Indian Journal of Science and Technology, *Vol 10(17), DOI: 10.17485/ijst/2017/v10i17/109509, May 2017*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

An Enhanced Ant Colony Clustering Method for Color Image Segmentation

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Abstract

Objectives: The aim of segmentation process is to divide the image into homogeneous, self-consistent region or objects. The segmentation algorithms try to make systematic uses of some physically measured image features. **Methods/Statistical Analysis:** In the earlier research work, the researchers covered only multi resolution, quad tree structure, ant colony optimization and Otsu method for segmentation object in gray scale but not for color images. To overcome these issues, the segmentation for color image is focused on Enhanced Ant Colony Clustering (EACC) method. **Findings:** The proposed EACC method has three main parts. The first part is used to isolate the components of the given color image including RGB pixel values. The second part finds the clustering center with the help of combination of statistical and artificial selection. The last part implements EACC algorithm to segment on color image. In the existing method of ACO, the processing time takes longer time to segment the object. At the same time, while comparing the threshold value on existing method is lower than current proposed method of EACC. **Applications/Improvements:** In this research work, the proposed method achieves better segmentation in color image for the data sets Oxford Flowers 17, Weizmann Horse and MSRC dataset. Further, this work may be extended to different type of images such as, multiband or multispectral images, satellite images, etc. Finally, the experimental results are shown through Mat Lab R2013a.

Keywords: Enhanced Ant Colony Clustering, RGB Pixel Values, Segmentation, Self-Consistent Region, Threshold Value

1. Introduction

Image segmentation is the basis of the image analysis for critical steps to separate object from the background[1]. Image segmentation directly affects effectiveness of the follow-up image processing and even the success or failure of the whole image analysis process. So the role of image segmentation is essential with the development of the recently technologies. The uses of color image become more and more popular. Thus, image segmentation has attracted a lot of more attention.

In general, there are two different types of image segmentation approaches, one is region-based and another is contour-based. The region-based finds the region of pixels with similar characteristics such as a color. In contrast, contour based detects the possible edges and to divide the image into regions by these edges. Image segmentation is based on Genetic algorithm method and has optimal threshold value to be widely applied. Therefore, in order to quickly and effectively to obtain optimal threshold value a better method can be used.

Image Segmentation partitions an image into distinct regions containing each pixel with similar attributes. To be meaningful and useful for image analysis and interpretation, the regions should strongly relate to depicted objects or features of interest. Meaningful segmentation is the first step from low-level image processing transforming a gray scale or colour image into one or more other images to high-level image description in terms of features, objects, and scenes. The success of image analysis depends on reliability of segmentation, but an accurate partitioning of an image is generally a very challenging problem. Image segmentation techniques are either contextual or non-contextual. The latter take no account of

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spatial relationships between features in an image and group pixels together on the basis of some global attribute, e.g. grey level or colour. Contextual techniques additionally exploit these relationships, e.g. group together pixels with similar grey levels and close spatial locations.

However, in most of real images, there are not clearly distinguishable marks between the target and the background. The optimal threshold is using a full search and it does not need preprocess for the histogram, but it has the sensitivity for target size and noise.

This paper is structured as follows. Section I introduces the essential impression of segmentation for color image. Section II describes the literature review analyzed. In section III, explains in the existing method. In section IV, the detailed formation of the future frame work is presented. In Section V, experimental Results and discussions are briefly explained. Finally, Section VI makes conclusion and future work.

2. Related Work

The evolutionary computing method has successfully been applied on various discrete and continuous problems. Image segmentation plays on necessary role in image processing and pattern recognition. The main purpose of this is to divide areas that do not separate each other is to select motivating target area. Many popular in image segmentation is to be studied and analyzed.

An adaptive threshold segmentation method[2] based on the wavelet. The genetic algorithm method[3] is to improve the quality of the segmentation. An adaptive PSO variant method is used in gray image segmentation[4]. Hybrid approaches based on an ACO with the Otsu method[5].

The color space conversion color cluster center and merging of cluster center[6]. An image edge information collection and merge different region of homogeneity[7]. Ant colony optimization (ACO) is solving the color image segmentation[1]. Probabilistic reasoning and conditional random fields are used in to detect similar objects that occur more than once within the scene[8]. These methods are not considered to detect small intra-object regions but to segment the objects of interest from the background.

An ant colony algorithm focused to solve the optimization problem with long search time[9]. In swarm algorithm[10] that utilize image pixel data and matching segment map to form a context in which stigmergy can occur. A regressive tree method which is used recursive partitions[11]. This method also gives good result in segmentation but not optimal tree. Ant Colony System (ACS) is a meta heuristic algorithm and derived from the observation of real ants. The data parallelism method is used in the ant colony system[12]. Since each task of data parallelism is executed by an individual processor the data should distributed all process which takes long time. An ant colony system is applied to perceptual graph of digital images which is not cover for color image[13].

A segmentation method for brain MR images using an ant colony optimization algorithm[14]. MR image support only gray scale value. The segmentation algorithm which integrates the genetic algorithm[15] with the ant colony algorithm but this algorithm increases ant colony traversal optimization. An ant colony based number plates extraction method[16] in edge detection while applying the image segmentation. An ACO segmentation algorithm is proposed to determine the optimum threshold value[17]. Even though this algorithm can be quickly and studiedly to find out threshold value in non-linear way but not covered target segmentation with its image background. The fuzzy entropy method[18] while it is applied to segmentation of infrared object. This method is not applicable entropy based object segmentation.

Even though many research works are studied and analyzed for various model and techniques regarding to color image segmentation, some are still lot of research issues such as different color space segmentation, maximum processing time, are not rectified in color image segmentation. In order to overcome the issues in existing system, there is a need to new proposal technique for color image segmentation.

3. Existing Methodology

3.1 Ant Colony Optimization

Ant Colony Optimization algorithm (ACO) is a variety of bionic development. It was encouraged by the surveillance of authentic ant colony and is utilized to discover an optimal way to food source in the food searching process. There is large number of ongoing activity in the scientific community to extend used to apply ant based algorithms. Ant algorithms inspired by the observation of real cent colonies. This algorithm, as a probabilistic search and matching technique is discrete, parallel, and robust etc.

Due to these features, ant algorithms has been successfully applied to a number of permutation optimization problems like routing, scheduling, imaging processing and task coordinate etc.

ACO takes inspiration from the aging behavior of some ant species. These ants deposit pheromone on the ground in order to make some favorable path by other members of the colony. A substantial corpus of theoretical results is becoming available that provides useful guidelines to researchers and practitioners. ACO is to introduce ant colony optimization and to survey its notable applications. ACO is to find the shortest path that includes each city to be visited once. In ant colony optimization, the problem is tackled by simulating number of artificial ants moving on a graph that encodes the problem itself. Each vertex represents a city and each edge represents a connection between two citizens.

4. Proposed Methodology for Color Image Segmentation

4.1 Color Model or Space

In color image segmentation, there are two existing problems. One is to select a proper segmentation method and another is to select a proper color space. There are so many standard color models available in image processing application. They are RGB color model, HSV color model, HSI color model, CMY color model and YIQ color model. For the sake of time, researcher considers only RGB model.

RGB Color Model: In an RGB color model, three primary colors Red, Green and Blue from the axis of the cube. Each point in the cube represents a specific color. The RGB is an additive color model.

4.2 Enhanced Ant Colony Algorithm Theoretical Foundation

An ant is one of the oldest social insects. It is a simple structure and has individual behavior. An Ant colony clustering algorithm can be used to address clustering problem. Every data sample is treated as ants of different attributes. While ants deposit some amount of pheromone on their paths related to the food quality and amount, if they find some foods on their paths. In many ant species, individual ants are walking to and from a food source deposit on the ground a substance called a pheromone. Ants can smell pheromone and follow pheromone with some probability. The more number of ants tracing the given path, more attractive path becomes larger.

4.3 Extracting the Feature of an Image

An image contents may be target, background, boundary, noise and the purpose of feature extraction. The feature extraction is to find out the difference in the content characteristics.

RGB values: In a color image, primary features are separated from the original image. This algorithm is based on red, green and blue color space. For faster arithmetic speed, the system selects individual value of RGB.

Image gradient: Boundary points or noises are happened in the position of gray mutation. System can extract the image gradient as the difference between the boundary points and area points of the image.

The image neighborhood: For an image which exist higher gradient boundary points and noise points, it can be differentiated by a neighborhood whose size is 3 x 3. If pixel value is 8, it is known as area of the image. If pixel value is 6, it is called boundary point. If the pixel value is 4, it is called noise point.

4.4 Setting the Clustering Center

The original Enhanced ant colony clustering algorithm requests that each pixel value does a classification for color image in each round of cycle. Even though the analysis of color image characteristics, the improved clustering center is determined. Using color RGB values the gradient and neighborhood that match with the different content in an image as a clustering center. The method attempts adaptively to define number of color clusters and cluster center points optimally, and assigns pixels to their nearest clusters. It terms out to be faster and more efficient.

4.5 Principles of the Enhanced Ant Colony Clustering (EACC) Algorithm

An Enhanced Ant Colony Clustering Algorithm is a kind of automatic progress in color image segmentation. This algorithm was expectant by the surveillance of real ant colony and utilized to discover the optimal path to food source to nest. Many ants are called as social insects and live in colonies. They are heading for by with help of the behavior more and more to the survival of the colony as

a whole than to that of a single individual component of the colony. The most important and interesting behavior of ant colonies are used to find the shortest path between the food source and their nest. As shown in figure 1, some ants travel as of their nest to hunt for food at the similar time toward on the way to two different directions.

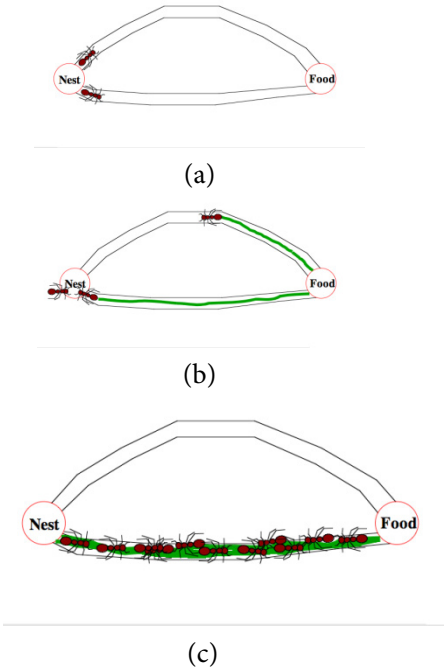

Figure 1. Ant Movement from nest to food and back (a) Ants start finding the food and (b) Pheromone is more density on the shortest path (c) ants finally choose the shortest path.

There are two group of ants' travel path available. Individual group of ants decide on the path with the intention of turns out to be shortest path at the same time as the other group of ants take the longer distance path. The ants moving in the direct path go back to the nest earlier and the pheromone compactness is automatically thicker than the deposited in the longer path. Other ants in the nest have high probability to go after the shortest route. These ants also deposit their own pheromone on the path. More and more ants are soon attracted to the path and hence the shortest route is established from nest to food source.

4.6 Enhanced Ant Colony Clustering (EACC) Algorithm for Image Segmentation

When giving the original image X, each pixel X [i, j, k], ($i=1,2,....M * N$), ($j=1,2,....M * N$) and ($k=1,2,....M * N$) is regarded as an ant. Color feature extraction can be done as three dimensional above vector space. Image segmentation is the process of different characteristics of ants searching for a food sources. The complete detailed proposed flow chart is shown in the Figure 2.

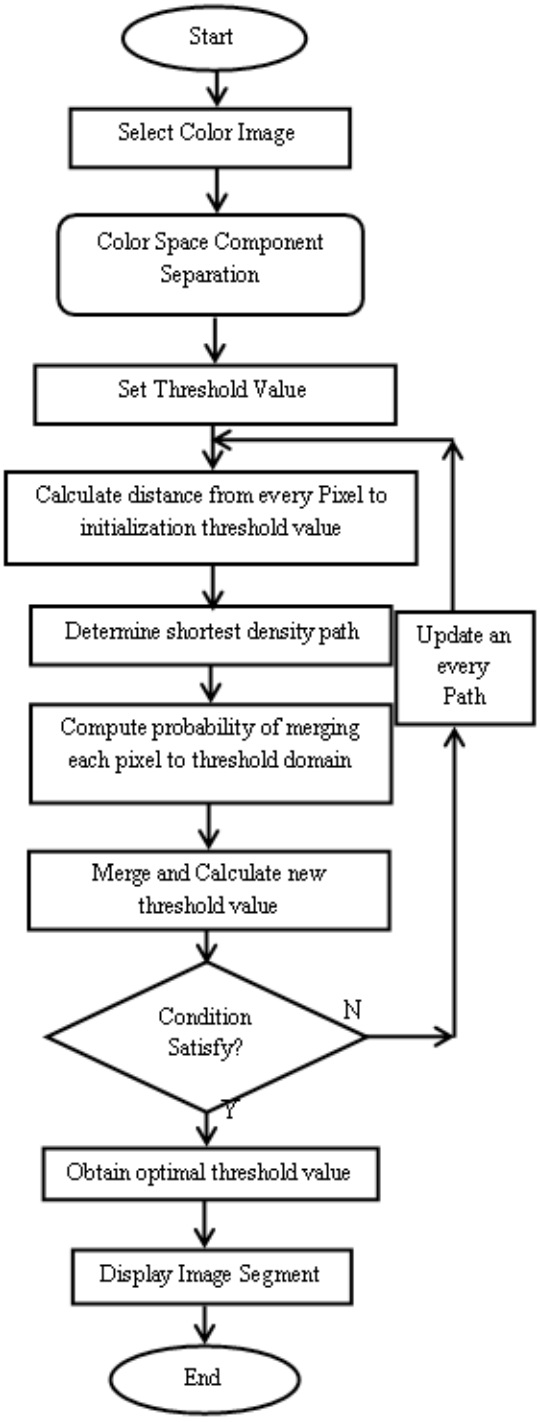

Figure 2. Image segment using enhanced ant colony clustering method.

The details algorithm is shown in Algorithm 1.

Algorithm 1. Enhanced ACO Algorithm

//Input: Color Image

// Output: Segmented Image

Step 1: Load color image from the internet

Step 2: Transfer image data into matrix format whose size is $M * N$

Step 3: Each gray scale matrix value corresponds to an ant

Step 4: Select the clustering center in manually

Step 5: Initialize center parameter, threshold clustering center, merging threshold

Step 6: Count the RGB values of each pixel through global travel and determine the number, RGB value of clustering centers

Step 7: Merger two clustering center between the classes according to the threshold value

Step 8: Initialize cyclic parameter, maximum cyclic time and clustering radius, amount of information

Step 9: Start clustering cycle times. Cycle times NC=NC+1

Step 10: For each ant determine the following parameters

$$d_{ij} = \sqrt{\sum_{k=1}^{m} p_k (x_{ik} - y_{jk})^2} \quad \ldots (1)$$

$$\eta_{ij} = \frac{r}{d_{ij}} = \frac{r}{\sqrt{\sum_{k=1}^{m} p_k (x_{ik} - y_{jk})^2}} \quad \ldots (2)$$

Step 11: Calculate transition probability of the pixel to the clustering center.

$$d_{ij} = \begin{cases} \frac{ph_{ij}\eta_{ij}}{\sum_{s \in S} ph_{is}\eta_{is}} \\ o, others \end{cases}, \text{if } j \in S \quad (3)$$

$$ph_{ij} = \begin{cases} [(1-\rho)(ph]_{ij} + \Delta ph), if\ select\ the\ path\ ij \\ (1-\rho)ph_{ij}, others \end{cases} \quad \ldots (4)$$

Step 12: Repeat the cycle until the last value meets the end condition.

Step 13: Finally display the Original and segmented image.

5. Experimental Result and Discussions

The experiment is carried out with the dataset such as (i) Oxford Flowers 17 data set (1360 Images) (ii) the Weizmann horse data set (328 Images) and (iii) the MSRC object category data set (240 Images) by the proposed method. Some necessary parameters are default set automatically. The definition of threshold T adopts the mid-point method between minimum and maximum values in the image. The threshold determination defined as

$$T = \frac{\max value + \min value}{2} \quad \ldots (5)$$

Figure 3 shows the original image and proposed segmented image for oxford flower 17 data set. Similarly figure 4 and 5. are represented original images and proposed segmented image of the Weismann horse and MSRC data set of experimental research work. Even though the existing method of ACO showed the normal image quality and compared with the original images from the different color images. The proposed enhanced ant colony clustering method gives the better expected results while comparing the existing method.

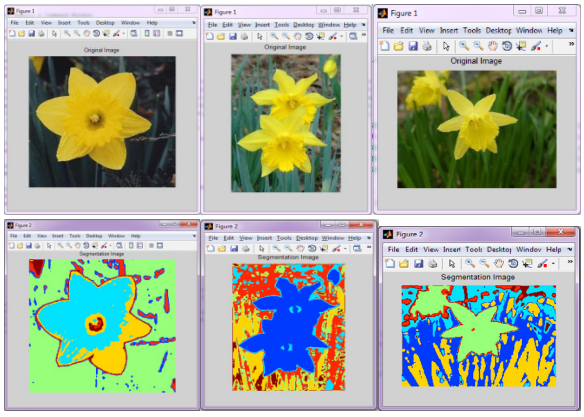

Figure 3. Oxford flowers 17 data set: first row is original image and second row is segmented image.

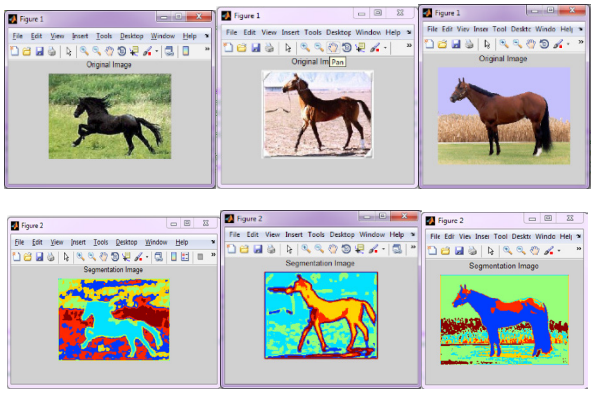

Figure 4. Weizmann horse data set: first row is original image and second row is segmented image.

Table 1. Comparison Table

Datasets	Analysis Factor	Image 1		Image 2		Image 3	
		ACO	E ACO	ACO	E ACO	ACO	E ACO
Oxford Flowers 17	Processing Time (ms)	26.30	23.48	28.59	26.75	27.84	24.67
	Thr. Value	115	124	90	112	85	97
Weizmann Horse	Processing Time (ms)	30.15	27.38	32.37	30.16	26.85	24.68
	Thr. Value	118	126	96	106	83	102
MSRC	Processing Time (ms)	29.18	26.71	30.67	28.93	31.47	29.82
	Thr. Value	127	130	94	102	79	88

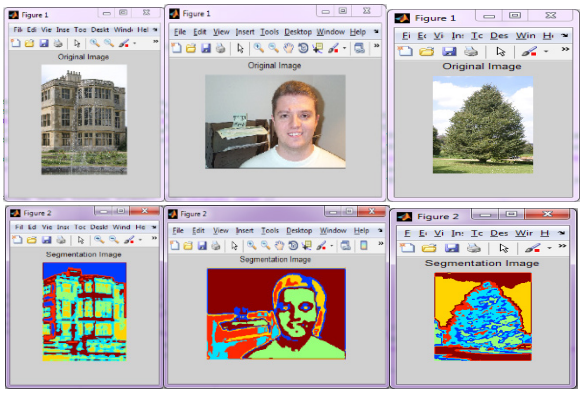

Figure 5. MSRC object category data set: first row is original image and second row is segmented image.

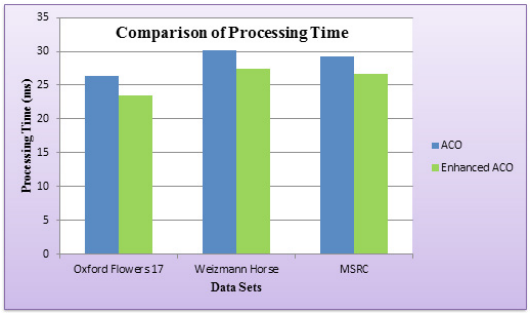

Figure 6. Comparison of processing time.

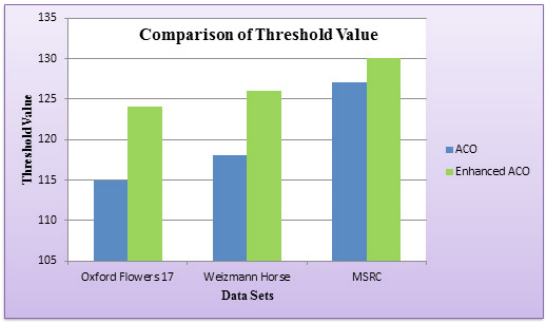

Figure 7. Comparison of threshold value.

After many color images are done experimentally, the existing and proposed comparison table is generated. This table is shown in Table 1. The corresponding comparison chart is given in the Figures 6 and 7 for sample image 1. The chart presents the existing methods take long processing time with less threshold values. Whenever increasing the threshold value, the proposed method reduces the processing time and gives better quality image.

6. Conclusion

Color image segmentation has extremely complicated task in image segmentation research work. A new Enhanced Ant Colony Clustering (EACC) algorithm is proposed in this paper. The new method retains both advantages of color image segmentation an enhanced ant colony clustering algorithm. This method improves the quality of segmentation and region integrity. The experimental result confirmed the above point that the new proposed method is better to the ant colony algorithm used alone. This work may be extended to the area of multispectral images, satellite images and various color model images.

7. References

1. Tseng SP, Chiang MC, Yang CS. An improved ACO by neighborhood strategy for color image segmentation. Mobile, Ubiquitous and Intelligent Computing, Lecture Notes in Electrical Engineering, Springer. 2014; 274:615–20. Crossref
2. Chen Z, Tao Y, Chen X, Griffis C. Wavelet-based adaptive thresholding method for image segmentation. Optical Engineering. 2001 May; 40(5):868–74. Crossref
3. Bhanu B, Lee S, Ming J. Adaptive image segmentation using a genetic algorithm. IEEE Transactions on Systems, Man and Cybernetics. 1995 Dec; 25(12):1543–67. Crossref

4. Chander A, Chatterjee A, Siarry P. A new social and momentum component adaptive PSO algorithm for image segmentation. Expert Systems with Applications. 2011; 38:4998–5004. Crossref
5. Liang Y-C, Chen AH-L, Chyu C-C. Application of a hybrid ant colony optimization for the multilevel thresholding in image processing. ICONIP 2006. LNCS, Springer. 2006; 4233:1183–192.
6. Aydin D, Ugur A. Extraction of flower regions in images using ant colony optimization. Procedia Computer Science. 2011; 3:530–6. Crossref
7. Xinyan M, Ying Z, Yanxiao H, Binjie S. Color image segmentation method based on region growing and ant colony clustering. IEEE Global Congress on Intelligent Systems; 2009. p. 173–9.
8. Dorigo M, Gambardella LM. Ant colony system: A cooperative learning approach to the travelling Salesman problem. IEEE Transaction on Evolutionary Computation, China. 1997 Apr; 1(1):53–66. Crossref
9. Zhishui Z. Ant colony algorithm based on path planning for mobile agent migration. Procedia Engineering. 2011; 23:1–8. Crossref
10. White CE, Tagliarini GA, Narayan S. An algorithm for swarm-based color image segmentation. Conference on Wavelet Analysis and Pattern Recognition. 2007 Nov; 2(4):296–300.
11. Hemmateenejad B, Shamsipur M, Shahabadi VZ, Akhond M. Building optimal regression tree by ant colony system-genetic algorithm: Application to modeling of melting points. Analytica Chimica Acta 704; 2011 August. p. 57–62. Crossref
12. Chu SC, Roddick JF, Pan JS. Ant colony system with communication strategies. Information Science, China. 2004 Dec; 167(1–4):63–76. Crossref
13. Zhuang X. Edge feature extraction in digital images with the ant colony system. Processings of the IEEE International Conference on Computational Intelligence for Measurement Systems and Applications; 2004 Jul. p. 133–6. Crossref
14. Lee ME, Kim SH, Cho WH, Park SY, Lim JS. Segmentation of brain MR images using an ant colony optimization algorithm. Ninth IEEE International Conference on Bioinformatics and Bioengineering; 2009. p. 366–9. Crossref
15. Haifeng Z. An improved ant colony algorithm combined with genetic algorithm and its application in image segmentation. Intelligence Computation and Evolutionary Computation, AISC 180; 2013. p. 389–93. Crossref
16. Dewan S, Bajaj S, Prakash S. Using ant's colony algorithm for improved segmentation for number plate recognition. IEEE/ACIS 14th International Conference on Computer and Information Science (ICIS); 2015 Jun 28–Jul 1. Crossref
17. Gao K, Dong M, Zhu L, Gao M. Image Segmentation method based upon Otsu ACO algorithm. Information and Automation, ISIA 2010, Communications in Computer and Information Science (CCIS), Springer. 2011; 86:574–80. Crossref
18. Tao W, Jin H, Liu L. Object segmentation using ant colony optimization algorithm and fuzzy entropy. Pattern Recognition Letters. 2007; 28:788–96. Crossref
19. Zhao X, Lee ME, Kim SH. Improved image thresholding using ant colony optimization algorithm. International Conference on Advanced Language Processing and Web Information Technology, IEEE; 2008. p. 210–15. Crossref