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Proposed Method for Color Image Quantization

Harmanjeet Kaur
Computer Science Engineering, PTU, India
RIEIT Railmajra, Punjab, India
harman.salh@gmaill.com

Abstract—The HSI color space is very important and attractive color model for image processing applications because it represents colors similarly how the human eye senses colors. The HSI color model represents every color with three components: hue(H), saturation (S), intensity (I). Honey bee optimization is an optimization algorithm inspired by the natural foraging behaviour of honey bees to find the optimal solution. Color image quantization is an important process of representing true color images using a small number of colors. The objective of this research work, is to investigate the performance of Honey Bee Optimization on color image quantization. To implement and test the proposed algorithm. To compare the designed algorithm with other quantization techniques. The conducted experiments indicate that proposed algorithm generally results in a significant improvement of image quality compared to other approaches.

Keywords— HSI color space, Honey Bee optimization, color image quantization, Maximum Difference, Mean Square Error.

I. INTRODUCTION

In computer science and operations research, the Honey bees optimization algorithm is a population-based search algorithm first developed in 2005.It is a new comer to the family of nature-inspired optimization algorithms. For over the last five decades, optimization algorithms like Genetic Algorithms (GAs), Evolutionary Programming (EP), Evolutionary Strategies (ES), which draw their inspiration from evolution and natural genetics, have been dominating the realm of optimization algorithms. Recently natural swarm inspired algorithms like Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) have found their way into this domain and proved their effectiveness. Following the same trend of swarm-based algorithms, Honey Bee Algorithm was developed. It is an optimisation algorithm inspired by the natural foraging behaviour of honey bees to find the optimal solution. It performs a kind of neighbourhood search combined with random search and can be used for both combinatorial optimization and functional optimisation.

A. Behaviour of Honey Bees in Nature

Honey bee swarm consists of the following essential components: food sources, employed foragers and unemployed foragers, experienced forgers:

1) Food Sources: The value of a food source depends on many factors such as its proximity to the nest, its richness or concentration of its energy, and the ease of extracting this energy. For the sake of simplicity, the "profitability" of a food source can be represented with a single quantity.

2) Employed foragers: (EF in "Fig.1"): They are associated with a particular food source which they are currently exploiting or are "employed" at. They carry with them information about this particular source, its distance and direction from the nest, the profitability of the source. After the employed foraging bee loads a portion of nectar from the food source, it returns to the hive and unloads the nectar to the food area in the hive. There are three possible options related to residual amount of nectar for the foraging bee. (1) If the nectar amount decreased to a low level or exhausted, foraging bee abandons the food source and become an unemployed bee. (2) it can continue to forage without sharing the food source information with the nest mates. (3) Or it can go to the dance area to perform waggle dance for informing the nest mates about the same food source.

3) Unemployed foragers: If it is assumed that a bee have no knowledge about the food sources, initializes its search as an unemployed forager. There are two possibilities for an unemployed forager: (1) Scout Bee (S in "Fig.1"): if the bee starts searching spontaneously without any knowledge, it will be a scout bee. The percentage of scout bees varies from 5% to 30% according to the information into the nest. The mean number of scouts averaged over conditions is about 10% . (2) Recruit (R in "Fig.1"): if the unemployed forager attends to a waggle dance done by some other bee, the bee will start searching by using the knowledge from waggle dance.

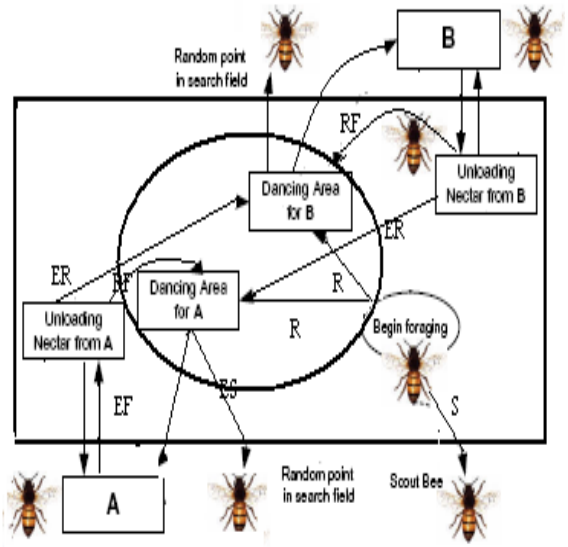

Fig.1 The behaviour of honey bee foraging for nectar

4) Experienced foragers: These types of forager use their historical memories for the location and quality of food sources.

It can be an inspector which controls the recent status of food source already discovered. It can be a reactivated forager by using the information from waggle dance. It tries to explore the same food source discovered by itself if there are some other bees confirm the quality of same food source (RF in Figure 1).It can be scout bee to search new patches if the whole food source is exhausted (ES in Figure 1).It can be a recruit bee which is searching a new food source declared in dancing area by another employed bee (ER in Figure 1).

B. Honey Bee Algorithm

The main steps of the algorithm are given below:

1) Send the scouts onto the initial food sources
2) REPEAT
3) Send the employed bees onto the food sources and determine their nectar amounts
4) Calculate the probability value of the sources with which they are preferred by the onlooker bees
5) Stop the exploitation process of the sources abandoned by the bees
6) Send the scouts into the search area for discovering new food sources, randomly
7) Memorize the best food source found so far
8) UNTIL (requirements are met)

C. Color Image Quantization

A color image quantization is a process that reduces the number of distinct colors used in an image, usually with the intention that the new image should be as visually similar as possible to the original image. Color quantization is important because quantized image can be used in many applications including the following:

- It can be used in lossy compression techniques
- It is suitable for mobile and hand-held devices where memory is usually small.
- It is suitable for low-cost color display and printing devices where only a small number of colors can be displayed or printed simultaneously.
- Most graphics hardware use color lookup tables with a limited number of colors.

So, the main objective of color image quantization is to map the set of colors in the original color image to a much smaller set of colors in the quantized image.

D. HSI Color Model

HSI color space is very important and attractive color model for image processing applications because it represents color s similarly how the human eye senses colors. The HSI The color model represents every color with three components: hue (H), saturation (S), intensity (I). The below figure illustrates how the HIS color space represents colors.

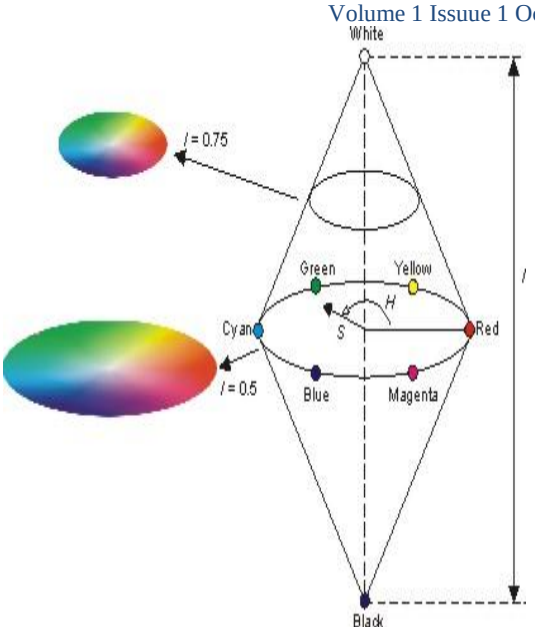

Fig. 2 HSI Color Model

The Hue component describes the color itself in the form of an angle between [0,360] degrees. 0 degree mean red, 120 means green 240 means blue. 60 degrees is yellow, 300 degrees is magenta. The Saturation component signals how much the color is polluted with white color. The range of the S component is [0,1].The Intensity range is between [0,1] and 0 means black, 1 means white. As the above figure shows, hue is more meaningful when saturation approaches 1 and less meaningful when saturation approaches 0 or when intensity approaches 0 or 1. Intensity also limits the saturation values

II. RELATED WORK IN THE FIELD OF COLOR IMAGE QUANTIZATION

Several heuristic techniques for color image quantization have been proposed in the literature. Some of them are discussed below.

The median cut algorithm (MCA) divides the color space repeatedly along the median into rectangular boxes until the desired number of colors is obtained.

Popularity Algorithm builds the color map by finding the K most frequently appearing colors in the original image. Therefore the colors are stored in a histogram. The K most frequently occurring colors are extracted and they are made the entries in the color table. Now the true image can be quantized.

The variance-based algorithm (VBA) also divides the color space into rectangular boxes. However, in VBA the box with the largest mean squared error between the colors in the box and their mean is split.

The octree quantization algorithm repeatedly subdivides a cube into eight smaller cubes in a tree structure of degree eight. Then adjacent cubes with the least number of pixels are

merged. This is repeated until the required number of colors is obtained.

M. G. Omran in his paper proposes Color image quantization based on PSO. The proposed approach is of the class of quantization techniques that performs clustering of the color space. The proposed algorithm randomly initializes each particle in the swarm to contain K centroids (i.e. color triplets). The K-means clustering algorithm is then applied to each particle at a user-specified probability to refine the chosen centroids. Each pixel is then assigned to the cluster with the closest centroid. The PSO is then applied to refine the centroids obtained from the Kmeans algorithm.

III. DESIGN OF PROPOSED ALGORITHM

Step 1: Design an algorithm for color image quantization of HSI images by mimicking the behaviour of honey bee.

Step 2: Validate the proposed algorithm by running on various types of images

Step 3: Compare the results of previous work with the results generated in step 2.

The performance matrix comprise of following image quality measures:

A. Mean Square Error

The large value of MSE means that image is poor quality.

B. Peak Signal to Noise Ratio (PSNR)

The small value of Peak Signal to Noise Ratio (PSNR) means that image is poor quality.

C. Maximum Difference (MD)

The large value of Maximum Difference (MD) means that image is poor quality.

IV. PROPOSED MODEL

Researchers are continuously searching for better techniques of color image quantization to display the image on the display with the less number of colors and to reduce the storage requirements. In the proposed model, an alternate technique of Color image quantization is proposed based on honey bee optimization. The position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. The number of the employed bees or the onlooker bees is equal to the number of solutions in the population.

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