

# An implementation of novel genetic based clustering algorithm for color image segmentation

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## Abstract

The color image segmentation is one of most crucial application in image processing. It can apply to medical image segmentation for a brain tumor and skin cancer detection or color object detection on CCTV traffic video image segmentation and also for face recognition, fingerprint recognition etc. The color image segmentation has faced the problem of multidimensionality. The color image is considered in five-dimensional problems, three dimensions in color (RGB) and two dimensions in geometry (luminosity layer and chromaticity layer). In this paper the,  $L^*a^*b$  color space conversion has been used to reduce the one dimensional and geometrically it converts in the array hence the further one dimension has been reduced. The  $a^*b$  space is clustered using genetic algorithm process, which minimizes the overall distance of the cluster, which is randomly placed at the start of the segmentation process. The segmentation results of this method give clear segments based on the different color and it can be applied to any application.

**Keywords:** cluster, computer vision, genetic algorithm, image segmentation

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## 1. Introduction

Image segmentation [1] is the technique of dividing a digital image into different sets of pixels. Pixels or spots in a group are similar in according to some properties of a group such as color, texture, and intensity. These pixels or spots have identified the cluster and edges in an image. Clustering or grouping [2] into different parts of an image is known as image segmentation and is applicable in various fields. It needs to segment an image and extract part of the image for image processing purposes. In computer vision, image processing [3] problem requires color image segmentation in order to identify a target and cluster the image into segments according to color, motion, texture etc. Real life application of color image segmentation is medical image processing, like tumor detection from the brain image, surgery by computer system, object detection in a satellite image, fingerprint recognition, face detection, traffic monitoring etc. Choice of image segmentation techniques is based upon type of image, it's their characteristics and the problem to be identified.

Many researchers working on the color image segmentation like Moghaddamzadeh and Bourbakis [4] are proposed the method for the gray image segmentation. They used segmentation in two steps first for fine segmentation for compression and coding. In the second step coarse segmentation for object detection application. Pablo Arbela'ez, Michael Maire, Charless Fowlkes, and Jitendra Malik [5], the authors are proposing contour detection and image segmentation algorithm for the computer vision problems. Their segmentation algorithm using of generic machinery for transforming the output of any contour detector into a hierarchical region tree. The simulation shows the proposed method is giving significant results on the datasets. David R. Martin, Charless C. Fowlkes, and Jitendra Malik [6], proposed a novel algorithm for brightness, color, and texture based boundary image segmentation. They used a supervised learning approach for local boundary detection in RGB color images and for the experiment, the authors used 100 natural images for boundary detection. They concluded treatment of texture is necessary for detecting boundaries in natural images.

The main objective of using a genetic-based clustering algorithm is to cluster pixels into small segments such that the pixel in each segment possesses similar characteristics though

the pixel clusters are distinct from each other. It is an evolutionary technique [7] which finds an optimal solution.

#### Related Work

There are many researchers working on a color image segmentation problem. S.-C. Cheng [8], proposed a region-growing approach to color image segmentation which is based on 3-D clustering and labeling. Hybrid labeling and 3-D clustering method is used to build homogeneous regions. Taking color similarity and spatial proximity as input is the feature of this algorithm. Good results of image segmentation are found by smoothing function and by removing isolated noise.

Researchers G Dong and M Xie [9], proposed a neural network based color image segmentation techniques.  $L^*u^*v$  color space is used to measure the color difference and unsupervised and supervised segmentation used by the algorithm for color image segmentation. An image is divided into small groups of color by self-organizing map (SOM) learning method. Color clustering method, simulated annealing (SA) seeks the best cluster results from SOM prototypes. Supervised color image segmentation is based upon color learning and pixel grouping. The proposed algorithm is efficient for the segmentation of color image in different types of computer vision that shows their results.

Scheunders P [10], proposed the genetic algorithm and classical c-means clustering algorithm (CMA) based color image segmentation. Tzoo-Hseng S. Li, Yin-Hao Wang, Ching-Chang Chen, and Chih-Jui Lin [11], proposed color image segmentation method based on an evolutionary approach to the control system. The HSV color model used for operator grasp and place color objects into the correct location. This method determines the threshold values of HSV range which is hand operated tuning. The disadvantages of being that, it is the time-consuming process of segmenting the boundary of the color images. Feral Souami and Fatima Zohra [12], proposed color image segmentation process by genetic algorithm based upon clustering method. The output of the algorithm is flexible string length and fitness value. The algorithm used a connected component labeling method for 2D-color image segmentation and for simulation Berkeley color images datasets,  $L^*a^*b$  color model.

There are many approaches used for the color image segmentation like Firefly Algorithm (FA) which used for multi-level image segmentation. The Red, green, and blue color luminosity is used for bi-level and multi-level color image segmentation [13] then threshold value is calculated for each color based on Otsu's function and finally for simulation purpose RGB dataset is used. The Firefly Algorithm is the combination of Lévy Flight and the Gaussian distribution and Brownian Distribution. The performance measuring parameter is SSIM, PSNR and CPU time. Alessia Amelio and Clara Pizzuti [14], investigates a graph-based approach to image segmentation. They used the image as a weighted undirected graph, where nodes correspond to pixels and edges connect similar pixels. The results show that the method is applicable to partition natural and human scenes and the results are compared with other approaches. The authors conclude the genetic algorithm can be a very efficient method compare to others.

#### Problem Definition

To optimize the consumption time for image segmentation in color image is a crucial task in related research. The use of evolutionary techniques [7] for identifying the number of cluster Centre has been chosen for fast and accurate image segmentation. Another issue of multidimensional image segmentation is solved using the  $L^*a^*b$  color space [12] which has reduced the effort of segmentation and also provide better results.

#### Proposed Solution

In this section, the proposed method is simulated with the experiment. The aim of this experiment is to improve the value of fitness functions, segment color image [15] and plot the graph between  $a^*b$  color labels. The proposed algorithm work as follows:

Step 1: Read RGB color image

Step 2: For every cluster, calculates the  $L^*a^*b^*$  factor of each color.

Step 3: Cluster every pixel using the Genetic based clustering algorithm and plot the graph between each color cluster and an ' $a^*$ ' and a ' $b^*$ ' value.

Step 4: Show results of color cluster. Use the  $L^*a^*b^*$  factor to group the pixel in the RGB image by color.

Step 5: Plot the graph between 'a\*' and 'b\*' values of the labelled space. The Genetic-based clustering algorithm cluster the different colors from the graph of 'a\*' and 'b\*' values of pixels that were segmented into different colors.

## 2. Research Method

### 2.1. Classification of Image segmentation

Image segmentation [16], is a digital image processing method of partitioning an image into a segment that is similar according to sets of predefined criteria. The evaluation of different segmentation algorithms based on the following techniques [17] as:

1. Point Based Method: In this method outliers embedded in an area of constant intensity in an image is detected.
2. Edge Based Method: Edge detection is an approach to find the boundaries of objects within images. It is the method by which detection is based upon discontinuity in luminosity of light.
3. Region-Based Method: In this method [18, 19], pixels of an image group up in the cluster based upon some properties of the neighboring pixels within one region and then this group of pixel shares their properties.

### 2.2. Genetic Algorithm

The genetic theory [7], is innovated by Darwin based on the theory of evolution. It was introduced in 1975 by Holland and genetic theory gives an optimal solution to the problem statement of multidimensional functions. The genetic algorithm approach [20], is used for the solution of the problems, which are treated very difficult for conventional optimization methods and not suitable for a solution for such type of problems. The genetic theory [21, 22], affects the continuity of the fittest in an individual over succeeding generations all over the solution of a problem. Every generation comprises of a population of character binary strings that are corresponding to the chromosomes. Its x-axis represents search space and the y-axis represents solution candidate. In this process of evolution, the generation is discovered. In the optimization techniques, new generations have better fitness value. The Figure 1 present the flowchart of the conventional Genetic Algorithm.

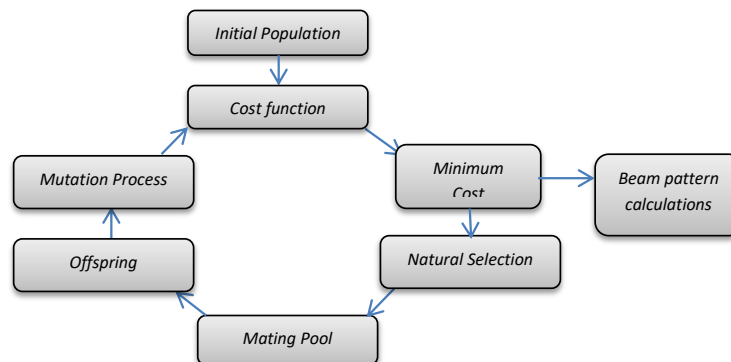


Figure 1. Flowchart of genetic algorithm

The genetic approach [14] is an evolutionary method initiated by random selection. These random selections represented by chromosomes are called population [21]. A group of chromosomes is taken to make new population and expected that the new population will have better results than the old one. The new population is created by choosing offspring, based on their fitness value. The result which is more convenient will be chosen to reproduce. The following process [23] is repeated until the condition is true. Basic genetic algorithm steps are as follows:

Step 1: Initiate with a random population, generated with on a chromosome.

Step 2: In this population, calculates the fitness value for every chromosome.

- Step 3: The new population is created using consecutive steps until the condition is true.  
 Step 4: In each population, select two parent chromosome with their fitness value.  
 Step 5: Using the probability of crossover parent's chromosome crossover to form a new offspring. If no crossover appears, then offspring as it is copied to the parents.  
 Step 6: Mutation probability of each location in an offspring differs from its location.  
 Step 7: Placing newly introduced offspring to the new population.  
 Step 8: Now newly introduced offspring is replaced with existing systems.  
 Step 9: Return the best solution in the population if the condition is satisfied.  
 Step 10: Repeat step 2 until the condition is true.

### 3. Experiment and Results Analysis

The block diagram shown in the Figure 2 is showing the experiment scheme. In the process of the segmentation [18], first the RGB is image converted in the Lab space. This process reduces one of the dimensions, which represents the color information. The  $L^*a^*b$  space is representing the color component of the image. This  $L^*a^*b$  component, then converted in the array, which reduce the two dimensional geometric information in one dimension. This  $a^*b$  space information is then clustered using genetic algorithm [24]. Each cluster [15] is processed to find the color segment of the image.

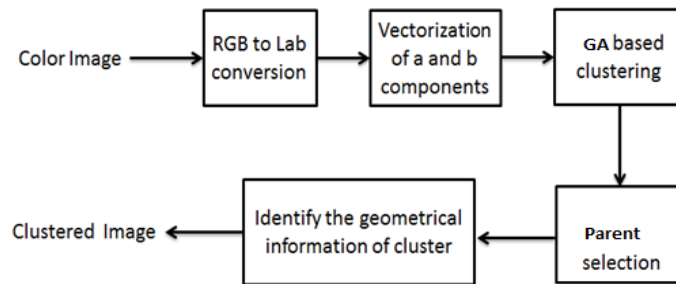


Figure 2. Simulation scheme for image segmentation based on color

#### 3.1 Simulation Parameters

The genetic based [14] clustering algorithm is implemented for color image segmentation. In this experiment, Matlab R2013a on an Intel (R) Core (TM) i5-6500 CPU @3.20 GHz, 4.00 RAM running Windows 10. The proposed method is tested for color RGB test images from <https://homepages.cae.wisc.edu/~ece533/images/> (512\*512 pixels), using MATLAB tools understand the color image segmentation by using genetic-based [25] clustering algorithm. The simulation of a genetic-based clustering algorithm is tested on several images.

The typical results for the different image of the color image are shown in the figures and Table 1 represents a simulation parameter used by the proposed algorithm. It is clear from the graph between no. of clusters in  $a^*b$  space for different Image that the distance between the color of each cluster element is now minimized and also cluster centers are well placed by genetic algorithm in the  $a^*b$  space. The objective function of a genetic algorithm is to minimize the sum of distances between cluster Centre and its members for each cluster. The convergence curve with the iteration for genetic algorithm is shown in segmented results in Figures 3 and 4.

Table 1. Simulation Parameter Table for Different Image

S No.	Parameter	Description
1	Image Size	512*512 Pixel
2	Image type	PNG Image
3	K-Factor	4
4	Maximum no. of Iteration	200
5	Crossover Percentage	0.8
6	Mutation Rate	0.02
7	Mutation Percentage	0.3

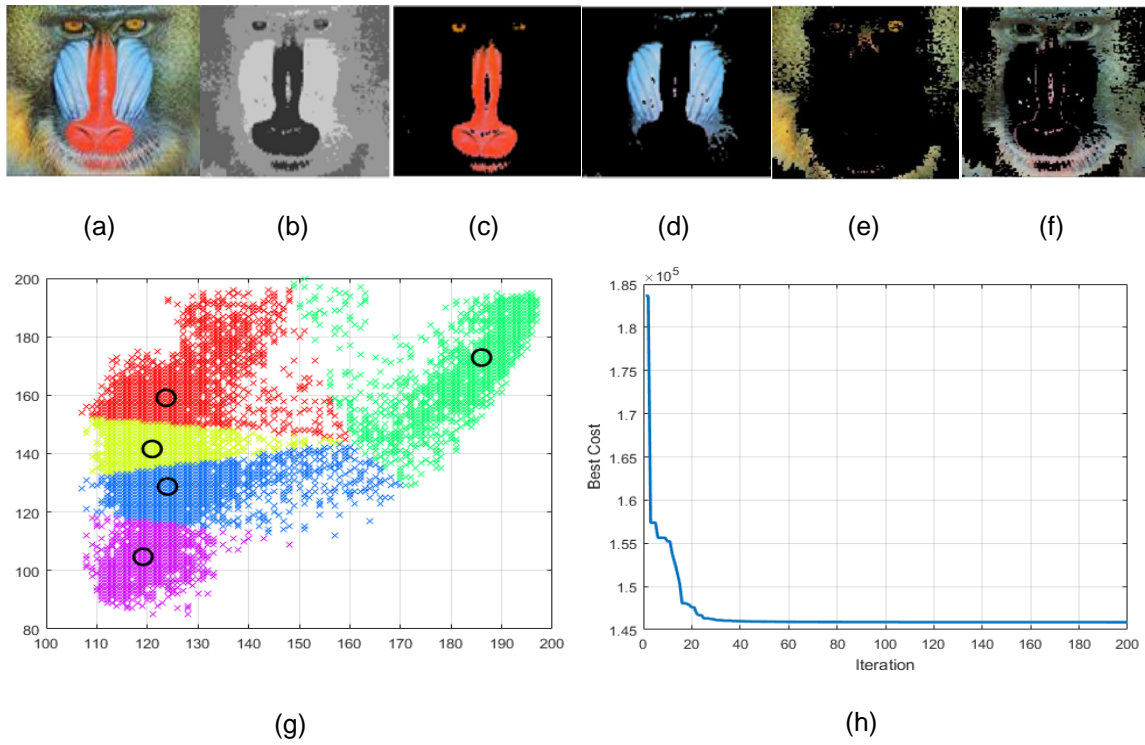


Figure 3. Original image and results of image segmentation for baboon image  
 (a) original image (b) gray image (c) red image (d) blue image (e) green image  
 (f) purple image (g) no. of clusters in a space (h) performance of GA

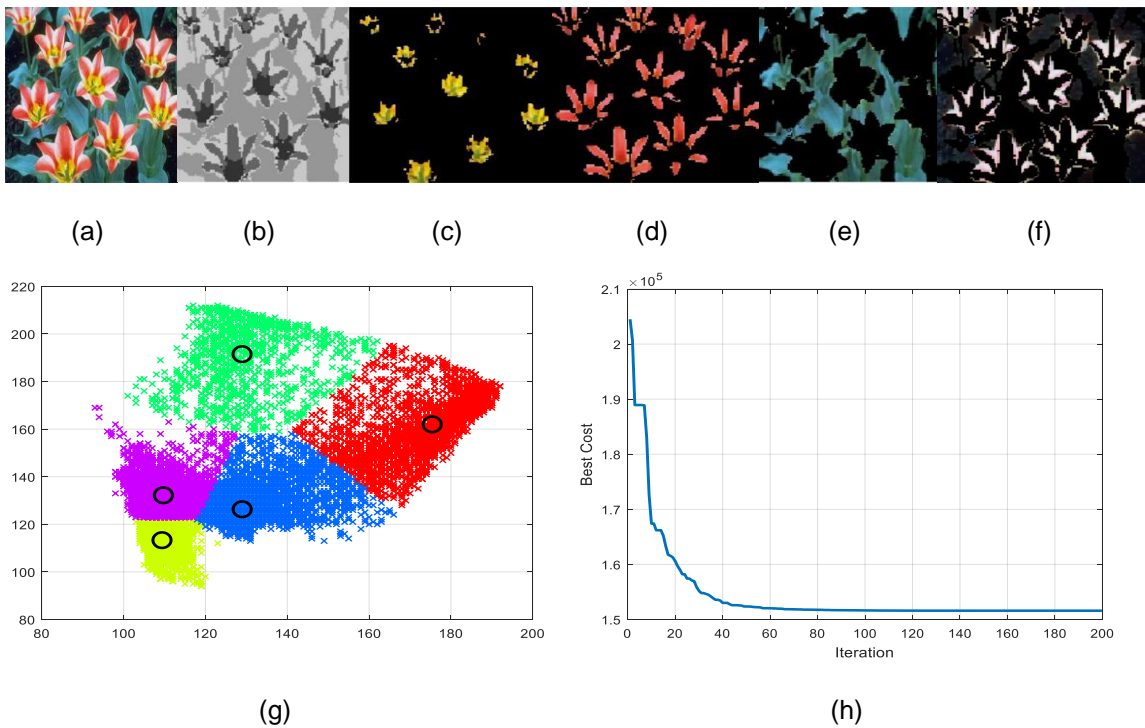


Figure 4. Original image and Results of image segmentation for Tulips image  
 (a) original image (b) gray image (c) red image (d) blue image (e) green image  
 (f) purple image (g) no. of clusters in a space (h) performance of GA

### 3.2. Performance Metrics

The performance of the proposed algorithm is determined by following factor: Cost Value: Cost value is showing the color difference in an image which is based on L\*a\*b\* color luminous. The proposed algorithm uses the concept of Euclidean distance and L\*a\*b\* color luminosity, the color difference between two colors, L1\*, a1\*, b1\* and L2\* a2\* b2\*) are to calculated which is described in section 1. and the performance genetic-based clustering algorithm is tabulated in Table 2 and Table 3 showing computation times for segmentation of each color image.

Table 2. Performance Table for Different Image

Iteration	Baboon	Tulips
	Cost value	Cost value
20	165216.28	175477.01
40	163775.09	174906.54
60	163726.87	174884.46
80	163707.81	174883.55
100	163706.64	174883.47
120	163706.27	174883.46
140	163706.23	174883.24
160	163705.03	174883.24
180	163705.03	174883.16
200	163705.02	174883.16

L\*a\*b\* Factor: The L\*a\*b\* color [12] space is q layered architecture approach, in which red-green axis represented by chromaticity layer 'a\*' and blue-yellow axis is represented by chromaticity layer 'b\*' and luminosity 'L\*' layer. The gene-based clustering approach is used to choose small sample cluster for each color and to calculate cluster average value of color in 'a\*b\*' space. Figure 5 shows the L\*a\*b\* color space generated by the RGB image.

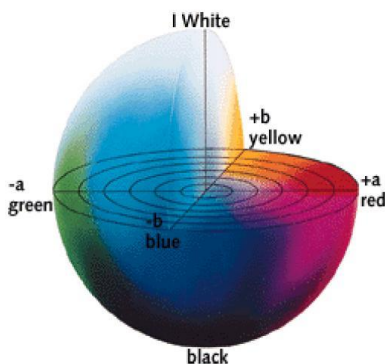


Figure 5. The LAB color space

Table 3. Computation Time for Different Image

S No.	Image	Computation Time
1	Baboon	41.431 s
2	Tulips	29.979 s

### 4. Conclusion

The proposed method works for color image segmentation using genetic-based clustering technique. The simulation results show that the proposed algorithm optimizes computation time for segmentation of a color image. Also, it is a very efficient method for the partitioning of an RGB color image. This method greatly, improves the genetic-based clustering efficiency and computation speed. The algorithm is tested on datasets (<https://homepages.cae.wisc.edu/ece533/images>) and shows their results with computation time, fitness value. The color image segmentation using Genetic-based clustering algorithm can directly be applied to medical image segmentation, machine-learning, content-based image retrieval system, sea object detection, etc.

## References

- [1] Sammouda R, Aboalsamh H, Saeed F. *Comparison between K mean and fuzzy C-mean methods for segmentation of near infrared fluorescent image for diagnosing prostate cancer*. In International Conference on Computer Vision and Image Analysis Applications. IEEE. 2015: 1-6.
- [2] Weinlich A, Amon P, Hutter A, Kaup A. *Edge modeling prediction for computed tomography images*. In 2012 *Visual Communications and Image Processing*. IEEE. 2012: 1-6.
- [3] Puranik P, Bajaj P, Abraham A, Palsodkar P, Deshmukh A. *Human perception-based color image segmentation using comprehensive learning particle swarm optimization*. In Emerging Trends in Engineering and Technology (ICETET), 2<sup>nd</sup> International Conference on IEEE. 2009: 630-635.
- [4] Moghaddamzadeh A, Bourbakis N. *A fuzzy region growing approach for segmentation of color images*. *Pattern recognition*. 1997; 30(6): 867-881.
- [5] Arbelaez P, Maire M, Fowlkes C, Malik J. *Contour detection and hierarchical image segmentation*. *IEEE transactions on pattern analysis and machine intelligence*. 2011; 33(5): 898-916.
- [6] Martin DR, Fowlkes CC, Malik J. *Learning to detect natural image boundaries using local brightness, color, and texture cues*. *IEEE transactions on pattern analysis and machine intelligence*. 2004; 26(5): 530-549.
- [7] Hancer E, Karaboga D. *A comprehensive survey of traditional, merge-split and evolutionary approaches proposed for determination of cluster number*. *Swarm and Evolutionary Computation*. 2017; 32: 49-67.
- [8] Cheng SC. *Region-growing approach to color segmentation using 3-D clustering and relaxation labelling*. *IEE Proceedings-Vision, Image and Signal Processing*. 2003;150(4): 270-276.
- [9] Dong G, Xie M. *Color clustering and learning for image segmentation based on neural networks*. *IEEE transactions on neural networks*. 2005;16(4): 925-936.
- [10] Scheunders P. *A genetic c-means clustering algorithm applied to color image quantization*. *Pattern recognition*. 1997; 30(6): 859-866.
- [11] Li TH, Wang YH, Chen CC, Lin CJ. *A fast color information setup using EP-like PSO for manipulator grasping color objects*. *IEEE Transactions on Industrial Informatics*. 2014; 10(1): 645-654.
- [12] Belahbib FZ, Souami F. *Color image segmentation by a genetic algorithm based clustering and Connected Component Labeling*. In Microelectronics (ICM), 24th International Conference on IEEE. 2012: 1-4.
- [13] Rajinikanth V, Couceiro MS. *RGB histogram based color image segmentation using firefly algorithm*. *Procedia Computer Science*. 2015; 46: 1449-1457.
- [14] Amelio A, Pizzuti C. *A genetic algorithm for color image segmentation*. In European Conference on the Applications of Evolutionary Computation. Springer, Berlin, Heidelberg. 2013: 314-323.
- [15] Neelambike S, Parashuram Baraki. *Color Image Segmentation By Clustering*. International Journal of Advanced Research in Computer Science & Technology. 2014; 2(1): 95-97.
- [16] Huang DC, Hung KD. *Leukocyte nucleus segmentation and recognition in color blood-smear images*. In 2012 IEEE International Instrumentation and Measurement Technology Conference Proceedings 2012 May 13. IEEE. 2012: 171-176.
- [17] Zhang YJ. *Evaluation and comparison of different segmentation algorithms*. *Pattern recognition letters*. 1997; 18(10): 963-974.
- [18] Dougherty AW, You J. *A kernel-based adaptive fuzzy c-means algorithm for M-FISH image segmentation*. In 2017 International Joint Conference on Neural Networks (IJCNN). IEEE. 2017: 198-205.
- [19] Baboo SS, Thirunavukkarasu S. *Image segmentation using high resolution multispectral satellite imagery implemented by fcm clustering techniques*. *International Journal of Computer Science Issues (IJCSI)*. 2014; 11(3): 154.
- [20] Kaur A, Singh MD. *An overview of pso-based approaches in image segmentation*. *International Journal of Engineering and Technology*. 2012; 2(8):1349-57.
- [21] Dhanachandra N, Manglem K, Chanu YJ. *Image segmentation using K-means clustering algorithm and subtractive clustering algorithm*. *Procedia Computer Science*. 2015; 54: 764-771.
- [22] Song DL, Ge LH, Qi WW, Chen M. *Illumination invariant color model selection based on genetic algorithm in robot soccer*. In The 2nd International Conference on Information Science and Engineering. 2010: 1245-1248.
- [23] Tang J. *A color image segmentation algorithm based on region growing*. In Computer engineering and technology (ICCET), 2nd international conference on IEEE. 2010; 6: V6-634..
- [24] Khatami A, Mirghasemi S, Khosravi A, Nahavandi S. *A new color space based on k-medoids clustering for fire detection*. In 2015 IEEE International Conference on Systems, Man, and Cybernetics. 2015: 2755-2760.
- [25] Gabbouj M. *Multidimensional particle swarm optimization and applications in data clustering and image retrieval*. In 2010 2<sup>nd</sup> International Conference on Image Processing Theory, Tools and Applications. IEEE. 2010: 5-5.