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A Note on Quantization using Cuckoo Search using Self Information: A Short Review and an Application with Real Images

Er. **Sandeep Kad**
Assoc. Prof., ACET, Asr

Er.**Sukhmeet Kaur**
Asst.Prof., KCET, Asr

Abstract-Color quantization is the process of reducing the number of colors in a digital image. The main objective of quantization process is that significant information should be preserved while reducing the color of an image. In other words, quantization process shouldn't cause significant information loss in the image. In this paper, a short review of Color Image quantization based on Cuckoo algorithm is presented.

Keywords-Color Image Quantization, Cuckoo Search.

I. INTRODUCTION

Color image quantization is a process of representing an image with a smaller number of well selected colors. It is known that high quality images can be displayed and stored without much effort with the rapid development of computer software and hardware. However, these images can contain a huge amount of detailed information causing transfer time and processing problems. In order to avoid these problems, unnecessary information should be eliminated from images with some pre-processing methods before processing and transmission. Color quantization, accepted as a pre-processing application, is used to reduce the number of colors in images with minimum distortion such that the reproduced image should be very close to the original image visually. In general, color quantization is performed in two steps. The first step is pallete design i.e. selecting appropriate number of colors (generally 8-256). The second step is pixel mapping i.e. replacing each pixel color with the color in the pallete. Therefore, color quantization can be accepted as a lossy image compression operation [3]. To address this problem, researchers have applied several stochastic optimization methods, such as GA(Genetic algorithm) and PSO(Particle Swarm Optimization). In particular, the literature [4–6] has compared the color image quantization algorithm using PSO and several other well known color image quantization methods. Cuckoo Search is a new metaheuristic algorithm, for solving optimization problems. It is based on the obligate brood parasitic behaviour of some cuckoo species in combination with the L´evy flight behaviour of some birds and fruit flies[7].

The paper 'A Note on Quantization using Cuckoo Search using self information' applies Cuckoo Search to solve the color image quantization. The paper proposes a color image quantization algorithm based on Cuckoo Search and evaluates 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.

In this paper, a short review of Color Image quantization based on Cuckoo algorithm is presented and the algorithm is tested on five more real images.

A. Color image quantization Based on Cuckoo Search

In this research, 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. 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 as described in Figure 1[1].

II. RESULTS AND DISCUSSIONS

'A Note on Quantization using Cuckoo Search using self information', tested algorithm on a set of four commonly used test images in the quantization literature which included Peppers.jpeg (256 x 256), peppers.png (512x512), Lena.jpeg (256 x 256), Lena.png (512 x 512) only . In this paper algorithm is tested on a set of five real images which include Ptu(256 x 256), Design(256 x 256),Khalsa(256 x 256), Acet(256 x 256), Jbagh(256 x 256),

A.Experimental Results.

For the algorithm, the test images are quantized into 16 colors. Our objective is to use the Cuckoo Search algorithm for Color image quantization on real images. The following figures show input image and resulting image with quantized colors.

1. Get the image.
2. Form the initial clusters of the image (using rough set theory). The centroid of the cluster will act as a cuckoo. Thus, n clusters correspond to n cuckoos in the algorithm.
3. Get K most frequently occurring colors from the image using k-means algorithm. Each of k-colors will act as an egg in the host nest. Thus, there are K-nests in the algorithm.
4. For i = 1 to n
   (a) Get i^{th} cuckoo.
   (b) Evaluate the fitness function of i^{th} cuckoo with respect to each of the K nests. Here, The fitness function is taken as CMC distance. i^{th} 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.

   end for
5. 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.

Figure 1: Algorithm Cuckoo Search Based Color Image Quantization

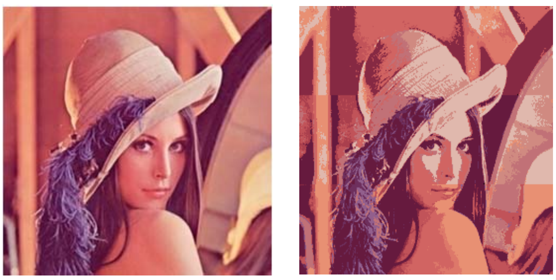

Figure 2: Original image 'Lena.png' (512 X 512) on left side and quantized image ''Lena.png' (512 X 512) on right side.

Figure 3: Original image 'Ptu.jpg' (256 X 256) on left side and Quantized image 'Ptu. jpg' (256 X 256) on right side.

Figure 4: Original image 'Design.jpg' (256 X 256) on left side and Quantized image ''Design.jpg' (256 X 256) on right side.

Figure 5: Original image 'Khalsa.jpg' (256 X 256) on left side and quantized image 'Khalsa.jpg' (256 X 256) on right side.

Figure 6: Original image 'Acet.jpg' (256 X 256) on left side and quantized image 'Acet.jpg' (256 X 256) on right side.

Figure 6: Original image 'Jbagh.jpg' (256 X 256) on left side and quantized image 'Jbagh.jpg' (256 X 256) on right side.

From the above results it can be observed that perceptual uniformity is there in the output image. There is no degradation in the image quality i.e. the image perception from the viewer point of view is same in both.

B. Histograms

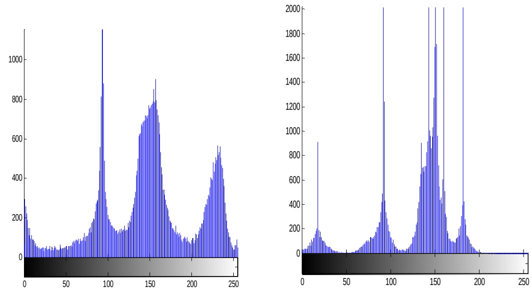

Figure 7: Histogram of original image of 'Ptu.jpg' (256 X 256) on left side and histogram of Quantized image of 'Ptu.jpg' (256 X 256) on right side.

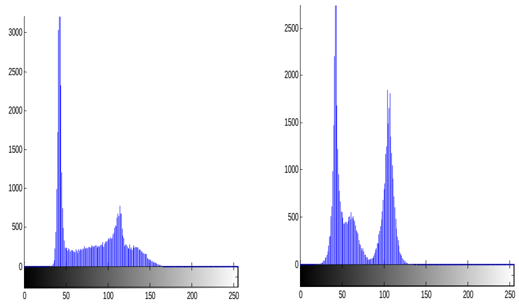

Figure 8: Histogram of original image of 'Design.jpg' (256 X 256) on left side and histogram of quantized image of 'Design.jpg' (256 X 256) on right side.

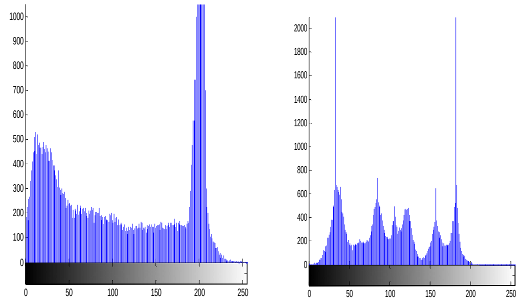

Figure 9: Histogram of original image of 'Khalsa.jpg' (256 X 256) on left side and histogram of quantized image of 'Khalsa.jpg' (256 X 256) on right side.

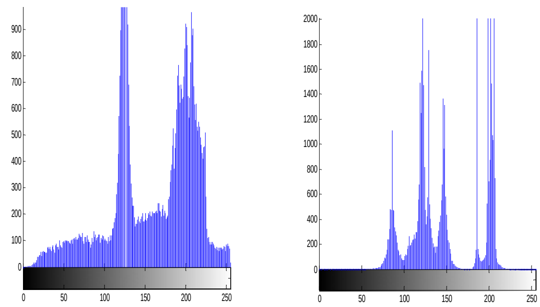

Figure 10: Histogram of original image of 'Acet.jpg' (256 X 256) on left side and histogram of quantized image of'Acet.jpg' (256 X 256) on right side.

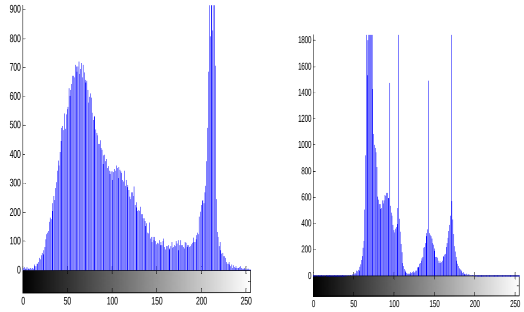

Figure 11: Histogram of original image of 'Jbagh.jpg' (256 X 256) on left side and Histogram of quantized image of 'Jbagh.jpg' (256 X 256) on right side.

Name of the Image	Original number of colors	Colors after quantization	PSNR with CS-CIQ
Lenna.jpg	9889	16	22.6910
Ptu.jpg (256 X 256)	5247	16	15.6037
Design.jpg (256 X 256)	4754	16	21.5530
Khalsa.jpg (256 X 256)	5632	16	14.5373
Acet.jpg (256 X 256)	3424	16	18.4202
Jbagh.jpg (256 X 256)	5631	16	16.8340

Table 1: Computational Result based on PSNR

After this, the performance of the CS-CIQ is compared with the color image quantization algorithm using BBO and BFO presented in literature the [2]:

Figure 12: 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.

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).

III. Conclusion And Future Work

This paper presents a Color Image Quantization algorithm based on Cuckoo Search (CS-CIQ). Experiments are implemented to investigate the performance of the CS-CIQ. For a set of commonly used test images and a set of five real the experimental results demonstrate the feasibility of the CS-CIQ. There is a lot of scope for improvement to develop this algorithm as efficient classifier.

Further research work may focus on developing some new algorithms related to Cuckoo search to decrease the computational cost and time. Future research may try to apply the CS-CIQ to other color spaces [1].

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