International Journal of Research and Development in Applied Science and Engineering (IJRDASE)
ISSN: 2454-6844

Optimized Digital Image Segmentation with Automated Computer Intelligence Clustering Method

[1]Jyoti Pandey, [2]Suyash Srivastav
Computer Science & Engineering,
S.R.Institute of Management & Technology, 485, Lucknow, India
rockjyotipandey1999@gmail.com[1]

Abstract: Image segmentation is a complex visual computation problem, which refers the process of distinguishing objects from background. Thresholding techniques is used for finding optimal thresholds between the various object and background. K-means is very popular clustering algorithm; it is most wide and effective in field of image segmentation. According to the characteristics of the ant colony optimization and the *K*-means clustering, a method for the image segmentation based on the ant colony optimization and the *K*-means clustering was proposed in this paper. Firstly, the basic principles of the two algorithms were introduced. Secondly, their characteristics on the image segmentation were analyzed. Finally the improved algorithm was proposed, this algorithm can effectively overcome shortages which are the slow rate of the ant colony optimization and the *K*- means clustering dependent on the initial clustering centers. Experimental results proved that the improved algorithm was an effective method for the image segmentation In the practical application, which could segment the object accurately.

Keywords: K-mean clustering, Ant colony optimization, Image segmentation, data mining

1. Introduction:

The technique of separating a picture's foreground from its background is known as image segmentation. It is a crucial processing task for numerous computer vision-dependent applications, including medical imaging, machine vision, object detection in satellite pictures, face and fingerprint recognition, agricultural imaging, and many more. The efficiency of the next steps of the image processing would greatly depend on how well the picture segmentation stage was performed. Although the problem of picture segmentation has been investigated by numerous academics for many years, it is still an open research problem and requires further research due to the features of the images, such as their various modal histograms [1, 2].

The split or separation of a picture into sections with comparable attributes is known as segmentation. Image amplitude, also known as brightness in monochrome and colour components in colour is the fundamental property for segmentation. Image edges and textures are additional helpful segmentation features. a group of areas that jointly The results of image segmentation are either the complete image or a set of contours that are recovered from the image. The segmentation of images has no theory. As a result, no one industry-standard technique for image segmentation has been developed. Instead, there are a number of impromptu techniques that have attained some level of fame [3, 4].

A digital image is divided into many portions by image segmentation (set of pixels). Segmentation's goals include simplifying an image's representation and/or making it more pertinent and comprehensible. It is common practise to employ picture segmentation to recognize objects and image boundaries (such as lines, curves, etc.) This thesis examines the picture segmentation methods Thresholding, K-means, and Genetic Algorithm. Improved clustering and segmentation techniques have been developed [5, 6].

2. Literature Survey

The image segmentation is a key process of the image analysis and the image comprehension. Because of the influence of the complicated background, the object characteristics diversity and the noise, the image segmentation is the difficult and hot research issues on the image processing. Generally, the image segmentation mainly included four kinds of methods. These methods are the segmentation based on the parallel boundary, the serial boundary, the parallel region and the parallel region respectively [7, 11]. The traditional segmentation methods are effective to some images, but are limited to other images which are applied to the especial field and characteristics. Presently, the general segmentation method is not found.

Image thresholding is a necessary step in many image analysis applications in its simplest form; thresholding means to classify the pixels of a given image into two groups (e.g. objects and background). One including those pixels with their gray values above a certain threshold, and the other including those with grey values equal to and below the threshold. This is called bi-level thresholding. Generally, one can select more than one threshold, and use them to divide the whole range of gray values in to several sub ranges. This process is called multilevel thresholding [2,8, 12, 19]

The K-means clustering is a partitioning method for grouping objects so that the within-group variance is minimized. By minimizing dissimilarity of each subset locally, the algorithm will globallyyield an optimal dissimilarity of all subsets [1,9].

Swarm intelligence is a relatively new approach to problem solving that takes inspiration from the social behaviors of insects and of other animals. In particular, ants have inspired a number of methods and techniques among which the most

International Journal of Research and Development in Applied Science and Engineering (IJRDASE)
ISSN: 2454-6844

studied and the most successful is the general purpose optimization technique known as Ant Colony Optimization (ACO)[1,10].

The ACO is a biometric evolution algorithm. This algorithm of the parallel positive feedback mechanism has some advantages which are the parallelism, the robustness and easy combination withother methods. Therefore, the ACO takes on the excellent performance and the tremendous development potential, and is successfully applied to the travel salesman problem (TSP), the vehicle routing problem (VRP), the data mining, the image processing, and so on[17].

The paper is organized as follows. Firstly, the basic principle of the Thresholding techniques and its application in the image segmentation were introduced. Secondly, the basic principle of the K- means clustering and its application in the image segmentation were introduced. Thirdly, the basic principle of the ACO and its application in the image segmentation were introduced [11].

3. Methodology

K-Mean Clustering

The K-means algorithm is a gradient-descent procedure that starts with a base set of K cluster centres and alters it over time to lower the error function. The K-means type algorithms' finite convergence is rigorously demonstrated in (Selim and Ismail, 1984). The K-means technique has an O(T * K * m * N) complexity when applied over T iterations on a sample size of m instances, each with N characteristics. One of the factors contributing to the K-means algorithms' popularity is its linear complexity. This approach is computationally appealing even if there are a lot of instances (which is frequently the case these days). As a result, the K-means algorithm has an advantage over other clustering techniques that have non-linear complexity, such as hierarchical clustering techniques. The K-means algorithm, a common partitioning algorithm, is less flexible than single link algorithms and performs best on data sets with isotropic clusters. This algorithm is also sensitive to noisy data and outliers (a single outlier can significantly increase the squared error); it can only be used when the mean is defined (specifically for numeric attributes); and it requires the number of clusters in advance, which is difficult to do when no prior information is available [13].

The K-means method is frequently applied only to numerical attributes. The K-prototypes algorithm, which is based on the K-means algorithm but removes restrictions on numeric data while maintaining its effectiveness, was introduced by Haung (1998). Similar to the K-means algorithm, the technique clusters objects with numerical and category attributes. The square Euclidean distance serves as the similarity metric for numerical characteristics, and the number of mismatches between objects and cluster prototypes serves as the metric for categorical qualities. Partition around medods, also known as PAM (Kaufmann and Rousseeuw, 1987), is another partitioning algorithm that aims to reduce the SSE. The K-means algorithm and this one are extremely similar. Its portrayal of the many clusters is primarily where it varies from the latter. Instead of using the implicit mean, which might not actually be a part of the cluster, each cluster is represented by its most central item. The K-medoids approach is more resistive to noise and outliers than the K-means algorithm because a medoid is less impacted by outliers or other extreme values than a mean. However, compared to the K-means approach, its processing is more expensive. The user must select K, the number of clusters, for both techniques.

K-means algorithm.

Input: S (instance set), K (number of cluster) **Output:** clusters

1: Initialize K cluster centers.
2: **while** termination condition is not satisfied **do**
3: Assign instances to the closest cluster center.
4: Update cluster centers based on the assignment.
5: **end while**

Ant Colony Optimization

For the creation of metaheuristic algorithms for combinatorial optimization problems, the ACO paradigm is used. Ant System was the first algorithm proposed by Colorni, Dorigo, and Maniezzo in 1991. (AS). Since then, numerous distinct variations of the fundamental idea have been published in [1,,15,16,17,18], including MAX-MIN Ant System and Ant Colony System (MMAS). The behaviour of actual ants serves as a loose model for the ACO's central concept. It was discovered that even in challenging environments, ants could locate the best route from the nest to the food source. When this path is blocked, ants may be able to retrace their steps by avoiding the obstruction. Ants can exchange information with one another while foraging by emitting a chemical called a pheromone. Each ant has the ability to release a pheromone into the air and detect its presence and intensity in order to direct its own movement. When a large number of ants choose one way, the pheromone along that road is amplified because ants tend to migrate along trails with high pheromone intensities. Future ants will select this route based on the bigger. The inspiration for the idea came from seeing how ants exploit food sources. Despite having individual cognitive limitations, ants were able to work together to determine the quickest route between a food source and their colony [14].

1.The first ant finds the food supply (F) through any method (a), finds its way back to the nest (N), and leaves a trail pheromone behind (b)
2.Ants will follow any of four possible routes, but the runway's improvement makes it more appealing as the quickest path.
3.Ants choose the shortest path since the trail pheromones on longer routes are lost.
1.4. It was discovered that ants tended to take the shortest way when given an option between two trails of different lengths that led to a food source. The following is a model for this behaviour:
2.An ant known as "Blitz" roams the colony in a largely random manner;
3.In general, if it locates a food source, it returns immediately to the nest, leaving a pheromone trail in its wake;
4.Because of these pheromones' allure, ants in the area will be drawn to follow the track more or less directly;
5.These ants will fortify the pathway when they return to the colony;
6.If there are two ways to go to the same food source, more ants will take the shorter one in a certain amount of time than the longer one;
7.The short way will become better and more appealing as time goes on;

International Journal of Research and Development in Applied Science and Engineering (IJRDASE)
ISSN: 2454-6844

8.Because pheromones are unstable, the lengthy path will soon disappear;
The shortest route is ultimately discovered and "selected" by all of the ants.

4. Results

Thresholding Technique

Figure 1: Output after applying thresholding technique

K-means Technique

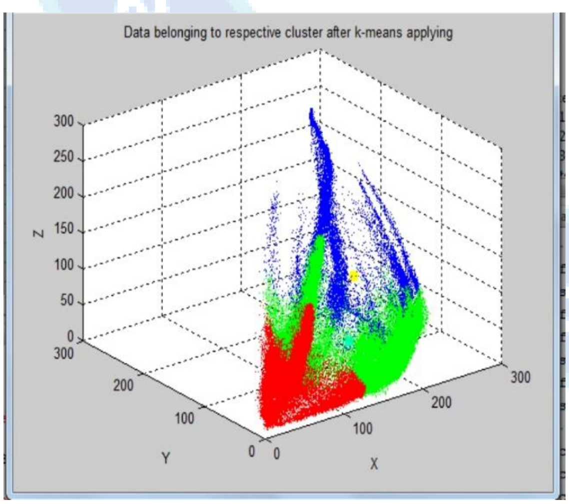


Figure 2: New mean position after applying K-means technique

Ant Colony Optimization Technique

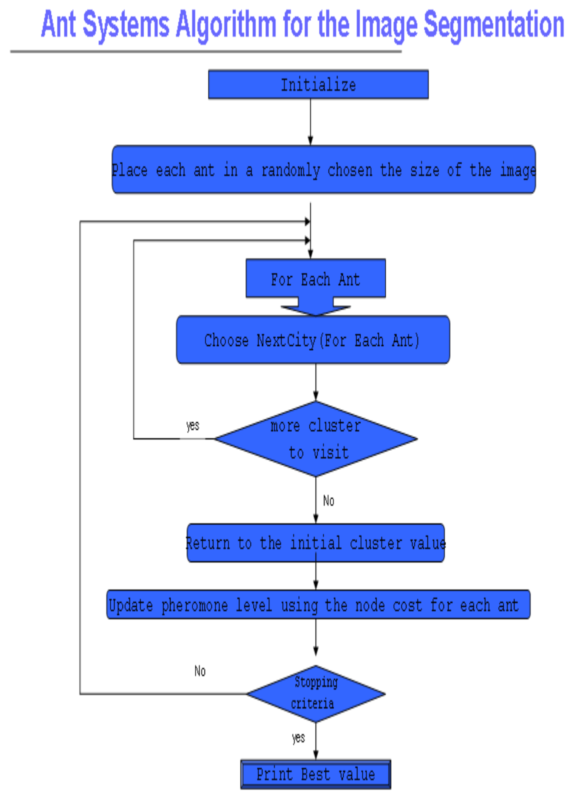


Figure 3 : Output after applying K-means

The flow chart that served as the foundation for the simulation is shown below. The full simulation was carried out in the MATLAB simulation environment utilising a P-4, Core due to processor with 4GB of RAM.

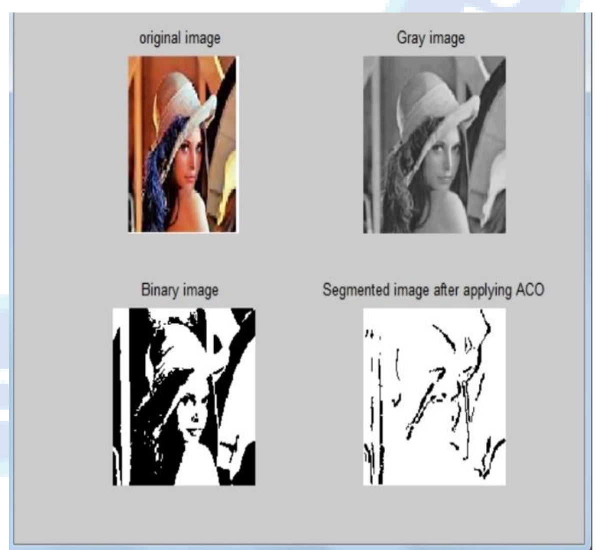
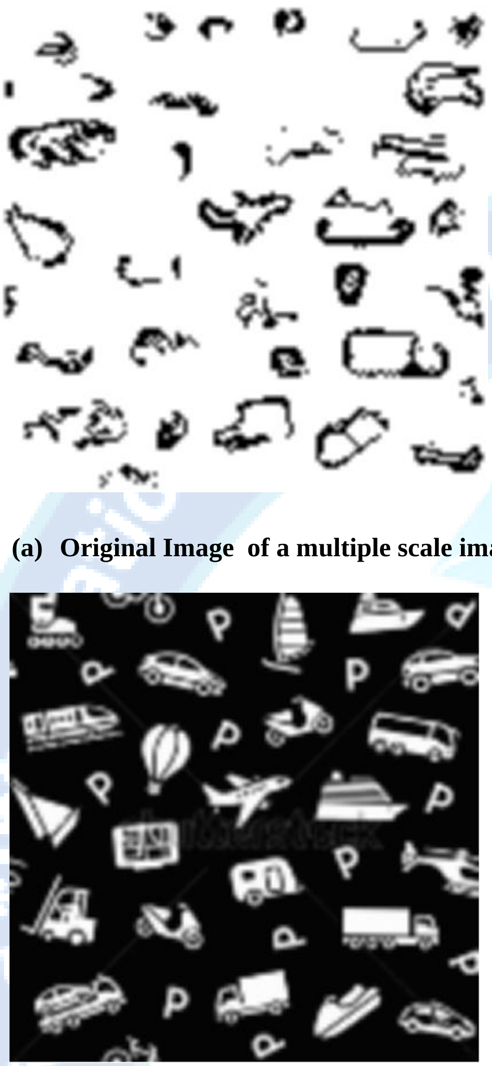


Figure 4: Output after applying ACO



(a) Original Image of a multiple scale image

(b) Cluster Image or Edge image by ACO

Fig. 5. Output after applying ACO for binary images

According to the aforementioned simulation results, the ACO has a higher rate of convergence than the K-mean cluster. It was also noted that the CPU time for K-mean clustering approach is 50 seconds, compared to 0.5 seconds for ACO. ACO is therefore simpler to implement in hardware than K-mean.

5. Conclusions

After learning about Thresholding, K-means, and Ant Colony Optimization Techniques, you may use MATLAB to apply them to picture segmentation. The results of the experiments demonstrated the efficacy of the ACO algorithm as a method for accurately segmenting objects within images while also speeding up and improving segmentation. Results of the experiment are superior in terms of both minimising noise and enhancing image details. Due to these benefits, the ACO technique has a lot of potential for use, especially in pattern recognition, image interpretation, and medical picture applications for item identification. The focus of future study will be on ACO parameter setting that utilises local information adaptively. The relationship between the ACO parameter and local data, such as average squared intensity error and gradient inside a single window, will be further researched. FCM (Fuzzy Clustering Method) can also be used to categorize and divide the output into various classes.

Reference

[1] Bo Zhao, Zhongxiang Zhu, Enrong Mao,Image Segmentation Based on Ant Colony Optimization and *K*-Means Clustering, Proceedings of the IEEE International Conference on Automation and Logistics August 18 - 21, 2007, Jinan, China.

[2] Segin M., Sankur B.: Survey over image thresholding techniques and quantitative performance evaluation. J. Electron. Img. 13,146-165 (2004).

[3] S.Chen, Y. Lin, Y. Liu and Z.Lu, " Image Segmentation by Multi-threshold based on Fisher Function and Histogram Algorithm ", International Conference on Computer Application and System Modeling, 2010.

[4] S. Chabrier, B. Emile, and H. Laurent. Psychovisual evaluation of an image segmentation result.International Conference on Signal Processing, nov 2006.

[5] Dorin Comaniciu and Peter Meer. Mean shift: A robust approach toward feature space analysis.IEEE Transactions on Pattern analysis and Machine Intelligence, 24 (5):603– 619, 2002.

[6] Sahay, S., Banoudha, A., & Sharma, R. On the use of ANFIS for Predicting Groundwater Levels in Hard Rock Area. Volume 6, Issue 1, November 2014, IJRDASE.

[7] C. Kermad and K. Chehdi. Multi-bands image segmentation: A scalar approach. IEEE International Conference on Image Processing, (6):1012–1025, 2000.

[8] C.C. Lai and C.Y. Chang. A hierarchical evolutionary algorithm for automatic medical image segmentation. Expert Systems with Applications, 2007.

[9] R. Pal and Sankar K. Pal. A review on image segmentation techniques. Pattern Recognition,26 issue 9:1277–1294, 2003.

[10] A. Winter, H. Maˆıtre, N. Cambou, and E. Legrand. An original multi-sensor approach to scale- based image analysis for aerial and satellite images. In IEEE International Conference on Image Processing, volume B, pages 234–237, 1997.

[11] Y. .J. Zhang. A survey on evaluation method for image segmentation. Computer vision and pattern recognition, 29:1335–1346, 1996.

[12] Srivastava, A., & Banoudha, A. Techniques of Visualization of Web Navigation System. Volume 6, Issue 1, November 2014, IJRDASE

[13] M.Luo, Y.F. Ma, H.J. Zhang, “A Spatial Constrained K-Means Approach to Image Segmentation”, Proc. the 2003 Joint Conference of the Fourth International Conference on Information, Communications and Signal Processing and the Fourth Pacific Rim Conference on Multimedia, Vol. 2, pp. 738-742, 2003.

ISSN: 2454-6844

[14] M.Awad, K,Chendi and A.Nasri,"Multi-Component image segmentation using a hybrid dynamic genetic algorithm and fuzzy C-means" IEEE,2009,ieee.org/ie15/4149689/4803712/04803714.pdf.

[15] A. Colorni, M. Dorigo et V. Maniezzo, Distributed Optimization by Ant Colonies,46 actes de la première conférence européenne sur la vie artificielle, Paris, France, Elsevier Publishing, 134 -142, 1991.

[16] Dorigo M, Maniezzo V and Colorni A. "Ant system: optimization by acolony of cooperating agents," IEEE Transactions On System, Man, and Cybernetics, vol 26, no. 1, pp. 29-41,1996.

[17] M Dorigo and Luca Maria Gambardella. "Ant colony system: a cooperative learning approach to the traveling salesman problem.," IEEE Transactions On Evolutionary Computation., vol 1, no. 1,pp. 5366, 1997.

[18] Malisia A. R., Tizhoosh H. R.: Applying ant colony optimization to binary thresholding. In: ICIP 2006. pp. 2409-2412. (2006).

[19] Yen J. C., Chang F. J., Chang S. Y.: A new criterion for automatic multi level thresholding. IEEE Trans. Img. Process. 4, 370--377 (1995).