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A Novel Method for Edge Detection of a Color Image with ACO algorithm in Swarm Intelligence

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Abstract—Edge detection is the most important task in image processing. It detects the presence and location of edges from an image having sharp changes in brightness or color intensity of an image. There are various techniques present for edge detection but the newer technique, Ant Colony Optimization is introduced here. Primarily ACO is used to detect edges of ray scale image but here an attempt is made to detect edges of color image. Using ACO feature extraction and edge pattern detection of a color image can be done. To avoid problem of over segmentation of an image which is observed in case of traditional algorithm due to static threshold value selection, the dynamic threshold value is generated with the help of an adaptive threshold histogram method.
Keywords-Adaptive threshold, Ant Colony Optimization, Edge detection, pattern detection, over segmentation.

I. INTRODUCTION

A new technique called Swarm intelligence is used mainly for problem solving. The swarm intelligence is inspired with the social behavior of some insects and animals such as bird flocks, fish schools and wildebeest herds etc. Ant colonies are so good at finding the shortest path from one location to another, that an algorithm was developed based on their behavior called as Ant Colony Optimization. Ant colony optimization (ACO) is inspired by their division of labor and foraging behavior of some ant species. The individuals are often ineffi-cient to perform the labor they might perform, but in group they might consistently work as fighters, scouts, nurses, undertakers, foragers, or cleaners with a defined line of work in a factory [1]. A chemical substance known as the pheromone is deposited by these ants on the ground to mark some promising path that should be followed by other members of the colony. The chemical trail i.e. pheromone has a falling action over time due to the evaporation of trail and the quantity left by ants depends on the number of ants using this trail. There is an indirect communication between the ants by way of chemical pheromone trails that enables them to find shorter paths between their nest and food sources. This real ant colonies characteristic is used in ACO algorithms to solve, discrete optimization problems [2]-[4].
ACO is primarily used for detection of edges in a grayscale images. The templates are used to study self organization process, where a template can be defined as a pattern used to construct another pattern [5]-[6]. The ACO uses distributed nature of swarm intelligence methods that allow us to utilize such nature inspired ap-proaches to increase efficiency in the self organizing process and to improve performance of problem solving.
Image segmentation is an important feature of image processing where image is divided into different regions [7].To achieve this different edge detection methods have been introduced.
In this paper ACO is presented to be used for detecting edges in color image as edge detection in color image is an important feature. The limitations occur due to static threshold value generation in case of ACO for gray scale image feature extractions are eliminated as the threshold value is generated dynamically. By giving the facility of dynamically adjusting threshold parameters to

individual swarm agents in response to the chang-ing environment, increases the self-organization capability of Swarm by increasing adaptability. Because of this the Swarm allows to successfully self-organize into patterns representing the image feature structure over a wider range of image characteristics (such as ambient lighting, entropy, noise) [8].

II. LITERATURE REVIEW

The Previous work on image edge detection performed by various researchers is given below. Raman Maini& Dr. HimanshuAggarwal proposed a variety of image edge detection techniques of Gradient and Laplacian based edge detection and their comparison. Gradient-based algorithms such as Sobel and Prewitt filter have a major drawback as they are very sensitive to noise. To overcome this, an adaptive edge detection algorithm is used to provide a robust solution which is adaptable to the varying noise levels of these images to help distinguish valid image contents from visual artifacts introduced by noise.

Bonabeau, B., Dorigo, M., &Theraulaz, G. propose that every single insect in a social insect colony seems to have its own plan, and so far an insect colony looks so organized. No supervisor is needed for the seamless integration of all individual activities. It is to use a positive feedback mechanism, based on an analogy with the trail-laying trail following behavior of some species of ants and some other social insects, to reinforce those portions of good solutions [9].

Rob J. Mullen, Dorothy N. Monekosso, Paolo Remagnino, propose that so far only image edge gradient is considered as the heuristic information that is used to guide the ant agents. ShwetaAgarwal performed Edge detection in Blurred images using Ant Colony Optimization Technique.

Edge detection in gray-level images is a well-established area, but edge detection in color images has not received the same attention. The primary difference between color images and gray-level images is that, in a color image, a color vector (which generally having three components Red, Green and Blue) is assigned to a pixel, while a scalar gray-level is assigned to a pixel of a gray-level image[10] - [12].

III. ACO FOR GRAY IMAGE FEATURE EXTRACTION

This algorithm is based on the workings of original AS (Dorigo & Gambardella, 1997), with an updated, application specific pheromone update rule and heuristic information. The algorithm uses artificial ants as a simple computational agent. It is initialized with N ants that occupy 'random' pixels within the image; here the image pixels are equivalent to states in the search environment. The aim of the ants is to locate and plot the boundaries within the image. To achieve this heuristic information is introduced. With each move to a new pixel every ant deposits an amount of pheromone, where the amount deposited may be a function of, e.g. change in image gradient, and pheromone evaporation occurs at a fixed rate per iteration. The transition rule is then a function of heuristic information and pheromone map [13].

3.1. Initialization Process

Every image I size is represented by M x N. Fig. 1 shows a two dimensional graph representation of an Image. The 'K' specifies number of artificial ants. These 'K' ants are taken as input and randomly distributed over the entire image such that every pixel is considered as a node [10].

3.2. Construction Process

At each time step t, one ant among N ants is randomly selected which moves a distance of 1 pixel to one of the eight surrounding pixels. The movement of ant is shown in Fig. 1.

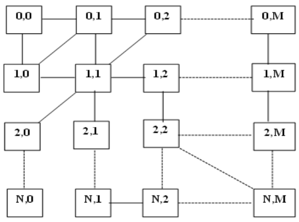


Figure 1. Graph Representation of M X N 2 D Image

Eq. (1)

In the above equation 'τ' represents the pheromone value at node (i, j), Ω (l, m) is the neighbouring node of node (l, m).The heuristic information at node (i, j) is represented by $\eta_{i,j}$. The influence of the pheromone matrix and heuristic matrix is shown by the constants α and β respectively.

3.3. Update Process

In this process the pheromone matrix is updated after the two update operations. The first update takes place after movement of each ant in each construction-step. Each building block of pheromone matrix is modified as given in equation (2) and the second update is performed after movement of entire ants in all construction-step as given in equation (3).

Eq. (2)

Eq. (3)

In this ψ is the pheromone decay coefficient. The search for subsequent ants is broadened by local update which reduced the pheromone level on the traversed edges. [14].

3.4. Decision Process

In this step, the solution is established from the values present in final pheromone matrix. By applying the threshold value τ on final pheromone matrix the decision is made.

3.5. Visualization Process

Here, different values of the Si (ψ) parameter are applied to the above algorithm. If the value of the phi parameter is smaller the algorithm detects more edges in the image. By decreasing the value of the phi parameter, output of the given image becomes clearer [15].

IV. PROPOSED METHODOLOGY

The proposed color image edge detection based on ACO is applied on a 2D image for generation of a pheromone matrix. Each entry of pheromone matrix represents intensity change in original image. The adaptive threshold value is generated at every time which is used in Decision Process by ants.

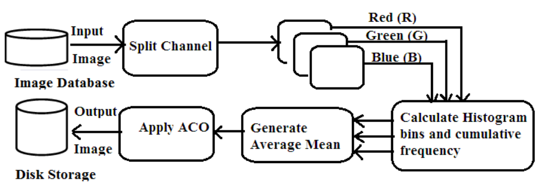


Figure 2. Block Diagram of Proposed System

The ACO is implemented for extracting RGB feature extraction. The Adaptive threshold Histogram technique is used. It splits up image into three primary colors. As per the color intensity values present in an image three separate histograms are generated for each image. Then cumulative frequencies are calculated and average mean value is generated. Then finally the result is fused [16]. These values depend on the input color image.

V. EXPERIMENTAL RESULTS

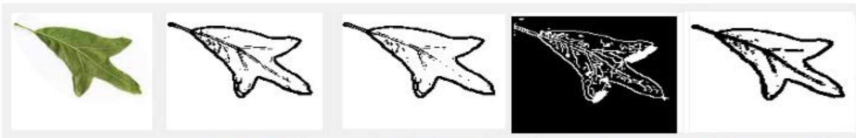
Experiments are conducted to evaluate the performance of the proposed approach on the basis of peak signal to noise ratio shown in Table 1 using some experiment images, three Quercus Family Leaf images, Lena and Flight are shown in Figure 3-7.

Leaf1 (a) (b) (c) (d)

Figure 3. Leaf1: (a) Sobel Edges, (b) Prewitt Edges, (c) Canny Edges, (d) Proposed Method

Leaf2 (a) (b) (c) (d)

Figure 4. Leaf2: (a) Sobel Edges, (b) Prewitt Edges, (c) Canny Edges, (d) Proposed Method



Leaf3 (a) (b) (c) (d)

Figure 5. Leaf3: (a) Sobel Edges, (b) Prewitt Edges, (c) Canny Edges, (d) Proposed Method

Lena (a) (b) (c) (d)

Figure 6. Lena: (a) Sobel Edges, (b) Prewitt Edges, (c) Canny Edges, (d) Proposed Method

Flight (a) (b) (c) (d)

Figure 7. Flight: (a) Sobel Edges, (b) Prewitt Edges, (c) Canny Edges, (d) Proposed Method

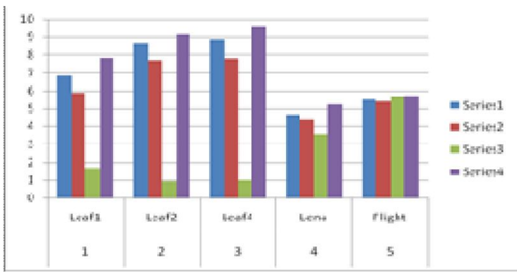


Figure 8. Comparison based on PSNR Values

Fig 8 shows comparison of ACO with other techniques based on PSNR values of Leaf and non leaf images

Table 1: The PSNR Values

Sr. No.	Image	PSNR Sobel	PSNR Prewitt	PSNR Canny	PSNR Proposed System
1.	Leaf1	6.81	5.89	1.68	7.83
2.	Leaf2	8.68	7.68	0.93	9.15
3.	Leaf4	8.86	7.78	0.98	9.52
4.	Lena	4.68	4.45	3.56	5.22
5.	Flight	5.51	5.40	5.65	5.72

CONCLUSION

The self-organizing properties of an ant algorithm have been investigated in this paper. The original Ant System algorithm is modified, especially for image feature extraction of a color image. In traditional ACO, it uses a static threshold value which may result into oversegmentation of an image. To avoid this, proposed algorithm uses adaptive threshold histogram method to improve the dynamic nature of threshold value. Which eliminates the problem of over segmentation occurs due to selection of static threshold. From the experimental results the peak signal to noise ratio (PSNR) is increased by 2 to 5% for leaf and non leaf images. By dynamically selecting optimal threshold value different images are successfully tested for boundary detection.
In future, this algorithm can be extended for simultaneously detecting multiple features from the color image. To achieve this multiple swarms may be used where one is detecting boundaries of an image whereas other is used to detect inner portion. These two swarms will be independent from each other and will generate two separate pheromone maps. Finally, these two maps will be combined to generate final result.

REFERENCES

[1] Fernandes, C., Ramos, V., & Rosa A.,"Varying the population size of artificial foraging swarms on time varying landscapes In W. Duch, J. Kacprzyk, E. Oja, & S. Zadrozny (Eds.), Artificial neural networks: Biological inspirations – ICANN 2005. Lecture notes in computer science", Berlin/Heidelberg: Springer, Vol. 3696, pp. 311–316.

[2] Bonabeau, B., Dorigo, M., & Theraulaz, G., "Ant Foraging Behaviour", in Swarm intelligence from natural to artificial systems. New York, NY: Oxford University Press, 1999, pp. 25-65.

[3] Marco Dorigo and Thomas Stützle, "Ant Colony Optimization Theory", in Ant Colony Optimization, Cambridge, Mas-sachusetts London, England, MIT Press, pp. 121-151.

[4] Marco Dorigo, Mauro Birattari, and Thomas St¨utzle, "Ant Colony Optimization Artificial Ants as a Computational In-telligence Technique", IEEE Computational Intelligence Magazine ", pp. 28-39, November-2006.

[5] Fernandes, C., Ramos, V., & Rosa, A. C.," Self-regulated artificial ant colonies on digital image habitats", International Journal of Lateral Computing, 2 (1), 1–8.

[6] Chittka, L., & Muller, H., "Learning, specialization, efficiency and task allocation in social insects", Communicative and Integrative Biology, 2 (2), 151–154.

[7] Ramandeep Kaur1 and Balwinder Singh2, "Design and development of sapling monitoring system", International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol.3, No.5, pp. 39-44, October-2013.

[8] Shweta Agrawal, "A review paper of edge detection using Ant Colony Optimization Techniques", International Journal of Latest Research in Science and Technology ISSN (Online):2278-5299, PP. 120-124.

[9] Raman Maini & Dr. Himanshu Aggarwal, "Study and Comparison of Various Image Edge Detection Techniques", Inter-national Journal of Image Processing (IJIP), Volume (3) : Issue (1), pp. 1-12.

[10] A. Koschan and M. Abidi, "Detection and Classification of Edges in Color Images," Signal Processing Magazine, Special Issue on Color Image Processing, Vol. 22, No. 1, 2005, pp. 64-73.
[11] Hasan Ihsan Turhan, Gozde Sahin and Aydan M. Erkmen," Comparing Color Edge detection Techniques"," unpublished", pp. 1-6.
[12] Rob J. Mullen, Dorothy N. Monekosso, Paolo Remagnino," Ant algorithm for image feature extraction", Expert Systems with Applications, 40 (2013) 4315–4332.
[13] Jing Tian, Weiyu Yu, and Shengli Xie, "An Ant Colony Optimization Algorithm for Image Edge Detection", IEEE Transactions, pp. 751-756, March 2009.
[14] Anna Veronica Baterina and Carlos Oppus, "Image Edge Detection Using Ant Colony Optimization", International Journal of circuits, System and Signal Processing, Issue 2 vol.4, pp. 25-33, 2010.
[15] Ioannis M. Stephanakis and George C. Anastassopoulos, "Segmentation Using Adaptive Thresholding of the Image Histogram according to the Incremental Rates of the Segment Likelihood Functions, "unpublished", pp. 1-5.
[16] Charu Gupta and Sunanda Gupta, "Edge Detection of an Image based on Ant Colony Optimization Technique", International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064, Vol. 2, No. 6, June- 2013, pp. 114-120.

