RESEARCH ARTICLE OPEN ACCESS

A Note on Quantization Using Cuckoo Search Using Self Information

Er. Sandeep Kad [1], Er.Sukhmeet Kaur [2]
Department of Computer Science and Engineering
Amritsar College of Engineering. & Tech.
Punjab - India

ABSTRACT
Colour Image Quantization algorithm based on Cuckoo Search (CS-CIQ) is a algorithm that reduces the number of distinct colours used in an image, usually with the intention that the new image should be as visually similar as possible to the original image. The objective of this research work is to evaluate the efficiency of this algorithm by calculating peak-signal to noise ratio (PSNR) and to compare it with other swarm intelligence techniques for the validation of the work. The conducted experiments indicate that algorithm generally results in a significant improvement of image quality compared to other well-known approaches.
***Keywords:* -** Colour Image Quantization, Cuckoo Search, peak-signal to noise ratio (PSNR).

I. INTRODUCTION

This Color image quantization, one of the common image processing techniques, it is the process of reducing the number of colors presented in a color image with less distortion [8]. The main purpose of color quantization is reducing the use of storage media and accelerating image sending time [5]. Many color quantization methods are found in the literature. Notable examples include the median-cut algorithm [14], the uniform algorithm [14], the octree algorithm [11], the center-cut algorithm [7], PGF [1], the window-based algorithm [16], clustering-based algorithms such as *k*-means [2, 3], the adaptive clustering algorithm [4], SOM-based clustering algorithms [9], and an ant colony clustering algorithm [6]. Since these methods focus on analysis in different aspects of the quantization process, they have unique advantages and disadvantages depending on the color data sets encountered. Color Image Quantization algorithm based on Cuckoo Search (CS-CIQ) is used to quantize the color image. This algorithm is based on Cuckoo Search. Cuckoo Search is a new metaheuristic algorithm, for solving optimization problems. This paper evaluates the efficiency of this algorithm by calculating mean square error and to compare it with other swarm intelligence techniques for the validation of the work. This paper is organized as follows: Section I briefly introduces the Color Image Quantization, Cuckoo Search, peak-signal to noise ratio(PSNR), Color Image Quantization algorithm based on Cuckoo Search. In Section II, results are discussed, Section III, concludes this paper and provides the guidelines for future research.

A. *Color Image Quantization*

Color image quantization is the process used to re digital color image. As a fundamental process in image processing, color quantization plays an important role in many subfields mentioned above. Generally speaking, color image quantization is divided into four phases [12]:

1) Sampling the original image for color statistics;
2) Choosing a color map based on the color Statistics;
3) Mapping original colors to their nearest neighbors in the color map; and
4) Quantizing and rendering the original image.

B. *Cuckoo Search*

Cuckoos are fascinating birds, not only because of the beautiful sounds they can make, but also because of their aggressive reproduction strategy. Some species such as the *ani* and *Guira* cuckoos lay their eggs in communal nests, though they may remove others' eggs to increase the hatching probability of their own eggs.

For simplicity in describing the Cuckoo Search, the following three idealized rules are used:

1) Each cuckoo lays one egg at a time, and dump its egg in randomly chosen nest;
2) The best nests with high quality of eggs will carry over to the next generations;
3) The number of available host nests is fixed.

The egg laid by a cuckoo is discovered by the host bird with a probability $\rho_a \in [0, 1]$. In this case, the host bird can either throw the egg away or abandon the nest, and build a completely new nest. For simplicity, this last assumption can be approximated by the fraction ρ_a of the *n* nests are replaced by new nests (with new random solutions) [17].
For simplicity, we can use the following simple representations that each egg in a nest represents a solution, and a cuckoo egg represent a new solution, the aim is to use the new and potentially better solutions (cuckoos) to replace a not-so-good solution in the nests.
Based on these three rules, the basic steps of the Cuckoo Search (CS) can be summarized as the pseudo code shown in Fig. 1

```
Cuckoo Search via L´evy Flights
begin
Objective function f(x), x = (x1, ..., xd)T
Generate initial population of
n host nests xi (i = 1, 2, ..., n)
while (t <MaxGeneration) or (stop criterion)
Get a cuckoo randomly by L´evy flights
evaluate its quality/fitness Fi
Choose a nest among n (say, j) randomly
if (Fi > Fj ),
replace j by the new solution;
end
A fraction (ρa) of worse nests
are abandoned and new ones are built;
Keep the best solutions
(or nests with quality solutions);
Rank the solutions and find the current best
end while
Postprocess results and visualization
End
```

Fig. 1: Pseudo code of the Cuckoo Search (CS).

C. Color Image Quantization algorithm based on Cuckoo Search

Cuckoo Search algorithm is used to quantize the color image. In this, initially clusters of the image are obtained using rough set theory. Each cluster of the image is considered as Cuckoo egg. Then, K most frequently occurring colors from the image are obtained using k-means algorithm. Each of these k-colors will act as an egg in the host nest. All the Cuckoo eggs(clusters) in the image are compared with every other host egg(most frequently occurring colors) in the image to find the most similar color. The fitness function is taken as CMC distance to find out the distance between cuckoo eggs(clusters) from each of the host egg(most frequently occurring colors). Cuckoo will lay egg in the nest where the fitness function is minimum i.e. cuckoo's egg is almost identical to the host egg. Each cuckoo egg(cluster) has been layed(absorbed) in nest(most frequency occurs colors). Each pixel in cluster should be assigned the color of pixel in nest.

D. Peak-signal to noise ratio

The Peak Signal to Noise Ratio (PSNR) is the ratio between maximum possible power and corrupting noise that affect representation of image. PSNR is usually expressed as decibel scale. The PSNR is commonly used as measure of quality reconstruction of image. The signal in this case is original data and the noise is the error introduced. High value of PSNR indicates the high quality of image. It is defined via the Mean Square Error (MSE) and corresponding distortion matric, the Peak Signal to Noise Ratio [15].

PSNR= 10.log10 [(255)2/MSE] (2)

Here, 255 bar color image with three RGB value per pixel.

E. Mean Square Error

The mean square error (MSE) is the most general measure of quality of a quantized image. It represents the color error between image *I* and its quantized image *I'*. Mean Square Error can be estimated in one of many ways to quantify the difference between values implied by an estimate and the true quality being certificated. In the following CS-CIQ, the MSE is defined as follows:

$$MSE = \frac{1}{N_p}\{\sum_{r=1}^{N_p}[\min_{k=1}^{K} d(p_r, c_k)\}$$

where the symbols used in above equation, whichwere used in the remaining parts of this work, are explained as follows:
(i) Np: the number of image pixels,
(ii) K: the color number in the colormap,
(iii) pr= ($pr1$, $pr2$, $pr3$): the rth pixel of the color image I, r = 1, 2, . , Np,
(iv) ck: the kth color triple in the colormap, k = 1, 2,

II. RESULTS AND DISCUSSIONS

In this section, the Color Image Quantization based on Cuckoo Search is tested on a set of four commonly used test images in the quantization literature.

Images. The set of test images include Peppers.jpeg(256 x 256), peppers.png(512x512), Lena.jpeg(256 x 256), Lena.png(512 x 512) pixels.

Experimental Results. For the algorithm, the test images are quantized into 16 colors. The following figures show input image with original number of colors and resulting image with quantized colors:

Fig. 2: Original image 'Peppers.jpeg' (256 X 256) with 6481 colors on left side and Quantized image 'Peppers. jpeg' (256 X 256) with 16 colors on right side.

Fig. 3: Original image 'Peppers.png' (512 X 512) with 6481 colors on left side and Quantized image 'Peppers.png' (512 X 512) with 16 colors on right side.

Fig. 4: Original image 'Lena.jpeg' (256 X 256) with 9889 colors on left side and quantized image 'Lena. jpeg'(256 X 256) with 16 colors on right side.

Fig. 5: Original image 'Lena.png' (512 X 512) with 9778 colors on left side and quantized image ''Lena.png' (512 X 512) with 16 colors on right side.

Name of the image	Original number of colors	Colors after quantization	PSNR with CS-CIQ
Peppers.jpeg (256 X 256)	**6481**	**16**	**19.6834**
Peppers.png (512 X 512)	**6481**	**16**	**17.5191**
Lena.jpeg (256 X 256)	**9889**	**16**	**22.6910**
Lena.png (512 X 512)	**9778**	**16**	**22.5848**

Table 1: Computational Result based on PSNR

In addition, the performance of the CS-CIQ is compared with the color image quantization algorithm using BBO and BFO presented in literature the [13]:

Fig. 6: Quantized image 'lenna.png' with 5779 colors using BFO on left side, Quantized image 'lenna.png' with 8616 colors using BBO in the centre and Quantized image 'lenna.png' with 16 colors using CS-CIQ on right side.

Analysis of Experimental Results: As shown in Fig. 6, the results obtained by using Color Image Quantization based on Cuckoo Serach(CS-CIQ) are comparatively better than the results obtained by Biogeography Based Optimization(BBO) and Bacterial Foraging Optimization(BFO). The CS-CIQ outperforms BBO & BFO in the visual quality of the quantized images for all test images. The above experimental results can be summarized as

(i) the CS-CIQ is an effective color image quantization method;
(ii) the CS-CIQ has better quantization quality than BBO & BFO;
(iii) the CS-CIQ converges more quickly than the BBO & BFO.

III. CONCLUSION AND FUTURE WORK

This paper validates a color image quantization algorithm based on Cuckoo Search (CS-CIQ). Numerical experiments are implemented to investigate the performance of the CS-CIQ and to compare it against BBO & BFO presented in the literature [13]. For a set of commonly used test images, the experimental results demonstrate the feasibility of the CS-CIQ and its superiority BBO & BFO in the quantization quality. In addition, the CS-CIQ has simpler operation, litter parameters, and faster convergence than the BBO & BFO.

REFERENCES:

[1] A. H. Dekker, "Kohonen Neural Networks for Optimal Colour Quantization", Network Computation. Neural System. vol. 5, pp. 351-367, 1994.

[2] A. Strehl and J. Ghosh, "Cluster Ensembles – A Knowledge Reuse Framework for Combining Multiple Partitions". Journal of Machine Learning Research, no.3 pp.583-617, 2002.

[3] A. Topchy, A.K. Jain and W. Punch, "Clustering Ensembles: Models of Consensus and Weak Partitions". IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 27, no. 12, pp. 1866-1881, 2005.

[4] A. Fred and A.K. Jain, "Combining Multiple Clusterings Using Evidence Accumulation". IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 27, no. 6, pp. 835-850, 2005.

[5] F. Alamdar, Z. Bahmani, and S. Haratizadeh, "Color quantization with clustering by F-PSO-GA," in Proceedings of the IEEE InternationalConference on IntelligentComputing and Intelligent Systems (ICIS '10), vol. 3, pp. 233–238,October 2010.

[6] H. Stokman and T. Gevers, Selection and Fusion of Color Models for Feature Detection. IEEE International Conference on Computer Vision and Pattern Recognition, vol. 1, pp. 560-565, 2005.

[7] I.-S. Hsieh and K.-C. Fan, 2000, An Adaptive Clustering Algorithm for Color Quantization, Pattern Recognition Letters, vol. 21, pp. 337-346, 2000.

[8] J.-P. Braquelaire and L. Brun, "Comparison and optimization of methods of color image quantization," *IEEE Transactions onImage Processing*, vol. 6, no. 7, pp. 1048–1052, 1997.

[9] L.I. Kuncheva and D.P. Vetrov, Evaluation of Stability of K-Means Cluster Ensembles with Respect to Random Initialization. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 28, no. 11, pp. 1798-1808.

[10] Mahamed G. Omran and Andries P. Engelbrecht, Ayed Salman "A Color Image Quantization Algorithm Based on Particle Swarm Optimization Informatica (2005)261– 269.

[11] O. Verevka, Color Image Quantization in Window System with Local K-means Algorithm. Proc. Western Computer Graphics Symposium, pp. 74-79, 1995.

[12] P.Heckbert, Color Image Quantization for Frame Buffer Display, ACM Computer Graphics, vol. 16, no. 3, pp. 297–307, 1982.Quantization, Proc. IEEE International Symposium

[13] Kaur R., Girdhar, A. and Gupta S., "Color Image quantization based on Bacteria foraging Optimization", International Journal of computer Applications, Vol. 25, No.7(2011).

[14] T. Kanunqo, D.M. Mount, N.S. Netanyahu, C.D. Piatko, R.Silverman and A.Y. Wu, An Efficient K-Means Clustering Algorithm: Analysis and Implementation. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, no. 7, pp. 881-892, 2002.

[15] Thakur N.., Devi S., "A New Method for Color Image Quality Assessment". International Journal of Computer Applications (0975 –8887)Volume 15– No.2, February 2011.

[16] X. Hu, T. Wang and D. Li, A New Approach of Color Quantization Based on Ant Colony Clustering Algorithm, International Conference on Information Technology: Coding and Computing, 2005.

[17] Yang, X.-S. and Deb, S., "Cuckoo search via Lavy flights", in Proc. of World Congress on Nature & Biologically Inspired Computing (NaBIC 2009),Coimbatore,India, pp.210-214(2009).