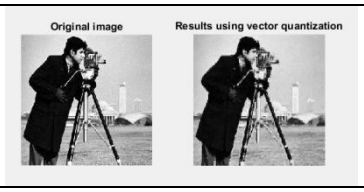
3		91.1504	28.5332	0.8514
4		123.8066	27.2034	0.8457
5		350.3214	22.6861	0.7641

TABLE

Lately, lots of efforts have been done to develop objective image quality metrics. MSE, PSNR, and SSIM are the most commonly used objective image quality measures. In our work we have both the original and the distorted images due to compression and focus on full-reference quality measures.

1. Pixel Difference Measurement:-

Types related to this category are like MSE and PSNR:

i) Mean Square Error (MSE):-

MSE is computed by averaging the squared intensity of the original (input) image and the resultant (output) image pixels as in (1).

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

ii) Peak Signal-to-Noise Ratio (PSNR):-

Signal–to-noise ratio (SNR) is a mathematical measure of image quality based on the pixel difference between two images [1]. The SNR measure is an estimate of quality of reconstructed image compared with original image. PSNR is defined as in

$$PSNR = 10\log_{10}(\frac{R^2}{MSE})$$

where R = 255 for an 8-bit image. The PSNR is basically the SNR when all pixel values are equal to the maximum possible value.

PSNR Analysis

PSNR Analysis of various images shown below in graph. PSNR block computes the peak signal to noise ratio in decibels, A high peak-to-signal noise ratio is to provide high fidelity. Peaksnr-psnr (A,ref) calculates the peak signal-to-noise ratio for the image A, with the image ref as the reference. A and ref must be of the same size and class.

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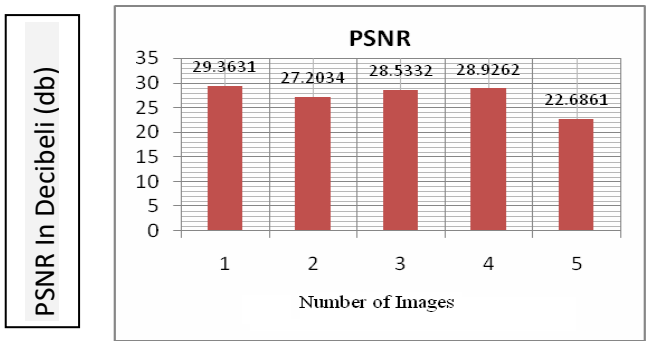
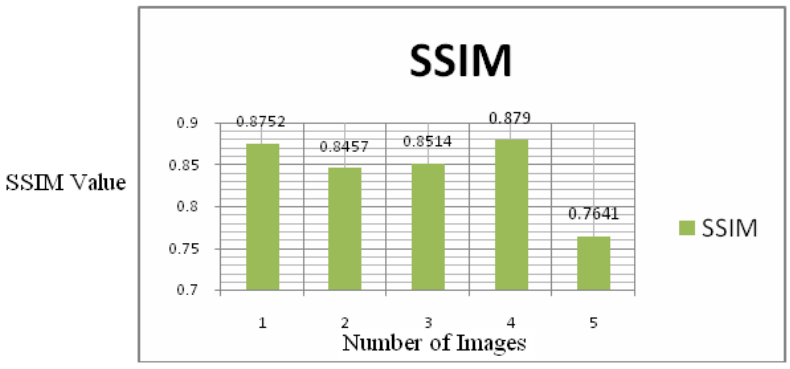


SSIM Analysis

SSIM is structural similarity index (SSIM) is a perceptual metric that quantifies image quality degradation caused by processing such as data compression or by losses in data transmission. It is a full reference metric that requires two images from the same image captured. – A reference image and a processed image. The processed image is typically compressed. SSIM is best known in video industry but has strong application for still photography. Any image may be used including those of lmatest test patterns such as spilled coins or Log F-contrast. Basically SSIM actually measures the perceptual difference between two images. Unlike PSNR, SSIM is based on visible structures in the image Al-though PSNR is no longer regarded as a reliable indicator of image quality degradation. It is available as an alternative measurement in the imatest SSIM module. The Imatest SSIM calculation is based on the MATLAB implementation of the paper, The range of SSIM is -1 to +1 and SSIM value equal to one shows original image and reconstructed image is similar. The algorithm is said to be good if SSIM value is near around +1.



V. CONCLUSION AND FUTURE SCOPE

Image compression using Hybrid Technique combining vector quantization and bacteria forging optimization gives the best result as we seen that PSNR, SSIM & MSE on the basis the various images. It is an algorithm that removes not only the noise but also a part of the textures will have a good score. The difference with respect to other techniques mentioned previously such as MSE or PSNR is that these approaches estimate absolute errors. On the other had SSIM is a perception based model that considers image degradation as perceived change in structural information while also. SSIM looks like a better quality measure (the exact formula involves one no. per pixel while PSNR gives us an average value for the whole image.

As we know soft computing is approximation to achieve tractability, robustness & low solution cost. Other soft com-puting techniques may also be applied on image compression. Nature- Inspired Algorithm such as Simulated Anneal-

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ing, Differential Evolution, Ant and Bee Algorithms, Particle swarm Optimization, The firefly Algorithm, The Flower Algorithm, Cuckoo Search, The Bat Algorithm etc. There are still many aspects to be investigated in the future, such as adaptive up-sampling enhanced indexing method & so on.

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